THE

COST-EFFECTIVENESS AND EFFICIENCY OF INTRAPARTUM MATERNITY CARE IN ENGLAND

LIZ SCHROEDER

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National Perinatal Epidemiology Unit

Department of Public Health

University of Oxford

Abstract

Background

High quality evidence on the cost-effectiveness of planned birth in alternative settings (at home, in a midwifery unit or an obstetric unit) has been lacking, and is a priority area for maternity policy.

Aim

To provide evidence about the efficiency of the configuration of maternity care in England and to estimate the cost-effectiveness of alternative settings for intrapartum care for ‘low risk’ women, thereby providing guidance for commissioners, clinicians and for pregnant women and their families.

Methods

A literature review of existing evidence was followed by four stand-alone empirical studies using different methods to determine the efficiency and cost-effectiveness of alternative settings for intrapartum care. Data from the Birthplace in England Programme of Research were analysed to explore whether there are differences in the efficiency of maternity units when they are stratified according to the type and scale of unit. Incremental cost-effectiveness ratios were used to estimate the short-term cost-effectiveness of different planned settings for birth for ‘low risk’ women and to develop a template for the design of decision-analytic models to estimate life-long cost-effectiveness for the mother and baby dyad.

Findings

The larger obstetric units (OUs) tended to be more efficient than the smaller OUs. Less than half of free-standing midwifery units (FMUs) were operating at full efficiency.

The cost of intrapartum and after birth care, and associated related complications, was less for births planned at home, in a free standing midwifery unit (FMU), or in an alongside midwifery unit (AMU) compared with planned births in an obstetric unit (OU).

Planned birth in a FMU or in an AMU compared with an OU will generate incremental cost savings but with uncertainty surrounding the outcomes for the baby. Planned birth in all non-OU settings generated incremental cost savings and improved outcomes for mothers. For ‘low risk’ women having a second or subsequent birth, planned birth at home was found to be the most cost-effective option.

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Glossary of terms/abbreviations

AMU	Alongside midwifery unit
BMI	Body mass index
CEA	Cost effectiveness analysis
CEMACE	Centre for maternal and child enquiries
CPAP	Continuous positive airway pressure
CS	Caesarean section
DAM	Decision analytic modelling
FMU	Freestanding midwifery unit
HB	Homebirth
HDU	High dependency unit
ICER	Incremental cost effectiveness ratio
ICU	Intensive care unit
MOB	Mode of birth
NB	Net benefit
NHS	National Health Service
NICE	National Institute for Health and Clinical Excellence
NPEU	National Perinatal Epidemiology Unit
OPCS	Office of Population, Censuses and Surveys
OU	Obstetric unit
PSSRU	Personal Social Services Research Unit
QALY	Quality adjusted life year
RLM	Regional Lead Midwife (Birthplace)
SCBU	Special Care Baby Unit
SVB	Spontaneous vertex birth
TC	Total cost
UC	Unit cost

Chapter 1

> "Of all areas of healthcare, the maternity services [in England] have one of the longest histories of striving to improve safety standards and reduce loss and suffering, having carried out formal reviews of care for almost 100 years" (King's Fund, 2008).

1.1 Background

There are approximately seven billion people in the world. The diversity of the human population can be described in terms of race, religion, demography, culture and gender, but all humans start life in the same way; as a new born following a birth from their mother's womb. It is a watershed moment for both and possibly not without some risk to the mother or her baby. This process of 'labour and childbirth' is described as the 'intrapartum' event. It is a unique occurrence within the broader maternity context because although it is a natural physiological process, it involves the care of two lives simultaneously, with possibly conflicting needs. The duration of labour is variable, and sudden and unexpected emergencies for the mother or baby can require immediate support and the skills of different professionals, with potentially life long consequences. In England, the changing demographics and needs of the childbearing population have had implications for the provision of intrapartum services. Birth rates have been rising over the past ten years and are projected to continue rising (King's Fund, 2008). Care for older mothers, obese mothers and women with multiple births, including those who have had fertility treatment leading to multiples, are associated with higher rates of complications and interventions. Women who have chronic diseases or who have survived illness in childhood also require extra care in labour. This kind of diverse childbearing population is a function of past and more recent patterns of migration and for some groups has led to cultural and communication difficulties between

staff and mothers during labour (King's Fund, 2008). These more recent challenges occur within a maternity service framework that has changed dramatically over the past one hundred years, both in terms of where intrapartum care is planned and who provides it.

1.2 A brief history of 'place of birth'

Historically, labour and childbirth took place at home. Childbirth was studied in ancient Greece and Rome and some ideas about practices were established that have endured in Western medicine for centuries, and case histories from as early as the Hippocratic texts document information about childbirth that is referenced now (Magner, 1992). Care during labour was entrusted to an informal network of female family members, neighbours and others who had given birth themselves. Women skilled in labour care came to be known informally as 'maia' or 'midwives' before the fifth century BC (Magner, 1992, University of Virginia Health System, 2012).

Home continued to be the primary place for labour and birth well into the early twentieth century. Historically, hospitals were not the health care institutions with specialized staff and equipment as we currently understand them, but rather places of care for the sick, dying and poor (Magner, 1992). Examples of such 'institutions for healing' have been recorded throughout history; as temples dedicated to the healer-god Asclepius in ancient Greece, as *'houses for dispensing charity and medicine'* in India in 400 CE and as *'valetudinari'* for the care of sick gladiators and soldiers in ancient Rome around 100 B.C. During the middle ages hospitals were charitable institutions functioning as 'almshouses' for

the poor and sick, etymologically similar to the French word '*hospitale',* meaning guest house or hostel (Risse, 1990, Wujastyk, 2009, Magner, 1992).

The building of hospitals expanded across Western Europe during the eighteenth century. An early example of this philanthropy was the establishment of the hospital 'Charité', founded in Berlin in 1710 and Guy's Hospital founded in London in 1721 with a legacy from a wealthy merchant. Women continued to give birth at home but hospitals offered 'lying-in' maternity wards for parturient women, who were most often poor. They would be attended by both doctors and midwives. The Vienna General Hospital, which opened in 1784, was the largest in the world and also functioned as a place of training and as a research center, enabling doctors from around the world to study medicine including practical experience in obstetrics. Unfortunately, with the establishment of institutions for birth and the inclusion of routine postpartum autopsy into medical practice, puerperal sepsis spread epidemically across Europe. The first epidemic occurred at the *Hôtel-Dieu de Paris,* and hospitals across Europe consistently reported death rates of between one fifth and one quarter of all childbearing women. At times epidemics resulted in one hundred percent maternal mortality (Magner, 1992).

Puerperal fever continued to cause high mortality rates, especially in larger hospital maternity wards between the 1600s and the late 1800s. By the mid-nineteenth century smaller free-standing units run by midwives for women without obstetric complications were favoured in England to reduce the risk of spread of puerperal fever (Local Government Board, 1918). After the First World War, provision for birth in these settings was incorporated into official Ministry of Health policy, and was expanded as part of planning for increasing facilities for intrapartum care (Ministry of Health, 1920). At the time they were called 'maternity

homes'. They were run by midwives and had an average capacity of approximately 20 beds. Over the next two decades there was a substantial expansion of 'maternity homes', with approximately 4000 beds available for labour and birth in free-standing midwife-led settings by the start of the Second World War (Campbell and Macfarlane, 1994, Macfarlane, 2008).

Irrespective of these developments, birth at home was still the favoured setting for birth in the first half of the twentieth century. It was still considered the safest setting but the choice of carer was changing. In 1869 the London Obstetrical Society claimed that the majority of poorer women were delivered by midwives, however it had become increasingly fashionable for wealthy women to receive their care from a doctor (McIntosh, 2012). Aveling noted in 1872 that less than two percent of these women living in London were attended by midwives (Aveling, 1872, reprinted 1967).

As the opening quote at the beginning of this chapter indicates, by the 1900's maternity care had become an important topic in public health with many scoping documents and reports written including: 'Maternity and Child Welfare', 1915; 'Child Welfare' published by the Ministry of Reconstruction, 1919; 'The Protection of Motherhood', published by the Ministry of Health, 1927; and 'Protect the Nations Mothers' 1936 (National Archives, 2012). These reports and policy changes built on the many public health developments from the nineteenth century (McIntosh, 2012). Amidst this interest from a plethora of health care planners, statisticians, clinicians and policymakers were underlying improvements in public health due to a multiplicity of factors, including improved public sanitation, family nutrition, and working conditions. Rates of child-birth related mortality began to fall from the turn

of the century although they still reached 150 babies per 1000 in some places (McIntosh, 2012, King's Fund, 2008).

The development of medicine from 1700 to 1900 and the expansion of hospitals across Europe during the period of Enlightenment had enabled clinicians' to gain clinical knowledge which they applied specifically to obstetrics in the twentieth century (Magner, 1992). Obstetric anaesthesia and analgesia, instruments for obstetric intervention and diagnostic technology contributed to the availability of pain relief and a shift in women's perception of comfort with an ever increasing expectation that birth in hospital might be safer. Coupled with socio-demographic shifts after the Second World War including reductions in fertility rates, changes in the status of women and medical advances (such as the introduction of antibiotics and blood transfusions) the demographic trend towards birth planned in hospital grew (McIntosh, 2012). The National Health Service was established in 1948 and commenced a hospital building programme, which provided for obstetric-led maternity care. At the same time, general practitioners (GPs) were paid for their involvement in maternity care situated in the 'maternity home' settings, which became known as 'GP units' (Campbell and Macfarlane, 1994, Macfarlane, 2008).

The setting for where intrapartum care was planned and provided thus changed dramatically in England during the first quarter of the twentieth century and the period that followed and was the most significant shift in the history of maternity care. Before the First World War, just over one percent of women gave birth in 'institutionalised settings (either in a hospital or in a free-standing midwife-led birth facility), increasing to fifteen percent in 1927, thirty five percent in 1937, fifty four percent in 1946, sixty-four percent in 1960 and reaching eighty-six per cent by 1970 (Macfarlane and Mugford, 2000, Macfarlane, 2008).

In 1970, the 'Peel Committee' (called the 'Standing Midwifery and Maternity Advisory Committee') recommended that all babies should be born in hospital. (Department of Health and Social Security Welsh Office, 1970). Two years later, they were criticised for this recommendation by Archie Cochrane, a pioneer of 'evidence based medicine'. In a report titled 'Effectiveness and efficiency' he challenged the lack of consistency in the tables and statistical trends that the committee had produced, requesting more rigorous data analysis (Cochrane, 1972). Irrespective of the evidence base for decision-making, subsequent policy promoted hospital birth and the phasing out of midwife-led and homebirths, to the extent that in the decade following, between 1980 and 1990, the number of 'GP units' fell by fifty percent (Macfarlane, 2008).

1.3 Recent policy changes in maternity care in the UK

The relative benefits and risks of birth in different settings have been vigorously debated over the last twenty years (de Jonge et al., 2009, Janssen et al., 2009, Lindgren et al., 2008, Mori et al., 2008, Wax et al., 2010, Hodnett et al., 2010, Gyte et al., 2009). In the early 1990's it was concluded that encouraging women to give birth in hospital on the grounds of safety could not be justified, and in the two decades that followed, the Department of Health published key reports that offered women increasing choice in their planned settings for birth (Campbell and Macfarlane, 1994, Department of Health, 2004a, Macfarlane, 2008). A report entitled 'Changing Childbirth' was published and was followed by the 'National Service Framework For Children, Young People and Maternity' which stated that women should be able to choose the most appropriate place and professionals to attend their childbirth, and required that trusts providing maternity services should ensure that midwife-led care options were available to women (Department of

Health, 1993, Department of Health, 2004b). A structured review of outcomes for women and babies following a birth in a birth centre found that there was no reliable evidence about clear benefit or harm associated with care in birth centres compared with intrapartum care offered in other settings (Stewart et al., 2005). 'Maternity matters' was published in April 2007 and referred to a 'national choice based guarantee' for planned birth. An implementation document 'Safer Childbirth' was published in October 2007 focussing on the objective of offering women and their partners 'informed choice about their place of birth': namely at home, in a midwife-led unit or in an obstetric-led hospital setting (Department of Health/Partnerships for Children Families and Maternity., 2007, Royal College of Obstetricians and Gynaecologists et al., 2007). However in the same year, the National Institute for Health and Clinical Excellence's (NICE) Intrapartum Care Guidelines Committee published a guideline on intrapartum care which described a paucity of evidence for ascertaining the safety or cost-effectiveness of birth in different settings (and implicitly, by different carers) (National Collaborating Centre for Women's and Children's Health, 2007). In the following year, a report by the King's Fund into the safety of maternity care stated that 'it is not possible to say how safe it is to give birth in England, or to compare this with the safety of maternity services elsewhere (King's Fund, 2008). Three factors were identified as causes for this paucity of evidence; namely that routine data collection did not include adverse outcomes other than death, data collected in different trusts were not comparable, and identified outcome measures were too broad to be informative.

1.4 The Birthplace Programme of Research

In view of this paucity of evidence, the Birthplace in England Programme of Research was commissioned and took place from 2006 to 2011, to account for and to quantify the configuration, safety, cost-effectiveness and quality of care supporting childbirth in England. It was a multi-disciplinary research programme, comprising six stand-alone projects, each designed to fill a knowledge gap in the evidence available for national policy making. Birthplace comprised two research programmes; planned first as an 'Evaluation of Maternity Units in England Research Programme' (EMU), and then in 2007 the Department of Health funded a 'Birth at Home' study to build on EMU and to include an evaluation of planned birth at home.

Birthplace was challenging to undertake. As stated previously, the maternity service is complex and caters for the diverse needs of a childbearing population ranging from healthy women with straightforward pregnancies and labour, to the care of women and babies who are unwell and require intensive support and care. Birthplace was designed to inform the 'choice agenda' and national maternity policies and took place in parallel with the implementation of them, including the 'Agenda for Change' which affected salary scales for maternity staff. The programme took place over a number of years in a changing international and national context that impacted on the NHS and its maternity services. For example, the implementation of the 'European Working Time Directive' and 'Modernising Medical Careers' led to changes in workforce configuration and medical training, new maternity service standards were brought in and the reconfigurations of neonatal and perinatal networks altered trust boundaries and staff skill-mix. Birthplace was designed within an evidence framework where the

availability of the different maternity services were ad hoc, and without uniformly agreed benchmarks and quality standards (Rowe, 2007).

Consequently, the first Birthplace component was a consensus study, so that the terminology associated with settings for birth could be clarified and agreed between key stakeholders. These terms and definitions were then consistently used in Birthplace. The other component studies which included 'mapping' the configuration of the service and a prospective cohort study of adverse outcomes will be discussed in the next chapter which describes the data that were collected overall, and the data that were specifically used to inform the health economic analyses for this thesis.

1.5 The economics of childbirth; why study the efficiency and cost-effectiveness of intrapartum care?

In 1945 the Labour Party won the general election, and commenced a programme of establishing a welfare state, including the founding of the National Health Service (Rivett, 2012). This resulted in a widening of the state's responsibility to provide health care to its citizens, prior to which, families were required to engage in 'out-of-pocket' payments for maternity services from doctors, nurses or midwives , and maternity care fitted within the 'market-driven economy' of the forces of demand and supply regulated by price as a transaction mechanism. The 'purchase' of intrapartum care depended on the affordability of the respective health professionals, and in 1915 a midwife would charge about four shillings compared to a doctor whose fee was one to two pounds, whilst options for destitute women included birth in a 'workhouse' or in a hospital if they could pay monthly subscriptions (McIntosh, 2012). After 1948, families ceased to

pay for maternity care because it was collectively paid from taxation for the National Health service (NHS) as a ‘guarantee of universal health coverage’ (Rivett, 2012). Consequently, maternity care became a ‘quasi-public good’, with the consumption of it being ‘non-excludable’ and quasi ‘non-rival’, meaning that the benefits of the service were available to all recipients irrespective of the cost and their ability to pay, and inexhaustible because the consumption by some members of society did not decrease the supply of the service for others (though this is not wholly true for health care). The basic economic problem arising in this type of welfare economy is *scarcity,* because society tends to have unlimited health care needs but limited resources to supply them. Health economics, the primary methodology of discourse for this thesis, is the study of how scarce resources are allocated among alternative uses for health care and the promotion and improvement of health. Because of scarcity, decisions should be made to allocate resources efficiently among competing alternative uses. Health economic evaluation techniques are appropriate for identifying alternative courses of action in terms of both their costs and consequences (Drummond et al., 1997).

1.6 Context of this thesis and related literature reviews

In 2007, the NICE Intrapartum Care Guidelines Committee reviewed the available economic evidence for aspects of intrapartum care and attempted to populate a decision-analytic model for place of birth.

The committee concluded that:

> ‘the poor quality of the UK data … makes it extremely difficult to make meaningful comparisons across different birth settings at the current time. These limitations … mean that good evidence-based conclusions about the relative cost-effectiveness of different birth settings in the UK cannot be made…The main conclusion to be drawn is that there is a need for better data’ (National Collaborating Centre for Women's and Children's Health, 2007).

NICE, having conducted a detailed literature review specified that evidence for the cost-effectiveness of birth in alternative settings was a priority for research in broader maternity care framework. At the same time as NICE’s guideline development, another review of the available evidence for cost-effectiveness for birth at home and in midwife-led units was undertaken by the National Perinatal Epidemiology Group and arrived at the same conclusion. The paper, by Henderson and Petrou (2008) was submitted for publication around the time that this doctorate commenced. It was a structured review of all the available literature on the economic aspects of place of birth. They used bibliographic databases including MEDLINE (from 1950), CINAHL (from 1982), EMBASE (from 1980) and an ‘in-house database’ to search for English language publications using MeSH and free text terms. Two hundred and one abstracts were reviewed, eighteen relevant papers retrieved and eleven studies included from the United Kingdom, United States, Australia and Canada. The review confirmed a ‘paucity of evidence’, noting that ‘the quality of the literature was poor and that selection bias was likely to be a problem’ (Henderson and Petrou, 2008). The authors reported on a few key papers and summarised their main findings in a table. Because the review was comprehensive and captured all the relevant papers published on the topic, and because it had been completed when this doctorate commenced, their findings are shown in the following table (table 1). The findings are presented

alphabetically by study author and the studies are numbered from 1 to 11, referenced by number in the text.

Table 1. Summary table of literature relating to economic implications of home births and birth centres (Henderson and Petrou, 2008)

Author, year, and country	Study type and Number	Comparison and Geographical coverage	Inclusion criteria	Clinical results (if included)	Cost and cost-effectiveness results	What was included in the costs?	Comment
(Anderson and Anderson, 1999), USA 1	Costs associated with 11,718 home births and 11,592 hospital births	Intended home births 1987-91 vs hospital births. Across USA	Low risk (undefined) mothers with uncomplicated births	No clinical comparisons made.	Average charge in 1991: Home $1,711 Hospital $5,382	Charges by CNMs for home births from survey and by obstetricians for hospital births from literature. Included cost for transfer.	Survey of CNMs for information on charges for home births 71% response rate. Likely to be selection bias.
(Byrne et al., 2000), Australia 2	Cost study integrated into RCT. 200 women randomized, 100 in each arm	BC consisting of 2 rooms close to conventional delivery suite vs. conventional care. Adelaide, Australia	Normal, uncomplicated pregnancies presenting to AN clinic before 31 wk	67% transferred from BC to conventional care, no differences in clinical outcomes.	'Cost-modeling approach'. Actual costs unspecified but no differences were found.	Resource use from case notes, midwives estimated time necessary for procedures. Excluded infrastructure costs.	Only 23% of eligible women agreed to be randomised, study underpowered.
(Henderson and Mugford 1997 in (Chamberlain et al., 1999), UK 3	Cohort study 1994 National Birthday Trust Fund 4,191 planned home births, 3,470 planned hospital births, 806 booked for home but delivered in hospital	Women booked for a home birth at 37 weeks compared to matched control group of women booked for hospital birth Across UK	None	Equivalent clinical outcomes, higher satisfaction in the home birth group, 15% transferred to hospital	Costs to NHS per delivery: Home £205 Hospital £332 Home booked-Hospital delivered £405 (1994 prices)	Unit costs from literature applied to AN, intrapartum and PN resource use	Overall response rate 61% so possibility of response bias as well as selection bias. Unplanned home birth estimated £100 per delivery but increased stillbirth and neonatal death rate.
Hundley et al 1995, UK 4	Cost analysis based on findings of RCT RCT 2,844 women	5 rooms in separate unit adjacent to labor ward run by MWs vs consultant led care. Aberdeen, Scotland	Low obstetric risk, i.e., excluding existing maternal disease, infertility, complicated obstetric history, height <150 cm or age >35 yr	No significant differences in fetal outcome or mode of delivery, but less epidural analgesia and CTG monitoring in MW unit.	Extra cost of MW unit £41 per woman, ranging from -£10 to +£44 (1992/93 prices)	Staff, consumables, capital, conversion and overheads.	MW unit only cost saving in scenarios that excluded cost of extra staff and building conversion costs.

Lubic 1983 , USA 5	Examination of accounts of Maternity Center Association	Freestanding childbearing center vs hospital care. Geographical coverage of childbearing center not stated	Births in New York hospitals vs child-bearing center	No clinical comparisons made.	Obstetric fees in New York ranged from $2,250-$5,000 (from New York Times 1980) vs $1,275 for child-bearing center in 1982.	Hospital costs not clear; childbearing center costs included salaries, supplies, contracted services and overheads.	Not a valid comparison – hospital costs include more complicated cases. Different price years. Not clear what is included in hospital costs.
Ratcliffe 2003 , UK 6	Bottom-up costing study. N = BC 35, home 26, hospitals 68	Freestanding BC vs home births vs 2 hospitals NW Thames Regional Health Authority (as was)	All women fitted (unspecif-ied) criteria for BC	Hospital births had higher rates of induction, epidurals, assisted delivery and suturing. 3/26 women booked to deliver at home transferred for complications. None of the BC women required transfer.	*Inpatient costs*: BC £297 Home £194 Hospital 1: £424 Hospital 2: £428 *Postnatal costs*: BC £392 Home £217 Hospital 1: £609 Hospital 2: £636 (1999-2000 prices)	Unit costs from finance departments 1999-2000; included type and duration of delivery, staffing, consumables, equipment, investigations, interventions, drugs, transfers, PN admissions and length of stay. Excluded capital costs in baseline analysis.	When capital costs were included in the analysis BC costs increased by 59%, hospital costs increased by 53%. Induction and assisted delivery available in BC. Likely to be selection bias.
Reinharz et al 2000, Canada 7	Costing done alongside observational study 1,000 women who delivered in BC's 1995-96 matched with 1,000 women giving birth in hospital	Care by MW in local community services center vs physician care in hospital 7 pilot projects in Quebec	Low risk women; 134 specific exclusion criteria	BC care was associated with increased satisfaction, less intervention and a reduction in caesarean section and severe perineal injury, fewer preterm and low-birthweight babies, but a trend toward a higher stillbirth ratio and more frequent neonatal resuscitation.	Total direct costs in the midwifery group Can$2,294 (range $2,062-2,930), in hospital group Can$3,020 (range $3,016-3,027). (Price year not stated)	Resource use from hospital files, costs from physician billing data, average salaries for staff, fees for other services, minimum wage for women and family.	The intervention was not standardised and evolved over time. Data collected in 7 centers; costs close and overlapping in 4 of them.Problems of access to physician clients. Likely to be selection bias.
Stone and Walker 1995, USA; Walker and Stone 1996, USA 8	Decision analytic model	Free standing BC vs. hospital care Across USA	Low risk women (variously defined)	Data from literature review, principally National Birth Center Study. Complications categorized as 'major' or 'minor'. Crude utilities derived using 'delphi technique'.	Mean cost per delivery: BC $3,385 Hospital $4,673 (Price year not stated)	Patient charges, finance managers. Provider fees, hotel and ambulance charges, building lease and equipment.	Used patient DRG-based charges. Method for deriving utilities not stated. Sensitivity analysis suggests that BC dominant for transfer rates up to 62%. Likely to be selection bias.

Stone et al 2000, USA 9	Quasi-experimental. 69 BC 77 hospital New York	Free standing BC, care provided by CNMs vs. Hospital care provided by physicians.	Eligibility assessed using 65 item instrument at 34-36 wk, English literate	Increased rates of intact perinea, breastfeeding at 6 weeks and satisfaction in BC group.	Mean cost of maternity care: BC $6,087 Hospital $6,803 (not sign. different). Mean IP costs: BC $4,257 Hospital $5,729 ($p<0.01$) (1996 prices)	Fixed and variable costs from BC, hospital and physician practices.	Some costs based on billing reports. Sensitivity analysis suggests that higher throughput in the BC would decrease costs significantly. Likely to be selection bias.
Walker and Stone 1996, USA 10	Quasi-experimental. 75 women purposefully selected to obtain representat-ative sample of outcomes	Freestanding BC, care provided by CNMs vs women's clinic, care by various staff vs traditional obstetric practice. New York	BC eligibility as defined in Stone et al 1998 applied through-out	Women in the BC had significantly less uterine monitoring, IV fluids and episiotomies and shorter lengths of stay.	Professional fees for prenatal care and delivery were: BC $1,076 Clinic $1,658 Hospital $2,228 (Price year not stated)	Fixed and variable costs from BC, hospital and physician practices.	Not clear how many women in each group. Costing based on DRG based charges. Likely to be selection bias.
Young et al 1997, UK 11	Costing study based on RCT. N=648 in midwifery care, 651 in traditional care	Midwife managed care in designated homely birth rooms in hospital vs traditional hospital care, 1993-94. Glasgow, Scotland	Women experi-encing normal, healthy preg-nancy	Midwifery care associated with fewer AN visits and admissions, fewer inductions and PN checks and increased satisfaction.	Assuming a caseload of 29 women per midwife, there were no significant differences in costs AN or intrapartum but mean PN care costs were £497 in midwifery group vs. £397 in traditional group. (Price year not stated)	Resource use data collected included AN visits, daycare attendances, AN admissions, tests and drugs, mode of delivery, PN stay and PN checks. Costs of capital assets not included except for equipment for fetal monitoring.	Costing based on incomplete samples ranging from 59-100%. Only 34% of midwifery group stayed in this group, others transferred temporarily or permanently (analysis by intention to treat). If caseload increased to 39 women per midwife PN care costs still significantly greater in midwifery group.

AN = antenatal; BC = birth center; CNM = certified nurse-midwife; CTG = cardiotocograph; DRG = diagnosis-related group; IP = intrapartum; IV = intravenous; MW = midwife; PN = postnatal; RCT = randomized controlled trial; UK = United Kingdom; USA = United States of America.

Birth at home was compared with other forms and locations of care. Women choosing a homebirth tended to be at low risk of complications and were not representative of the general population (Henderson and Petrou, 2008). It seemed probable that the accommodation ('hotel' costs), catering and overheads were less for births at home than for births in hospital (1,3). Previously, Henderson and Mugford (1997) had noted that the perspective of the study might be important, as women having a home birth tended to buy a birth pool or pay for an independent midwife whilst their partners took longer absence from work. This results in a cost shifting of the intrapartum resources used and the care for the mother and baby from hospital to home (3).

The literature produced conflicting results when birth in birth centres was compared to birth in hospitals, possibly due to difficulties in categorising and comparing the evidence. Some of the studies showed that birth centres produced similar results but with higher costs (4, 11), and others that birth centres were associated with lower costs and better outcomes (8,9). The literature reported differences in study perspectives and the resource use components included within them, also differences in study design and the outcomes analysed, and the probability of selection bias in the results. Some birth centres were situated in a hospital setting but were allocated to midwifery care (11), whilst other birth centres were free-standing and transfers to hospital weren't always reported (2, 8, 9). Some studies showed that women in birth centres tended to report less monitoring and medical interventions (4), higher maternal satisfaction (4), a shorter duration of postnatal stay (4) and it was suggested that birth centres could be cost-effective were they to have a higher throughput of women (Henderson and Petrou, 2008). Other studies reflected higher costs by including building costs and even building

conversion costs (4, 5). Some studies did not include capital costs and used diagnosis related reimbursement rates instead, thus the methods of costing resource use differed between the studies reviewed (1, 5, 8, 9).

Overall, the literature review recommended that 'further economic research be undertaken to include detailed bottom up costing of alternative options for place of birth and to measure multiple outcomes' (Henderson and Petrou, 2008).

In view of the comprehensive reviews undertaken by NICE and within the NPEU immediately prior to this doctorate, a more limited search was undertaken for this research during early 2008; to update the previous review, to identify any new publications in the subject area and to define the methodology of the planned Birthplace cost-effectiveness analyses and the planned empirical chapters for the thesis. The search strategy was expanded to include a broader number of bibliographic databases including Medline, EMBASE, the Cochrane Library, OVID: Maternity and Infant Care, the Health Economic Evaluations Database (HEED), Biomed Central, the British Nursing Index (BNI), the RCN Journals Database, the Health Management Information Consortium (HMIC) and the Cumulative Index to Nursing and Allied Health Literature (CINAHL). The electronic databases were searched from 1980 until June 2008 or from the start of the database if after 1980. The search terms included all minor and major topics covered by the review by Henderson and Petrou (2008) and also included any of the following "maternity," "cost$ maternity," "cost-effectiveness maternity," "efficiency maternity," "preferences maternity," "models of care (citation + abstract)" "care pathways maternity" "data envelopment analysis maternity" "service configuration maternity" (see Appendix 1). Exclusion criteria included papers from developing countries and non-English language papers. No new studies were identified over

and above those cited by Henderson and Petrou (2008), reflecting again the paucity of health economic evidence highlighted above. All NICE publications and the sources they cite for intrapartum and postpartum care were reviewed for the thesis. Relevant papers cited in NICE were included in the thesis, including in the structured review.

Ovid alert systems were then created with monthly emailed alerts to update the literature search for the duration of the thesis (2008 to 2012). The OVID monthly alerts were set up for the term “maternity” from Medline and EMBASE. A second review of the literature was undertaken during 2012 for the decision-analytic modelling component, and is described fully in chapter 6 and in appendix 18 of the thesis.

1.7 Research aim and objectives

Sections 1.3 to 1.6 explain that previous research by NICE and others identified that was not possible to quantify how efficient or cost-effective it was to give birth in alternative settings in England and the structured review published at the same time as the start of the doctorate recommended further economic research be undertaken to include detailed bottom up costing of alternative options for place of birth and to measure multiple (particularly rare but serious) outcomes.

This doctorate was designed to address these questions using data captured for Birthplace which had been commissioned prior to the commencement of the doctorate. Through Birthplace, cross-sectional activity-based ‘top-down’ data were available for comparative research, hence the research objectives were developed to ‘determine the relative efficiency of alternative settings for intrapartum care’ by

exploring differences in efficiency when units are stratified according to the type and scale of unit, and the consequent possible improvements in efficiency that could be recommended .

The Birthplace prospective cohort study provided individual level data for planned birth; hence it became possible to develop an estimate of the cost-effectiveness of birth in alternative planned settings. Furthermore, Birthplace provided a vehicle for the measurement and valuation of the resource use identified for intrapartum care. Together these objectives could be used in the design of a template for the modelling of the longer-term outcomes of planned birth, once this evidence becomes available. Overall, they provide evidence that could contribute to planning efficient and cost-effective maternity services.

1.7.1 Aim

The overarching aim of this research was to provide evidence about the efficiency and cost-effectiveness of intrapartum care in England, to contribute to planning the appropriate configurations of maternity services; to provide guidance for clinical practice and for informed decision-making about planned place of birth for pregnant women and their families.

1.7.2 Objectives

The thesis comprises four stand-alone empirical studies using different methodologies to determine the efficiency and cost-effectiveness of alternative settings for intrapartum care. As such the specific objectives of the thesis are to:

- determine the relative efficiency of alternative settings for intrapartum care

- to explore whether there are differences in the efficiency of maternity units when they are stratified according to the type and scale of unit;
- to explore whether improvements in productive efficiency can be recommended
- to apply detailed ‘bottom up’ and ‘top down’ unit cost measurement and valuation to resources use identified for intrapartum care at an individual level of analysis
- to estimate the cost-effectiveness of different planned settings for birth in terms of incremental cost *per adverse perinatal outcome avoided* for babies of women judged to be at ‘low risk’ of complications prior to the onset of labour
- estimate the cost-effectiveness of different planned settings for birth in terms of incremental cost *per maternal morbidity avoided* for women judged to be at ‘low risk’ of complications prior to the onset of labour.
- to develop a template for the design of future decision-analytic models about planned place of birth that could estimate life-long cost-effectiveness for the mother and baby dyad

The aim and objectives of the research are limited to a health system perspective and only direct costs to the NHS were included. However key costs in maternity care for the intrapartum period will be captured in a health system perspective, though some cost shifting to home may occur for home births – but these have been documented and costed in previous research.

Birthplace was commissioned by the Department of Health to identify cost-effectiveness only in maternity care settings available to women during 2006 to 2011, using their planned birth location and so does not reflect a service that

ensures choice is delivered. This thesis was also limited to anonymised Birthplace data so capturing women's perspectives on their choice of setting was not possible. At present, womens' preferences and the complex factors that encourage or discourage women to opt for births in alternative settings are not fully understood. These issues are discussed at length in the final chapter of the thesis.

1.8 Thesis organisation

To address the research aims and objectives this thesis is organised as follows: Chapter 2 gives an overview of Birthplace in England Programme of Research which acted as the primary source of empirical data. It includes consensus work carried out on terms and definitions and the mapping study which documented the organisation of intrapartum care, including service configuration, unit capacity and staffing. The primary and secondary objectives of the Birthplace national prospective cohort study and the methods used are outlined. The cohort study provided individual level data for the cost-effectiveness analysis reported in Chapter 5.

Chapter 3, an 'exploratory' chapter, introduces data envelopment analysis for comparative efficiency measurement. It is a superficial technique for exploring the relationships between the multiple inputs and outputs in a sector (the maternity sector in this instance). Potential gains in efficiency that could be achieved from service reconfiguration are described using the broad themes and patterns of efficiency that emerge. Improvements in productive efficiency that could be recommended for units that are underperforming, relative to other units are discussed.

Chapter 4 describes a theoretical framework of performing costing for health economic evaluation. The general principles of health economic evaluation are outlined. It also includes an exploratory cost minimisation analysis that was performed for a study adjunct to Birthplace and which acted as the vehicle for the resource use and unit cost measurement for the Birthplace individual level cost-effectiveness analysis described in Chapter 5.

Chapter 5 presents the full ‘short-term’ cost-effectiveness analysis of four possible settings for birth: home, FMU, AMU and OU, separately for women and babies at ‘low risk’ of complications prior to the onset of labour using individual level data for women included in the Birthplace national prospective cohort study and during the period from the start of care in labour, until discharge from postnatal or higher level care.

As the study described in chapter 5 was limited by the analytical strategy which was not designed to link the effectiveness outcomes for the baby and mother together, a decision analytic model was designed to synthesise the data collected from Birthplace to estimate combined cost-effectiveness outcomes (and related uncertainty) for both the mother and baby in a single analysis and is presented in chapter 6.

Finally, chapter 7 discusses the main findings of the research and the contribution of this thesis to the broader field of health economics and perinatal research. The chapter explores the policy implications as well as the potential limitations of this work and related methodologies, and concludes with recommendations for future research.

Chapter 2

The Birthplace in England Research Programme (hereafter Birthplace for brevity) addressed the following questions:

- Where is intrapartum care provided? How do we define the different settings for birth? Can these terms be standardised?
- How is maternity care organised in England? Did this change over the three years of Birthplace data collection?
- Are outcomes different for mothers and babies with straightforward pregnancies, but who start their labour care in different birth settings?
- Do costs and cost-effectiveness differ between the birth settings?
- How does the quality and safety of care differ between settings? Which organisational, capacity and logistical aspects of the maternity care system affect the safety and quality of intrapartum care?

Each question was addressed by a stand-alone component study, which made up the broader Birthplace research programme as explained below.

2.1 Terms and definitions

The first of the component studies was a consensus process aimed at developing standard definitions for place of birth which could be applied to all Birthplace research (Rowe, 2007). Previous terms have been historic and 'ad hoc' such as 'birth centre', 'maternity care home' and 'GP unit', which although similar, prevented precise comparisons of birth setting, care providers and outcomes. The consensus process occurred in two phases; with the development of draft terms

and definitions and then a broader consultation with research advisors, co-investigators and a sample of twelve senior midwives who agreed the final terms.

Four distinct settings were ultimately defined for birth.

Obstetric unit (OU): an NHS clinical location in which care is provided by a team, with obstetricians taking primary professional responsibility for women at high risk of complications during labour and birth. Midwives offer care to all women in an OU, whether or not they are considered at high or low risk, and take primary responsibility for women with straightforward pregnancies during labour and birth. Diagnostic and treatment medical services including obstetric, neonatal and anaesthetic care are available on site, 24 hours a day.

Alongside midwifery unit (AMU): an NHS clinical location offering care to women with straightforward pregnancies during labour and birth in which midwives take primary professional responsibility for care. During labour and birth diagnostic and treatment medical services, including obstetric, neonatal and anaesthetic care are available, should they be needed, in the same building, or in a separate building on the same site. Transfer will normally be by trolley, bed or wheelchair.

Freestanding midwifery unit (FMU): an NHS clinical location offering care to women with straightforward pregnancies during labour and birth in which midwives take primary professional responsibility for care. General Practitioners may also be involved in care. During labour and birth diagnostic and treatment medical services including obstetric, neonatal and anaesthetic care, are not immediately available but are located on a separate site should they be needed. Transfer will normally involve car or ambulance.

Home: Midwives take primary professional responsibility for care for the woman in established labour, and a midwife will stay at home with her. Often a second midwife will arrive shortly before the birth. During labour and birth diagnostic and treatment medical services including obstetric, neonatal and anaesthetic care, are not immediately available. Transfer will normally involve car or ambulance. The term 'home' relates to women who receive care from a NHS midwife during established labour at home, regardless of where the woman actually gives birth.

The above abbreviations; OU, AMU, FMU and home will be used throughout the remainder of the thesis.

The term 'low risk' was adopted to define women with 'straightforward' or 'normal' pregnancies (Rowe, 2007).

2.2 Mapping maternity care in the current NHS context

At the start of Birthplace, reliable evidence was not available for the geographic location of alternative settings for intrapartum care, including the distribution of maternity units and their relationship to obstetric and home birth services, and unit-level staffing and capacity. Two 'mapping studies' collected maternity service data from trusts in 2007 and again in 2010 to describe the organisation of maternity care in England, and to document configuration changes that had taken place in the interim. Birthplace focused on maternity care provided in the NHS and recent statistics show that more than 99.5 percent of births took place within it (Office for National Statistics, 2009). Participation in the first survey was mandatory for trusts providing maternity services because it was collected as part of the Care Quality Commission's (formerly Healthcare Commission) Maternity

Service Review. The data for the first survey were returned in October 2007. A follow-up survey (not mandatory) was carried out in 2010. Sixty-three percent of trusts responded to the follow-up questionnaire (Redshaw et al., 2011).

2.2.1 OUs

Birth in an OU setting was the most common. OUs provided intrapartum care for more than ninety five percent of women in the year ending 31 March 2007. In comparison, one percent of births occurred in FMUs and 3% in AMUs. On the average, OUs provided a birth capacity of between nine hundred and seven thousand per annum, with a median of 3200 births. About a third delivered less than 2500 women, and another third more than 4000 women per annum. The geographical distribution of OUs, numbers of women delivered and delivery beds tended to reflect the centres of population. There were 177 OUs in 2010, and almost all NHS trusts providing maternity care had at least one OU (98%).

2.2.2 AMUs

The number of AMUs in England doubled between 2007 and 2010, to fifty-three units across 51 trusts (35% of all trusts). AMUs tended to be smaller than OUs and bigger than FMUs with a median of approximately 600 births per annum (range 93-2380 births). In 2007 there were differences in the numbers of midwife-led units in the different geographic areas of England: AMUs were more common in London and in the South and FMUs were most common in the South West.

2.2.3 FMUs

Historically FMUs have opened and closed across England, though more recently the number has been fairly consistent at around fifty to sixty units. In 2007, 18% of trusts contained an FMU and by 2010 this had increased to 24%.There were fifty-nine FMUs across England in 2010. FMUs were the smallest providers of intrapartum care in size and capacity, providing for a median of two hundred births per year (ranging from 8-548) and a median of two delivery beds (ranging from one to seven).

In addition to providing information about maternity care configuration, the mapping study provided comprehensive unit level data about intrapartum care. This included aggregate midwifery and medical staffing data in whole time equivalents (WTEs), numbers of women delivered, numbers of births, rooms, delivery beds, and transfers between units (Redshaw et al., 2011). Analyses of the mapping data using data envelopment methods are presented in chapter 3.

2.3 Qualitative organisational case studies

The aim of this Birthplace component, the case studies, was to explore features of trust based maternity care systems that could affect the provision of safe and high quality care in the different birth settings. In addition, to describe and explore womens' and staff perceptions of their access to a choice of place of birth, and their experiences when care escalated because complications arose. The author was not involved in this component study and it is not discussed further in the thesis.

2.4 The Birthplace National Prospective Cohort Study

2.4.1 Context

As stated previously, reports circulating at the time Birthplace was commissioned highlighted a paucity of evidence for the safety or cost-effectiveness for birth in different settings. The King's Fund stated that 'it was not possible to say how safe it is to give birth in England, or to compare this with the safety of maternity services elsewhere' (King's Fund, 2008). Similarly NICE emphasised the need for good quality evidence, in particular for rare but serious outcomes for the baby (National Collaborating Centre for Women's and Children's Health, 2007).

The Birthplace National Prospective Cohort Study was designed to address questions about the benefits and risks associated with labour and childbirth in different settings, for women who would expect to be at 'low risk' of complications at the time they commence labour, i.e. at the start of intrapartum care (Hollowell et al., 2010). Throughout her pregnancy, a mother and her baby's health status can change from low to high risk, or vice versa and so women need to have a broad knowledge of the options available for their birth setting. The start of labour marks the final opportunity that women have to decide where they give birth without knowing how the labour and birth will progress. The timing; 'start of care in labour' is the critical moment by when health professionals and pregnant women need information about the benefits and risks associated with birth in alternative settings, so that informed decision-making can occur. They will need to integrate a multiplicity of factors that should be known at that point, such as; the woman's clinical risk status, her likelihood of a transfer to an OU based on the transfer rates of women with similar characteristics, or perhaps the likelihood of a 'normal birth' without medical intervention in a particular setting.

Furthermore the cohort study aimed 'to compare aspects of safety by *planned place of birth'* and planned place of birth is important, because previous studies have made inferences about birth settings inappropriately using outcomes data from the actual (final) place of birth (Mori et al., 2008). These could be different and so important information about the labour care pathway and related events occurring at the planned (initial) birth setting (for example, data about transfers) were missed.

2.4.2 Methods

2.4.2.1 The study design

The study was a prospective cohort study, collecting data on women during intrapartum care. ‘Planned place of birth at the start of care in labour’ was the exposure, and women were included in the group where labour care commenced regardless of whether they subsequently transferred. The primary outcome was ‘adverse perinatal morbidity’; a composite measure of ‘ intrapartum and early neonatal mortality and specific neonatal morbidities’. This measure included stillbirth during labour, the death of the baby in the first week after birth, neonatal encephalopathy (disordered brain function caused by oxygen deprivation before or during birth), meconium aspiration syndrome (compromised breathing and lung capacity after the baby breathes meconium into their lungs), or physical birth injuries such as spinal cord injury, and bone fractures. The composite outcomes were specifically chosen because they may reflect differences in the *quality of intrapartum care*. They are not equally severe but they are all ‘rare but serious’ events that can occur directly after a labour and birth, and being rare events, individual numbers would have been too small for the differences in outcomes between the settings to be identified (Hollowell et al., 2010).

2.4.2.2 Risk status and inclusion criteria

Women were considered to be at ‘low risk’ of complications and eligible for inclusion in the study if their pregnancy had been straightforward. Medical conditions listed in the NICE Intrapartum Care Guidelines defined the clinical classification of ‘high risk’, and these were listed in the cohort study’s data collection forms. Common reasons for being classified at a higher risk include

medical conditions such as diabetes, epilepsy, high blood pressure or infections that can potentially harm the baby and maternal obesity (body mass index >35kg/m^2). Where women had one or more risk factors, they would have been advised to give birth in an OU and were not eligible for the study. In addition, women who were not eligible for birth in all of the alternative settings (or where the risk status might be unknown) were excluded; including those who presented in labour before 36 completed weeks' gestation, or who had a breech baby, a multiple pregnancy, received no antenatal care or had undergone a caesarean section before labour started (Hollowell et al., 2010).

2.4.2.3 Planned place of birth

Data were collected from the four settings defined as part of the consensus process, namely birth planned in an OU, AMU, FMU and at home. The 'planned place' was defined as where the woman chose to give birth at the start of care in labour, and where she received some care from a health professional when labour care commenced.

2.4.2.4 Ethics approval

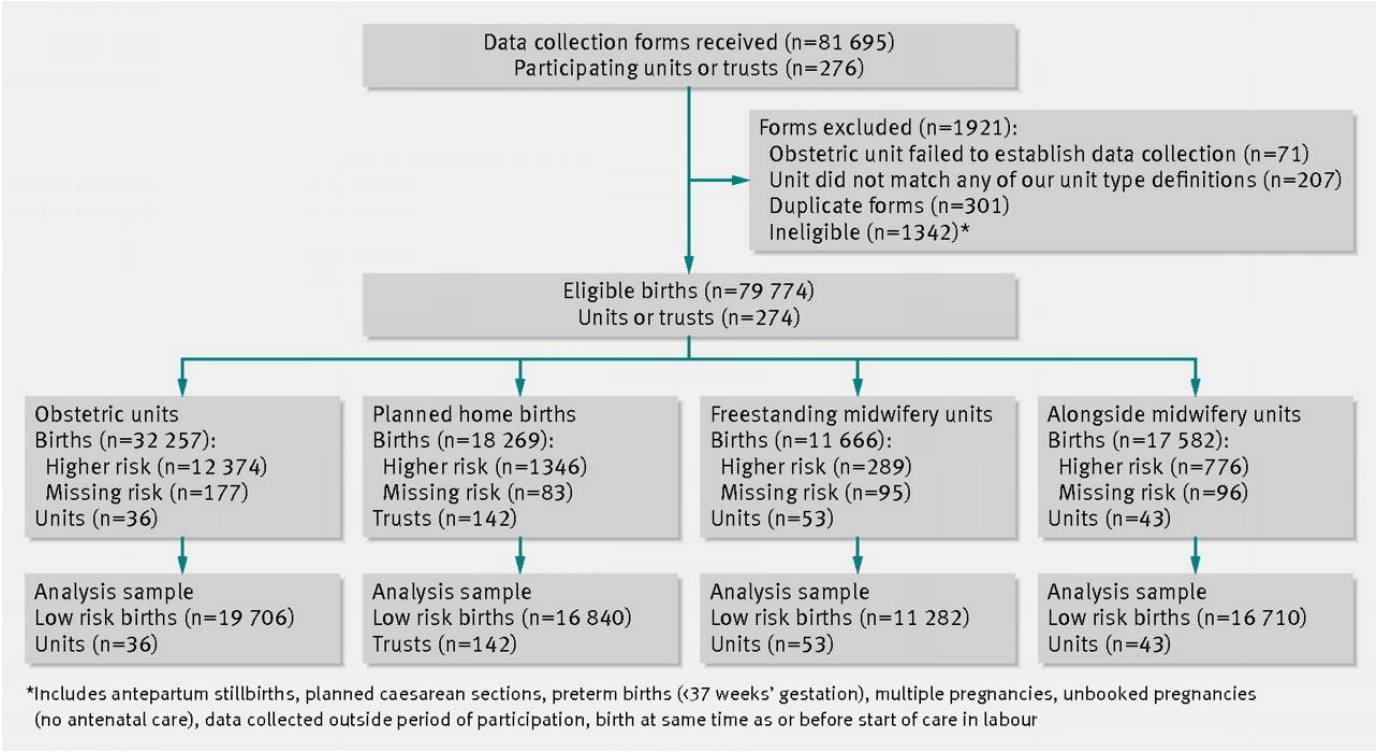
Ethics approval was granted by the Berkshire Research Ethics Committee in October 2007 (ref: 07/H0505/151) and an amendment was approved in April 2008. No personally identifiable data was collected so women's consent was not required (Hollowell et al., 2010).

2.4.2.5 Setting and participants

The study planned to collect data from every NHS trust providing intrapartum care at home in FMUs and in AMUs in England, and from a stratified sample of thirty seven OUs between 1st April 2008 and 30th April 2010.

Over ninety-seven percent of NHS trusts providing home birth services and almost ninety percent of all midwifery units in England ultimately participated. Data were collected from a representative random sample of 36 OUs. Overall, detailed information was obtained for care in labour, delivery and birth outcomes for over 64538 'low risk' births in England including nearly 16840 planned 'low risk' home births, 11282 planned 'low risk' births in FMUs and 16710 in AMUs and 19706 planned 'low risk' obstetric unit births. The completeness and quality of the data were high because most units and trusts were able to provide data on over 85% of their eligible births. Important information about the mother or baby was missing for less than 4% of the records (Hollowell et al., 2010). Figure 1 (overleaf) shows a flowchart of participants in the cohort study. Further details about the original target numbers for trusts, units, the participating centres and the study sample can be viewed in the cohort study report (Hollowell et al., 2010).

Figure 1. Flowchart of participants in the cohort study (Hollowell et al., 2010).



2.4.2.6 Data collection and management

Data collection was co-ordinated *regionally* across England [North (Liverpool), Midlands (Oxford), South (Somerset and Taunton) and London] by four senior midwives employed by the cohort study for one day per week. It was co-ordinated in each *site* by local co-ordinating midwives who supplied data collection forms to midwives, kept denominator records of eligible women, managed the collection of missing data and removed any personally identifying information. Midwives providing labour care to women used a study specific data collection form tailored to each setting, and completed the form during labour care using information routinely recorded in the women's notes (see appendix 3). If the woman transferred, then her data collection forms transferred as part of her notes and

were completed in the new setting. The forms were completed retrospectively if they had not been started for an eligible woman. Although data collection officially ceased in April 2010, retrospective data collection continued until October 2010 and the dataset then closed in December 2010.

The study was co-ordinated by a team at the National Perinatal Epidemiology Unit (NPEU). A private company was employed to double enter all data and all queries were sent to the local co-ordinating midwives for consistency checks. Data cleaning was carried out by the team of Birthplace researchers at the NPEU between December 2010 and June 2011 (Hollowell et al., 2010).

2.4.2.7 Initial data analysis and adjustment

The duration of each unit's participation in the cohort study varied, depending on commencement of recruitment, unit capacity, numbers of babies delivered and the speed of attaining the sample target. This meant that women receiving care in different units did not have the same probability of recruitment into the study. To adjust for this, the Birthplace statisticians derived probability weights applied to each observation (women and babies in the same unit were given the same weight), which was inversely proportional to the duration of data collection in that unit (Hollowell et al., 2010).

It was also likely that the characteristics of women and the care they received in one unit would be more similar to each other than to women in other units, and so they were 'clustered' by unit. Not accounting for the presence of clustering can lead to inappropriately small standard errors, p-values and wide confidence

intervals. Robust variance estimation was used for the calculation of standard errors (Hollowell et al., 2010).

Clinical and socio-demographic characteristics were summarised for all eligible women by planned place of birth in the following categories:

- Ethnicity: White (referent); Indian; Pakistani; Bangladeshi; Black Caribbean; Black African; Mixed; Other
- Maternal age: <20; 20-24; 25-29 (referent); 30-35; 35-40; ≥ 40
- Pre-existing risk status: numbers of risk factors 0;1;≥2 Type of pre-existing risk: low risk; medical condition; obstetric history; both medical and obstetric history
- Risk factors identified at the start of care in labour: 0; 1; ≥2
- Body mass Index (BMI) in pregnancy: not recorded; < 18.5; 18.5-24.9 (referent); 25.0-29.9; 30.0-35.0; 35.1-70
- Parity: Number of previous pregnancies ≥ 24 weeks gestation: 0 (referent);1;2;≥3
- Gestation at birth in completed weeks: 37; 38; 39; 40 (referent); 41; 42-44
- Birthweight (grams): 1000-2499; 2500-2999; 3000-3499; 3500-3999; 4000-4499; 4500-7500
- Index of multiple deprivation score (grouped as quintiles, noted by the local coordinating midwife (LCM) and derived from the women's postcode): 1 least deprived (referent); 5 most deprived
- Marital or partner status: Married/Living with partner (referent); Single / unsupported
- Understanding of English: Fluent (referent); Some Understanding; No Understanding

Numerous sensitivity analyses were performed to test the plausibility of the sample characteristics, including the examination of data distributions and outliers. Further details of analyses undertaken to establish internal consistency can be viewed in the cohort study report (Hollowell et al., 2010). All analyses were conducted using Stata SE version 11.1 (StataCorp, 2009).

2.4.3 Results

2.4.3.1 Characteristics of the sample

There were differences in the characteristics of women by planned place of birth. The characteristics of women planning a birth in a FMU or AMU tended to lie between those of the OU and home birth groups, with the characteristics of women in the AMU group generally more similar to those of the OU group, and the characteristics of women planning a birth in a FMU more similar to those planning a birth at home.

In comparison to women planning to give birth in an obstetric unit, women planning a birth at home tended to be older (28% aged 35 or over at home, compared with 16% aged 35 or over in OUs), more likely to be white and have a fluent understanding of English, be married or living with a partner, or be living in a socioeconomically advantaged area. Most importantly, they were markedly more likely to have had one or more previous pregnancies. Relative to women planning a birth in an OU or AMU, women planning a birth in an FMU were more likely to be white, have a fluent understanding of English and to live in a socioeconomically advantaged area.

Overall the most striking difference between the groups was for parity. Mothers having a second or subsequent pregnancy accounted for forty-six percent of births in OUs, fifty percent in AMUs, fifty-four percent in FMUs and seventy two percent at home (Hollowell et al., 2010).

2.4.3.2 Complicating conditions at the start of care in labour

There were unexpected differences between planned place of birth in the proportion of women with complicating conditions identified by the attending midwife at the start of care in labour and these were associated with adverse outcomes. The most common complicating conditions were prolonged rupture of membranes and meconium stained liquor, and both could potentially cause harm to the baby. Almost 20% of women whose birth was planned at an OU had at least one complicating condition noted, compared with fewer than seven percent planned in non-OU settings The unexpected finding suggests that that there were differences in the risk profile of the groups of women planning birth in the OU compared with the non-OU settings. They could possibly be explained by the maternity system of ‘triage’, where women are advised by their midwife (possibly by phone) to go directly to the OU. This would result in an OU becoming the planned place of birth ‘at the start of care in labour’. Additional analyses restricted to women without complicating conditions were undertaken throughout the study, to enable outcomes to be compared across groups that were homogeneous with regard to risk (i.e. ‘like-with-like’) (Hollowell et al., 2010).

2.4.3.3 Outcomes for babies

There were 250 primary outcome events (adverse perinatal outcomes using the 'composite' outcome measure). The primary outcome was 'adverse perinatal morbidity'; a composite measure of ' intrapartum and early neonatal mortality and specific neonatal morbidities'. This measure included stillbirth during labour, the death of the baby in the first week after birth, neonatal encephalopathy (disordered brain function caused by oxygen deprivation before or during birth), meconium aspiration syndrome (compromised breathing and lung capacity after the baby breathes meconium into their lungs), or physical birth injuries such as spinal cord injury, and bone fractures. This translates into an overall incidence of 4.3 adverse perinatal events per 1000 births for women considered to be 'low risk' prior to labour onset. Overall, there were no significant differences in the odds of the primary outcome between the planned birth settings.

When parity was accounted for in a pre-specified sub-group analysis, then the odds of the primary outcome for mothers was higher for planned home births than for planned births in OUs (adjusted odds ratio 1.75, 1.07 to 2.86), and even higher for first time mothers (adjusted odds ratio 2.80, 1.59 to 4.92). There were 9.3 adverse perinatal events per 1000 births for first time mothers having a planned home birth compared with 5.3 per 1000 births for first time mothers having planned birth in OUs. There were no significant differences in the odds of the primary outcome between midwifery units and OUs, or for mothers having a second or subsequent pregnancy planned in any alternative birth settings. The following table shows the primary outcome for babies of healthy women with low risk pregnancies by their planned place of birth at start of care in labour. It is also categorised by parity for all women and then restricted to those without complicating conditions at start of care in labour (Hollowell et al., 2010).

Table 2. Primary outcome for babies of healthy women with low risk pregnancies (Hollowell et al., 2010)

Planned place of birth	No of events/births	Incidence of events/1000 (95% CI)†	Odds ratio (95% CI)† Unadjusted	Adjusted‡
All women				
	250/63 827	4.3 (3.3 to 5.5)	(n=62 036)§	
Total:				
Obstetric unit	81/19 551	4.4 (3.2 to 5.9)	1.00	1.00
Home	70/16 553	4.2 (3.2 to 5.4)	0.96 (0.65 to 1.42)	1.16 (0.76 to 1.77)
Freestanding midwifery unit	41/11 199	3.5 (2.5 to 4.9)	0.82 (0.52 to 1.28)	0.92 (0.58 to 1.46)
Alongside midwifery unit	58/16 524	3.6 (2.6 to 4.9)	0.84 (0.54 to 1.30)	0.92 (0.60 to 1.39)
	153/28 443	5.3 (4.0 to 7.0)	(n=27 669)§	
Nulliparous women¶:				
Obstetric unit	52/10 541	5.3 (3.9 to 7.3)	1.00	1.00
Home	39/4488	9.3 (6.5 to 13.1)	1.76 (1.10 to 2.82)	1.75 (1.07 to 2.86)
Freestanding midwifery unit	24/5158	4.5 (2.8 to 7.1)	0.85 (0.49 to 1.48)	0.91 (0.52 to 1.60)
Alongside midwifery unit	38/8256	4.7 (3.1 to 7.2)	0.90 (0.53 to 1.54)	0.96 (0.58 to 1.61)
	97/35 289	3.1 (2.2 to 4.5)	(n=34 367)§	
Multiparous women¶:				
Obstetric unit	29/8980	3.3 (2.2 to 5.0)	1.00	1.00
Home	31/12 050	2.3 (1.6 to 3.2)	0.70 (0.40 to 1.21)	0.72 (0.41 to 1.27)
Freestanding midwifery unit	17/6025	2.7 (1.6 to 4.6)	0.86 (0.44 to 1.69)	0.91 (0.46 to 1.80)
Alongside midwifery unit	20/8234	2.4 (1.4 to 4.3)	0.77 (0.38 to 1.57)	0.81 (0.40 to 1.62)
Women without complicating conditions at start of care in labour				
Total:	199/57 127	3.1 (2.4 to 4.0)	(n=55 572)§	
	48/15 676	3.1 (2.2 to 4.2)	1.00	1.00
Obstetric unit				
Home	62/15 538	4.0 (3.0 to 5.3)	1.34 (0.88 to 2.05)	1.59 (1.01 to 2.52)
Freestanding midwifery unit	35/10 571	3.2 (2.3 to 4.6)	1.11 (0.69 to 1.77)	1.22 (0.76 to 1.96)
Alongside midwifery unit	54/15 342	3.4 (2.4 to 4.9)	1.19 (0.74 to 1.91)	1.26 (0.80 to 1.99)
	121/24 384	3.8 (2.8 to 5.1)	(n=23 742)§	
Nulliparous women**:				
Obstetric unit	28/8018	3.5 (2.4 to 5.1)	1.00	1.00
Home	36/4063	9.5 (6.6 to 13.7)	2.81 (1.66 to 4.76)	2.80 (1.59 to 4.92)
Freestanding midwifery unit	22/4785	4.5 (2.8 to 7.4)	1.33 (0.72 to 2.46)	1.40 (0.74 to 2.65)
Alongside midwifery unit	35/7518	4.4 (2.7 to 7.0)	1.31 (0.71 to 2.39)	1.38 (0.75 to 2.52)
	78/32 662	2.5 (1.6 to 3.9)	(n=31 830)§	
Multiparous women**:				
Obstetric unit	20/7637	2.6 (1.5 to 4.4)	1.00	1.00
Home	26/11 461	2.0 (1.4 to 2.9)	0.80 (0.41 to 1.54)	0.83 (0.44 to 1.58)
Freestanding midwifery unit	13/5772	2.2 (1.3 to 3.8)	0.90 (0.42 to 1.94)	0.97 (0.46 to 2.04)
Alongside midwifery unit	19/7792	2.5 (1.4 to 4.5)	1.04 (0.47 to 2.30)	1.09 (0.50 to 2.39)

*Primary outcome was perinatal mortality and intrapartum related neonatal morbidities (stillbirth after start of care in labour, early neonatal death, neonatal encephalopathy, meconium aspiration syndrome, brachial plexus injury, fractured humerus or clavicle).
†Weighted to reflect each unit's duration of participation and probability of being sampled; confidence intervals take account of the clustered nature of the data.
‡Adjusted for maternal age, ethnic group, understanding of English, marital or partner status, body mass index, deprivation score quintile, previous pregnancies, and weeks of gestation.
§Restricted to women who were not missing any potential confounder data.
¶Test for statistical interaction between planned place of birth and parity. P values for parity adjusted regression tests of heterogeneity: overall 0.06; pairwise (v obstetric unit) for home 0.01, freestanding midwifery unit 0.99, and alongside midwifery unit 0.69.
**Test for statistical interaction between planned place of birth and parity. P values for parity adjusted regression tests of heterogeneity: overall 0.03; pairwise (v obstetric unit) for home 0.006, freestanding midwifery unit 0.47, and alongside midwifery unit 0.66.

Individual adverse perinatal outcomes were rare, and the numbers too small for the estimation of adjusted odds ratios. For individual components of the composite adverse measure (250 events), neonatal encephalopathy contributed the most (46%), and then meconium aspiration syndrome (30%). Stillbirths and early neonatal death together accounted for thirteen percent (Hollowell et al., 2010).

2.4.3.4 Outcomes for mothers

The majority of 'low risk' women in all settings had a spontaneous vertex birth. The proportion varied from 74% for planned OU births, 86% for planned AMU births, 90% for planned FMU births, and 93% for planned home births. A more restricted term 'normal birth', is defined as a birth with none of the following interventions; induction of labour, epidural or spinal analgesia, general anaesthetic, forceps or ventouse, caesarean section, episiotomy was also higher in non-OU setting. 'Normal birth' is considered a positive measure because the mother does not receive any medical interventions that could have long term adverse consequences. It occurred in 58% of planned OU births, 77% of planned AMU births, 83% of planned FMU births and 88% of planned home births.

Instrumental and operative births were lower in all planned non-OU settings (averaging between 5-8%) compared with 10-12% of births planned in OUs, for women without complicating conditions at labour onset. There was no consistent relationship with planned place of birth for serious adverse maternal outcomes, (a measure of 'safety' for the mother was defined as no third or fourth degree perineal trauma, maternal blood transfusion, and maternal admission to higher level care) although these adverse maternal outcomes were generally lowest in FMUs (Hollowell et al., 2010).

2.4.3.5 Transfer

Women having a first baby had a high probability of transfer from their planned setting to an OU. The transfer rate for first time mothers was forty percent for planned AMU births, thirty-six percent for planned FMU births and forty-five percent for planned home births. The transfer rate decreased for mothers having a second or subsequent baby to between nine and thirteen percent. The duration and timing of transfer, (either during labour or after birth), varied by parity and by setting (Hollowell et al., 2010).

2.4.3.6 Sensitivity analyses

Additional analyses were carried out, restricted to women without complicating conditions at the onset of labour (as mentioned previously), and for units and trusts with a response rate of at least 85% of eligible women to test the robustness of the results. Propensity score techniques were conducted to explore the effects of the baseline characteristics of women in the different planned settings on the primary outcome. The additional analyses strengthened the associations identified in the primary analyses (Hollowell et al., 2010).

2.4.4 Discussion

The study concluded that giving birth in England is generally safe and that the incidence of adverse perinatal outcome for 'low risk' mothers was low, being 4.3 events per 1000. Midwifery units (FMUs and AMUs) appeared to be safe for the baby because there were no significant differences in outcomes between these birth settings and OU settings. They also seemed to offer protective benefits to the mother due to significantly fewer interventions. The risk of adverse outcome for

the baby was higher for planned birth at home for first time mothers. Further details of the study, including strengths, limitations and implications for policy can be viewed in the cohort study report (Hollowell et al., 2010). This chapter has described the cohort study in 'plain English' to ensure clarity, but the empirical chapters of the thesis do use technical and clinical terms such as 'nulliparous' (first time mothers) and 'multiparous' (mothers having a second or subsequent birth) to ensure consistency with all Birthplace publications.

2.5 The Birthplace cost-effectiveness analysis

2.5.1 Scope of the Birthplace funded study

A cost-effectiveness of planned birth using decision-analytic modelling was funded for Birthplace. It was designed to synthesise the data from the cohort study with published data. Because the cohort study was collecting individual level data for women and babies separately, (to which resource use and unit cost data could be applied), it was prudent to address the research in two stages. First, a stand-alone cost-effectiveness analysis of planned birth using individual level data from the cohort study. Second, an economic evaluation that combined outcome measures for mothers and babies, using decision-analytic modelling techniques.

2.5.2 Scope of the thesis

In addition to the empirical studies planned for Birthplace and described above, two additional 'exploratory' studies were undertaken for the thesis. These were ancillary, not included in the Birthplace in England Programme of Work. The first study, designed to 'set the scene' for maternity care in the thesis, involved a data

envelopment analysis that used primary data from the mapping study of Birthplace and is described in chapter 3 of the thesis. The second, a cost minimisation analysis described in chapter 4, used primary data from a study adjunct to Birthplace, 'the Barkantine study' as a vehicle for data collection.

2.5.3 Author's contribution

The author was employed to work on Birthplace, and worked as part of the Birthplace 'research team' on three component studies; the mapping study, the cohort study and the cost-effectiveness analysis until its completion in July 2012. Additional work for the thesis was also undertaken during this period; from October 2007 until December 2012. [The author was on maternity leave during 2009].

2.5.3.1 Author's contribution to the mapping study

The author participated in all planning meetings and questionnaire design meetings with the Care Quality Commission in her capacity as the Birthplace health economist. The author contributed to the design of the data collection forms, to the interim and final reviews of the data, the draft report, and is named as a co-author of the study. The author separately used some unit-level data for analysis in the thesis, described in chapter 3.

2.5.3.2 Author's contribution to the cohort study

The author participated in all relevant research meetings, in particular weekly 'in-house' team meetings in her capacity as the Birthplace health economist. The author contributed to the design of the data collection forms for economic

purposes and contributed to the general progress of the study. Changes to the cohort study's timetable caused by delays in securing research governance approval in all relevant NHS trusts and by extra data collection at the request of the funders meant that the dataset became available in stages, with a few 'freezes' of the dataset for interim analyses. The author contributed to data cleaning of the cohort study during this period, including all the duration variables, free text coding for adverse maternal and neonatal outcomes and transfer. The author also participated in the design of decision rules for data analysis, and is acknowledged as part of the NPEU research team for the study.

2.5.3.3 Author's contribution to the cost-effectiveness analysis

As the primary Birthplace health economist the author conducted all analyses for the individual level cost-effectiveness analysis and for the decision analytic modelling study described in chapters 5 and 6. Data collection forms for resource use and unit cost data were designed and piloted by the author. Unit cost data were collected by another researcher as part of the adjunct study when the author was on maternity leave. The author presented the economic component frequently in the Birthplace research, co-investigator and advisory meetings and is the first author of the two Birthplace reports on cost-effectiveness and in a summary paper published in the British Medical Journal in April 2012, see appendix 3 (Schroeder et al., 2012a, Schroeder et al., 2012b).

2.5.4 Conclusion

To conclude therefore, two Birthplace component studies provided primary data for the empirical research set out in the next three chapters (3-6). Chapter three

acts as a starting point for exploring maternity service configuration and for measuring efficiency in the sector, and then the chapters following explore the costs and cost-effectiveness of intrapartum care in greater detail.

Chapter 3

3 Data Envelopment Analysis

3.1 Aims and objectives

The research described in this chapter shows the relative efficiency of alternative settings for intrapartum care using data envelopment analysis techniques. Data were collected for the Birthplace Mapping Study and as part of the Care Quality Commission review of maternity services (formerly the Healthcare Commission) (Redshaw et al., 2011, Healthcare Commission, 2008). The chapter explores whether there are differences in the efficiency of maternity units when they are stratified according to the type and scale of unit; and whether improvements in productive efficiency can be recommended for the units that are underperforming relative to the most efficient units.

3.1.1 Objectives

The objectives are to:

1. Estimate the efficiency of maternity units in England by evaluating their performance with reference to each other and to a benchmark frontier.
2. Explore patterns of efficiency and inefficiency in maternity units stratified according to the type and scale of unit.
3. Explore potential target improvements in efficiency for the units underperforming relative to their peers.

3.2 Methods

3.2.1 Principles of Data Envelopment Analysis

Data envelopment analysis (DEA) is used more broadly in operations research and health economics for the estimation of production frontiers (Charnes A et al., 1978, Charnes et al., 1994, Cooper et al., 2000, Norman M, 1991, Ganley and Cubbin JS, 1992). It is a linear programming technique which examines the resources and activities of units (hereafter called 'peers') aiming to achieve the same productive purpose. It provides a rigorous theoretical framework where efficiency can be quantitatively measured (Charnes A et al., 1978, Charnes et al., 1994, Cooper et al., 2000, Norman M, 1991, Ganley and Cubbin JS, 1992). Efficiency in this context is defined as the 'allocation of scare resources used to maximise the achievement of intended aims'. DEA combines the principles of both technical and productive efficiency. Interventions are *technically efficient* if they produce outputs using the minimum amount of inputs possible, or through maximising the highest output possible given limited inputs. Determining the productively efficient (least costly) combination of inputs to produce increasing levels of output, will then maximise *productive efficiency* (Charnes A et al., 1978, Charnes et al., 1994, Cooper et al., 2000, Norman M, 1991, Ganley and Cubbin JS, 1992, Farrell, 1957).

Decision-makers may value the importance of inputs and outputs differently, and so weights are applied to them during analysis (Allen et al., 1997, Banker et al., 1984, Pedraja-Chaparro et al., 1997). Weighting is calculated by the analyst who places emphasis on inputs or outputs of primary importance, and by means of mathematical programming to achieve constant or variable returns to scale.

In its simplest form, the equation fitted to measure efficiency in DEA is shown as:

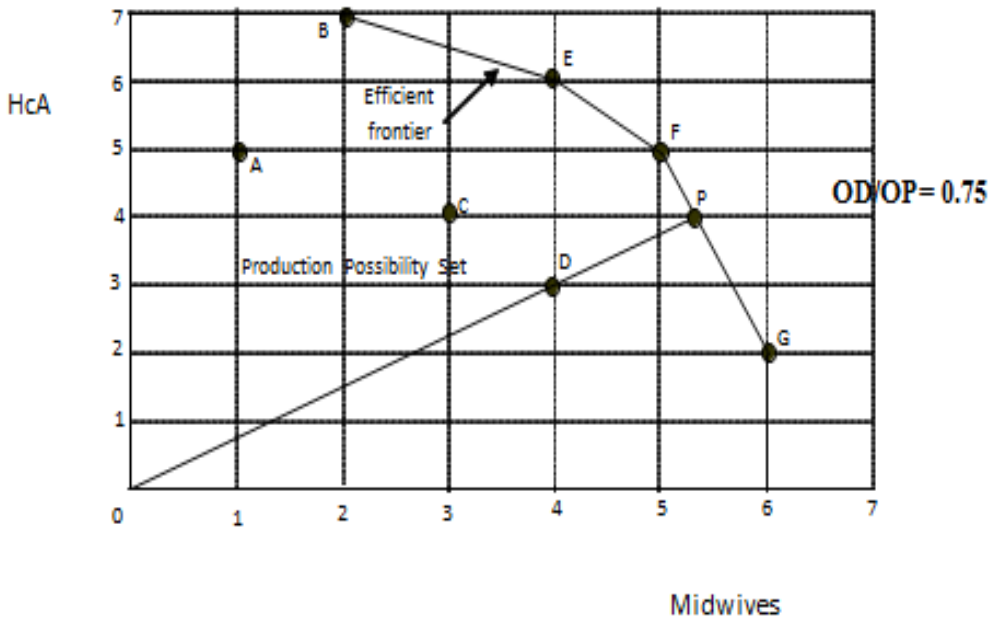
$$E = \frac{Output\ n * Weight\ n \ldots.}{Input\ k * Weight\ k \ldots.}$$

In the above equation efficiency (E) is defined as a ratio of the weighted sum of outputs to a weighted sum of inputs (Allen et al., 1997, Banker et al., 1984, Pedraja-Chaparro et al., 1997).

Maternity units undertake many activities with the aim of delivering high quality and efficient intrapartum healthcare (output). They also require many resources (inputs) to achieve this. For example, a dataset of information about maternity units may contain data for both inputs (e.g. midwifery staffing, medical staffing, and equipment) and outputs (e.g. numbers of births). The weighted relationship between these factors determines the 'healthcare input/output ratio' or 'E' in the equation above. In a regression analysis, a regression line can be depicted reflecting the average or central tendency of all the compared observations (Wilson et al., 2012). In contrast, DEA deals with the units (observations) with reference to the highest efficiency score (E), and evaluates the performance of all peers in comparison. Units performing with the highest efficiency scores can be used to plot the benchmarking efficient frontier, depicted as an isoquant. An isoquant is a (usually upwardly convex or downwardly concave) graph of all possible combinations of inputs that result in the production of a given level of output, used in the study of microeconomics to measure the influence of inputs on the level of output achieved (Cooper et al., 2000).

The efficiency of units is calculated by their deviations from the frontier line measured from the point of origin of the isoquant to the point of its most efficient peer as can be seen in the following diagram.

Example of a benchmarking efficient frontier



Source: diagram adapted from teaching slide, permission granted by the University of York 2012

The diagram above shows the production possibilities for a range of healthcare facilities (plotted as A – G and P), combining two inputs; 'midwives' on the x-axis and health care assistants on the y-axis. Radial efficiency is measured for the 'less efficient unit' D from the point of the origin to the nearest point on the benchmark frontier, shown as P, and so radial efficiency is measured as OD/OP, which in this example is shown to be 0.75.

DEA is thus a non-parametric approach to providing efficiency scores for units relative to others in the same sample. The method allows for the derivation of efficiency-related performance targets, and thereby inherently provides suggestions for changes in the (unit level) input and output combinations (Nunamaker, 1985, Hollingsworth, 2003, Hollingsworth B and Parkin D, 2003).

3.2.2 Data collection

The survey instrument was designed by members in the 'Mapping study' component working group of Birthplace and by the maternity care review team at the Care Quality Commission, and data sharing was formally agreed (Redshaw et al., 2011, Health Care Commission., 2008). Participation in the survey was mandatory for trusts providing maternity services. Trust leads completed the online questionnaires and the data were returned in October 2007. Some of the data questions were cross-sectional, specific to the month of March 2007, with all other statistics requested from the year to 31 March 2007. Data were returned by 148 (all eligible) acute trusts providing combinations of obstetric and midwifery-led services and 4 trusts providing only midwifery-led services. Both trust and unit level data were collected. Units were classified using the definitions developed in the Birthplace 'terms and definitions: consensus process' which defined the classification and remit of obstetric units (OUs), alongside midwifery units (AMUs) and free-standing midwifery units (FMUs) (Hollowell et al., 2010). If trusts had more than one distinguishable maternity unit then the data were entered separately. A total of 262 maternity units provided data within the 148 acute trusts. These included 180 obstetric units (OUs), 26 alongside midwifery units (AMUs) and 56 free-standing midwifery units (FMUs).

The Care Quality Commission analysed the data and published a report detailing trust ranking alongside other trusts and a rationale for their benchmarking indicators in January 2008 (Healthcare Commission, 2008). Additional analyses were carried out in 2009 for the Birthplace mapping report (Redshaw et al., 2011) and during 2008 and 2010 for this thesis chapter.

The data items relevant to this study included midwifery and medical staffing in whole time equivalents (WTEs), numbers of women delivered, numbers of births, eligibility criteria for births planned out of obstetric units, the rooms and beds available, and transfers. Data cleaning was carried out during November 2008, with cross checks between trust and unit data on staffing numbers and women delivered. These were then cross-referenced with trust data on homebirths to account for over-reporting. Unit closures and working hours were double checked. The data was entered into MS Access, coding was conducted in Microsoft Excel and preliminary analyses were conducted with STATA 10.1 SE and SPSS 15.0. (StataCorp, 2009).

3.2.3 Resource Data

Resource variables collected at a unit level were categorized as either inputs or outputs for this analysis. The variables are shown in the table following.

Table 3. Categories of resource use data for intrapartum care

Resource use Variables	Categories	Quantification	Models where resource use variables were included (appendix 5)
Inputs			
Unit open (working) hours		Number of days open per year, numbers of hours unit staffed per week	1-13, 23-25
Midwifery staffing	*(banding /usual staff, bank, agency, overtime)*	In post WTE	1-25
Midwifery support workers	*(banding /usual staff, bank, agency, overtime)*	In post WTE	1-22
Unit non clinical management and administration		In post WTE	1-6, 13-22
Medical Staffing Consultants and specialist registrars (obstetricians and anaesthetists)	*if split, % allocated*	In post WTE dedicated to obstetrics	13-22
Procedures/equipment	*(Cardiotocographs, fetal blood gas sampling, portable cots, ultrasounds, resuscitation equipment, medication)*	Numbers of items in delivery suite and maternity wards, total quantity supplied by pharmacy to the maternity unit for year preceding March 2007	1-6, 13-25
Intrapartum care attributable to planned place of birth			23-25
In utero transfer	(*same trust, within network, outside network*)	Distance in kilometers	23-25
Outputs			
Mode of delivery	*Spontaneous vaginal delivery, assisted delivery with ventouse, forceps, non-elective caesarean section, elective caesarean section*		1-25
Postnatal days for mother and baby		Number of days spent in postnatal care (mother and baby)	1-3, 7-9, 13-15, 17-22,

Detailed resource variables for intrapartum and immediate after birth care were included in the design of the original survey instrument. These included data for unit opening hours measured as a combination of two variables; ‘hours per week when the unit was staffed’ and ‘numbers of days in the preceding year when the unit was closed’. Unit opening hours were used as a proxy for the unit’s capacity to provide intrapartum care.

For midwifery staffing, posts were documented by ‘band’ (including bands 5, 6, 7, 8ab and 8cd) and ‘additional midwifery staff time’ including overtime, bank and agency staff time. Midwifery support staff data was collected for bands 1-4, inclusive of overtime, bank and agency staff time. Dedicated nursing staff time was collected in a similar manner, as were unit management and administrative staffing. Medical staffing included consultant obstetricians, associate specialists in obstetrics, specialist registrar obstetricians and obstetric senior house officers. Committed anaesthetic time was documented for in post consultant anaesthetists and anaesthetic registrars. All staffing data were measured in whole time equivalents. We conducted a separate staffing log of midwifery and medical staffing to supplement data collection and the data documented all staffing levels per ward by band. GP input was not specifically measured as this research was based on Care Quality Commission data collected from trusts disaggregated by maternity unit, though were GPs to be working in the units then their staffing commitment would have been included (by grade) in the dataset.

Data were collected on key ‘cost driver’ equipment including cardiotocograph machines, fetal blood gas monitoring machines, portable ultrasounds, cots and bassinets and adult and baby resuscitation equipment. Medication included pethidine, meptid, syntocinon, propess, prostin, hemabate, ergometrine and

syntometrine, and expressed as the total medication supplied by the pharmacy department for use in the year preceding March 2007.

Data on transfers were gathered for ‘total in-utero’ transfers. ‘Ex-utero / post-delivery’ transfers were aggregated for the transfers of mothers, babies or both. A variable to capture ‘intrapartum care attributable to the transferring unit’ was created to capture the initial intrapartum care given at the *planned* place of birth. The ‘numbers of women delivered’ data in the questionnaire was captured according to *actual* place of birth. The analysis was retrospective and not designed as an ‘intention to treat’ analysis, and this is an important difference between this chapter and the Birthplace individual-level cost-effectiveness analysis.

Birth data were categorized by mode and included spontaneous vaginal births, assisted birth with a ventouse, assisted birth with forceps, non-elective caesarean sections and elective caesarean sections. The average duration of post-natal stays was also collected. Data cleaning was carried out, with cross checks between trust and unit data for staffing numbers and women delivered.

3.2.4 Valuation of resource use using unit cost data

The analysis was initially undertaken with all the variables expressed in natural units but the widely divergent denominators for the input and output variables (for example ten obstetricians or seventy thousand units of syntocinon compared with one hundred live births) meant the analysis could not be computationally performed by the computer processing package, ‘Frontier Analyst’. The input data were then multiplied by unit costs to create one denominator which would implicitly

incorporate relative weighting in the analysis (because the quantities of medications supplied may be very high but relatively low cost in comparison to whole time equivalents of obstetric staffing). Substantial work was undertaken to apply unit costs to all resource use variables. Detailed unit cost data was obtained from a variety of primary and secondary sources and sometimes a combination of both. Table 4.1 A in Appendix 4 shows a breakdown of the costing research undertaken for this.

The NHS agenda for change pay rates were used to grade midwifery bands and the midpoint of each pay rate was used in attributing costs for these (NHS, 2008). The costing of agency, bank and overtime midwifery staffing was initially informed through discussions with Birthplace research midwives. Overtime was attributed the midpoint for each band group (e.g. bands 5 to 8) and was equated to the equivalent hourly rate using the PSSRU Unit Costs of Health and Social care compendium (Curtis, 2010). Overtime during unsociable hours was costed as 'overtime plus thirty percent', informed by the NHS agenda for change pay reference document (NHS, 2008). Agency rates were allocated in a similar manner, and banked staff time was paid at a band less than the median rate for average hourly pay. Midwifery support worker and nursing staff were costed using the same principles. Unit opening hours were converted into a new variable which was denoted 'total hours when the unit was available to provide intrapartum care' and was measured using the denominator of 'always available' which equated to 8670 (365*24) hours per annum if the unit was open all year with no closures. Obstetric staffing costs were estimated using the NHS Employer Medical and Dental Pay Circulars and adjusted by the PSSRU Unit Costs of Health and Social care digest to take training and on-costs into consideration (Curtis, 2010, NHS, 2008).

Equipment costs were obtained from the UK neonatal staffing study and updated and inflated to current prices. The inflated costs were then cross checked with Birthplace unit cost data for comparableness.(UK neonatal staffing study). Outstanding costs were supplemented from an in-house NPEU dataset of equipment costs from the STOPPIT cost-effectiveness study (Eddama et al., 2010). Medication costs were supplemented with data from the British National Formulary, version 59 (British Medical Association and Royal Pharmaceutical Society of Great Britain, 2010).

Costs for ambulance transfers were estimated according to the Department of Health reference costs (Department of Health, 2010). Substantial work was undertaken to identify the 'hub and spoke' networking relationships between obstetric units and freestanding units to ascertain the distances between these in order to attribute transfer costs by distance travelled. Distances were directly calculated using the British Association of Perinatal Medicine's on-line Networks Information Guide (British Association of Perinatal Medicine, 2010). The total numbers of patients transferred requiring initial or complete intrapartum care was calculated based on whether transfer occurred in utero or after delivery, and the cost of the transfer was attributed to the unit where labour care commenced. The upper and lower interquartile range estimates from the Department of Health reference costs were used to estimate the cost of a one day maternity admission and these were allocated to the units providing initial intrapartum care for women who were then transferred (Department of Health, 2010). Department of Health reference costs were used for the estimation of mode of delivery for a whole intrapartum event, calculated from the commencement of labour care to the end of the intrapartum period. These costs were cross-checked for face-validity with

costs obtained from bottom up costing for Birthplace during 2010. Costs were estimated to include overheads costs but to exclude medical and midwifery staffing, equipment and medication costs which were estimated separately. Postnatal care was also valued separately average and interquartile ranges for the Department of Health reference costs for the combined mother and baby dyad (Department of Health, 2010).

3.2.5 Data Envelopment Analysis

A strategy was used for data analysis beginning at the broadest level possible (all units) to an increasingly restricted sample (units disaggregated by type and scale), each presented as a 'model'. Analyses were performed for twenty-five models, and the strategy systematically disaggregated the units according to the type of unit (OU, FMU and AMU); and the scale defined by 'numbers of women delivered'.

Both input minimization and output maximization techniques were employed and compared. Input minimization calculates 'by how much input quantities could be proportionally reduced' when holding outputs constant (Banker et al., 1984). Output maximization calculates the quantity by which outputs can be proportionally expanded whilst holding inputs constant. Input and output models will estimate the same frontier and identify the same units as efficient, but the percentage efficiency may differ depending on which analytical method is used (Banker et al., 1984). Input and outputs were attributed a flexible weighting (Allen et al., 1997, Banker et al., 1984).

There was substantial missing data on resource use from the original data collection. There were patterns of missingness by variable and by unit type, and

by unit type and scale. It was not appropriate to impute data across the units and imputation techniques because the data were not missing at random. The DEA technique of measuring efficiency for maternity care combines multiple inputs across many settings, a complex data set for benchmarking multiple indicators. In order to maximise the different but relevant indicators of efficiency, missing data was accommodated by the stratification of analyses by scale, unit type and analyses were repeated with systematically reduced inputs and outputs to maximize the numbers of units incorporated in the different analyses.

There were three outliers, and these were consistent in all analyses of the data. Separate checks were conducted on the outliers to see why they showed different results. Two outliers were units which were newly opened (and were not able to offer annual data) as they had not been operational. The third unit had closed. The three outliers were excluded from the analysis as they could not offer comparable and relevant data.

The models included and compared different returns to scale; a *constant* returns to scale represents an increase in inputs resulting in a proportionate increase in the output. A *variable* return to scale means that an increase in inputs results in higher or lower returns (Farrell, 1957). A constant returns to scale may be achieved in the short run, but over the long run – a variable return to scale (incorporating both increasing or decreasing returns) is more likely (Farrell, 1957). Adjustments for outliers which could confound the analysis were made, and the analyses were then repeated to exclude them. All analyses were conducted in Microsoft Excel version 2007 and Banxia Frontier Analyst 4.0.10.

3.3 Results

3.3.1 All units

For ease of reference, the results of the data envelopment analyses are presented together in tables in appendix 5.

When all units were analysed together regardless of the unit type or scale, 156 units (models 1-3, table 5.1A) were available for analysis and a further 19 units were available when post-natal care was excluded (models 4-6, table 5.1 A). Of these, approximately a third (51/156) functioned at full efficiency (100%, on the benchmark frontier) with another one third (53/156) at 70-90% efficiency. Analyses for these models applied a variable returns to scale (VRS), and they achieved higher efficiency overall than the models that applied aconstant returns to scale, (models 2 and 5) where only 25% (40/156) of the observed units achieved full efficiency.

Inputs included all employed midwives, additional midwives (bank, agency or overtime), midwifery support workers, managerial and 'non-clinical' staffing, equipment, and 'working hours' when the unit was fully operational. As medical staffing does not constitute the norm for maternity care in FMUs it was excluded. Transfer data and medications were also excluded due to the high proportion of missing data for these inputs.

The models show that there could be efficiency gains of up to 20% spread across all inputs with the exception of 'working hours'. The output maximization model

(models 1 and 4, table 5.2A) showed that efficiency gains of up to 26% could be achieved if inputs were held constant and outputs (i.e. number of women delivered) increased across all units, and up to 50% when postnatal care was included in the analysis. The correlation co-efficients (CC, table 5.3A) for each input and output of interest ('number of women delivered') combination, revealed differences in each contribution to efficiency and inefficiency. The CC for in-post midwifery was 0.93 and 0.84 for employed midwifery support workers, but was 0.42 for additional midwifery support workers (bank, agency and overtime), 0.58 for management staff and 0.2 for 'working hours'. Efficiency gains across the sector could therefore be made from changes in the deployment of agency, bank and overtime midwifery staff, midwifery support staff and managerial staffing. Most observed units were functioning throughout the year so the correlation co-efficient of 0.2 with 'working hours per year' was to be expected. More detailed analyses of these variables showed that 23 (15%) units would need to reduce their overtime and bank midwifery staffing by up to 50%, one third (50/156) their managerial staffing by 50% and 30% (46/156) their equipment by up to 50% in order to achieve competitive efficiency scores with their peer decision making units (DMUs).

3.3.2 Analyses of all units with <2499 women delivered per year

Almost all FMUs delivered <2499 women per year. Consequently the inputs in the previous analyses were compared for all units of the same scale, and 87 units were represented in the analysis (models 7-12, table 5.4A). Staffing inputs included in-post midwives, additional midwives, midwifery support workers and working hours. There were high levels of missing data for equipment and managerial staffing in FMUs, so these inputs were excluded. Efficiency gains

(table 5.5A) through reductions in staffing of up to 20% could be achieved for all variables of interest; particularly extra midwifery staffing. Efficiency gains of between 16% and 34% could be achieved by expanding outputs (numbers of women delivered) while holding inputs constant. 'Numbers of women delivered' was highly correlated with established midwifery staffing (0.95), and in-post midwifery support workers (0.9) whereas the correlation with extra midwifery staffing was weak [(0.54), table 5.6A]. The input minimization model incorporating a CRS design shows that efficiency gains of over 80% could be made in 42/87 (48%) of the observed units. When post-natal care as an outcome measure was excluded from the analysis (model 11) then the efficiency gains could be made in 62% of the observed units [(63/101), table 5.4A].

3.3.3 Obstetric units

Models 13-16 (table 5.7A) show the results for all obstetric units analysed together. In order to maximize the sample size and to minimize the missing data, the models were repeated with the elimination of an input category. The input variables included in model 13 were in-post midwives, extra midwives, midwifery support workers, management, medical staff, equipment, medication and working hours. Outputs include numbers of women delivered and postnatal care. Model 14 repeats model 13 with the exclusion of 'working hours', model 15 repeats model 14 and excludes 'medication', and model 16 repeats model 15 and excludes 'post natal care'. These additional analyses increase the numbers of observed units in the sample from 134 (model 13) to 159 (model 16), though they reduce the estimated overall productive efficiency scores. Fifty percent (69/134) of units are identified as functioning at full efficiency on the bench-mark frontier in

model 13 compared with 33% (54/159) in model 16; where fewer inputs are available to translate into outputs.

Inputs requiring reconfiguration for efficiency purposes are shown to be managerial staffing (17%), equipment (12%), medication (10%) and extra midwifery staffing (8.7%) [table 5.8A]. If inputs are held constant then reconfiguring outputs to achieve overall efficiency gains would be needed for the 16% (numbers of babies delivered) and 25% (postnatal care) shortfall in efficiency relative to the benchmark frontier (model 13). In all the models, managerial staffing, equipment and extra midwives contribute the most to inefficiency and would need to be reconfigured (table 5.9A).

3.3.4 Obstetric units by scale (>4000, 2500-3499, <2499) women delivered per year

Models 17 to 22 (table 5.10A) show analyses for OUs stratified by scale. Model 17 shows efficiency scores for units with more than 4000 women delivered each year. Model 19 shows efficiency scores for units with between 2500 and 3499 women delivered each year and model 21 shows efficiency scores for units with less than 2500 women delivered each year. Each of the output maximization analyses (models 17, 19 and 21) is repeated using input minimization techniques (models 18, 20 and 22).

The larger obstetric units tended to be functioning at a higher level of efficiency with up to 70% (26/37) of units functioning on the benchmark frontier, compared with approximately 50% (31/63) of the moderate-sized units (2500-3499) and the smaller units (<2499, 60%, (25/41) efficiency, tables 5.10A). In the larger units, managerial staffing and equipment are identified as important areas for

improvements in efficiency compared with inefficiencies identified for additional midwifery and medical staffing in the units of a smaller scale (table 5.11A and 5.12A).

3.3.5 Free-standing midwifery units

Models 23 to 25 (table 5.13A) show the efficiency scores for the observed FMUs. Less than half operate at full efficiency, with only 19/47 on the benchmark frontier. In contrast to obstetric units and analyses overall, 'working hours per year', 'equipment' and 'in-utero transfers' and transfer related activities contribute to inefficiencies measured in the analyses (table 5.5.14A). Contributions to inefficiencies are reflected as follows; equipment (22%), transfers (19%) and working hours per year (9%). Employed midwifery staff also contributes to inefficiencies (25%) which suggests that reconfiguring the midwifery staffing arrangements in FMUs would be beneficial. The correlation co-efficient between employed midwifery staff and 'numbers of women delivered' is 0.61 (compared to previous estimates of 0.95 in obstetric units and overall) suggesting that the staffing levels are not as aligned to levels of output as noted in previous analyses (table 5.14A). Furthermore, to attain full efficiency in this model, the numbers of women delivered should increase by approximately 20%.

3.4 Discussion

The results of the DEA show that there are gains in 'productive efficiencies' in intrapartum maternity care that could be achieved were inputs to be reconfigured to generate greater outputs or, alternatively, if holding outputs constant and reducing the inputs required to generate them. Overall, approximately one third of

‘all units’ functioned at full efficiency and another one third functioned at between 70-90% of their capacity relative to other units. The larger OUs tended to be more efficient than the smaller OUs. Managerial staffing and equipment were identified as important areas for improvements in the larger OUs. Less than one half of FMUs were operating at full efficiency, and midwifery staffing, working hours per year, equipment and in-utero transfers have contributed to inefficiencies in FMUs. Similar ‘themes’ of inefficiency in the maternity care sector have been identified in previous national reports, though the reports did not make use of a quantitative construct like DEA (King's Fund, 2008, Health Care Commission., 2008, Redshaw et al., 2011). Excerpts from these reports are included in the discussion below, which presents the contribution to overall productive efficiency separately for each input.

3.4.1 ‘Working hours’ (models 1-13, 23-25)

Most units were functioning throughout the year, and reduced ‘working hours’ was a contributor to inefficiency for FMUs. The mapping study reports that [most units]..’had not closed to admissions during the period of data collection, but of those which had closed FMUs and AMUs were more likely to have closed for longer durations, but less frequently than OUs’ (Hollowell et al., 2010). Furthermore, the Care Quality Commission linked opening hours and bed occupancy together and stated that ‘trusts needed to make greater use of their midwifery units,’ reflecting the excess capacity for throughput in these settings (Health Care Commission., 2008).

3.4.2 Midwifery staffing (models 1-25)

In-post and established midwifery staffing was highly correlated with ‘numbers of women delivered’ per year for almost all DEA models and was generally a contributor to efficiency, with the exception of FMUs. The mapping study showed that in comparison to other settings, FMUs accounted for a higher ratio of midwives to women (Hollowell et al., 2010). The Kings Fund commented that ‘FMUs provide women with ‘private care’ compared to OUs… ‘reflecting the higher rates of staffing and midwifery capacity in FMUs than in other settings’. The Kings Fund, the Royal College of Midwives and the mapping study identified the substantial variation in vacancy rates and the proportion of senior midwives reaching retirement age as cause for concern for future staffing levels (King's Fund, 2008, Hollowell et al., 2010, Healthcare Commission, 2008).

Extra midwifery staffing (bank, overtime and agency) is consistently shown to be a contributor to inefficiency for all units and for the restricted models. It was weakly correlated with the main output ‘numbers of women delivered’ in all analyses. Reconfiguring the deployment of extra midwifery staff for efficiency purposes would be recommended from these analyses.

Similarly, in-post midwifery support workers (input) were highly correlated to ‘numbers of women delivered’ (output) but extra midwifery support workers were not, and these inefficiencies were also reflected in the smaller OUs.

3.4.3 Medical staff (models 13-22)

Medical staffing was included as an input in analyses for OUs. Overall and for larger scale units there was no noticeable effect, but medical staffing contributed to some inefficiency and was weakly correlated with outputs in the smaller units. A recent recommendation from the King's Fund stated that 'midwife-led models' of care should be deployed across the service for low-risk women, with a view to providing a more cost-effective service that releases obstetricians to focus on women with more complex needs' (King's Fund, 2008). The findings of this DEA seem to agree with the recommendation. Future research which could assess the reconfiguration of the service to release obstetricians (particularly in the smaller obstetric units) to focus more on women with more complex needs is recommended for efficiency purposes.

3.4.4 Unit management and non-clinical staffing (models 1-6, 13-22)

Overall, one third of units need to reconfigure the deployment of their managerial and administrative staffing by fifty percent in order to achieve competitive efficiency with their peers. This finding was consistent for larger obstetric units where the staffing was shown to be inefficient and weakly correlated with outcomes. The Kings Fund recommended that 'there should be greater use of non-clinical staff to do administrative or clerical work, freeing up clinical staff to focus on patient care' and this view was echoed in a recent roundtable discussion, with speakers who represented the Royal College of Midwives, Royal College of Obstetrics and Gynaecology, Royal College of Pediatrics and Child Health, National Childbirth Trust and NPEU and where it was stated that 'maternity

support workers could take on more of the administrative tasks, such as 'inputting data into computers, which 'overwhelm' midwives, thus freeing them up to use their skills more of the time' (Guardian Roundtable Debate, 2012). Reconfigurations of the deployment of unit management and administrative staffing are recommended depending on the information technology and record systems in place.

3.4.5 Equipment (models 1-6, 13-25)

A cost driver, namely equipment, was included in the DEA for obstetric units. In all the models, 'unit management and non-clinical staffing, equipment and extra midwives' contributed the most to inefficiency, of between twelve and thirty percent, depending on which analysis was used. It is an interesting finding that equipment costs contributes to 'inefficiencies' and is not surprising that equipment was a major cost driver in obstetric units. This issue becomes more relevant in later chapters because overheads (including equipment) were the greatest cost driver in the obstetric unit. Obstetric units carry the highest cost burden of service delivery due to the more costly hospital services they provide for obstetric and other maternity care support. In addition, they provide the more costly medical interventions, procedures and staffing for women of 'high risk' and for women of 'low risk' whose labours become more complex. Capital costs in OUs will always be generated because of the need to have an OU in place so that transfers can take place from non-OU to OU birth settings.

3.4.6 Transfers (models 23-25)

Transfer related activities contribute to approximately twenty percent of the inefficiencies shown for FMUs. Whilst transfer to an OU is important and necessary for women (and their babies) whose birth becomes more complex, the likelihood of a transfer to an OU based clinical risk should be appropriately identified during admission to minimise the unnecessary transfer. Unit eligibility critearia should reflect this. The Birthplace cohort study identified that 36.3% nulliparous and 9.4% multiparous women required an intrapartum transfer from an FMU to an OU (Hollowell et al., 2010). Reviews of the criteria and procedures for eligibility and the management of transfers from FMUs for efficiency and safety purposes are recommended from these findings.

3.4.7 Limitations

Data envelopment analysis has been described as a 'can-opener' because it is a technique for exploring the relationships between multiple inputs and multiple outputs in one analysis and does not require the specification of a functional form (Hollingsworth B and Parkin D, 2003). However, it is simply a marker of relative efficiency compared with other units with the same productive purpose, without accounting for differences between the units' characteristics, performance targets and challenges. Other important differences between units are not accounted for; such as differences in regions, geography, uncontrollable environmental forces and the differences in the baseline characteristics of the maternity population served by them (including ethnicity and relative disadvantage). Furthermore, pervasive problems across all units in the maternity sector will not be reflected in

the dataset (such as a generic shortage of midwives) and would not be identified in this type of analysis, hence could even distort the findings.

The results of the study are however consistent with previous studies about maternity care and reflect the findings from recent key national reports such as ‘Staffing in Maternity Units’, the ‘maternity benchmarking exercise’ conducted in 2007 by the ‘Care Quality Commission’ and the Birthplace mapping study, and reports identified key areas for reconfiguring the service including changes to the deployment of managerial and administrative staffing, medical staffing in smaller obstetric units, and vacancy rates and shortages of midwifery staff in the maternity sector (King's Fund, 2008, Hollowell et al., 2010, Health Care Commission., 2008).

The research has demonstrated that DEA techniques can identify whether there are differences in the efficiency of maternity units when they are stratified according to the scale and type of unit and furthermore, that improvements in productive efficiency could be recommended for units that are underperforming, relative to other units. This analysis was exploratory and aimed to ‘set the scene’ for the Birthplace cost-effectiveness analyses. Based on the findings of this study however a reconfiguration of intrapartum care inputs is recommended, so that greater efficiency and consequently cost-savings could be generated in the future.

Chapter 4

4 Cost-minimisation; data collection, methods, and case study

> 'The pursuit of efficiency in the healthcare sector requires priority to be given to those treatments which provide the greatest benefit per unit of cost' (Palmer et al., 1999).

In the previous chapter (chapter 3), technical efficiency was measured more broadly at a unit level, producing estimates of *relative* efficiency of units according to their type and scale. However, to determine whether allocative efficiency can be measured according to the *'greatest benefit per unit of cost'*, alternative settings can be compared through an appraisal method called economic evaluation. It is a means of identifying, measuring, valuing, and comparing the costs and consequences of different services (or interventions); thereby providing a clear comparative framework for the strategy deemed the most cost-effective (Palmer et al., 1999, Drummond et al., 1997). The outcome will depend on the type of economic evaluation undertaken. In healthcare a 'cost-effectiveness analysis' is commonly used, because the benefits are measured using a single outcome usually expressed in 'natural units' (e.g. 'adverse perinatal outcomes avoided' or 'cases detected') (Palmer et al., 1999, Drummond et al., 1997). The cost-effectiveness analysis performed for Birthplace (described in the next chapter) primarily estimates the incremental cost per *adverse perinatal outcome avoided* or *maternal morbidity avoided* for women judged to be at 'low risk' of complications prior to the onset of labour at home, in an FMU, AMU or OU.

This chapter presents research that was undertaken prior to the Birthplace cost-effectiveness analysis, for an adjunct study. The overall study was designed to assess the uptake and outcome of a new birth centre care (FMU) for pregnant women in inner city London. The cost minimisation analysis presented here was predicated on the following safety equivalence hypothesis: that due to stringent eligibility criteria at the FMU, the 'low risk' group of pregnant women who planned birth there would not experience worse outcomes for the mother and baby; thus employing an economic hypothesis of 'weak dominance'; i.e. that the FMU was as safe but less costly than the nearest OU (Briggs AH and O'Brien B, 2001). It provided an opportunity for the more detailed resource use and unit cost measurement and valuation for the Birthplace cost-effectiveness analysis.

As part of the chapter a theoretical framework for costing within economic evaluation is provided and the methods employed in performing a cost analysis are briefly described.

4.1 Costing within economic evaluation

> 'Costs are calculated by quantifying the different types of resources used in producing a service, and then [by] multiplying these amounts by their respective unit costs' (Gray et al., 2011).

There are typically three stages to performing a cost analysis; *identification* and estimation of resources, *measurement* of resources – such as the quantity, frequency and mode of administration of a drug or medication, and finally *valuation* of resource use, by applying unit costs to each resource category (Mugford et al., 1998, Gray et al., 2011, Rafferty, 2000).

4.1.1 Identifying resource use

The identification of ‘resource use’ commences with an understanding of the purpose of the evaluation; the resources needed for the intervention and measured between the study comparators, and the time horizon relevant for comparison (Drummond et al., 1997, Gray et al., 2011, Gold et al., 1996, Brouwer et al., 2001, Rafferty, 2000). In addition, an understanding of the perspective of the ‘target audience’ is important, because the study may be relevant to the costs to society more broadly (societal perspective) or to a more restricted scope, for example the cost to the health service (health service perspective). Finally, familiarity with the relevant care pathways or disease process, within the specified time horizon will make identification of the appropriate resources clearer.

4.1.2 Measuring resource use

The quantities of resources by category are measured and documented during the process of data collection. Purposefully designed data collection forms may be used for stand-alone studies, and may be completed by researchers, health professionals, carers or even patients self-reporting their health service utilisation. Other data can be collected from patient notes or routine hospital reporting systems which document, for example, the duration of a hospital inpatient stay or the type, dose and mode of administration of medication (Drummond et al., 1997, Gray et al., 2011, Gold et al., 1996, Brouwer et al., 2001, Rafferty, 2000, Mugford et al., 1998). An analysis using a broader societal perspective will typically expand the measurement of resource use to include community services or informal care provided by family members (Rafferty, 2000, Mugford et al., 1998,

Gray et al., 2011). Overall, and once resource use has been measured for all aspects of a study, it is then 'valued' with unit cost data.

4.1.3 Valuing resource use: 'top down' and 'bottom up' techniques

When valuing cost data, two different methods can broadly be employed to generate unit cost estimates. Firstly, 'top-down' costing involves estimating the total resource cost for a scenario and then dividing the total cost by the numbers of patients or by the volume of service provided. Secondly, 'bottom-up costing' (micro-costing) involves measuring each resource 'by its components' so that all of the resources used by a specific patient are included, i.e. aggregating the individual cost components of all the elements that comprise it (Brouwer et al., 2001, Drummond et al., 1997, Gold et al., 1996, Gray et al., 2011, Mugford et al., 1998, Palmer et al., 1999, Rafferty, 2000). A combination of the two costing techniques, 'a mixed-method' approach can also be used depending on the requirements of the analysis (Rafferty, 2000, Mugford et al., 1998).

The method of 'top down' costing using national data sources is a pragmatic approach for valuing resource use; because it allows for the use of externally validated national statistics, which are averaged out to account for unit level variations and cost or price fluctuations. It is generally easier to perform than 'bottom up costing' because it has fewer data requirements, uses routinely collected data and is likely to estimate costs for categories of the main cost-drivers (Gray et al., 2011, Rafferty, 2000, Mugford et al., 1998). In the previous chapter, the Care Quality Commission's dataset, (the cross-sectional overview of maternity trust and unit level activity) was primarily analysed using a 'top down' technique for

estimating production frontiers (i.e. data envelopment analysis), hence a 'top down' method of *valuing* resource use (e.g. by using national sources for unit cost estimation) was appropriate for the data and planned analyses.

'Top down' costing may fail to detect cost differences when interventions, settings or units are being compared as it does not account for inter-patient variation within units, and when the associated resource use may differ between them. 'Bottom up' costing can account for the effects of case-mix on cost and generally offers a more reliable analysis of cost variations (Mugford et al., 1998, Gray et al., 2011, Rafferty, 2000), (Wordsworth et al., 2005).

4.1.4 Adjustments to cost data

4.1.4.1 Discounting

Researchers are concerned with the immediate costs and consequences generated by healthcare interventions, as well as those that accrue in the future. An equivalent present value is calculated when future costs and benefits are discounted, so that they can be compared fairly with other programmes or interventions. This is relevant for intrapartum care because outcomes at birth can extend through childhood and into adulthood, with associated life long costs. During the period of the thesis, discounting was applied at an annual rate of 3.5% as recommended by NICE (Gray et al., 2011, Wordsworth et al., 2005).

4.1.4.2 Inflation

Costs and consequences can occur at different time periods. To ensure that all costs are comparable, they are valued at a common base year to mitigate the effects of inflation. In health economic evaluations in the UK, the Hospital and Community Health Services index (a weighted average of two inflation indices) is commonly used. (Gray et al., 2011, Wordsworth et al., 2005)

4.1.4.3 Missing data

If values are missing for a case in a dataset, most statistical packages will default to discarding the case with the missing value. This may introduce bias or affect the representativeness of the results. Imputation is often used to resolve this, and is the process of replacing missing data with substituted values thus preserving the dataset by replacing missing data with a probable value based on other available information. Once all missing values have been imputed, the data set can then be analysed using standard techniques for complete data. Mean imputation occurs when the missing value is replaced with the mean of the variable for all other cases, and multiple imputation; a processes of imputing data similar to stochastic regression can be run on the same data set multiple time (Little and Rubin, 2002).

4.1.5 Alternative costing perspective

4.1.5.1 Measuring productivity

Studies can vary in the range of patient-related cost data that they include. Broader costing approaches will include the consequences of an illness including loss of productivity in addition to the direct cost of treatment, or the indirect costs associated with it (such as travel) (Gray et al., 2011). There are also different approaches to valuing productivity, such as a narrower perspective including only the potential loss of earning from illness, or a broader view that incorporates earnings-related benefits of a treatment (such as the reduced risk of mortality). Different approaches have been proposed; such as the human capital approach, the Washington Panel approach or the friction cost method, though these are not explored further here (Drummond et al., 2005, Gray et al., 2011).

4.1.6 Presenting cost data

Constructing a cost data set requires the separate identification, measurement and valuation of resource use and unit cost data. They are then combined, and aggregated to create a total cost variable for a particular patient in the dataset. Alternative costing approaches or adjustments to the data in reference to the planned evaluation should be considered so that the costing methods and perspective are applied appropriately. Events-based costing using multiple regressions, with the explanatory variable as the occurrence of the health-related event can identify true cost differences between groups (Gray et al., 2011, Wordsworth et al., 2005).

4.2 Forms of economic evaluation

4.2.1 Cost-minimisation analysis

Cost minimisation analysis (CMA) establishes the least costly method of intervention and is only appropriate if the outcomes of the interventions are known to be the same. It is a simple method of analysis and it has been argued that CMA is only appropriate in very rare circumstances. This is discussed later in this thesis chapter (Drummond MF et al., 1997, Briggs AH and O'Brien B, 2001).

4.2.2 Cost-effectiveness analysis

Cost-effectiveness analysis (CEA) is a form of economic evaluation that compares the relative costs and outcomes (effects) of two or more courses of action, using a common outcome measure. In cost-effectiveness analyses, the costs are expressed in monetary units, while benefits are expressed in natural or physical units, such as years of life gained, hospital episodes or clinical events avoided.

CEA involves calculating the difference in costs and difference in outcomes between the health care interventions or courses of action being compared, and then expressing these as a ratio. The denominator of the ratio usually represents a measure of health gain and the numerator usually represents an incremental cost associated with the health gained. Cost-effectiveness is expressed as an incremental cost-effectiveness ratio (ICER), which is simply the difference in costs divided by the difference in effects:

ICER = (change in costs) / (change in effects)

ICER = (cost of scenario A – cost of scenario B) / (effectiveness of scenario A - effectiveness of scenario B)

The ICER represents the additional cost of achieving an additional unit of outcome through a healthcare intervention or course of action, when compared to the next best alternative, mutually exclusive intervention or strategy (Palmer et al., 1999, Drummond et al., 2005, Gray et al., 2011).

4.2.3 Cost-utility analysis

The outcomes of health interventions can be measured as a single metric combining health-related quality of life and life years gained, called a quality adjusted life year (QALY). Validated preference based measures such as the 'EuroQol five dimension standardised health status measuring survey' (EQ-5D), and the health utilities index (HUI) can be used for determining QALYs in clinical trials (EuroQol Group, 1990, Furlong WJ Feeny DH Torrance GW Barr RD, 2001). QALYs have the advantage of cardinal properties, so that very different life long outcomes can be compared (Gray et al., 2011).

4.2.4 Cost-benefit analysis

A ‘willingness to pay’ approach, sometimes incorporating ‘discrete choice experiments’ is used to measure and value health benefits so both costs and consequences are measured in monetary terms. A simple rule of ‘positive net benefit’ is used to determine whether an intervention is desirable, based on the criteria of ‘benefits exceeding cost’ (Drummond et al., 1997).

4.3 The Barkantine Study

The methods employed in performing costing research have been very briefly described. For the purpose of this thesis, detailed cost data was collected through a cost-minimisation analysis (described here in the ‘Barkantine study’) which acted as the vehicle for the design of the care pathways and the piloting of data collection for resource use and unit costs for the main cost-effectiveness analysis to follow.

The Barkantine Birth Centre in Tower Hamlets, London opened in January 2008. It was the first new free-standing birth centre to open in an inner-city multi-ethnic community. The Birth Centre planning group proposed a study to compare aspects of the Barkantine Birth Centre (a FMU) and the nearest obstetric unit situated in the Royal London Hospital (OU), which, like the Barkantine was also run by the Barts and the London NHS Trust. The overall aims of the Barkantine evaluation were to assess the uptake and appropriateness of the birth centre for women in the catchment area and to compare local women’s preferences and experiences of intrapartum care through surveys conducted both before and after

the opening of the birth centre. A cost-minimisation study was funded to compare the cost of providing intrapartum care in the two units, predicated on the following safety equivalence hypothesis: that due to stringent eligibility criteria at the FMU, the 'low risk' group of pregnant women who planned birth there would not experience worse outcomes for the mother and baby; thus employing an economic hypothesis of 'weak dominance', i.e. that the FMU was as safe but less costly than the nearest OU. The study was conducted from a health system perspective and consequently only direct costs to the NHS were included. The time horizon identified women at the start of their care in labour and was completed when intrapartum and related postnatal care for both mother and baby ended.

4.4 Methods

4.4.1 Study population

Women were eligible to be included in the study if they were judged to be at low risk of complications at labour onset and admitted to the Barkantine Birth Centre between August 2008 and March 2009, or the Royal London Hospital between January 2008 and March 2009. If their admission did not result in the establishment of labour and the birth of a baby in the same episode of care, they were excluded from the study. The criteria used to define 'low risk' were the same as those used in the Birthplace Study, which were set out in the NICE Intrapartum Care Guidelines (National Collaborating Centre for Women's and Children's Health, 2007). Data were collected by midwives employed by the Barts and the London Trust who had access to the clinical notes, and the data were entered into

a purpose-designed SPSS database. The author designed the data collection forms and supervised the database development. Data collection was carried out by Nishma Patel, a health economist working alongside the project at the NPEU. Data were extracted from women's notes by two research midwives working in both units in the Barts and London trust with the permission of the Acting Head of Midwifery. When women's notes were missing, more limited data were extracted from obstetric summaries. Anonymised data were extracted from 167 sets of notes for women resident in Tower Hamlets who began labour at the Barkantine Birth Centre and 113 sets of notes and 53 obstetric summaries for women who began labour at the Royal London Hospital. Data items were extracted retrospectively from clinical notes following discharge of both the mother and the baby from postnatal care. Additional information was collected from notes for the father's occupation, and was coded using the National Statistics Socio-economic Classification [NS-SEC] (Office for National Statistics, 2002). Although the midwives extracting the data checked the women's eligibility for midwife-led care, two women from the Royal London Hospital were found to fall outside the exclusion criteria and were therefore excluded.

An application was made for ethics approval to the East London and the City Local Research Ethics Committee prior to the study, but the project was subsequently categorised as 'service evaluation' and ethics approval was not required. Permission for the study was then granted by the Caldicott Guardians for Barts Health NHS Trust and the Tower Hamlets Primary Care Trust. Their mandate is to ensure the highest practical standards for handling patient information, the confidentiality of patient and service-user information and the enabling appropriate information-sharing by advising on options for the lawful and ethical processing of information.

4.4.2 Costing approaches for the Barkantine (and Birthplace) study

'Bottom up' costing methods are a more complex costing method to undertake because of the difficulty of allocating costs between healthcare settings. They were considered appropriate for this study because 'individual level' resource use data were available for the cohort of women and their babies.

A subgroup of researchers involved in Birthplace (Alison MacFarlane, Christine McCourt, Nishma Patel and Liz Schroeder) was also involved in both the Barkantine and Birthplace research. The two research projects were complementary and the documentation methods employed in the Barkantine study were used as a template for the Birthplace CEA. The Barkantine study provided for a more detailed compilation of intrapartum resource use, unit costs, management protocols and care profiles than was available for Birthplace and offered the researchers an insight into the functioning and interaction between maternity settings within a trust. It also provided an opportunity for both observation and active participation in research meetings with the senior management and clinical staff responsible for intrapartum care in both the FMU and OU. The following sections describe the exploratory analysis undertaken for the Barkantine study, and explain how the resource use and unit cost data were identified and documented. Although resource use identification, measurement and valuation was undertaken for the Barkantine study, individual level data from the Barkantine study were not included in Birthplace.

4.4.3 Resource use data

Data were collected on the resources used in the care of each mother and baby dyad during the period between admission and discharge for both the FMU and OU (see appendices 6 and 7 for the data collection forms). Data collection were designed to capture a 'care pathway' during labour by documenting the care setting (birth room or ward), staffing, procedures and duration of each phase of labour and birth. Women admitted to the Barkantine study stayed in a birthing room for the duration of their inpatient care, unless transferred. Alternatively women admitted to the Royal London Hospital moved between rooms and wards, namely antenatal ward (including triage), labour ward, theatre if required, and the postnatal ward or higher level postnatal care. The data extraction forms documented detailed estimates of the following: duration of the first stage of labour, augmentation, pain relief, use of opiates, midwifery support (continuous, intermittent and percentage of dedicated care), total number of vaginal examinations performed during labour, date and time of first clinical assessment by an obstetrician, mode of delivery, the duration of the second and third stages of labour, perineal trauma, maternal complications, blood transfusions, surgical procedures performed as a result of a complication, admission to postnatal care and breastfeeding at discharge. Data was also extracted on the duration and intensity of any adult high dependency care and also neonatal care, based on standard criteria for level of care (neonatal intensive care, high dependency care and special care).(British Association of Perinatal Medicine, 2010) The complications experienced by mothers and babies were noted as were the type and quantities of treatments, diagnostic imaging tests, scans and medications administered and ambulance transfers undertaken for both mothers and babies.

4.4.4 Unit costs

Detailed ‘bottom up’ unit cost data collection was undertaken. The unit cost proformas were drafted on a procedural basis through a ‘pathway of intrapartum care’, and every item with an associated cost component was documented. Primary data were obtained for almost all the unit costs. Interviews were held with the Acting Head of Midwifery and the Birth Centre Manager to collect data on staffing, protocols and administration in the two units. Contact was then made with relevant departments at the Royal London Hospital where management decisions are made for both units. Interviews were held at the Royal London Hospital with the pharmacy department to obtain the costs of medications. Finance managers were contacted for the costs of equipment, stock and the overall running costs of the unit but it was not possible to obtain data for unit overheads. Ambulance service providers were interviewed for the costs of transfer between the birth centre and the hospital. Equipment costs were discounted over five years, at a 3.5% discount rate. Specific cost information for equipment and medical supplies were standardised using the NHS supply chain catalogue 2009 (National Health Service Supply Chain, 2009). Secondary unit costs were applied to resource items when required, for example; the per diem cost of neonatal intensive care. Unit costs were cross-referenced with the Department of Health reference costs and the Unit Costs of Health and Social Care compendium (Department of Health, 2010, Curtis, 2010). Drug costs not obtained from primary data were obtained from the British National Formulary (British Medical Association and Royal Pharmaceutical Society of Great Britain, 2010).

The same midwifery bands were used for midwifery time in each setting (band 6 or 7) though varying proportions of committed time per episode were apportioned

depending on the responsibilities and activities of the midwives in each setting. Midwifery care allocated to women who started care at the Barkantine was allocated to ‘continuous’ care and following discussions with senior midwives, was apportioned at 80% per hour of contact. In the Royal London Hospital, midwifery care was estimated ‘per ward’ or setting (such as antenatal assessment, labour ward or theatre), and allocated according to the stage and duration of labour, and the procedures required. Care at the Barkantine and the Royal London Hospital reflect differences in resource use between the groups. At the Barkantine Birth Centre, the women were generally admitted to a birthing room and usually stayed in the room until discharge. Midwifery care, estimated to be continuous from admission to the end of third stage labour was thus costed separately from other procedures.

4.5 Data analysis

The characteristics of the patients attending the Barkantine and the Royal London Hospital were compared using the Pearson's chi-squared test. The resource use values were combined with unit costs to generate estimates of costs of maternity care for both mother and baby from admission to discharge in both units, inclusive of transfer between the units. Mean imputation was used for estimating the missing data for resources use and outcomes in the analysis, though this was minimal and less than ten percent of the overall dataset. Comparisons were made and were expressed as mean differences in resource use and costs with 95% confidence intervals (CIs) where applicable. Although the cost data were skewed, the arithmetic mean was chosen as it is the most informative measure for cost data because measures other than the arithmetic mean (such as transformed data or medians) are complex to understand and can be associated with misleading

conclusions drawn by policy makers. (Thompson and Barber, 2005) In addition to Student t tests of cost differences, non-parametric bootstrap estimation was used to derive 95% CIs for the mean total cost difference between the comparison groups (Dixon, 1993). Each of these confidence intervals was calculated using 1000 bias-corrected bootstrap replications. All analyses were performed with a microcomputer using the Statistical Package for the Social Sciences (SPSS) (version 17.0; SPSS Inc, Chicago, I11) and Microsoft Excel 2007 software (Microsoft Corporation, WA).

4.6 Results

4.6.1 Study Population

Data were extracted from a total of 331 sets of clinical notes. The socio-demographic characteristics of the women giving birth in the two settings are shown in Table 8.1A, appendix 8. Differences between the patient groups are evident. English was the primary language for most of the women who began labour care at the Barkantine (93%). The predominant category for ethnicity was White British (43%), most were married or living with their partner (74%), almost all did not need support from interpreters (93%) and one half had partners with higher managerial and professional occupations [combined NS-SEC groups 1 and 2 (53%)]. In contrast, equal proportions of English and Bengali speaking women were represented at the Royal London Hospital (30.5%, $p \leq 0.001$) and twenty-six percent required translation by an interpreter. The predominant maternal ethnicity was Asian, which included women from India, Pakistan and Bangladesh (77.4%). Six percent were classified as White British. Fifty four percent (compared with

74%) were married or living with a partner (p≤0.001). Twenty percent of partners were classified as coming from higher managerial and professional groups (combined NS-SEC groups 1 and 2 (19.5%)), compared with 53% at the Barkantine. Twenty-six percent were classified as coming from the lowest occupational group, with almost ten percent unemployed (9.1%). Socio-economic data was missing for approximately one third of women commencing labour care at the Royal London Hospital, because this item was not available in the obstetric summaries.

4.6.2 Resource use

Mean values for procedures administered to women during intrapartum care showed differences between the two birth settings (see table 9.1 A in appendix 9).

During the first stage of labour, more women used a birth pool for pain relief at the Barkantine (0.71 compared to 0.01 p≤0.001) and were more likely to experience fetal heart monitoring without a cardiotocograph (0.75 compared to 0.45, p≤0.001). Epidural use was less common (0.09 compared with 0.18, p=0.01), and women would transfer to the Royal London Hospital to have an epidural. Approximately thirty percent of women who started labour care at the Barkantine transferred (0.32 compared with 0.00); though data were not collected on whether this was before or after birth. There were no transfers of women from the Royal London Hospital to any other unit.

Spontaneous vaginal deliveries were higher among women who started labour at the Barkantine (0.85 compared with 0.73 p=0.007). Mean numbers of assisted

deliveries were also similar; ventouse (0.05 compared with 0.06, p=0.76), forceps (0.04 compared with 0.04 p=0.74). There were fewer caesarean sections (0.07 compared with 0.17) following care at the Barkantine. (p=0.003) but more perineal suturing (0.49 compared with 0.41, p=0.19).

Women who started labour care at the Barkantine stayed longer in postnatal care (2.0 days compared with 1.2, p=0.002). One woman who started care at the Barkantine spent a day in high dependency care; one woman who started care in the Royal London Hospital spent a day in intensive care. The mean differences in numbers of days spent in neonatal care were not significant, and there was low use of higher level following care in both units.

4.6.3 Economic costs

Resource use values were combined with the unit costs (table 10.1A in appendix 10) to estimate the total costs of intrapartum care from admission to discharge by category. The costs shown in table 11.1A (in appendix 11) are estimates that combine midwifery care and equipment for each procedure, specific to each intended place of birth. The average cost of midwifery care for women at the Barkantine was £99 (SD 114.2). Women presenting at the Royal London Hospital were admitted to an admission or triage area, and were monitored with a cardiotocograph. Both clinical and midwifery staff might attend to a women at admission, and assessments such as vaginal examinations were included in the cost category.

The cost attributable to epidural use was greater among women who started labour in the Royal London Hospital, reflecting a higher uptake there. The unit cost of a transfer from the Barkantine to the Royal London Hospital was estimated as £255.16, with an additional £230 if the baby was transferred separately. The total cost of transfer, when averaged across all of the Barkantine study participants was £93.50 per transfer. Emergency ambulance staff and one midwife were estimated to have accompanied the transferred mother or baby. Time to admission in a ward in the Royal London hospital was estimated for each transfer (mean cost £66.80, table11.1A). This was calculated as the time differential between the length of the transfer and the commencement of care in the designated setting (admission area, labour ward, theatre). Data were collected on whether a consultant assessed the woman on arrival and this was also included in the cost estimate.

The Royal London Hospital had a higher mean cost of lower section caesarean section, with more women having the procedure (£210.20 compared to £81.1, p=0.01). The cost attributed to staff care was higher for the second stage of labour at the Royal London Hospital (mean cost £16 compared to £9, $p \leq 0.001$), and was likely to be due to the extra clinical staff attending assisted deliveries for a short time period.

The cost of postnatal care for women who planned their labour in the Barkantine was higher overall (£964 per patient compared to £577.5, $p \leq 0.001$) reflecting a longer duration of postnatal stay. The unit cost estimate for postnatal stay was high, and variation the unit costs in a sensitivity analysis was undertaken. There were no significant differences between the mean costs of the other postpartum

levels of care for the mother and baby (adult intensive care, neonatal intensive care and special baby care).

With the exclusion of a theatre-based repair of a third degree perineal trauma, no mothers had surgery for complications. Complications for mothers postnatally who commenced labour care at the Royal London hospital included shortness of breath, which required an ECG Xray, a perineal haemotoma and perineal infections treated with antibiotics. A few mothers were noted to be anaemic. Neonatal complications where labour commenced at the Royal London Hospital included a baby with mild renal pelvic dilatation and another with haematuria. One baby had papules in its mouth. One baby was admitted to intensive care having developed pneumonia. One baby was diagnosed with a cleft palate, but did not receive a higher level of care prior to postnatal discharge. One baby was transferred after birth from the Royal London Hospital to Great Ormond Street Hospital.

Although not the main focus of the economic component of the study, data were collected on the initiation of breastfeeding, although half of these data were missing from clinical notes at the Royal London Hospital. Ninety percent of the women who planned birth at the Barkantine intended to exclusively breastfeed. Eighty-seven percent of the mothers breastfed their baby for the first feed and seventy three percent were exclusively breastfeeding their babies at discharge. Eighty percent stated they had received breastfeeding support by an attending midwife. In contrast, fifty percent of women breastfed the baby for its first feed at the Royal London Hospital and twenty five percent were exclusively breastfeeding at discharge. Fifty percent said they had received breastfeeding support by an

attending midwife, a midwifery care assistant or a peer supporter. Differences in the establishment of breastfeeding between the two birth settings are evident. Women spent more time on average in post-natal care prior to discharge from the Barkantine; and presumably this would have given them more time to establish breastfeeding and to recover from giving birth.

The total average cost per mother and baby initiating her intrapartum care at the Barkantine was £1348.6, approximately £850 per patient lower than the average cost per mother and baby who received all their care at the Royal London Hospital. This total cost estimate was £2200.70. The bootstrap arithmetic mean cost for the Barkantine Birth centre was £1353.51 (95%CI 1097.3, 1644.19) and the bootstrap arithmetic mean cost for the Royal London Hospital was £2273.35 (95%CI 563.27, 8273.26). The bootstrap arithmetic mean total cost difference between the two units is £850.32 (-265.9, 2032.9). These costs reflected bottom up costing per patient, from admission to discharge, including transfer but excluding unit overheads and running costs.

4.7 Discussion

4.7.1 Findings from the study

The findings of this study would imply that planning intrapartum care at the newly established Barkantine Birth Centre is a viable option for women at low risk of complications at labour onset and who are planning birth in inner-city Tower Hamlets. However, it was not powered to calculate significant differences in

maternal or perinatal outcomes, and was an exploratory analysis in preparation for the Birthplace cost-effectiveness study. The study's remit was designed to assess the uptake and appropriateness of the birth centre for women in the catchment area. Originally patient preferences data, collected through purpose-designed discrete choice experiments was to be carried out as part of the main study's data collection and to be linked to costing research. Delays in ethics approval, research and development approval and the recruitment of midwives to capture the economic data meant that this was not carried out. Consequently only the cost date collection was carried out, and so the study was used solely as a vehicle for detailed resource use and unit cost data collection. It seemed possible, given that cost data had been collected for each pilot site, to undertake a cost 'comparison' analysis in the form of a CMA. A literature search then showed however that CMA's are not appropriate because they introduce bias measures of uncertainty, causing overestimation or underestimation of the value of information and the probability that treatment is cost-effective. Cost-effectiveness analysis (including evaluation of the joint distribution of costs and benefits) is therefore required to avoid biased estimation of uncertainty. Thus, in view of these findings, the study was used as solely as a vehicle to obtain cost data.

The results of the study show marked differences in the socio-economic characteristics of the participants between the two settings, likely to place a higher resource burden on the Royal London Hospital, for example with regards to the interpretation requirements of non-English speaking women. The findings suggest that the two birth settings are providing care for two very different socio-economic populations within the catchment area but a major limitation of the study is that it did not account for parity, hence parity could not be adjusted for in the cost

differences between the settings and in differences in labour duration, mode of birth and maternal and perinatal outcome.

It has been suggested that giving birth in free-standing midwifery units has the potential to reduce medical intervention and the need for assisted delivery, and to increase breastfeeding rates (Hodnett et al., 2010, Walsh and Downe, 2004). Women who planned their birth at the Barkantine received more continuous midwifery care and experienced higher rates of spontaneous vaginal delivery, greater use of a birth pool, less epidural use, similar rates of birth interventions with forceps, similar rates of perineal repair, lower rates of caesarean section, higher rates of established breastfeeding and longer durations of post-natal stay when compared with those who planned their birth at the Royal London Hospital. The spontaneous vertex delivery rate was approximately ten percent higher among women who started labour care in the Barkantine Birth Centre, and epidural rates were approximately ten percent lower. These factors will be explored in more detail in the next chapter, utilising data from the main Birthplace prospective cohort study in the full cost-effectiveness analysis, which shows the total cost per planned place of birth adjusted for maternal characteristics including parity. No conclusions can be drawn about the overall running costs and the affordability of the centre as this was not explored.

To conclude therefore, the Barkantine study enabled the collection of detailed resource use data for intrapartum care, and access to local management protocols and care profiles which informed the design of the data collection of the Birthplace individual level cost-effectiveness analysis. Participation in the study highlighted the cost and resources use interaction between maternity settings within a trust,

as well as providing the basis for detailed data collection. After the publication of the Birthplace cost-effectiveness analysis (which is described in the next chapter), a summary of the overall costing study, and its relevance to the larger Birthplace study was presented to the Maternity Health Improvement subgroup at the Barts and London Trust in early 2012. The group is responsible for the development and implementation of 'maternity health improvement' and they report to the Trust's maternity strategic board. They are now planning to explore costing strategies and budgetary target setting with the aim of improving maternal and perinatal outcomes. This case study and the main Birthplace programme enabled us to explore economic aspects of intrapartum care which had not been previously researched.

Chapter 5

5 Birthplace cost-effectiveness analysis of planned place of birth: individual level analysis

Introduction

Evidence on the cost-effectiveness of birth in alternative settings is a priority area for maternity policy, as was highlighted by the recent National Institute for Health and Clinical Excellence (NICE) clinical guidelines on intrapartum care. In 2007, NICE reviewed the available economic evidence and attempted to populate a decision-analytic model for place of birth; and they concluded that

> '*the poor quality of the UK data on health outcomes by place of birth makes it extremely difficult to make meaningful comparisons across different birth settings at the current time. These limitations in the data mean that good evidence-based conclusions about the relative cost-effectiveness of different birth settings in the UK cannot be made…The main conclusion to be drawn is that there is a need for better data.*' (National Collaborating Centre for Women's and Children's Health, 2007).

The gap in evidence is critical as reliable evidence is needed by service commissioners and clinical managers, policy makers and parent representatives for planning maternity services; health professionals for guiding practice; and women and their families for making informed decisions about their planned place of birth.

The previous chapter (chapter 4) described a cost-minimisation analysis which enabled the collection of detailed resource use data for intrapartum, postnatal and neonatal care from two units within a London trust; an obstetric unit (OU) and a birth centre (FMU). Participation in the study provided a template for detailed data

collection for a *cost-effectiveness analysis for all four possible settings for birth in the NHS* and this is described in this chapter; chapter 5.

5.1 Aims and objectives

This aims of this chapter are to estimate the cost-effectiveness of four settings for birth: home, FMU, AMU and OU, for women and babies at 'low risk' of complications prior to the onset of labour using individual level data collected for the Birthplace prospective cohort study (hereafter cohort study).

5.1.1 Objectives

1. To estimate the cost-effectiveness of births planned at home, in FMUs and in AMUs, in comparison with births planned in OUs, in terms of incremental cost per adverse perinatal outcome avoided for babies of women judged to be at 'low risk' of complications prior to the onset of labour.

The composite measure of adverse perinatal outcome used for the economic evaluation was defined as 'intrapartum stillbirth, early neonatal mortality and specific neonatal morbidities', and was the primary effectiveness measure in the cohort study. This composite measure is described in more detail in chapter 2.

2. To estimate the cost-effectiveness of births planned at home, in FMUs and in AMUs, in comparison with births planned in OUs, in terms of incremental cost per maternal morbidity avoided for women judged to be at 'low risk' of complications prior to the onset of labour.

The composite measure of maternal morbidity used for the economic evaluation represented a subset of secondary outcomes in the cohort study and included at least one of the following: general anaesthetic; instrumental birth or intrapartum caesarean section; third or fourth degree perineal trauma; blood transfusion; admission to an intensive therapy unit, high dependency unit or specialist unit; and maternal death (within 42 days of giving birth).

3. To estimate the cost-effectiveness of births planned at home, in FMUs and in AMUs, in comparison with births planned in OUs, in terms of incremental cost per additional 'normal birth' for women judged to be at 'low risk' of complications prior to the onset of labour.

'Normal birth' was defined by the Maternity Care Working Party as birth without any of the following interventions: induction of labour; epidural or spinal analgesia; general anaesthetic; episiotomy; forceps, ventouse or caesarean section (Maternity Care Working Party, 2007).

5.2 Methods

5.2.1 Economic evaluation perspective and time horizon

In this analysis, the incremental costs and incremental effectiveness of planned birth at home, in an AMU or in a FMU for women at 'low risk' of complications prior to the onset of labour were compared with a reference birth setting, namely an OU. The OU group contains the largest number of eligible births so using it as a reference group maximised statistical efficiency and this does not imply that OUs should be the standard or optimal place of birth. All four planned places of birth

were additionally compared in one analysis and the differences between them expressed as ICERs.

The economic evaluation was conducted from a health system perspective and consequently only direct costs to the NHS were included. The time horizon primarily mirrored the duration of follow-up of the cohort study, which identified women at the start of their care in labour and was completed when the intrapartum and related postnatal care for both mother and baby ended, be it at home or discharge from a midwifery unit or hospital. This might be anytime between a few hours or a few days after the birth of the baby. If higher level care following the birth was required for either the mother or the baby, or both, this was included in the economic evaluation.

5.2.2 Study population

Chapter 2 presented an overview of the Birthplace Programme of Research. The characteristics of the study population in the cohort study are described in section 2.3. In brief, the cohort study included 79,774 eligible women, 64,538 of whom were at 'low risk' of complications prior to the onset of labour. All women attended by a NHS midwife during labour in their planned place of birth, for any amount of time, were eligible for inclusion with the exception of women who had an elective caesarean section or caesarean section before the onset of labour, presented in preterm labour (<37 weeks gestation), had a multiple pregnancy, or who were 'unbooked' (i.e. had received no antenatal care). Women with stillbirths occurring prior to the start of care in labour were excluded. The women were recruited from 142 of 147 trusts providing home birth services, 53 of 56 freestanding midwifery units, 43 of 51 alongside midwifery units and a stratified random sample of 36 of 180 obstetric units in England. Participating units/trusts collected data for varying

periods of time within the study period 1 April 2008 to 30 April 2010. Additional information including a description of the participating trusts, selection of OUs, study eligibility criteria, sample size calculations, derivation of risk status and potential confounders, derivation of denominator data, and the analyses and sensitivity analyses undertaken are all available in the cohort study report (Hollowell et al., 2010). The study population for the economic evaluation included all women where the primary outcome and potential confounders were not missing.

5.2.3 Resource use data collection

5.2.3.1 Measurement of resource use data

As mentioned in chapter 2, individual data collection forms (see appendix 2) were designed as part of the cohort study and were completed by the attending midwife at the time of each woman's labour episode. In addition, maternal and neonatal morbidity forms were completed during or after maternal or neonatal discharge. The resource use data collected from these Birthplace data collection forms were identified, and additional data needing to be collected for costing purposes are described below.

5.2.3.2 Additional resource use data collection to supplement the Birthplace data collection forms

Additional data collection for intrapartum resource use was planned, specifically to identify and quantify the resource use variables more thoroughly. The additional resource use variables are shown in columns 4 and 5 in table 12.1A in Appendix 12. Five informal focus groups were held with Birthplace local coordinating

midwives who were working in all types of units and maternity services, and who attended Birthplace meetings at several time points, early in the project timeline. The optimal ways of obtaining resource use data, to capture variation in the data, and to collect related ‘top down’ and ‘bottom up’ cost data were discussed in these meetings. Following the focus group meetings, structured resource use data collection forms for resource use measurement were designed and tested (appendices 6, 7, 13 and 14). They represent a detailed approach to capturing all possible NHS resources used in the care of the mother and baby during the period between admission and discharge in midwifery units and hospitals.

As stated previously (chapter 4), in developing the supplementary data collection forms, it was possible to draw on the work carried out in the adjunct Barkantine cost-minimisation study. The data collection forms were a template designed to capture the ‘pathway of care’ experienced by a woman progressing through the stages of labour according to a planned place of birth, reflecting the design of the cohort study. Having been piloted in the Barkantine study, they were then assessed individually in a structured interview with each of the four Birthplace regional lead midwives, to take account of differences in regional maternity care practices. The interviews with the Birthplace appointed regional lead midwives were undertaken at Liverpool Women's Hospital NHS Foundation Trust, Taunton and Somerset NHS Trust, the Oxford Radcliffe Hospitals NHS Trust and Kings College Hospital NHS Foundation Trust, and the data were collected from these trusts. The trusts represented contrasting geographical regions of England (North, South west, Central and London), as well as providing different configurations of maternity services, and were chosen so that the variations in region and service configuration could be captured in the unit cost estimations for this report. A working document was generated to capture the generalisability and variability in the process management of labour and birth in the interviews (appendix 13). For

each scenario the regional lead midwife was asked to describe in detail the 'standard procedures' that would be undertaken for labour and birth events and, where possible, the typical ratios of 'staff to woman' care. Scenarios were then varied between the least and the most complex, and included a description of the associated change in activity, staffing levels, and related resource use. Each of the interviews included approximately one and a half hours of structured, recorded time plus an additional one and a half to two hours of discussion and clarification. The interviews were recorded and then transcribed. The data were then compiled into comparative resource use spreadsheets and cross-referenced.

5.2.4 Unit cost data collection

The research for the costing component of this economic evaluation used both 'top down' and 'bottom up' methods to identify costs relevant to Birthplace. All unit costs in this study were expressed in pounds sterling and valued at 2009-10 prices.

5.2.4.1 'Bottom up' unit cost data

Prior to interview the regional lead midwives were sent a lengthy cost sheet (appendix 14), which listed every item identified in an action, event or procedure from the structured questionnaires (appendices 2 and 13) and the data collection forms from the adjunct study (appendices 6 and 7). Midwives documented the staffing, medications and equipment that might be required for birth related procedures such as augmentation, different modes of delivery or perineal repair. They were asked to update the sheet to specify their own resource components according to their trust or unit protocols and policies. This captured all resource components that might be used in any labour, birth or after birth event. The

regional lead midwives were asked to supply the contact details for the person who could be contacted to price each resource component or to supply it themselves.

The following procedures were microcosted using ‘bottom up’ methods (see appendix 15 for details):

- Homebirth delivery pack
- NHS re-imbursement for midwifery travel costs to attend a birth at home
- NHS re-imbursement for midwifery travel costs to attend a transfer from a planned birth at home
- Entonox for a home-birth
- Augmentation of labour with syntocinon
- Epidural and spinal analgesia
- General anaesthetic
- Spontaneous vertex birth
- Ventouse birth
- Forceps delivery
- Caesarean section
- Active management of the third stage of labour
- Suturing episiotomy
- Suturing third and fourth degree perineal tear
- Manual removal of the placenta
- Blood transfusion

- Care following a stillbirth or neonatal death

Unit costs derived from bottom up costing methods can differ because of differences in management protocols e.g. staffing inputs) and other local variations, particularly differences in staffing levels due to the type of maternity unit represented (i.e. OU, AMU or FMU). For example, for Birthplace the average cost of the of the assisted birth using a ventouse in obstetric care included an obstetric registrar and a paediatrician present. Hence the combined additional staffing cost of £194.68 paediatrician and £97.34 obstetric registrar) which account for the difference between the costs in each study (Barkantine and Birthplace).

5.2.4.2 'Top down' cost data

All cost data that could contribute to a 'total cost per woman per intrapartum care episode' were collected. Finance managers were contacted in each trust where there was a regional co-ordinating midwife working for Birthplace to obtain details of unit overheads and all other costs involved in running the unit. These included management and administrative costs, operational costs (including heating and lighting, training, building maintenance), indirect overheads including the personnel and finance functions, and capital costs based on the new build and land requirements of NHS facilities. They also included the proportional use of other hospital services such as screening, haematology and pathology and followed the costing guidelines detailed in the NHS costing manual (Department of Health Gateway Reference, 2010). Contact with finance managers was often difficult to attain and patchy. Finance staff changes, work commitments and a lack of comparable data collection methodology in the finance departments resulted in inadequate responses and incomplete data returns. As a consequence, any data that were received were included in a purpose designed model to calculate trust

overheads apportioned to intrapartum care. The model used data from the Healthcare Commission's review of maternity services (published January 2008, which was mandatory and captured unit data from all acute trusts providing maternity care in England) to generate running costs, bed days and occupancy rates adjusted for unit operational days per year, numbers of women delivering and intrapartum transfers. The data for overheads that were received from trust finance departments were subsequently included in the model, and the disaggregated costs were modelled into a generic 'overheads cost per place of birth per hour' variable. Management, supervision and administration time was included in the overheads costings. This cost was then varied in a sensitivity analysis.

Staff costs for midwives and clinicians who have direct contact with women during their episode of labour care were excluded from the overheads calculations, because they were separately attributed to each individual woman's duration of labour care. Firstly, midwifery staff time which is considered to be the main cost driver generalisable across all settings for birth, was allocated directly to the duration (hours) of the labour episode per woman. This duration variable was calculated directly from the information returned in the Birthplace data collection forms. The midwifery staff cost was calculated using data from the Unit Costs of Health and Social Care 2010 compendium, developed by the Personal Social Services Research Unit (PSSRU) (Curtis, 2010). This unit cost therefore included the midpoint salary for both a Band 6 and 7 midwife, including salary oncosts, indirect and direct overheads and contribution to qualifications adjusted for working hours per week, study and leave days. The cost of administration of the birth at home service within the community was captured by the 'overheads' cost within the midwifery staffing variable, as apportioned direct and indirect overheads are included in cost calculations for midwifery staff in the PSSRU compendium.

Midwifery staff time was considered to approximate continuous care in the non-OU settings and was calculated to approximate 65% intermittent care in the OU setting. If a woman was transferred into an OU, then her midwifery staffing and overheads costs changed accordingly. These costs were varied in a sensitivity analysis.

The Clinical Negligence Scheme for Trust (CNST) contributions per staff member (per hour) were added to the cost of direct maternity contact time documented for midwifery staff. The actual value of the CNST contribution was developed through primary data collection, in conjunction with the NHS Litigation Authority and was calculated using the contributions to CNST by the trust finance managers we had contacted. Although paid for by the trust as part of overheads, CNST contributions are calculated per whole time equivalent (WTE) staff member using a trust apportioned risk formula, which is measured in terms of clinical specialty, staff grade, proportional WTEs, the numbers of registered births in the trust and a pooled relative risk rating (National Health Service Litigation Authority, 2010). It was allocated directly to the staffing component to capture the real cost of staffing across all settings for birth.

Medical staffing costs were calculated in a similar way, using the costs allocated to direct person contact from data in the PSSRU compendium with the addition of the CNST contribution. Medical staffing (consultant obstetrician, paediatrician, neonatologist, anaesthetist, obstetric registrar and foundation year doctor [including senior house officers]) costs were allocated per patient contact hour and were calculated in this study within labour related events or procedures. Medical staff time was included in events such as the augmentation of labour, administration of an epidural, a general anaesthetic or perineal repair. All unit costs calculated for maternity staffing can be viewed in Appendix 15.

Medication costs were supplemented with data from the British National Formulary, version 61 (British Medical Association and Royal Pharmaceutical Society of Great Britain, 2010). Pharmacy departments had initially been contacted with the aim of capturing variation in medication costs. The response to numerous follow up contacts was minimal with incomplete data returns. The NHS Supply Chain Catalogue version April 2009 was used to capture the costs of resource items such as medical supplies as it was not possible to comprehensively collect these from maternity units (National Health Service Supply Chain, 2009).

The PSSRU compendium of Unit Costs of Health and Social Care and the DH reference costs both include detailed 'bottom up' costing of emergency and non-emergency transfers, including obstetric and neonatal ambulance transfers. Time-weighted cost variables were created from these two sources (Curtis, 2010, Department of Health, 2010). Primary data collection was required for the calculation of other modes of transfer, such as transfer in a helicopter. Only medical staff time was attributed to helicopter transfer as the cost of the service is not funded by the NHS.

The most recently published Department of Health reference costs capture per diem costs for admissions to a neonatal intensive care unit, high dependency care unit or special care baby unit. A per diem cost is also available for adult intensive and high dependency admissions, and for admissions to a specialist ward. The cost of higher level care provided within the labour ward immediately after labour is also included. All Department of Health NHS reference costs used in this study were taken from the reference costs appendix NSRC4: Trust and PCT combined reference cost schedules. (Department of Health, 2010)

5.2.5 Quality of the data

Data management procedures for the cohort study are described in the cohort study report (Birthplace in England Collaborative Group, 2011). The additional resource use and unit cost data collected directly from regional lead midwives were single entered at the NPEU. The data were compiled into comparative resource use spread sheets and cross-referenced between the four trusts. It was then checked for face-validity with two obstetricians at the NPEU and presented to the Birthplace Co-investigator Group in December 2010 and the Birthplace Advisory Group in March 2011.

5.2.6 Representation of cost-effectiveness

Differences in resource use and costs were tested using t tests and differences in effects were tested using the odds ratios from the cohort study data. Cost effectiveness was expressed as incremental cost per (i) adverse perinatal outcome averted, (ii) maternal morbidity avoided and (iii) additional 'normal birth'. All of these analyses were repeated for women without complicating conditions at the start of care in labour. Nonparametric bootstrapping was used to calculate uncertainty around all cost-effectiveness estimates. Non-parametric bootstrapping is a statistical method that estimates measures of distribution for the variables of interest; it is based on repeated sampling (with replacement) from the dataset. This is used to establish confidence intervals for any test statistic and allows for tests of statistical significance (Dixon, 1993). Non-parametric bootstrapping was used to generate 1,000 bias-corrected replications of each of the ICERs, which were represented on four quadrant cost-effectiveness planes. An ICER represents the additional cost of achieving an additional unit of outcome through a course of

action, when compared to the next best alternative, mutually exclusive intervention or strategy. The cost-effectiveness results reflected in the ICER scatterplots reflect data that were weighted for each unit's duration of study participation and takes into account the clustered nature of the data within the cohort study. Probability weights were incorporated in the analysis to adjust for the probability of selection of each woman. The weight applied to each observation was inversely proportional to the probability of selection of the unit and the duration of data collection in that unit. The weights were re-calculated for each bootstrapped sample. All ICERs express bootstrapped weighted data using 1,000 replications with resampling. Decision uncertainty was addressed by estimating net benefit statistics and constructing cost-effectiveness acceptability curves across cost-effectiveness threshold values of between £0 and £100,000 for the outcomes of interest. This range of cost-effectiveness threshold values includes the thresholds implicitly used by NICE for broader cost-effectiveness purposes. Although this study was not able to estimate a cost per quality-adjusted life year (QALY) gained attributable to alternative planned places of birth, the cost-effectiveness thresholds used more broadly by NICE seemed appropriate for the primary outcome measure.

A series of sub-group analyses repeated all analyses by parity sub-group for the primary cost-effectiveness outcome, namely incremental cost per adverse perinatal outcome avoided. In addition, a series of sensitivity analyses was undertaken to explore the implications of uncertainty surrounding the key cost-drivers in intrapartum care and the variables where there was the most uncertainty surrounding the resource use parameters. These included varying the overheads, occupancy rates and staffing costs attributed to the duration of labour care. The ICERs were re-calculated following these sensitivity analyses.

Multivariable analyses of the outcomes data are reported in the cohort study report (Hollowell et al., 2010). Multiple regression was used to estimate the differences in total cost between the settings for birth and to adjust for potential confounders such as maternal age, parity, ethnicity, understanding of English, marital status, BMI, index of multiple deprivation score, parity and gestation, which may each be associated with planned place of birth and with adverse outcomes. For the generalized linear model (GLM) on costs, a gamma distribution and identity link function was selected in preference to alternative distributional forms and link functions on the basis of its low Akaike's Information Criterion (AIC) statistic. The GLM approximates linear regression by allowing the linear model to be related to the response variable via a link function and by allowing the magnitude of the variance of each measurement to be a function of its predicted value. GLM has the ability to predict confidence bounds. In addition to predicting a best estimate and a probability for each row, GLM identifies an interval wherein the prediction (regression) will lie.

The data were originally entered into Microsoft Access software. All analyses were performed using Stata version 11, SPSS (the Statistical Package for the Social Science) version 17 (SPSS, Chicago, IL) and Microsoft Excel (Microsoft, Seattle, WA) 2010 software.

5.3 Results

5.3.1 Study population

A total of 62,036 women at ‘low risk’ of complications prior to the onset of labour, where the primary outcome data and potential confounders were not missing, were included in this analysis. This corresponds to the population used for the adjusted analyses in the cohort study (Hollowell et al., 2010). Of these, 18,847

planned to give birth in an OU, 16,187 planned to give birth at home, 10,971 planned to give birth in a freestanding midwifery unit and 16,031 planned to give birth in an alongside midwifery unit. The socio-demographic and clinical effectiveness differences between the birth settings are presented in detail in the cohort study report (Hollowell et al., 2010).

There were unexpected differences between planned places of birth in the proportion of women at 'low risk' with complicating conditions identified by the attending midwife at the start of care in labour. Almost 20% of women whose planned place of birth was an obstetric unit had at least one complicating condition noted at the start of care in labour compared with fewer than 7% for all other planned places of birth. The higher prevalence of complicating conditions at the start of care in labour was discussed by the co-investigators and the independent Advisory Group prior to the analysis of the primary outcome; it was agreed to modify the analysis plan to include additional analyses of outcomes by planned place of birth, restricted to women without complicating conditions at the start of labour care. This was replicated in the cost-effectiveness analyses and separate cost-effectiveness results were generated for women without complicating conditions for each measure of outcome.

5.3.2 Resource use

Table 16.1 in appendix 16 shows the resource use values from the start to end of the episode of labour care, including post-natal, neonatal and maternal higher level admissions for each planned place of birth. The values are given as means (standard deviations).

The mean duration (hours) of labour care for all women who were not transferred from their initial planned place of birth differed within a range of approximately 2.4 hours. It was longest in the OU (9.01), similar in the AMU (7.92) and FMU (7.49), and shortest for home (6.61). For the planned non-OU births where a transfer did occur, the duration of labour care prior to transfer was longest in the FMU (6.68), similar in the AMU (6.5), and shortest at home (5.71). For women who were transferred, the duration of transfer (hours) was longer from the FMU compared with home (0.59 versus 0.48) and substantially longer than transfer from the AMU (0.17); this translates to 29 minutes (from home), 35 minutes (from FMU) and 10 minutes (from AMU), respectively. As expected, the predominant mode of transport for transfer from FMU or home was via ambulance or a private car. In contrast, transfer from an AMU was most commonly via a wheelchair or trolley and then a bed. The average duration of labour care (hours) from arrival in the OU after transfer was similar for all women; home (6.8), FMU (6.6) and AMU (6.8).

The highest rates of spontaneous vertex birth occurred for planned birth at home (0.93), then in FMUs (0.91), AMUs (0.86) and lastly in the OUs (0.74). A much higher assisted delivery rate (with ventouse, forceps or a caesarean) occurred for women who had planned their birth in an OU. The intrapartum caesarean section rate was highest in the OU (11%) compared with home (3%), FMU (4%) and AMU (4%). The assisted delivery rate was lowest in the planned home birth group. Differences in mode of birth and receipt of intervention are described in more detail in the cohort study report. These differences affect costs.

A higher proportion of women who planned their birth in the OU had their labour augmented with syntocinon. In the OU, this proportion decreased when women with complicating conditions at the start of care in labour were excluded from the analysis, though there was little change in the other settings for birth when this adjustment was made. Proportionately more women who planned their birth in an

OU received an epidural (0.31 compared with 0.08 (home), 0.11 (FMU) and 0.15 (AMU)). Similarly, a higher proportion of women who planned their birth in the OU had active management of the third stage of labour and an episiotomy. The proportion of women with perineal trauma ranged between 0.032 (OU) and 0.019 (home). A higher proportion of women who planned birth in the OU received high dependency care (increased observation) within the labour ward immediately after birth compared with women with a planned non-OU birth. Most of these cases involved increased care for women following an operative delivery (0.18 compared with 0.05 (home), 0.07 (FMU) and 0.09 (AMU)). There were very small absolute numbers of women admitted to higher level care (intensive or high dependency care) after the birth, more women were admitted from planned OU and AMU settings. Substantially more babies were admitted to neonatal care from the planned OU group, compared with other settings. An extremely small number of babies received ECMO or total body cooling. Very few babies died (either as a stillbirth or early neonatal death). Additional reference to the weighted event rates of the primary or secondary outcomes or interventions can be viewed in greater detail in the cohort study report.

5.3.3 Costs

Table 4 shows the unit costs for key resource items, episodes or procedures. Unit overheads and midwifery staffing were apportioned to each woman according to her actual place of labour and birth, and the duration in hours that they spent there. If a woman was transferred, then her overheads and staffing costs were adjusted accordingly. Analyses were by ‘intention to treat’, so the final costs incurred were attributed to the setting where the woman planned to give birth at the start of care in labour and included costs when she transferred care. Medical

staff time was incorporated into specific intrapartum care procedures. The detailed bottom up costing results can be viewed in Appendix 15.

Table 4. Unit costs per resource item (£ sterling, 2009/10 prices)

Resource item (unit)	Unit cost or range	Source of unit cost
GENERIC COSTS APPLIED TO DURATION VARIABLES		
Unit financial overheads (hour)		
OU	63.7 (50.9 – 76.4)	Primary cost data collection
Home	0.0	Primary cost data collection
FMU	55.4 (44.3 – 66.5)	Primary cost data collection
AMU	54.4 (43.5 – 65.3)	Primary cost data collection
Midwifery staffing (hour)		
OU	81.3 Intermittent care 65%	PSSRU Unit Costs of Health and Social care 2010 Primary cost data collection for CNST
Home	81.3 Continuous care plus one extra midwife for an hour at birth	PSSRU Unit Costs of Health and Social care 2010 Primary cost data collection for CNST
FMU	81.3 Continuous care 100%	PSSRU Unit Costs of Health and Social care 2010 Primary cost data collection for CNST
AMU	81.3 Continuous care	PSSRU Unit Costs of Health and Social care 2010 Primary cost data collection for CNST
Medical Consultant (hour)	389.4	PSSRU Unit Costs of Health and Social care 2010 Primary cost data collection for CNST
Registrar (hour)	179.5	PSSRU Unit Costs of Health and Social care 2010 Primary cost data collection for CNST
Foundation House Officer (F2) (hour) Senior House Officer/ Specialty or Core Training year 1	141.8	PSSRU Unit Costs of Health and Social care 2010 Primary cost data collection for CNST

COSTS INCURRED FOR A PLANNED BIRTH AT HOME		
Homebirth packs	34.3	Primary cost data collection
Staff travel to homebirth – distance 23 miles return trip	23.2	Primary cost data collection
COSTS INCURRED FOR PLANNED 'NON-OU BIRTHS' IF TRANSFERRED TO AN OU		
Mode of transfer (per hour)		
Ambulance	402.0	PSSRU Unit Costs of Health and Social care 2010 DH reference costs
Private car	0.0	Cost not attributed to NHS
Wheelchair or trolley	0.01	PSSRU Unit Costs of Health and Social care 2010
Bed	0.01	PSSRU Unit Costs of Health and Social care 2010
Rapid response ambulance car	214	PSSRU Unit Costs of Health and Social care 2010 DH reference costs
Helicopter	144.5	Primary data collection (NHS staff costs only)
Taxi	0.0	Cost not attributed to NHS
No physical transfer	0.0	Cost not attributed to NHS
COSTS INCURRED FOR CARE DURING LABOUR AND BIRTH		
Mode of birth		
Spontaneous vertex birth		
OU	26.3	Primary cost data collection
Home	28.5	Primary cost data collection
FMU	29.3	Primary cost data collection
AMU	29.3	Primary cost data collection
Vaginal breech birth	99.1	Primary cost data collection
Ventouse	429.2	Primary cost data collection
Forceps	569.9	Primary cost data collection
Caesarean section	1052.6	Primary cost data collection
Procedures related to intrapartum care		
Augmentation	159.1	Primary cost data collection
Epidural/Spinal	311.1	Primary cost data collection
General Anaesthetic	846.5	Primary cost data collection
Active Management of the third stage of labour	4.1	Primary cost data collection

Episiotomy	24.6	Primary cost data collection
Perineal trauma	595.3	Primary cost data collection
ECMO	1651.0	Primary cost data collection
Total body cooling	2110.0	Primary cost data collection
Care following a stillbirth	644	Primary cost data collection
Care following a neonatal death	644	Primary cost data collection
POST NATAL AND HIGHER LEVEL CARE FOR THE MOTHER		
Postnatal care (days)	95	DH reference costs
High dependency care following birth provided within the labour ward (per 4 hours)	80	DH reference costs
Admission to intensive care unit (days)	560	DH reference costs
Admission to high dependency unit (days)	1525	DH reference costs
Admission to specialist care (days)	400	DH reference costs
HIGHER LEVEL OF CARE FOR THE BABY		
Admission to neonatal intensive care unit (days)	1081	DH reference costs
Admission to neonatal high dependency unit (days)	759	DH reference costs
Admission to neonatal specialist care (days)	429	DH reference costs

Table 5 combines resource items and their associated unit costs to generate costs per woman according to planned place of birth. These are shown as means and standard errors. The bootstrap mean differences between the comparison groups for each cost category and 95% bootstrap confidence intervals are also shown in the table.

Unit overheads and staffing costs are shown to be the key cost drivers in the study. The average cost attributed to unit overheads was highest in the planned OU setting (£569.4 compared with £426.1 (FMU), £450.6 (AMU) and £93.1 (home), $p<0.001$). Unit overheads are not directly attributed to women who plan birth at home, but these accrue when the woman is transferred for care in an OU. Thus unit overheads and midwifery staff costs capture both directly apportioned

overheads and staffing, but also capture the adjusted overheads and staff costs following a transfer from any non-OU setting into an OU.

Midwifery staffing, although attributed the same unit cost per hour in all birth settings, was highest in the planned AMU group, reflecting a longer duration of labour care in comparison with the other non-OU settings (£611.0 (AMU) compared with £580.5 (home), £577.9 (FMU) and £472.4 (OU) $p<0.001$). Planned births at home were attributed a second midwife for an hour during the birth of the baby and this is captured in the staffing cost. The calculation of this additional staffing measure was made following consultation about staff to woman ratios from data collection meetings with the Birthplace regional lead midwives. The midwifery staff cost in the OU is the lowest, most likely reflecting the 65% intermittent support during labour allocated there.

Table 5. Mean cost per woman according to planned place of birth for all 'low risk' women

Cost category	OU		Home		FMU		AMU		P value	Bootstrap mean difference (95% CI)		
	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)		OU-Home	OU-FMU	OU-AMU
Overheads	569.4	(2.9)	92.6	(1.9)	426.1	(3.1)	450.6	(2.8)	p<0.001	-475.6 (-482.0, -468.8)	-143.3 (-152.2, -134.9)	-118.7 (-126.9, -110.6)
Midwifery staffing	472.4	(2.4)	580.5	(2.8)	577.9	(3.8)	611.1	(3.4)	p<0.001	108.1 (100.2, 116.4)	105.2 (95.9, 114.4)	138.7 (130.4, 147.2)
Homebirth resources	0.0	(0.0)	111.8	(0.2)	0.0	(0.0)	0.0	(0.0)	p<0.001	111.7 (111.2, 112.1)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)
Transfer	0.0	(0.0)	33.9	(0.7)	49.3	(1.0)	0.003	(0.0)	p<0.001	33.7 (32.4, 35.1)	49.1 (46.9, 51.2)	0.0036 (0.0034, 0.0037)
Procedures after transfer	0.0	(0.0)	53.1	(0.9)	36.4	(0.7)	43.0	(0.6)	p<0.001	53.0 (51.2, 54.8)	36.4 (34.9, 37.8)	42.9 (41.8, 44.2)
Birth	207.0	(2.5)	76.5	(1.5)	93.9	(2.1)	114.1	(1.9)	p<0.001	-130.1 (-135.8, -124.7)	-113.4 (-119.9, -107.2)	-92.9 (-99.2, -86.6)
Procedures during labour care	174.1	(1.9)	49.9	(1.3)	64.9	(1.7)	83.9	(1.5)	p<0.001	-122.8 (-127.1, -118.2)	-109.3 (-114.2, -104.4)	-89.9 (-94.9, -85.1)
Postnatal care	122.0	(0.6)	17.7	(0.4)	127.2	(0.9)	101.9	(0.6)	p<0.001	104.3(-105.9,-102.5)	5.1 (2.7, 7.6)	-20.1 (-22.1, -18.3)
Higher care – mother	21.7	(0.9)	7.9	(0.8)	9.3	(0.9)	11.8	(0.6)	p<0.001	-13.2 (-15.5, -10.8)	-11.9 (-14.3, -9.8)	-9.6 (-11.8, -7.6)
Admission to higher care – baby	64.2	(5.2)	42.1	(4.3)	49.6	(7.5)	44.7	(6.2)	0.037	-21.9 (-36.6, -9.4)	-15.0 (-32.8, -3.7)	-19.6 (-35.6, -1.9)
Total cost	**1631.2**	**(10.1)**	**1066.5**	**(8.9)**	**1434.9**	**(13.5)**	**1461.2**	**(11.1)**	**p<0.001**	**-564.6 (-591.7, -533.9)**	**-195.4 (129.1, -157.4)**	**-169.5 (-199.7, -137.4)**

Table 6. Mean cost per woman according to planned place of birth for women at 'low risk' without complicating conditions at the start of care in labour

Cost category	OU		Home		FMU		AMU		P value	Bootstrap mean difference (95% CI)		
	Mean	(SE)	Mean	(SE)	Mean	(SE)	Mean	(SE)		OU-Home	OU-FMU	OU-AMU
Overheads	544.5	(3.1)	81.3	(1.8)	419.7	(3.2)	441.5	(2.8)	p<0.001	-463.2 (-473.6, -453.8)	-125.2 (-138.8, -111.5)	-103.2 (-115.7, -90.2)
Midwifery staffing	451.7	(2.6)	573.6	(2.9)	572.6	(3.9)	602.9	(3.5)	p<0.001	121.9.0 (109.8, 133.3)	-120.9 (107.7, 137.6)	151.1 (136.9, 165.2)
Homebirth resources	0.0	(0.0)	112.0	(0.2)	0.0	(0.0)	0.0	(0.0)	p<0.001	111.7 (111.2, 112.1)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)
Transfer	0.0	(0.0)	31.6	(0.7)	46.3	(1.0)	0.003	(0.0)	p<0.001	31.6 (29.1, 33.8)	46.2 (42.2, 49.2)	0.0036 (0.0034, 0.0037)
Procedures after transfer	0.0	(0.0)	49.4	(0.9)	34.0	(0.7)	40.3	(0.6)	p<0.001	49.4 (47.6, 51.2)	33.9 (32.5, 35.4)	40.2 (38.9, 41.5)
Birth	175.4	(2.5)	71.1	(1.5)	89.2	(2.1)	108.2	(1.9)	p<0.001	-104.4 (-113.3, -95.8)	-86.2 (-95.9, -76.2)	-67.4 (-76.1, -56.1)
Procedures during labour care	151.5	(2.0)	46.1	(1.2)	61.5	(1.7)	79.6	(1.5)	p<0.001	-105.3 (-112.7, -96.1)	-90.1 (-98.2, -82.4)	-71.8 (-78.9, -63.3)
Postnatal care	114.2	(0.7)	15.5	(0.4)	125.7	(0.9)	100.0	(0.6)	p<0.001	-98.8 (-101.3, -96.1)	11.5 (7.63, 14.9)	-14.23 (-17.7, -11.7)
Admission to higher care – mother	18.5	(0.9)	7.3	(0.8)	8.9	(0.9)	11.0	(0.6)	p<0.001	-11.3 (-15.3, -7.6)	-9.6 (-15.4, -5.1)	-7.6 (-10.8, -4.5)
Admission to higher care – baby	54.4	(5.8)	37.6	(4.3)	47.3	(7.8)	42.6	(6.4)	0.037	-16.9 (-39.5, 5.5)	-7.02 (-38.9, -35.1)	-11.7 (-27.1, 20.3)
Total cost	**1510.6**	**(10.1)**	**1026.9**	**(8.8)**	**1405.0**	**(13.7)**	**1426.4**	**(11.3)**	**p<0.001**	**-483.8 (-537.5, -435.6)**	**-105.1 (-165.4, -45.6)**	**-84.0 (-114.4, -55.2)**

The mean cost of transfer per woman was highest for the FMU group compared with the other planned places of birth, though a small absolute cost, which reflected the slightly greater use of ambulance services and the comparatively longer distances travelled from FMUs.

The mean cost of procedures during labour care included the costs of augmentation of labour, epidural or spinal analgesia, general anaesthesia, episiotomy, active management of the third stage of labour, repair of perineal trauma and the cost of blood transfusion. It was substantially higher in the women who planned to give birth in the OU (£174.1) compared with the planned non-OU settings; £64.9 (FMU), £83.9 (AMU) and £49.9 (home), $p<0.001$.

Although the absolute costs for higher level post-natal and neonatal care were small, and few mothers or babies were admitted, the costs were still significantly higher in the planned OU birth setting, ($p<0.05$).

The 'normal birth' definition used by the Maternity Care Working Party as birth with none of the following interventions: induction of labour, epidural or spinal analgesia; general anaesthetic; episiotomy; forceps, ventouse or caesarean section. Women with an induction of labour were excluded from the 'low risk' cohort included in this study. The following average costs were generated for women in all planned settings for birth; the average cost of 'normal birth' was £938; the average cost of a spontaneous vaginal birth without complications was £947, which is similar to the HRG code for 'NZ11B normal delivery no clinical complications' estimated at £976. 'NZ11A' is the HRG code for 'normal delivery with clinical complications' costing £1,711; we calculated the average cost of spontaneous vaginal birth with clinical complications to be £2,081. Our results tended to show similar costs when compared to the HRG code estimates for straightforward uncomplicated births. Our estimates were slightly lower, possibly

because women with high risk of complications at the start of care in labour were excluded from our analysis. Our cost estimates tended to be elevated compared with HRG costs for deliveries with clinical complications, for example, we estimated the average cost of a spontaneous vaginal birth with an epidural and with complications to be £2,448, compared with the HRG code NZ11C, which estimated 'normal delivery with epidural with clinical complications' at £1,868.

Total costs capture the resource use and the unit costs associated with them. The total mean costs per 'low risk' woman planning a birth in the alternative settings at the start of care in labour were as follows: OU £1,631.2, AMU £1,461.2, FMU £1,434.9 and home £1,066.5.

When women with complicating conditions at the start of care in labour were excluded from the analysis of mean cost per women, the average costs generally reduced, although the patterns of resource use and average costs that were estimated for the planned OU and non-OU settings remained similar to those shown in table 5.

Health care cost data tend to be highly skewed. This can only be partly addressed using parametric methods because the arithmetic mean is the informative instrument, providing information about the cost of treating all patients, which is required for healthcare policy decisions (Bradley et al., 1990). In order to fully address the skewed nature of the data we performed additional non-parametric analyses on the cost differences between the planned settings for birth. Initially, we conducted a bootstrap (using 1,000 replications with resampling) of the mean cost differences for each cost category within this dataset, for women both with and without complicating conditions at the start of care in labour as shown in tables 2 and 3.

The bootstrapped mean differences in total cost between the planned OU and non-OU settings for all ‘low risk’ women are: -£564.6 (reflecting the average cost saving of planned birth at home compared with an OU), -£195.4 (reflecting the average cost saving of planned birth in a FMU compared with an OU) and -£169.5 (reflecting the average cost saving of planned birth in an AMU compared with an OU).

This was repeated for women at ‘low risk’ without complicating conditions at the start of care in labour. Total mean costs decreased across all planned settings for birth, but this reduction was substantial for births planned in an OU and relatively small for births planned in non-OU settings. Total mean costs for women without complicating conditions at the start of care in labour approximated as follows: OU £1,510.6, AMU £1,426.4, FMU £1,405.0 and home £1,026.9. It was found that the bootstrapped mean cost differences were: -£483.8 (reflecting the average cost saving of planned birth at home compared with an OU), -£105 (reflecting the average cost saving of planned birth in a FMU compared with an OU) and -£84 (reflecting the average cost saving of planned birth in an AMU compared with the OU). The mean cost differences between the OU and non-OU settings decreased and this is due to the reduction in costs borne by the OU when women without complicating conditions at the start of care in labour were excluded.

An additional adjustment of these cost data was performed using a bootstrap (1,000 replications with resampling) of the data adjusted for the same confounders as in the multiple regression on clinical outcomes. Mean cost differences and standard errors were generated for these estimates. They are shown in section 5.3.3.1.

5.3.3.1 Generalised linear regression on cost

Table 7 shows the results of a generalised linear regression on total cost. Planned place of birth acted as the main exposure. Included as potential confounders in the analysis were parity, completed weeks of gestation, BMI, ethnicity, maternal age, IMD quintiles and mother's 'understanding of English'. The following variables acted as referents; planned place of birth (OU), parity(nulliparous), gestational age at birth (40 weeks), marital status (married), BMI (19-24 kg/m^2), ethnic group (white British), maternal age (25-29 years), IMD score (least deprived quintile) and mother's understanding of English (fluent). When compared with planned place of birth in an OU, this regression shows that planned place of birth in non-OU settings are cost saving. This finding is statistically significant. Planned birth at home reduces costs the most, followed by approximately similar cost-savings for planned birth in a FMU and then an AMU. The estimates produced from this regression were -£310 (the average cost saving of planned birth at home compared with an OU), -£130 (the average cost saving of planned birth in a FMU compared with an OU) and £-134 (the average cost saving of planned birth in an AMU compared with an OU). Adjusting for parity resulted in sizable and significant cost differences, which overshadowed all other adjustments for confounding and the mean costs of care were substantially reduced for women who were parous compared to nulliparous. This cost-saving was accentuated for each previous pregnancy.

The costs of care increased above 40 weeks gestation at birth; for example, birth at 42-44 weeks gestation reflected a much higher cost increase (£462) than birth at 41 weeks gestation (£112.2).

A maternal age of 35 – 39 years and above increased the mean costs of care, and this was even more apparent in women aged over 40 years.

Being married (referent) seemed to be associated with being cost-saving when compared with being single or unsupported by a partner.

A BMI below the referent (19-24 kg/m^2) seemed to be cost saving, and a greater BMI than the referent more costly in terms of the provision of maternity care. A BMI that was 'not recorded' was associated with the highest cost increment in this category, and might have reflected a higher BMI score on average that was not recorded prior to the start of care in labour.

IMD score and women's understanding of English did not have significant effects on total cost.

An additional bootstrapped analysis was performed on the adjusted weighted cost data. It generated the following cost differences between births planned in the different settings: average cost difference between planned births in an OU and at home -£366.8 (SE 38.1); average cost difference between planned birth in an OU and a FMU -£182.1, (SE 44.0); and average cost difference between planned birth in an OU and an AMU -£129.3, (SE 59.2). All these cost figures are negative reflecting the cost-saving effect of planned birth in a non-OU setting compared with planned birth in an OU setting.

Table 7. Cost per woman adjusted for socio-demographic and other factors: generalised linear regression*

Covariate	Coef.	Std. Err.	p value	[95% CI]	
Planned place birth OU (referent)	-				
Planned place birth: home	-310.0	11.2	0.000	-332.05	-287.9
Planned place birth: FMU	-130.1	13.4	0.000	-156.5	-103.7
Planned place birth: AMU	-134.4	12.2	0.000	-158.5	-110.4
Parity: 0 prev pregnancy (referent)	-				
Parity: 1 prev pregnancy	-917.7	11.9	0.000	-941.1	-894.5
Parity: 2 prev pregnancies	-1037.7	13.3	0.000	-1063.8	-1011.6
Parity: 3+ prev pregnancies	-1058.3	15.4	0.000	-1088.5	-1028.2
37 weeks gestation	54.7	25.4	0.031	4.9	104.5
38 weeks gestation	-56.1	13.3	0.000	-82.2	-30.0
39 weeks gestation	-72.4	9.5	0.000	-91.2	-53.7
40 weeks gestation (referent)	-				
41 weeks gestation	112.2	11.3	0.000	89.9	134.6
42-44 weeks gestation	462.5	48.6	0.000	367.2	557.9
Married (referent)	-				
Single/unsupported partner	45.7	17.1	0.008	12.1	79.2
BMI not recorded	50.1	10.9	0.000	28.6	71.6
BMI 10-18	-19.2	24.7	0.438	-67.6	29.3
BMI 19-24 (referent)	-				
BMI 25-29	35.9	9.9	0.000	16.4	55.4
BMI 30-35	33.1	14.7	0.024	4.3	61.8
White British (referent)	-				
Indian/Bangladeshi	42.0	27.9	0.131	-12.5	96.7
Pakistani	56.3	30.3	0.063	-3.1	115.8
Black Caribbean	-62.9	36.3	0.083	-134.1	8.2
Black African	59.2	30.3	0.051	-0.2	118.8
Mixed	27.0	32.1	0.400	-35.8	89.9
Other	29.4	24.1	0.223	-17.9	76.7
Maternal age <20	-159.8	22.7	0.000	-204.5	-115.2
Maternal age 20-24	-44.8	12.1	0.000	-68.7	-20.9
Maternal age 25-29 (referent)	-				
Maternal age 30-34	37.6	10.3	0.000	17.3	57.9
Maternal age 35-39	58.5	11.8	0.000	35.2	81.8
Maternal age 40-60	151.3	24.8	0.000	102.7	199.9
IMD 0.37-8.31 (least deprived -referent)	-				
IMD 8.32-13.73	15.4	13.0	0.234	-10.0	40.9
IMD 13.74-21.21	30.6	12.8	0.017	5.4	55.8
IMD 21.22-34.41	33.9	12.4	0.007	9.4	58.3

IMD 34.42-85.46 (most deprived)	24.0	12.0	0.047	0.3	47.7
Fluent in English (referent)	-				
Some English	19.2	24.6	0.435	-29.0	67.4
No English	-39.9	40.2	0.322	-118.8	39.0
Constant	2004.7	17.7	0.000	1969.9	2039.5

**UK Sterling (2009/10 prices), estimated using a gamma distribution and an identity link function*

n= 62036 AIC = 16.26562

5.3.3.2 Additional analyses of costs by parity sub-group

Additional subgroup analyses of total mean costs were conducted by parity. These found the total bootstrapped weighted mean cost per 'low risk' nulliparous woman to be £2075.2 for a planned OU birth, £1,983.1 for a planned AMU birth, £1,912.5 for a planned FMU birth and £1,793.7 for a planned home birth. This compared to total bootstrapped weighted mean costs per 'low risk' multiparous woman of £1,142.4, £991.3, £968.9 and £780.4 for a planned OU birth, a planned AMU birth, a planned FMU birth and a planned home birth, respectively.

The total bootstrapped weighted mean cost per 'low risk' nulliparous woman without complicating conditions at the start of care in labour was £1,940.4 for a planned OU birth, £1932.5 for a planned AMU birth, £1,880.7 for a planned FMU birth and £1,719.0 for a planned home birth. In contrast, the total bootstrapped weighted mean costs per 'low risk' multiparous woman without complicating conditions at the start of care in labour was £1076.9 for a planned OU birth, £978.3 for a planned AMU birth, £953.7 for a planned FMU birth and £765.8 for a planned home birth.

5.4 Cost effectiveness

Three sets of cost-effectiveness analyses were conducted: for adverse perinatal outcome averted, maternal morbidity avoided and additional 'normal birth'. These three measures enable a comprehensive analysis of cost-effectiveness of planned place of birth for women at 'low risk' of complications prior to the onset of labour both the baby and mother.

The ICERs that were generated in these analyses are shown in tables 8 -20 and weighted bootstrapped scatterplots are represented graphically in cost-

effectiveness planes in Figures 2-33. ICER estimates were recalculated for women without complicating conditions at the start of care in labour, and subgroup analyses by parity were conducted for the estimates of incremental cost per adverse perinatal outcome averted.

All sets of ICERs were bootstrapped. The origin of the cost-effectiveness planes represents the average cost and average effect for the reference group, in this case planned birth in an OU. The point estimates of mean ICERs therefore represent the incremental changes in costs and effects generated by the differences between the OU and the alternative planned places of birth. In each analysis, 1,000 bootstrapped mean ICERs were plotted on the cost effectiveness plane. They show the uncertainty around the mean reported ICERs. An attempt was made to fit all the vertical and horizontal axes to the same scale (x axis: +/- 0.4, y axis: +/-£600), but this caused several ICER scatterplots to shrink into near point estimates, so the axes were individually adjusted to maximise the scatterplot presentation. They have been standardised to common scales for each outcome measure; 'perinatal' outcome (x axis: +/- 0.009, y axis: +/- £700), maternal outcome (x axis: +/- 0.02, y axis: +/- £600), 'normal birth' (x axis: +/- 0.03, y axis: +/- £600).

5.4.1 Cost-effectiveness analyses for the primary outcome

The primary outcome measure was defined as a case of 'intrapartum stillbirth and early neonatal mortality and specific neonatal morbidity'.

5.4.1.1 Incremental cost effectiveness ratios and net benefit statistics for the primary outcome

Table 8 shows the estimate of the ICER using differences in costs divided by differences in effects between planned place of birth and using the OU as the reference group.

Table 8. Incremental cost per additional case of intrapartum stillbirth and early neonatal mortality and specific neonatal morbidity avoided

Baseline	**(OU) → (Home)**	**(OU) → (FMU)**	**(OU) → (AMU)**
Cost differences between planned birth in an OU and non-OU setting (95% CI)	-565 (-591, -538)	-196 (-229, -163)	-170 (-199, -141)
Difference in adverse perinatal outcome (95% CI)	-0.00007 (-0.0014, 0.0013)	+0.0004 (-0.0010, 0.0019)	+0.0005 (-0.0007, 0.0019)
for **Mean ICER†**	**7 950 356**	**-431 873**	**-296 400**
Quadrant on the cost-effectiveness plane	south west	south east	south east
Mean net benefit (95% CI)*	591.8 (547.1, 638.6)	263.3 (210.9, 314.8)	167.2 (111.4, 223.7)

†*95% CI surrounding the ICERs are not provided because bootstrapped replicates of the ICERs fall across more than one quadrant of the cost-effectiveness plane*

Estimated at a £20,000 cost-effectiveness threshold

Differences in effects are calculated as the change in adverse perinatal outcome (a measure of negative outcome), by subtracting adverse perinatal outcome for planned birth in an OU from adverse perinatal outcome for planned birth in a non-OU setting. Differences in costs are calculated by subtracting mean costs for planned birth in an OU setting from mean costs in a non-OU setting. Thus the changes in costs for planned places of birth from an OU to non-OU settings are reflected as negative values in the table above, because they are cost-saving.

This is true for all the cost changes for the planned places of birth shown in table 8.

The incidence of adverse perinatal outcomes (intrapartum stillbirth, early neonatal death, neonatal encephalopathy, meconium aspiration and specified birth related injuries including brachial plexus injury) was low in all settings. However, when differences in effects were measured, a small increase in adverse perinatal outcome was identified in the planned home birth group, explaining the negative summary statistic as shown in the table. We know from the cohort study that a significantly increased odds of an adverse perinatal outcome for 'low risk' nulliparous women was identified in the planned home birth group. For multiparous women, there were no statistically significant differences between birth settings in rates of adverse perinatal outcome. The ICER measure shown in the table is, on average, positive for the cost-effectiveness analysis of switching from planned birth in an OU to home, both being cost saving but with a small increase in adverse perinatal outcome. It is, on average, negative for the switches to planned birth in midwifery units reflecting both cost-savings and positive perinatal effects. The differences in effects are very small; however these are magnified in the ICER calculations, as the mean differences in effects are used as the denominators of the ICER statistics. Thus the ICER estimates range from -£296,400 to £7,950,356, reflecting sizable reductions in cost and small changes in perinatal outcome when measuring differences between planned birth in an OU and non-OU settings. These estimates have very wide confidence intervals. 1,000 bootstrapped weighted estimates for each of the ICERs are presented on cost-effectiveness planes in figures 2-4 below.

Figure 2. Cost effectiveness plane: planned birth at home compared with OU for all 'low risk' women

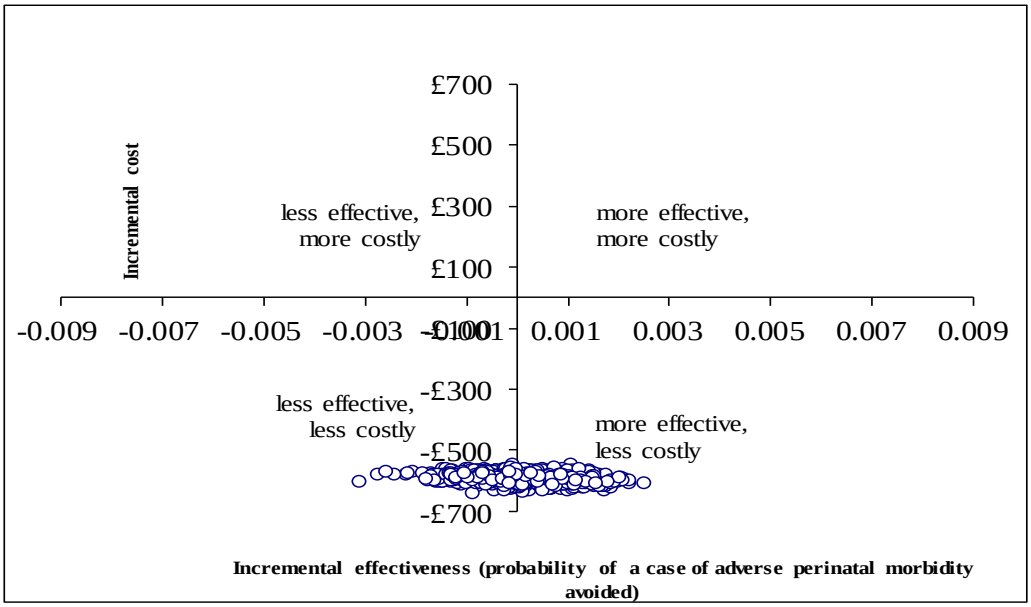


Figure 3. Cost effectiveness plane: planned birth in a FMU compared with OU for all 'low risk' women

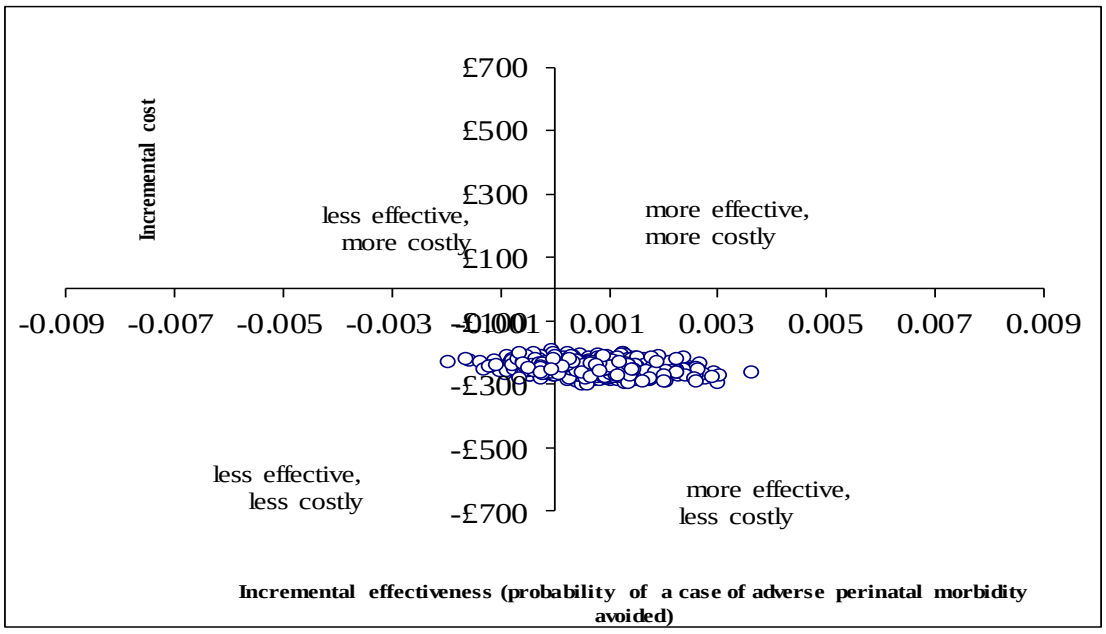
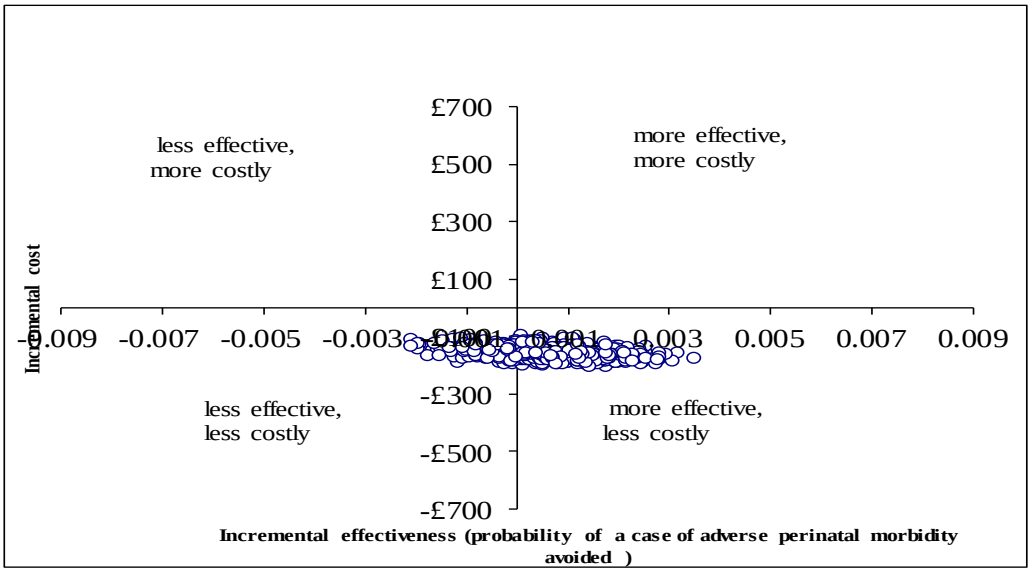


Figure 4. Cost effectiveness plane: planned birth in an AMU compared with OU for all 'low risk' women



The scatterplots of bootstrapped ICERs fall across the south west and south east quadrants of the cost-effectiveness planes (Figures 2-4). This represents a lower cost attributable to births in planned non-OU settings, but also represents considerable uncertainty about any difference in the primary clinical outcome for the groups of women who planned their birth in non-OU settings. The south east quadrant represents improved outcomes and the south west quadrant worse outcomes, though they both represent lower cost.

5.4.1.2 Cost-effectiveness analyses for the primary outcome for 'low risk' women without complicating conditions at the start of care in labour

The primary outcome is defined as a case of 'intrapartum and early neonatal mortality and specific neonatal morbidity'. The analyses were repeated for women without complicating conditions at the start of labour care. Table 9 reflects very small differences in effectiveness between the planned places of birth. The mean ICER statistics are positive for the cost-effectiveness analyses assessing changes

from planned birth in an OU to non-OU settings, being on average both cost-saving but with a small increase in adverse perinatal outcome. As in table 8, the differences in effects are small; however these are magnified in the ICER calculations, as the mean differences in effectiveness are used as the denominators of the ICER statistics. Thus the mean ICER estimates range from £143,382 (AMU) to £497,595 (home), reflecting, on average, sizable reductions in costs and small changes in perinatal outcomes. These changes in adverse perinatal outcome were not significant for planned births in midwifery units.

The cost differences between planned birth in the OU and non-OU settings were smaller in this set of analyses. This is due to the reduction in the total cost following the exclusion of women at 'low risk' who had complicating conditions at the start of care in labour. A disproportionate number of women with complicating conditions noted at the start of labour care were observed in the planned OU group. When excluded, summary statistics show a narrowing of the cost differences between the OU and the other birth settings. Consequently, in these additional analyses, reductions in the OU-related costs are captured by the decreased mean ICER statistics. The cost differences here are closer to the costs reflected in the adjusted costs shown in the multiple regression, which were -£310 (home compared with OU), -£130.1 (FMU compared with OU) and -£134 (AMU compared with the OU) (table 7). They are also similar to the cost differences calculated in the adjusted bootstrapped analysis (OU and home:-£366.8 OU and FMU -£182.1, OU and AMU -£129.3), and are therefore possibly more representative of the true cost differences for outcomes of women at 'low risk' prior to the onset of labour. Figures 5-7 show scatterplots of the 1,000 bootstrapped ICER estimates for the analyses shown in table 9.

Table 9. Incremental cost effectiveness ratios and net benefit statistics for the primary outcome for women without complicating conditions at the start of care in labour

	Incremental cost per additional case of intrapartum stillbirth and early neonatal mortality and specific neonatal morbidity avoided		
Baseline	**(OU) → (Home)**	**(OU) → (FMU)**	**(OU) → (AMU)**
Cost differences between planned birth in an OU and non-OU setting (95% CI)	-484 (-511, -456)	-105 (-139, -71)	-84 (-115, -53)
Difference in adverse perinatal outcome (95% CI)	-0.0009 (-0.0023, -0.0003)	-0.0003 (-0.0017, 0.0011)	-0.0005 (-0.0019, 0.0007)
Mean ICER†	**497 595**	**313 886**	**143 382**
Quadrant on the cost-effectiveness plane	south west	south west	south west
Mean net benefit (95% CI)*	482.8 (434.3, 534.4)	142.6 (91.8, 192.5)	58.3 (4.5, 113.6)

†*95% CI surrounding the ICERs are not provided because bootstrapped replicates of the ICERs fall across more than one quadrant of the cost-effectiveness plane*

Estimated at a £20 000 cost-effectiveness threshold

Figure 5. Cost effectiveness plane: planned birth at home compared with OU for 'low risk' women without complicating conditions at the start of care in labour

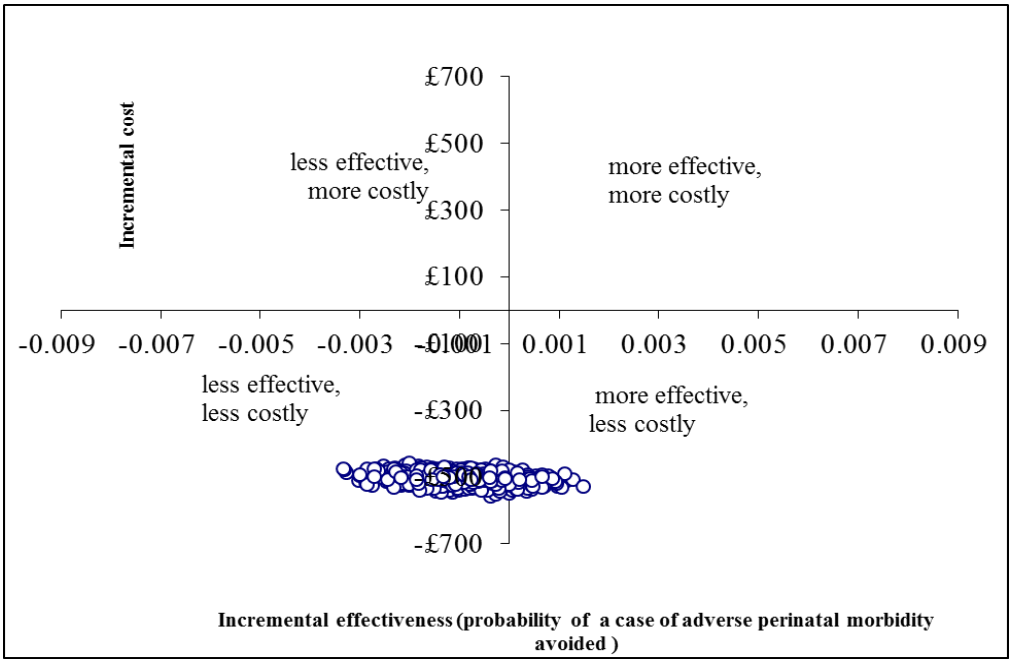


Figure 6. Cost effectiveness plane: planned birth in a FMU compared with OU for all 'low risk' women without complicating conditions at the start of care in labour

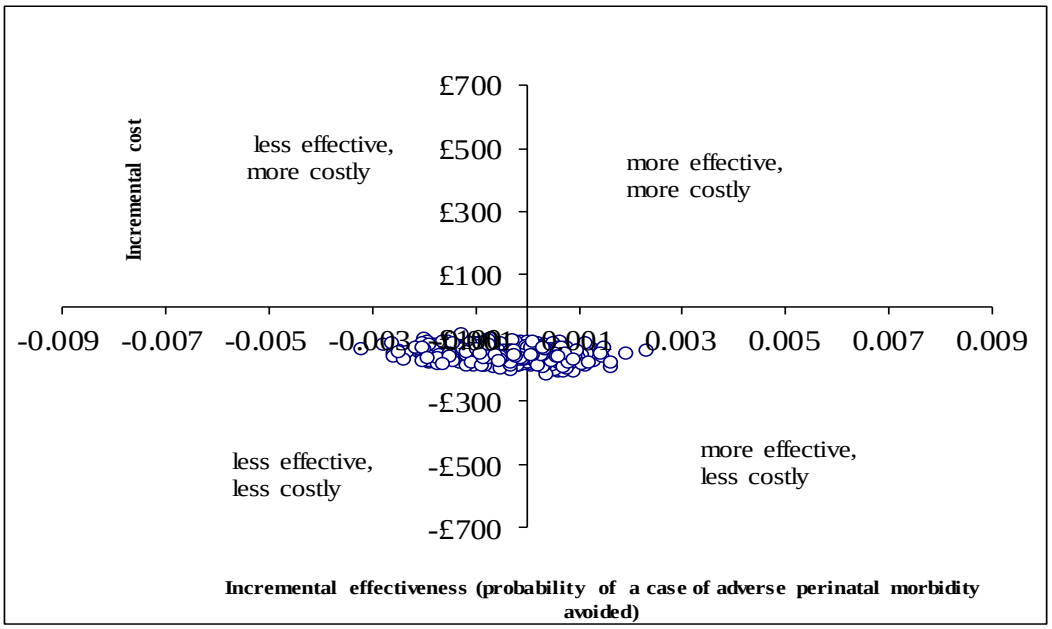
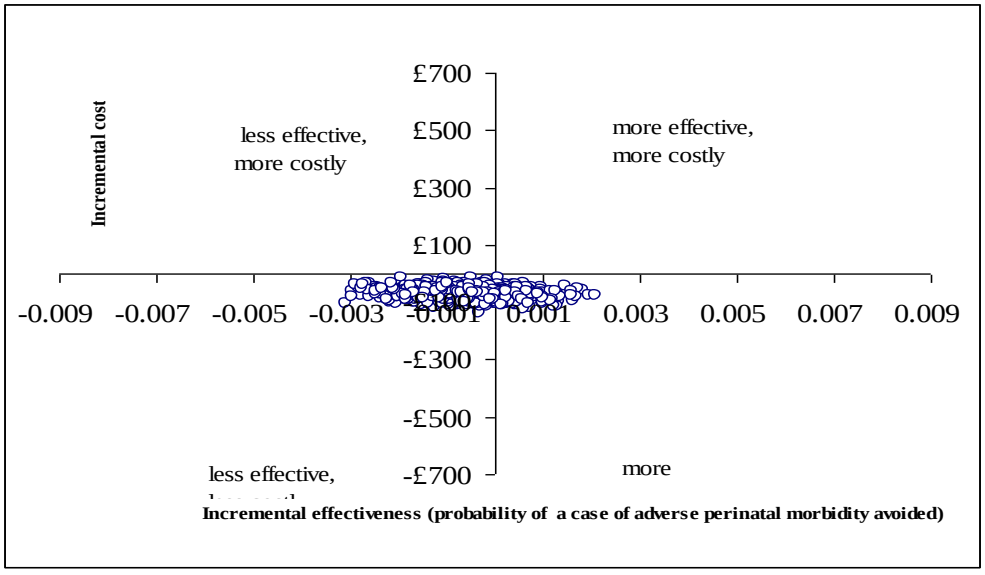


Figure 7. Cost effectiveness plane: planned birth in an AMU compared with OU for all 'low risk' women without complicating conditions at the start of care in labour



When women with complicating conditions at the start of labour care were excluded from these analyses (see figures 5-7), cost savings were observed but

with an associated small increase in adverse perinatal outcomes that was not statistically significant in the midwifery units. The cost savings were smaller than in the previous analyses. Although all the scatterplots fell within the south west and south east quadrants, their position changed reflecting reduced cost savings, though similar levels of uncertainty surrounding the changes in adverse perinatal outcomes.

5.4.1.3 Sensitivity analyses performed on the primary cost-effectiveness outcome for all 'low risk' women

Sensitivity analyses were performed on key cost variables. Uncertainty remained about the modelled overheads costs and the midwifery costs, which included CNST contributions. These were also seen to be generic cost drivers relevant to all settings of birth. Estimates of effects (adverse perinatal outcome) were not changed for these analyses.

When overheads for all birth settings (excluding home) were recoded to be 20% greater than their original unit cost, the mean cost differences between planned birth at home and planned birth in an OU increased as would be expected, and narrowed between the planned OU and midwifery settings, reflecting the increased costs experienced by all units. When overheads were reduced by 20%, the mean cost differences narrowed. This shows that the OU has a higher overhead cost per labour episode per woman, and consequently carries more of the 'burden' of the overhead costs when compared with care in midwifery units. Occupancy rates in FMUs and AMUs were then increased to 50% greater than baseline, and for the OU up to full capacity (100% occupancy), which was less than the 50% increase for FMUs and AMUs. The cost differences between planned place of birth in an OU and at home narrow, as would be expected. Cost

differences between all units increase as the FMUs and AMUs become more ‘efficient’ due to a higher throughput. The cost-savings increased and, as a result of higher occupancy rates, planned place of birth in non-OU midwifery units would be even more cost-effective.

In this study, assumptions based on primary research had been made about midwifery staff to woman ratios during labour across different settings. This was recorded as either intermittent or continuous support that midwifery staff were able to offer in different birth settings. Planned FMU and AMU births had all been attributed continuous midwifery support and this was reduced to 80% in a sensitivity analysis, with a consequent increase in the mean ICERs. Similarly, the midwifery staff to woman ratio during labour in OU settings had been set at 65% in the baseline analysis and this was subsequently varied to between 50% and 90%. As would be expected, the cost differences narrowed between settings when midwifery support during labour decreased in OU settings, and increased when midwifery support during labour increased in OU settings. It is impossible to comment on the ‘quality of care’ impact that these proportional changes in dedicated staff time could have, but this would be valuable to ascertain in future research.

The findings were generally robust to the sensitivity analyses that shed more light on the nature of the main cost drivers: overheads, occupancy rates and midwifery support during labour, and indicate that the cost-effectiveness results depicted as ICERs respond to changes in these variables in a manner consistent with our expectations.

Table 10. Sensitivity analyses performed on cost variables for the primary cost-effectiveness outcome

Sensitivity analyses			
	Incremental cost per additional case of intrapartum stillbirth and early neonatal mortality and specific neonatal morbidity avoided		
1) Overheads 20% greater than baseline			
	(OU) → (Home)	**(OU) → (FMU)**	**(OU) → (AMU)**
Cost differences between planned birth in an OU and non-OU setting (95% CI)	-616 (-744, -588)	-160 (-196, -125)	-133 (-164, -101)
Difference in adverse perinatal outcome (95% CI)	-0.00007 (-0.0014, 0.0013)	+0.0004 (-0.0010, 0.0019)	+0.0005 (-0.0007, 0.0019)
Mean ICER†	**8 669 940**	**-352 975**	**-231 449**
Quadrant on the cost-effectiveness plane	south west	south east	south east
2) Overheads 20% lower than baseline			
	(OU) → (Home)	**(OU) → (FMU)**	**(OU) → (AMU)**
Cost differences between planned birth in an OU and non-OU setting (95% CI)	-469 (-495, -444)	-168 (-199, -136)	-146 (-175, -118)
Difference in adverse perinatal outcome (95% CI)	-0.00007 (-0.0014, 0.0013)	+0.0004 (-0.0010, 0.0019)	+0.0005 (-0.0007, 0.0019)
Mean ICER†	**6 607 830**	**-368 790**	**-255 019**
Quadrant on the cost-effectiveness plane	south west	south east	south east
3) Occupancy rates 50% greater than baseline			
	(OU) → (Home)	**(OU) → (FMU)**	**(OU) → (AMU)**
Cost differences between planned birth in an OU and non-OU setting (95% CI)	-488 (-514.-463)	-234 (-266, -202)	-208 (-236, -179)
Difference in adverse perinatal outcome (95% CI)	-0.00007 (-0.0014, 0.0013)	+0.0004 (-0.0010, 0.0019)	+0.0005 (-0.0007, 0.0019)
Mean ICER†	**6 875 502**	**-514 135**	**-361 770**
Quadrant on the cost-effectiveness plane	south west	south east	south east

4) Midwifery staffing in the AMU and FMU 20% less than baseline (80% intermittent care)			
	(OU) → (Home)	**(OU) → (FMU)**	**(OU) → (AMU)**
Cost differences between planned birth in an OU and non-OU setting (95% CI)	-565 (-591, -538)	-294 (-327, -261)	-270 (-299, -241)
Difference in adverse perinatal outcome (95% CI)	-0.00007 (-0.0014, 0.0013)	+0.0004 (-0.0010, 0.0019)	+0.0005 (-0.0007, 0.0019)
Mean ICER†	**7 950 355**	**-647 054**	**-470 778**
Quadrant on the cost-effectiveness plane	south west	south east	south east
5) Midwifery staffing in the OU 15% less than baseline (50% intermittent care)			
	(OU) → (Home)	**(OU) → (FMU)**	**(OU) → (AMU)**
Cost differences between planned birth in an OU and non-OU setting (95% CI)	-456 (-482, -430)	-87 (-120, -55)	-61 (-90, -32)
Difference in adverse perinatal outcome (95% CI)	-0.00007 (-0.0014, 0.0013)	+0.0004 (-0.0010, 0.0019)	+0.0005 (-0.0007, 0.0019)
Mean ICER†	**6 415 591**	**-192 025**	**-106 363**
Quadrant on the cost-effectiveness plane	south west	south east	south east
6) Midwifery staffing in the OU 25% greater than baseline (90% intermittent care)			
	(OU) → (Home)	**(OU) → (FMU)**	**(OU) → (AMU)**
Cost differences between planned birth in an OU and non-OU setting (95% CI)	-746 (-774, -719)	-378 (-412, -344)	-352 (-382, -321)
Difference in adverse perinatal outcome (95% CI)	-0.00007 (-0.0014, 0.0013)	+0.0004 (-0.0010, 0.0019)	+0.0005 (-0.0007, 0.0019)
Mean ICER†	**10 508 297**	**-831 620**	**-613 129**
Quadrant on the cost-effectiveness plane	south west	south east	south east

†95% CI surrounding the ICERs are not provided because bootstrapped replicates of the ICERs fall across more than one quadrant of the cost-effectiveness plane

5.4.1.4 Cost-effectiveness analyses for the primary outcome for ‘low risk’ nulliparous women

Table 11 captures the cost and effect differences between the planned OU and non-OU settings for ‘low risk’ nulliparous women. The mean ICER for planned birth at home lies in the south west quadrant of the cost-effectiveness plane (figure 8), reflecting on average both a less effective and less-costly maternity option than planned birth in an OU. The differences in effects were calculated in the cohort study and were found to be significant (0.05 level of statistical significance). The mean ICERs for planned birth in an FMU or an AMU did not reflect significant differences in effects and lay in the south east quadrants of the cost-effectiveness plane (figures 9-10), reflecting, on average, reduced costs and improved outcomes but with substantial uncertainty surrounding the latter. The cost differences between planned OU and non-OU settings narrowed in comparison to the cost differences between the settings for all ‘low risk’ women. The cost of intrapartum maternity care in all settings was higher for nulliparous low risk women when compared with all ‘low risk’ women.

Table 11. Incremental cost effectiveness ratios and net benefit statistics for the primary outcome for 'low risk' nulliparous women

	Incremental cost per additional case of intrapartum stillbirth and early neonatal mortality and specific neonatal morbidity avoided		
Baseline	**(OU) → (Home)**	**(OU) → (FMU)**	**(OU) → (AMU)**
Cost differences between planned birth in an OU and non-OU setting (95% CI)	-281 (-342.6, -217.2)	-163 (-216.5, -108.3)	-92 (-142.4, -33.4)
Difference in adverse perinatal outcome (95% CI)	-0.004 (-0.008, -0.00001)	0.0008 (-0.002, 0.003)	0.0005 (-0.003, 0.003)
Mean ICER†	**69761.23**	**-98135.8**	**-47994.9**
Quadrant on the cost-effectiveness plane	south west	south east	south east
Mean net benefit (95% CI)*	203.8 (77.4, 319.2)	179.2 (97.8, 259.3)	103.3 (9.2, 188.6)

†*95% CI surrounding the ICERs are not provided because bootstrapped replicates of the ICERs fall across more than one quadrant of the cost-effectiveness plane*

**Estimated at a £20 000 cost-effectiveness threshold*

Figure 8. Cost effectiveness plane: planned birth at home compared with OU for 'low risk' nulliparous women

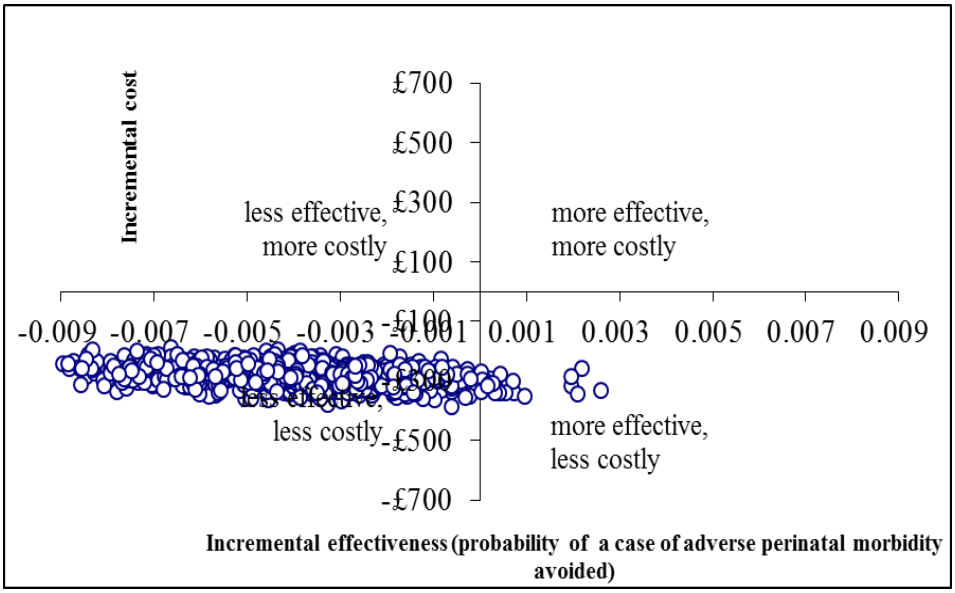


Figure 9. Cost effectiveness plane: planned birth in a FMU compared with OU for 'low risk' nulliparous women

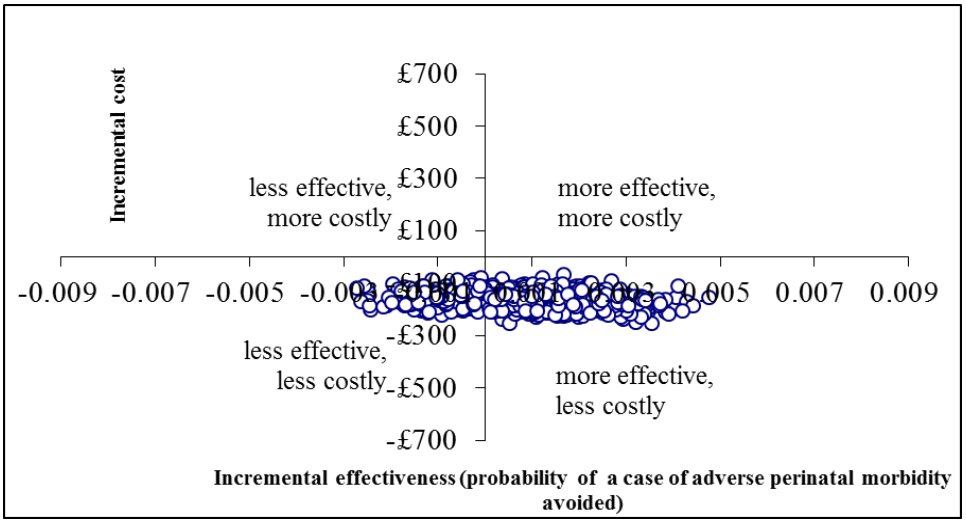
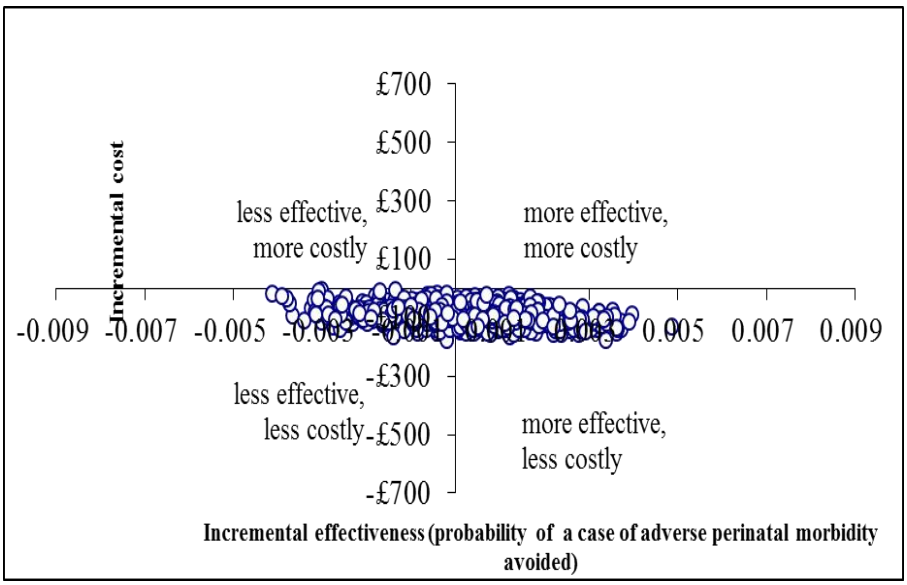


Figure 10. Cost effectiveness plane: planned birth in an AMU compared with OU for 'low risk' nulliparous women



5.4.1.5 Cost-effectiveness analyses for the primary outcome for 'low risk' nulliparous women without complicating conditions at the start of care in labour

When the data were analysed for low risk nulliparous women without complicating conditions at the start of care in labour, the ICER scatterplot for planned birth at home lay entirely within the south west quadrant of the cost-effectiveness plane (figure 11). This reflects both a less costly and less effective option for intrapartum maternity care than planned birth in an OU. The differences in effects were calculated in the cohort study and were found to be significant (0.05 level of statistical significance). ICERs for this comparison are shown in table12. The differences in adverse perinatal outcomes generated by planned birth in a FMU or an AMU were not statistically significant (table 12). The cost differences between these settings and the OU setting narrow as shown in table 12 and the ICER scatterplots (figures 11-13).

Table 12. Incremental cost effectiveness ratios and net benefit statistics for the primary outcome for 'low risk' nulliparous women without complicating conditions at the start of care in labour

	Incremental cost per additional case of intrapartum stillbirth and early neonatal mortality and specific neonatal morbidity avoided		
Baseline	**(OU) → (Home)**	**(OU) → (FMU)**	**(OU) → (AMU)**
Cost differences between planned birth in an OU and non-OU setting (95% CI)	-222.4 (-281.4, -157.3)	-58.8 (-117.1, -2.9)	-8.04 (-61.1, 48.1)
Difference in adverse perinatal outcome (95% CI)	-0.006 (-0.011, -0.002)	-0.001 (-0.004, 0.0012)	-0.00099 (-0.0041, 0.0013)
Mean ICER† (95% CI)	**39177.6** **(16734, 103511)**	**30168.8**	**1630.8**
Quadrant on the cost-effectiveness plane	south west	south west	south west
Mean net benefit (95% CI)*	98.1 (-34.5, 210.3)	34.9 (-34.4, 126.7)	-12.7 (-99.2, 63.5)

†*95% CI surrounding the ICERs are not provided because bootstrapped replicates of the ICERs fall across more than one quadrant of the cost-effectiveness plane*

**Estimated at a £20 000 cost-effectiveness threshold*

Figure 11. Cost effectiveness plane: planned birth at home compared with OU for 'low risk' nulliparous women without complicating conditions at the start of care in labour

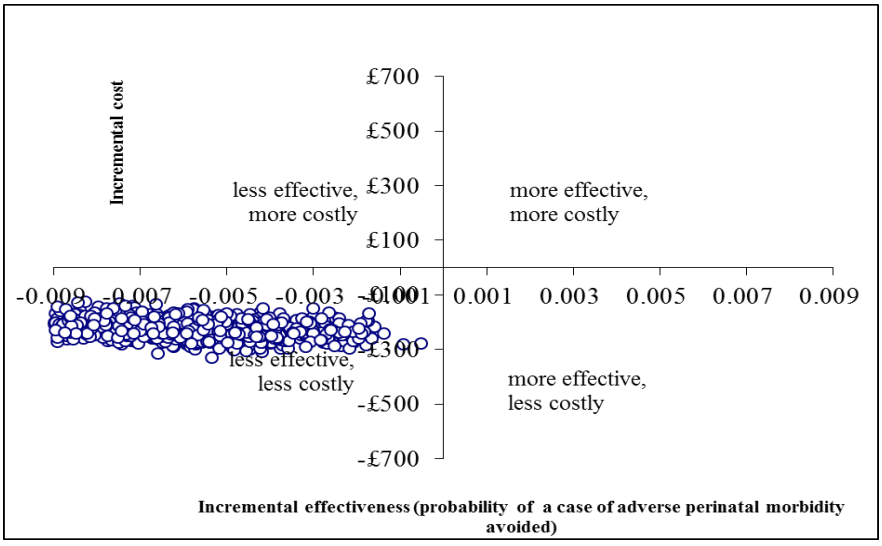


Figure 12. Cost effectiveness plane: planned birth in a FMU compared with OU for 'low risk' nulliparous women without complicating conditions at the start of care in labour

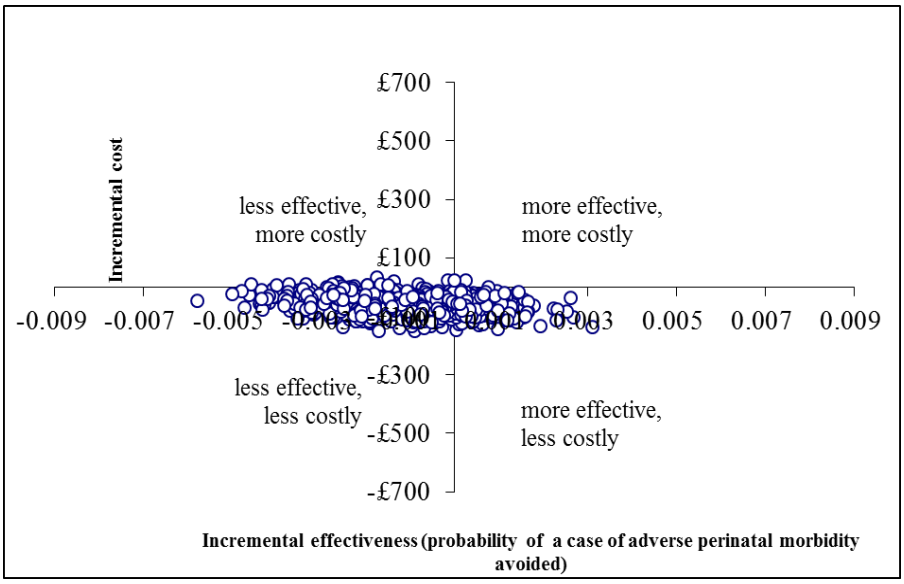
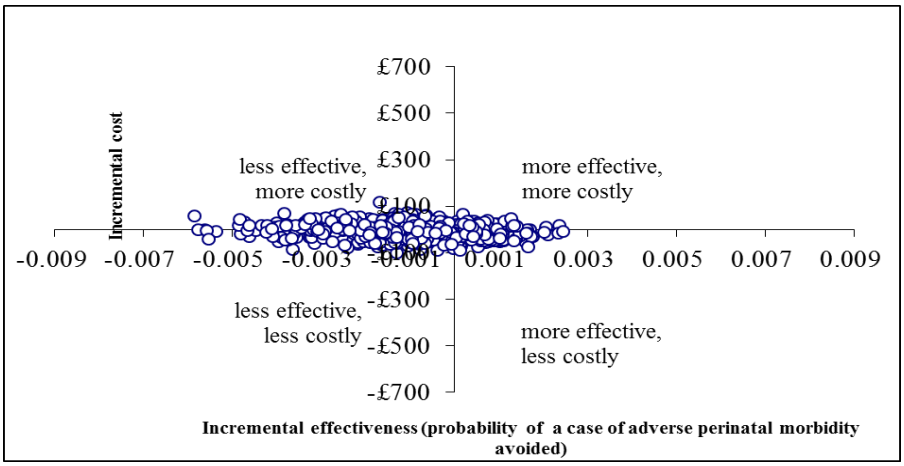


Figure 13. Cost effectiveness plane: planned birth in an AMU compared with OU for 'low risk' nulliparous women without complicating conditions at the start of care in labour



5.4.1.6 Cost-effectiveness analyses for the primary outcome for 'low risk' multiparous women

When the cost-effectiveness analyses for the primary outcome were replicated for low risk multiparous women, all mean ICER statistics lay in the south east quadrant of the cost-effectiveness plane (Table 13), reflecting on average, reduced costs and improved perinatal outcomes in the planned non-OU settings,

though considerable uncertainty surrounded the effects on perinatal outcomes (figures 14-16).

Table 13. Incremental cost effectiveness ratios and net benefit statistics for the primary outcome for 'low risk' multiparous women

	Incremental cost per additional case of intrapartum stillbirth and early neonatal mortality and specific neonatal morbidity avoided		
Baseline	**(OU) → (Home)**	**(OU) → (FMU)**	**(OU) → (AMU)**
Cost differences between planned birth in an OU and non-OU setting (95% CI)	-362 (-389.7, -335.2)	-173 (-207.8, -138.6)	-151 (-183.7, -117.0)
Difference in adverse perinatal outcome (95% CI)	0.001 (-0.0004, 0.0025)	0.0005 (-0.0015, 0.0024)	0.0007 (-0.001, 0.003)
Mean ICER†	**-323037.4**	**-128133.8**	**-119618.4**
Quadrant on the cost-effectiveness plane	south east	south east	south east
Mean net benefit (95% CI)*	381.7 (336.1, 426.9)	182.4 (119.8, 244.0)	164.6 (114.6, 222.0)

†*95% CI surrounding the ICERs are not provided because bootstrapped replicates of the ICERs fall across more than one quadrant of the cost-effectiveness plane*

**Estimated at a £20 000 cost-effectiveness threshold*

Figure 14. Cost effectiveness plane: planned birth at home compared with OU for 'low risk' multiparous women

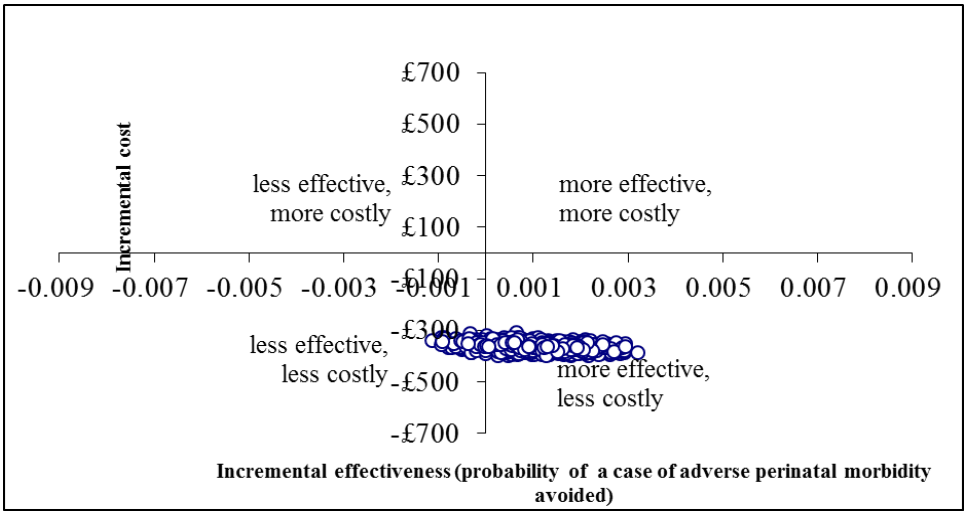


Figure 15. Cost effectiveness plane: planned birth in a FMU compared with OU for 'low risk' multiparous women

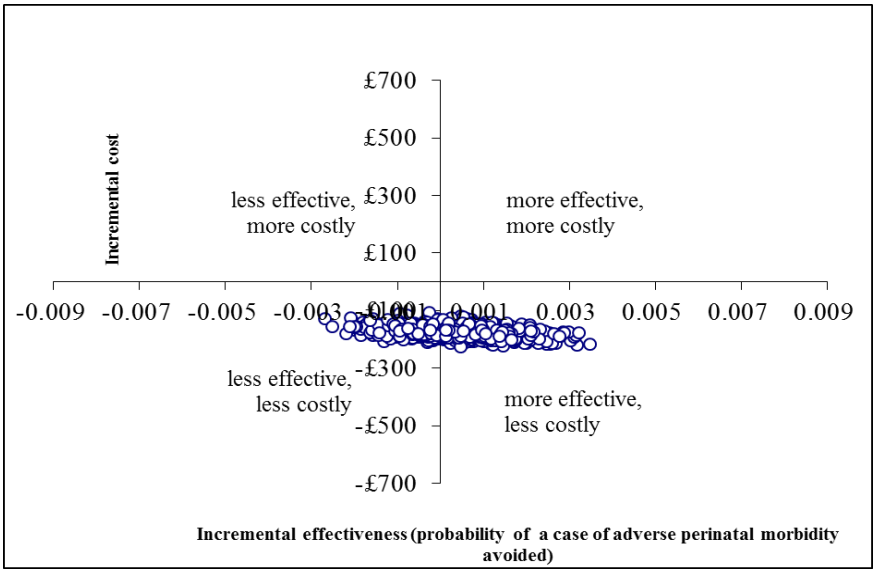
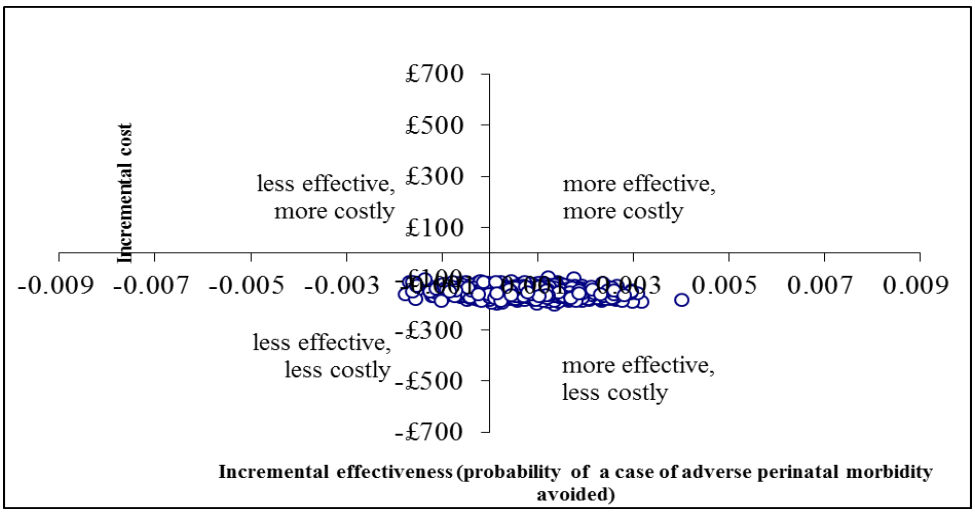


Figure 16. Cost effectiveness plane: planned birth in an AMU compared with OU for 'low risk' multiparous women



5.4.1.7 Cost-effectiveness analyses for the primary outcome for 'low risk' multiparous women without complicating conditions at the start of care in labour

When the cost-effectiveness analyses for the primary outcome were replicated for low risk multiparous women without complicating conditions at the start of care in labour, the mean ICER statistics for planned birth in a FMU and at home lay in the south east quadrant of the cost-effectiveness plane (table 14), reflecting, on average reduced costs and improved perinatal outcomes in these settings. In contrast, the mean ICER statistic for planned birth in an AMU lay in the south west quadrant of the cost-effectiveness plane (table 14), reflecting, on average reduced costs and worst outcomes in this setting. Considerable uncertainty surrounded the effects on perinatal outcomes in all three comparisons (figures 17-19).

Table 14. Incremental cost effectiveness ratios and net benefit statistics for the primary outcome for 'low risk' multiparous women without complicating conditions at the start of care in labour

	Incremental cost per additional case of intrapartum stillbirth and early neonatal mortality and specific neonatal morbidity avoided		
Baseline	**(OU) → (Home)**	**(OU) → (FMU)**	**(OU) → (AMU)**
Cost differences between planned birth in an OU and non-OU setting (95% CI)	-311.2 (-340.4, -284.7)	-123.6 (-158.4, -87.7)	-98.3 (-64.01, -131.97)
Difference in adverse perinatal outcome (95% CI)	0.0005 (-0.0008, 0.0019)	0.0003 (-0.0015, -0.0020)	-0.00009 (-0.00196, 0.00162)
Mean ICER†	**-315419.8**	**-92180.1**	**47221.6**
Quadrant on the cost-effectiveness plane	south east	south east	south west
Mean net benefit (95% CI)*	321.2 (270.7, 367.3)	128.4 (71.2, 183.2)	97.8 (40.7, 150.7)

†*95% CI surrounding the ICERs are not provided because bootstrapped replicates of the ICERs fall across more than one quadrant of the cost-effectiveness plane*

**Estimated at a £20 000 cost-effectiveness threshold*

Figure 17. Cost effectiveness plane: planned birth at home compared with OU for 'low risk' multiparous women without complicating conditions at the start of care in labour

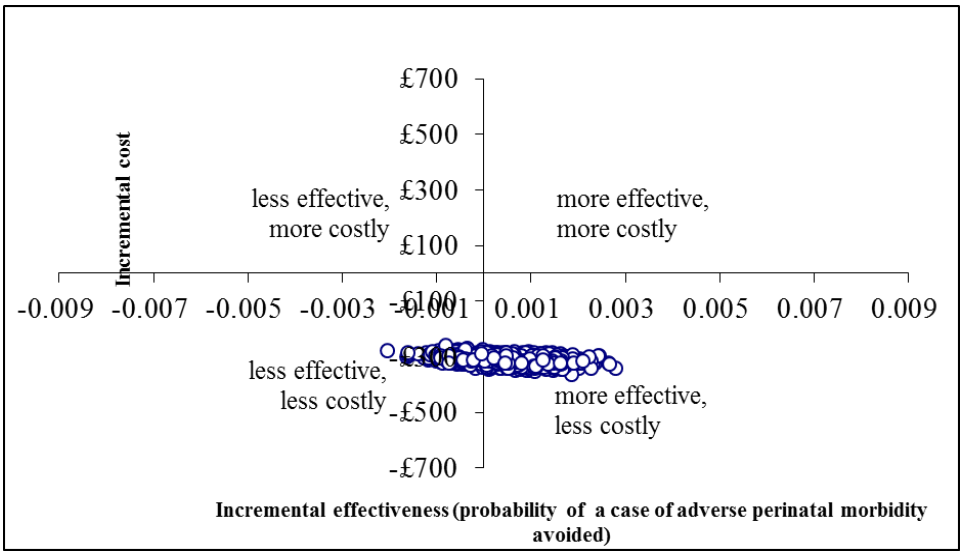


Figure 18. Cost effectiveness plane: planned birth in a FMU compared with OU for 'low risk' multiparous women without complications at the start of care in labour

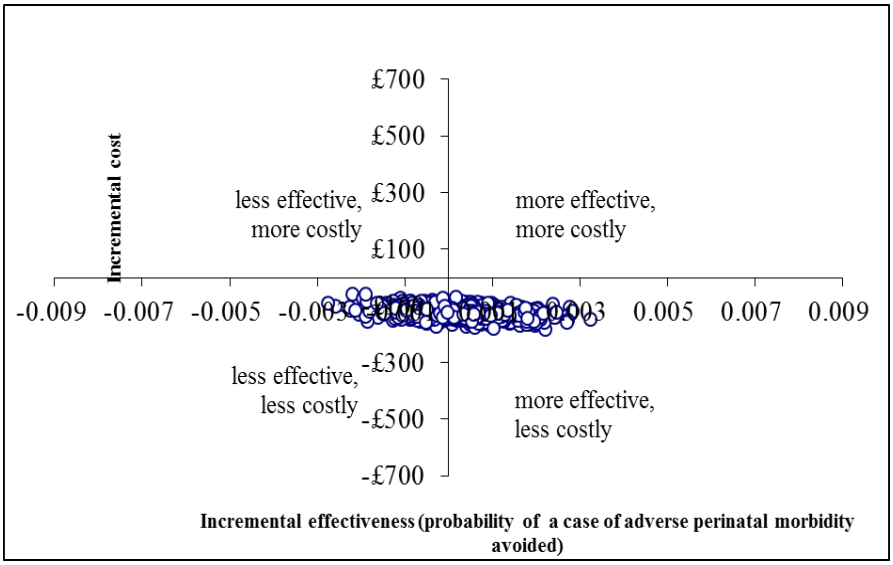
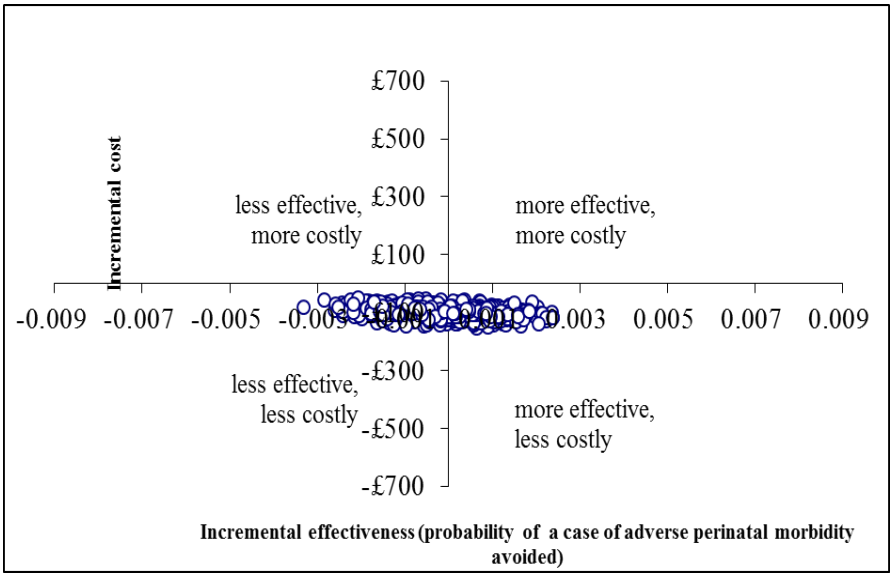


Figure 19. Cost effectiveness plane: planned birth in an AMU compared with OU for 'low risk' multiparous women without complicating conditions at the start of care in labour



5.4.2 Cost-effectiveness analyses for maternal morbidity outcome for all 'low risk' women

All three planned non-OU settings for birth led to increases in positive maternal outcomes and reductions in costs to the NHS when compared to planned birth in an OU (see table 15 and figures 20-22). In this analysis the negative ICER summary statistic reflects a cost saving (negative estimate) combined with a positive change in outcome (maternal morbidity avoided).

The change in maternal morbidity avoided shown in table 15 is calculated as the estimate of maternal morbidity avoided for planned birth in an OU subtracted from planned birth at home, FMU or an AMU. The mean estimates of women without a maternal morbidity were generated using 1,000 bootstrapped replications of weighted data. Table 15 reflects the differences in these outcome measures.

Table 15. Incremental cost effectiveness ratios and net benefit statistics for the maternal outcome

	Incremental cost per additional case of maternal morbidity avoided‡		
Baseline	**(OU) → (Home)**	**(OU) → (FMU)**	**(OU) → (AMU)**
Cost differences between planned birth in an OU and non-OU setting (95% CI)	-590 (-618, -563)	-247 (-280, -211)	-154 (-190, -118)
Differences in maternal morbidity avoided (95% CI)	+0.195 (+0.187, +0.204)	+0.172 (+0.168, +0.182)	+0.116 (+0.106, +0.126)
Mean ICER	**-3024**	**-1442**	**-1322**
95% CI	**(-3138, -2912)**	**(-1600, -1284)**	**(-1572, -1049)**
Quadrant on the cost-effectiveness plane	south east	south east	south east
Mean net benefit (95% CI)*	4497.7 (4305.5, 4669.3)	3683.1 (3451.0, 3904.3)	2486.1 (2259.4, 2691.6)

‡*Avoidance of at least one of the following: general anaesthetic; instrumental birth; caesarean section, third or fourth degree perineal trauma; blood transfusion; admission to an intensive therapy unit, high dependency unit or specialist unit; and maternal death (within 42 days of giving birth). This is a composite measure and was also the secondary outcome of interest in the Birthplace cohort study.*

**Estimated at a £20 000 cost-effectiveness threshold*

Figures 20-22 show cost-effectiveness scatterplots of the 1,000 bootstrapped ICER estimates for the analyses summarised in table 12.

Figure 20. Cost effectiveness plane: planned birth at home compared with an OU for all 'low risk' women

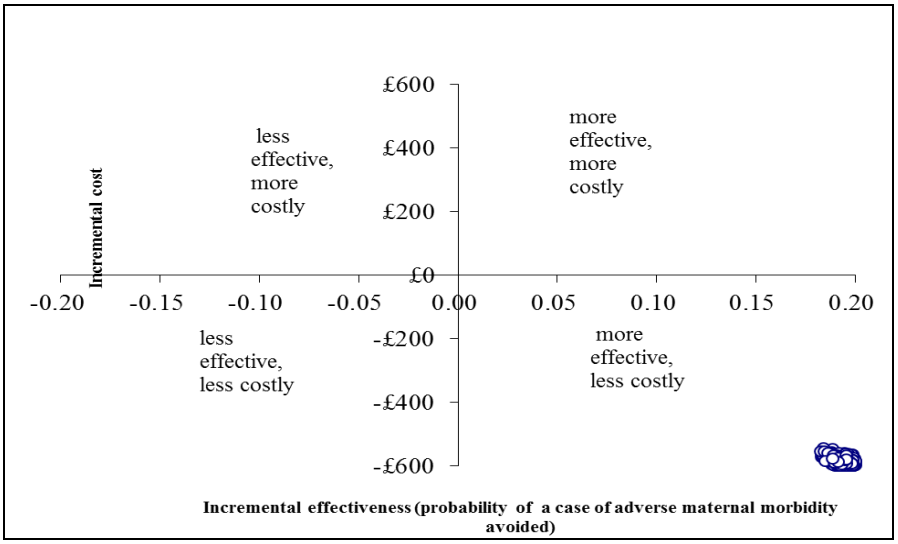


Figure 21. Cost effectiveness plane: planned birth in a FMU compared with an OU for all 'low risk' women

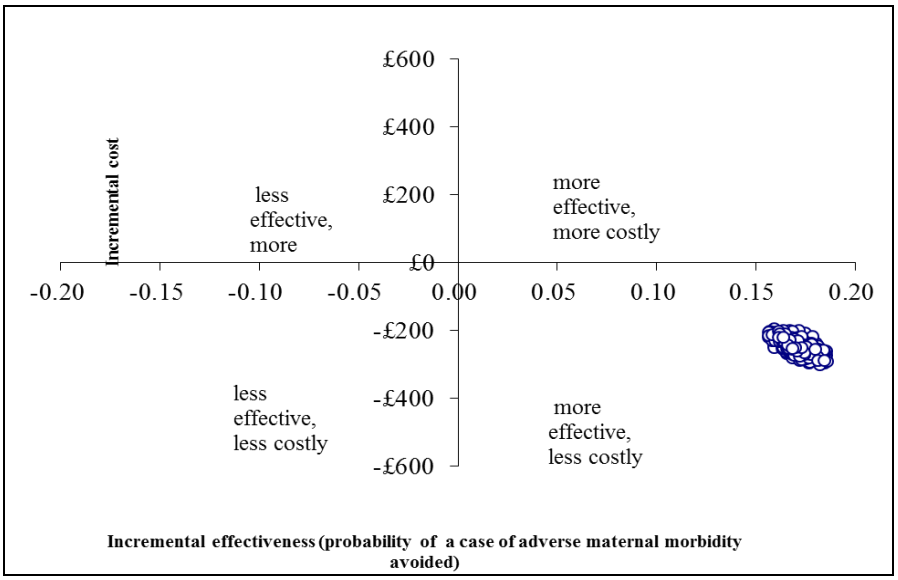
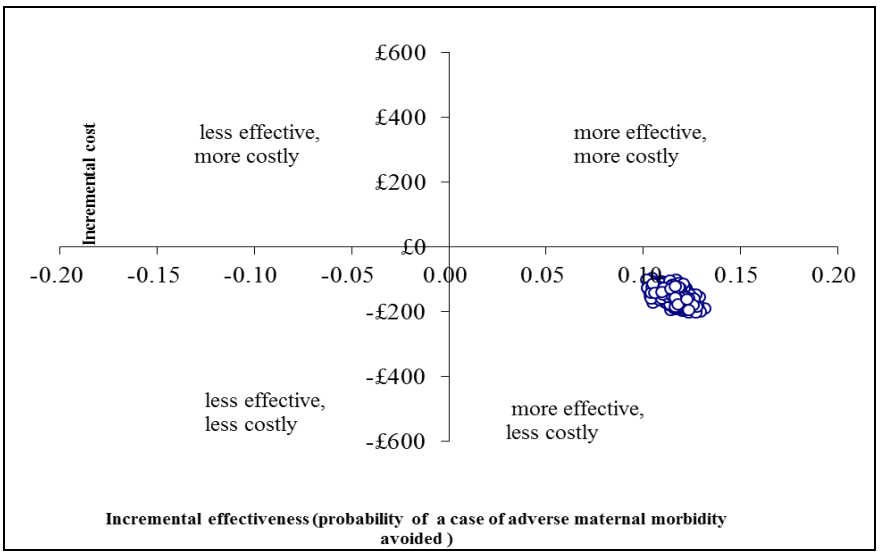


Figure 22. Cost effectiveness plane: planned birth in an AMU compared with an OU for all 'low risk' women



All bootstrapped ICERs fell within the south east quadrant of the cost-effectiveness planes, suggesting that planned non-OU births for 'low risk' women will generate positive maternal outcomes and less costly care when compared with planned birth in an OU.

5.4.2.1 Cost-effectiveness analyses for maternal morbidity outcome for 'low risk' women without complicating conditions at the start of care in labour

When women with complicating conditions at the start of labour care were removed from these analyses, similar results were obtained, though the absolute cost savings were smaller (see table 16 and figures 23-25). These reductions in cost differences do not affect the uncertainty around the estimates reflected by the bootstrapped ICER scatterplots. They all fall within the south east quadrant of the cost-effectiveness plane, suggesting that planned place of birth in non-OU settings still generates positive effects in maternal morbidity avoided and less costly care,

compared with planned birth in an OU. When planned birth in an AMU is compared with planned birth in an OU, the scatterplot falls very close to the x-axis, between the south east quadrant, which reflects reduced costs, and the north east quadrant, which reflects increased costs, though they both represent improved outcomes. Patterns of resource use in the AMU tend to reflect similarities with the OU, with a consequent converging of their total mean costs per woman.

Table 16. Incremental cost effectiveness ratios and net benefit statistics for the maternal outcome for women without complicating conditions at the start of care in labour

	Incremental cost per additional case of maternal morbidity avoided‡		
Baseline	**(OU) → (Home)**	**(OU) → (FMU)**	**(OU) → (AMU)**
Cost differences between planned birth in an OU and non-OU setting (95% CI)	-504 (-535, -474)	-150 (-186, -115)	-69 (-105, -36)
Differences in maternal morbidity avoided (95% CI)	+0.165 (0.156, 0.174)	+0.139 (+0.131, +0.149)	+0.088 (0.078, 0.098)
Mean ICER	**-3052**	**-1075**	**-782**
95% CI	**(-3215, -2902)**	**(-1285, -843)**	**(-1130, -431)**
Quadrant on the cost-effectiveness plane	south east	south east	south east
Mean net benefit (95% CI)*	3807.7 (3619.6, 4011.7)	2941.9 (2742.7, 3165.9)	1827.9 (1605.3, 2058.9)

‡*Avoidance of at least one of: general anaesthetic; instrumental birth; caesarean section; third or fourth degree perineal trauma; blood transfusion; admission to an intensive therapy unit, high dependency unit or specialist unit; and maternal death (within 42 days of giving birth). This is a composite measure and was also the secondary outcome of interest in the Birthplace cohort study.*

**Estimated at a £20 000 cost-effectiveness threshold*

Figure 23. Cost effectiveness plane: planned birth at home compared with an OU for women without complicating conditions at the start of care in labour

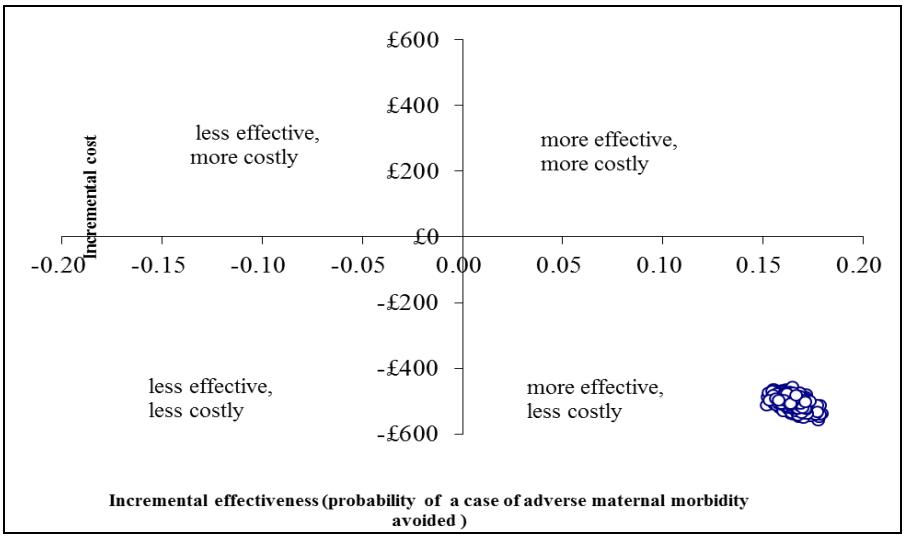
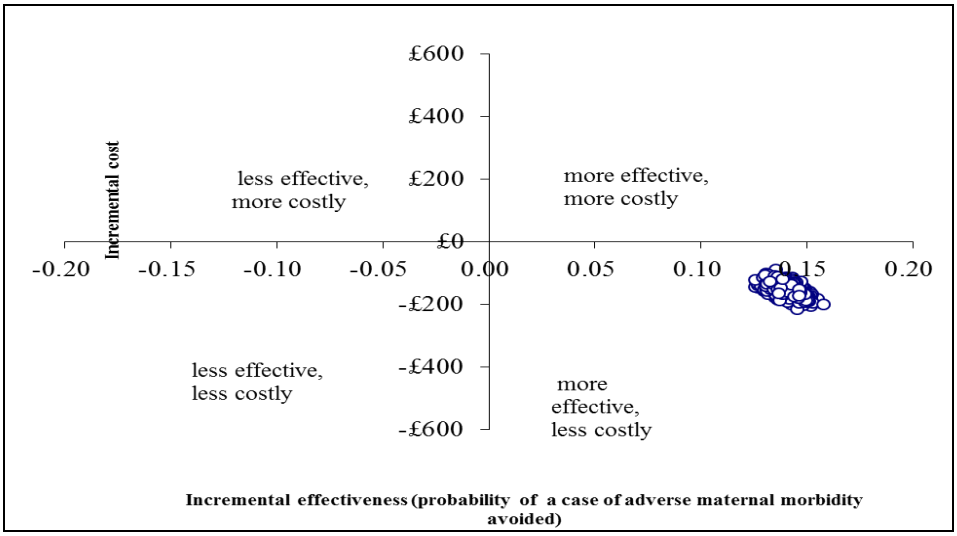
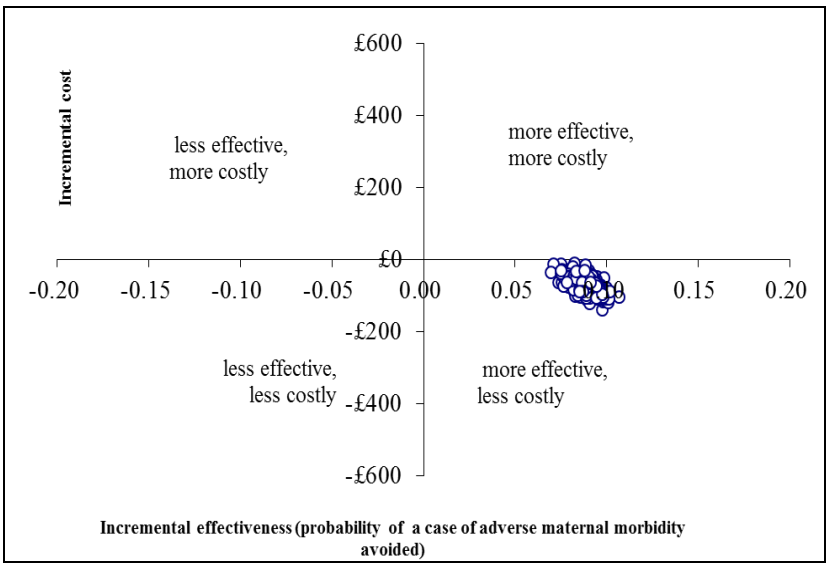


Figure 24. Cost effectiveness plane: planned birth in a FMU compared with an OU for women without complicating conditions at the start of care in labour



Cost effectiveness plane: planned birth in an AMU compared with an OU for women without complicating conditions at the start of care in labour



5.4.2.2 Sensitivity analyses performed on maternal morbidity outcome for all 'low risk' women

Sensitivity analyses were performed on key cost variables and the resulting impacts on the ICER statistics for the maternal morbidity outcome were estimated (table 16). The modelled overheads costs and the midwifery costs, which included CNST contributions, were varied. When overheads for all birth settings (excluding home) were recoded to be 20% greater than their original unit cost, the mean cost differences between planned birth at home and the OU increased, as would be expected, whilst they narrowed between the planned OU and midwifery settings, reflecting the increased costs experienced by all units. When overheads were reduced by 20%, the mean cost differences narrowed. This shows that the OU has a higher mean overhead cost per labour episode per woman, and consequently carries more of the 'burden' of the overhead costs when compared with care in midwifery units. The cost-savings increased with higher occupancy rates; consequently, the non-OU settings become even more cost-effective.

Planned birth in FMUs and AMUs had all been attributed continuous support during labour and this was reduced to 80% in a sensitivity analysis, with a consequent increase in the mean ICER statistics. Similarly, the midwifery staff to woman ratio during labour in OU settings had been set at 65% in the baseline analyses, and this was subsequently varied between 50% and 90% care. As would be expected, the cost differences narrowed between all settings midwifery support during labour in OU settings decreased, and increased when midwifery support during labour in OU settings was set at 90% direct contact time. The findings were generally robust to changes in the sensitivity analyses and indicate that the cost-effectiveness results depicted as ICERs respond to changes in key cost variables in a manner consistent with expectations.

Table 17. Sensitivity analyses performed on cost variables for the maternal morbidity cost-effectiveness outcome

	Incremental cost per additional case of maternal morbidity avoided		
	(OU) → (Home)	**(OU) → (FMU)**	**(OU) → (AMU)**
1) Overheads 20% greater than baseline			
Cost differences between planned birth in an OU and non-OU setting (95% CI)	-686 (-715, -658)	-278 (-312, -240)	-176 (-213, -138)
Differences in maternal morbidity avoided (95% CI)	0.195 (0.187, 0.204)	+0.171 (0.162, 0.181)	+0.116 (0.106, 0.125)
Mean ICER 95% CI	**-3528 (-3644, -3395)**	**-1620 (-1784, -1457)**	**-1511 (-1771, -1229)**
Quadrant on the cost-effectiveness plane	south east	south east	south east
2) Overheads 20% lower than baseline			
Cost differences between planned birth in an OU and non-OU setting (95% CI)	-346 (-374, -320)	-165 (-197, -131)	-61 (-96, -28)
Differences in maternal morbidity avoided (95% CI)	0.195 (0.187, 0.204)	+0.171 (0.161, 0.182)	+0.116 (0.107, 0.126)
Mean ICER 95% CI	**-1773 (-1873, -1661)**	**-960 (-1119, -792)**	**-519 (-778, -289)**
Quadrant on the cost-effectiveness plane	south east	south east	south east

3) Occupancy rates 50% greater than baseline			
Cost differences between planned birth in an OU and non-OU setting (95% CI)	-512 (-540.-485)	-282 (-314, -248)	-194 (-228, -160)
Differences in maternal morbidity avoided (95% CI)	0.195 (0.186, 0.204)	+0.171 (0.162, 0.181)	+0.116 (0.106, 0.125)
Mean ICER **95% CI**	**-2628** **(-2736, -2528)**	**-1648** **(-1796, -1505)**	**-1666** **(-1901, -1407)**
Quadrant on the cost-effectiveness plane	south east	south east	south east
4) Midwifery staffing in the AMU and FMU 20% less than baseline (80% intermittent care)			
Cost differences between planned birth in an OU and non-OU setting (95% CI)	-590 (-618, -562)	-344 (-376, -309)	-256 (-292, -221)
Differences in maternal morbidity avoided (95% CI)	0.195 (0.187, 0.204)	+0.171 (0.162, 0.181)	+0.116 (0.106, 0.125)
Mean ICER **95% CI**	**-3024** **(-3381, -2912)**	**-2008** **(-2138, -1879)**	**-2201** **(-2447, -1941)**
Quadrant on the cost-effectiveness plane	south east	south east	south east
5) Midwifery staffing in the OU 15% less than baseline (50% intermittent care)			
Cost differences between planned birth in an OU and non-OU setting (95% CI)	-480 (-503, -453)	-137 (-170, -102)	-44 (-79, -9)
Differences in maternal morbidity avoided (95% CI)	0.195 (0.187, 0.204)	+0.171 (0.162, 0.181)	+0.116 (0.106, 0.125)
Mean ICER **95% CI**	**-2461** **(-2550, -2374)**	**-801** **(-942, -650)**	**-377** **(-656, -88)**
Quadrant on the cost-effectiveness plane	south east	south east	south east
6) Midwifery staffing in the OU 25% greater than baseline (90% intermittent care)			
Cost differences between planned birth in an OU and non-OU setting (95% CI)	-773 (-802, -744)	-430 (-465, -393)	-337 (-367, -307)
Differences in maternal morbidity avoided (95% CI)	0.195 (0.187, 0.204)	+0.171 (0.162, 0.181)	+0.116 (0.106, 0.125)
Mean ICER **95% CI**	**-3926** **(-4096, -3824)**	**-2509** **(-2676, 2355)**	**-2896** **(-3115, -2670)**
Quadrant on the cost-effectiveness plane	south east	south east	south east

5.4.3 Cost-effectiveness analyses for 'normal birth' outcome for all 'low risk' women

In the third set of cost-effectiveness analyses, 'normal birth' was the effectiveness measure (see table 18 and figures 26-28). The incidence of 'normal births' was highest for planned births at home, then planned births in a FMU, then planned births in an AMU and lowest in planned births in an OU. The results of the cost-effectiveness analyses were almost identical to those generated for the maternal morbidity outcome; all ICERs reflected both cost-savings and improved outcomes in 'normal birth' when planned place of birth changed from an OU to a non-OU setting. Planned birth at home generated both the greatest cost-savings and the highest proportion of 'normal births' when compared with the other non-OU settings, and consequently the largest (negative) mean ICER statistic.

Table 18. Incremental cost effectiveness ratios and net benefit statistics for 'normal birth'

	Incremental cost per additional case of 'normal birth'		
Baseline	**(OU) → (Home)**	**(OU) → (FMU)**	**(OU) → (AMU)**
Cost differences between planned births in an OU and non-OU setting (95% CI)	-590 (-618, -563)	-247 (-280, -211)	-154 (-190, -118)
Differences in 'normal birth' (95% CI)	+0.30 (+0.29,+0.31)	+0.256 (+0.245, +0.268)	+0.184 (+0.173, +0.194)
Mean ICER	**-1960**	**-956**	**-836**
(95% CI)	**(-2034, -1890)**	**(-1076, -847)**	**(-1002, -664)**
Quadrant on the cost-effectiveness plane	south east	south east	south east
Mean net benefit (95% CI)*	6608.9 (6411.2, 6809.7)	5376.5 (5132.8, 5618.4)	3828.4 (3599.9, 4051.9)

**Estimated at a £20 000 cost-effectiveness threshold*

Figure 25. Cost effectiveness plane: planned birth at home compared with an OU

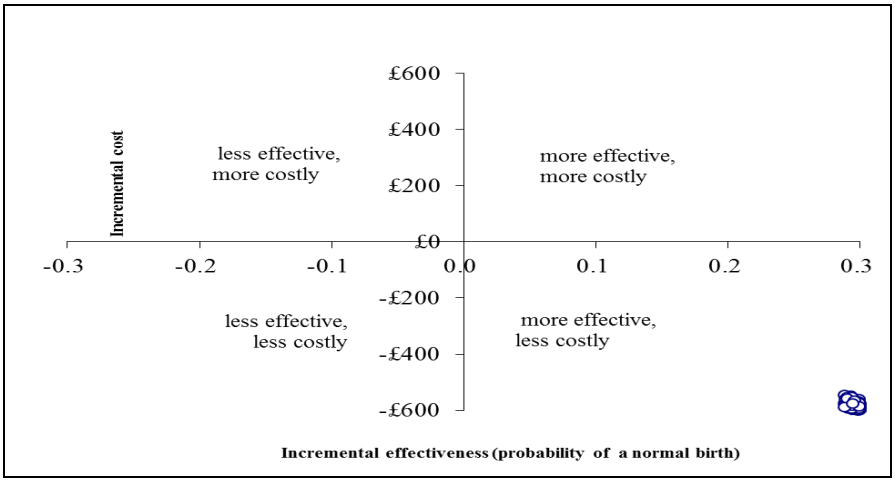


Figure 26. Cost effectiveness plane: planned birth in a FMU compared with an OU

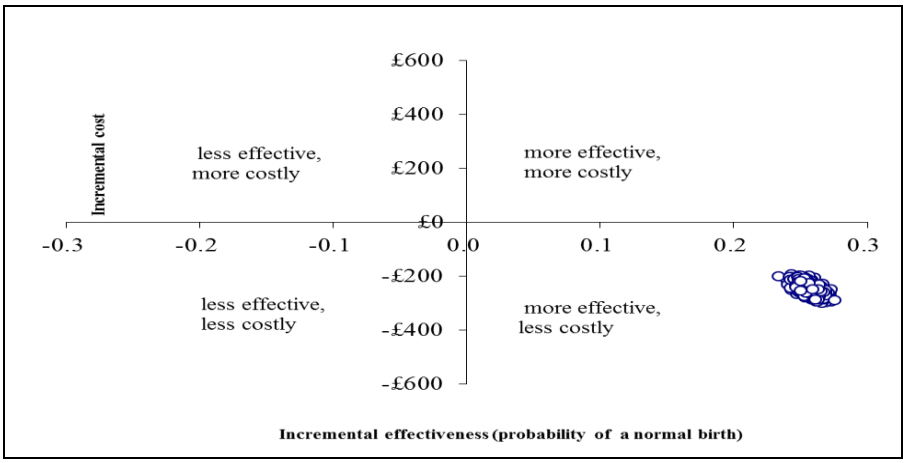
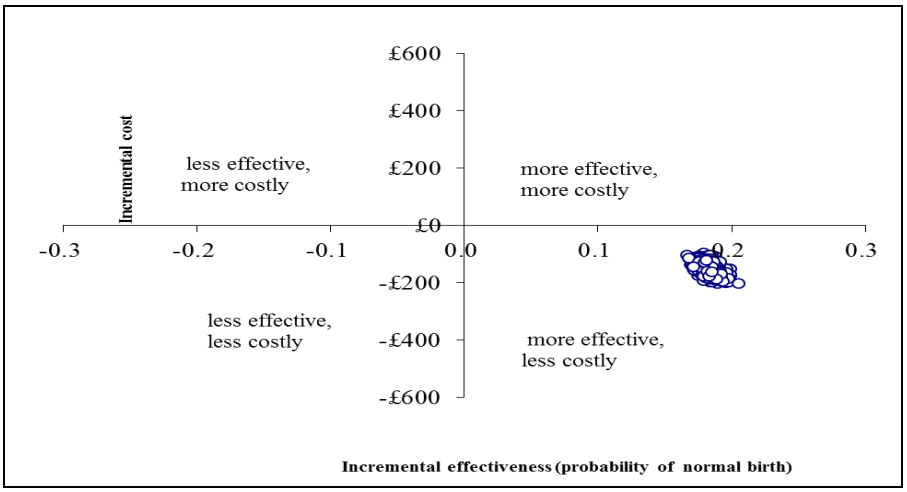


Figure 27. Cost effectiveness plane: planned birth in an AMU compared with an OU



5.4.3.1 Cost-effectiveness analyses for 'normal birth' outcome for women without complicating conditions at the start of care in labour

When women with complicating conditions identified at the start of care in labour were removed from these analyses, the findings broadly replicated those for the 'normal birth' cost-effectiveness outcome for all 'low risk' women (see table 19 and figures 29-31). We know from the cohort study that for planned OU births, there appeared to be an association between complicating conditions at the start of care in labour and the outcome of a 'normal birth': 63% of women without complicating conditions at the start of care in labour compared with 40% of women with complicating conditions at the start of care in labour had a 'normal birth' (Hollowell et al., 2010). Planned birth at home or in a FMU generates positive normal birth health effects and less costly care. Planned birth in an AMU generates cost savings though the bootstrap scatterplot approaches the x-axis of the cost-effectiveness plane.

Table 19. Incremental cost effectiveness ratios and net benefit statistics for 'normal birth' for women without complicating conditions at the start of care in labour

	Incremental cost per additional case of 'normal birth'		
	(OU) → (Home)	**(OU) → (FMU)**	**(OU) → (AMU)**
Cost differences between planned births in an OU and non-OU setting (95% CI)	-504 (-535, -474)	-150 (-187, -116)	-69 (-105, -36)
Differences in 'normal birth' (95% CI)	+0.266 (+0.256, 0.275)	+0.218 (0.207, 0.229)	+0.149 (+0.138, 0.160)
Mean ICER	**-1897**	**-689**	**-464**
(95% CI)	(-1985, -1812)	(-823, -538)	(-685, -254)
Quadrant on the cost-effectiveness plane	south east	south east	south east
Mean net benefit (95% CI)*	5822.4 (5611.7, 6036.1)	4507.4 (4284.6, 4766.0)	3041.7 (2811.6, 3307.1)

**Estimated at a £20 000 cost-effectiveness threshold*

Figure 28. Cost effectiveness plane: planned birth at home compared with an OU for women without complicating conditions at the start of care in labour

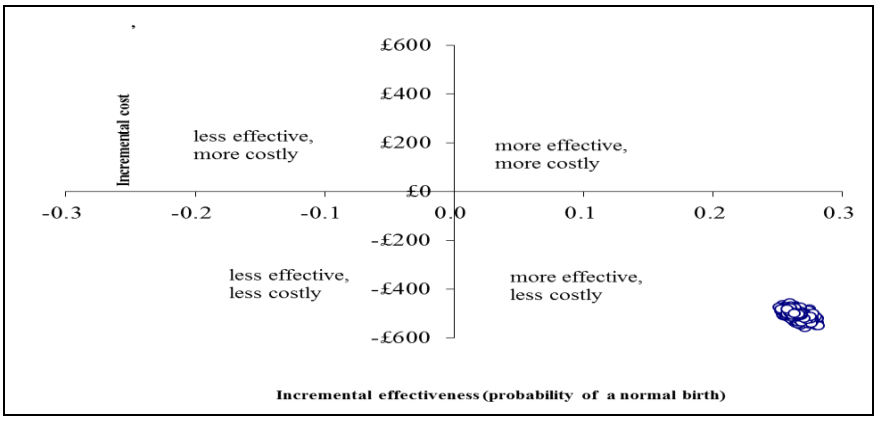


Figure 29. Cost effectiveness plane: planned birth in a FMU compared with an OU for women without complicating conditions at the start of care in labour

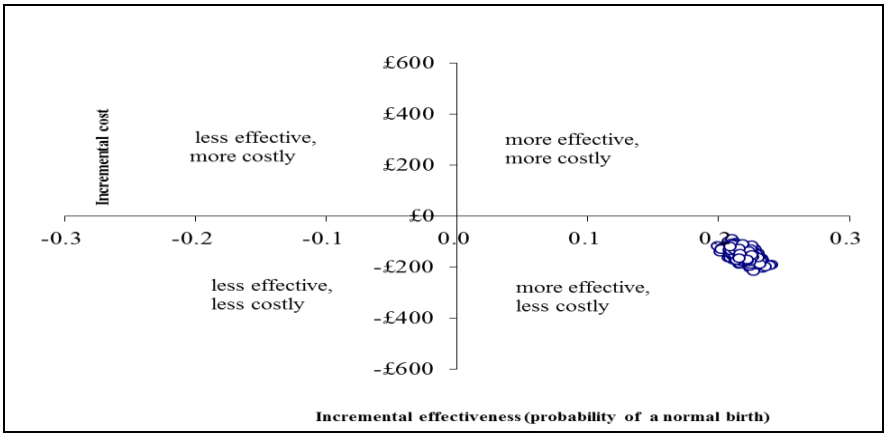
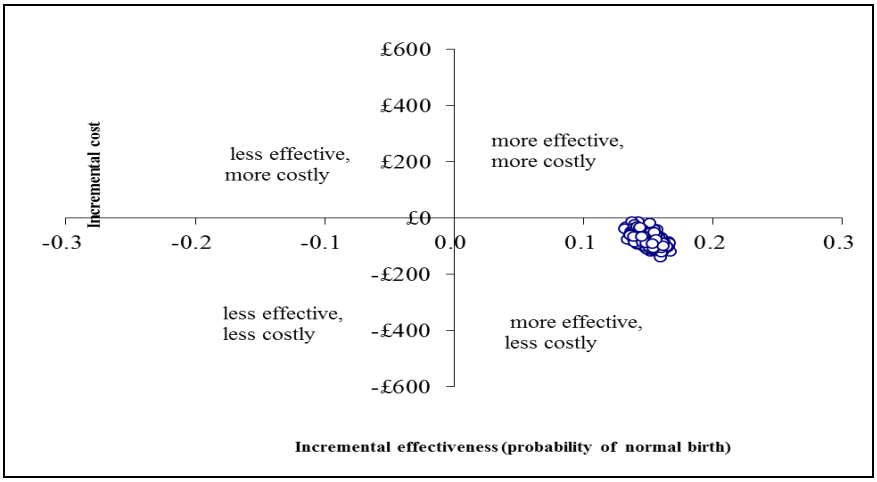


Figure 30. Cost effectiveness plane: planned birth in a AMU compared with an OU for women without complicating conditions at the start of care in labour



5.4.3.2 Sensitivity analyses performed on cost variables for the 'normal birth' cost-effectiveness outcome for all 'low risk' women

The ICER estimates in table 20 reflect variations in the cost estimates for key cost drivers, and their impacts on the cost-effectiveness estimates for the normal birth outcome for all low risk women. Once again, the findings were generally robust to the sensitivity analyses performed and indicate that the cost-effectiveness results depicted as ICERs respond in a manner consistent with our expectations.

Table 20. Sensitivity analyses performed for the 'normal birth' outcome

Sensitivity analyses			
	Incremental cost per additional case of 'normal birth'.		
	(OU) → (Home)	(OU) → (FMU)	(OU) → (AMU)
1) Overheads 20% greater than baseline			
Cost differences between planned birth in an OU and non-OU setting (95% CI)	-686 (-715, -658)	-278 (-312, -240)	-176 (-213, -138)
Change in 'normal birth' (95% CI)	0.301 (0.292, 0.310)	0.256 (0.247, 0.265)	0.183 (0.172, 0.194)
Mean ICER (95% CI)	**-2281 (-2360, -2208)**	**-1084 (-1198, -964)**	**-956 (-1125, -779)**
Quadrant on the cost-effectiveness plane	south east	south east	south east
2) Overheads 20% lower than baseline			
Cost differences between planned birth in an OU and non-OU setting (95% CI)	-346 (-370, -323)	-165 (-196, -131)	-61 (-95, -28)
Change in 'normal birth' (95% CI)	0.301 (0.292, 0.310)	0.256 (0.247, 0.265)	0.183 (0.173, 0.194)
Mean ICER (95% CI)	**-1150 (-1214, -1091)**	**-642 (-752, -521)**	**-329 (-513, -158)**
Quadrant on the cost-effectiveness plane	south east	south east	south east
3) Occupancy rates 50% greater than baseline			
Cost differences between planned birth in an OU and non-OU setting (95% CI)	-512 (-541.-486)	-282 (-314, -249)	-194 (-228, -160)
Change in 'normal birth' (95% CI)	0.301 (0.293, 0.308)	0.256 (0.245, 0.268)	0.183 (0.172, 0.194)

Mean ICER (95% CI)	**-1703 (-1775, -1634)**	**-1103 (-1206, -996)**	**-1054 (-1211, -889)**
Quadrant on the cost-effectiveness plane	south east	south east	south east
4) Midwifery staffing in the AMU and FMU 20% less than baseline (80% intermittent care)			
Cost differences between planned birth in an OU and non-OU setting (95% CI)	-590 (-618, -563)	-344 (-377, -309)	-256 (-292, -221)
Change in 'normal birth' (95% CI)	0.301 (0.293, 0.308)	0.256 (0.247, 0.265)	0.183 (0.175, 0.192)
Mean ICER (95% CI)	**-1960 (-2034, -1890)**	**-536 (-634, -429)**	**-1392 (-1530, -1261)**
Quadrant on the cost-effectiveness plane	south east	south east	south east
5) Midwifery staffing in the OU 15% less than baseline (50% intermittent care)			
Cost differences between planned birth in an OU and non-OU setting (95% CI)	-480 (-508, -453)	-137 (-170, -102)	-44 (-79, -9)
Change in 'normal birth' (95% CI)	0.301 (0.292, 0.308)	0.256 (0.245, 0.267)	0.183 (0.172, 0.194)
Mean ICER (95% CI)	**-1595 (-1670, -1526)**	**-536 (-651, -412)**	**-239 (-419, -53)**
Quadrant on the cost-effectiveness plane	south east	south east	south east
6) Midwifery staffing in the OU 25% greater than baseline (90% intermittent care)			
Cost differences between planned birth in an OU and non-OU setting (95% CI)	-773 (-802, -744)	-430 (-465, -393)	-337 (-374, -301)
Change in 'normal birth' (95% CI)	0.301 (0.293, 0.308)	0.256 (0.245, 0.265)	0.183 (0.175, 0.192)
Mean ICER (95% CI)	**-2568 (-2648, -2494)**	**-1679 (-1784, -1571)**	**-1832 (-1972, -1963)**
Quadrant on the cost-effectiveness plane	south east	south east	south east

5.4.4 Cost effectiveness acceptability curves

Cost-effectiveness acceptability curves (CEACs) were generated to show the probability of each planned birth setting being optimal in terms of cost-effectiveness at alternative cost-effectiveness thresholds held by decision-makers. These were generated for each of the outcome measures explored, for both women with and without complicating conditions at the start of labour care, and for each parity sub-group.

NICE guidance suggests the following "In addition to details of the expected mean results (costs, outcomes and ICERs), the probability that the treatment is cost effective at thresholds of £20,000–£30,000 per QALY gained and the error probability (that the treatment is not cost effective) should also be presented, particularly when there are more than two alternatives." (NICE, 2008). This raised two issues: (i) there are no published cost-effectiveness thresholds (the willingness to pay for health gain, or λ) for the clinical outcomes in the Birthplace study, e.g. adverse perinatal outcome avoided. (ii) thus the mean net benefits for cost-effectiveness thresholds ranging from £0 to £100,000 were calculated for each clinical outcome. This is consistent with what is reported in the literature more broadly albeit in different healthcare contexts and in studies with different clinical outcomes and seemed intuitive based on fuller NICE guidance. In the analyses, the finding was that home birth was the most cost-effective option for multiparous low risk women at all cost-effectiveness thresholds (£0 - £100,000). This was depicted graphically in a CEAC curve. The CEAC was horizontal for a planned birth at home for multiparous low risk women at a probability of 1.0 and the CEACs for the remaining settings (OU, FMU and AMU) were horizontal on the x-axis. It was an odd-looking CEAC to present and consequently it was better to describe in written form. However, for ‘low risk’ nulliparous women, planned place of birth in a FMU had a 0.35 probability of being the most cost-effective option at a £20,000 cost-effectiveness threshold for the primary outcome (figure 32). This probability increased to 0.59 when the cost-effectiveness threshold for the primary outcome increased to £30,000. Similarly, for ‘low risk’ nulliparous women without complicating conditions at the start of care in labour, planned place of birth in a FMU had a 0.16 probability of being the most cost-effective option at a £20,000 cost-effectiveness threshold for the primary outcome (figure 33). This probability

increased to 0.35 when the cost-effectiveness threshold for the primary outcome increased to £30,000

Table 21. Net benefit statistics for 'low risk' nulliparous women for adverse perinatal outcome avoided

Ceiling ratio	Probability cost-effective			
	OU	HB	FMU	AMU
0	0	1	0	0
5000	0	0.99	0.01	0
10000	0	0.935	0.064	0.001
15000	0	0.818	0.178	0.004
20000	0	0.632	0.352	0.016
25000	0	0.493	0.474	0.033
30000	0	0.359	0.592	0.049
35000	0	0.276	0.649	0.075
40000	0	0.228	0.677	0.095
45000	0	0.19	0.688	0.122
50000	0	0.15	0.71	0.14
55000	0	0.116	0.728	0.155
60000	0	0.098	0.721	0.18
65000	0	0.082	0.723	0.194
70000	0	0.072	0.72	0.207
75000	0	0.057	0.719	0.222
80000	0	0.047	0.722	0.228
85000	0	0.041	0.718	0.236
90000	0	0.036	0.716	0.24
95000	0	0.032	0.709	0.249
100000	0	0.028	0.707	0.254

Figure 31. Cost effectiveness acceptability curves for planned place of birth for 'low risk' nulliparous women for adverse perinatal outcome avoided

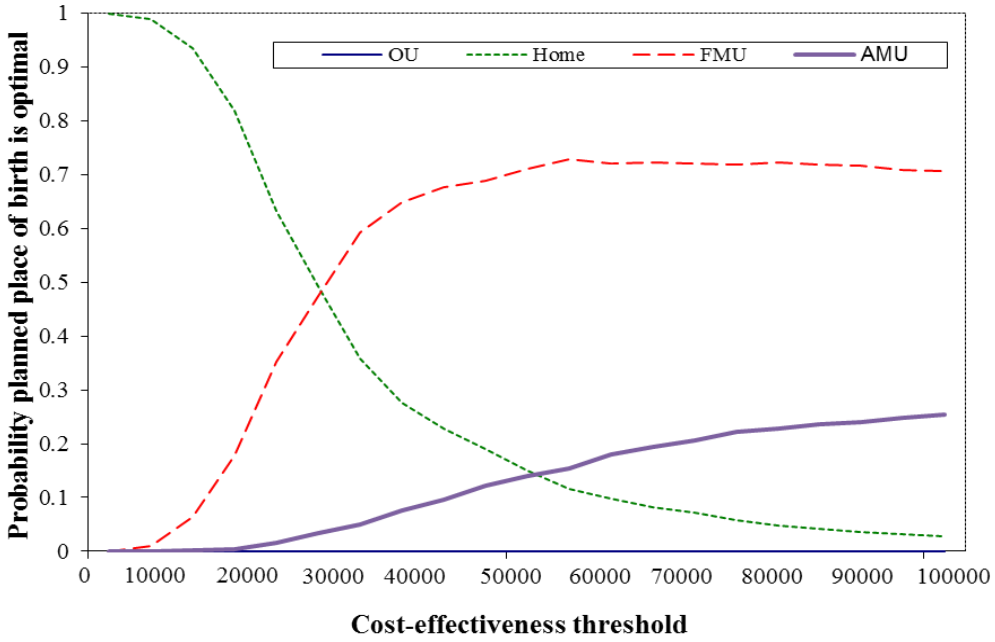
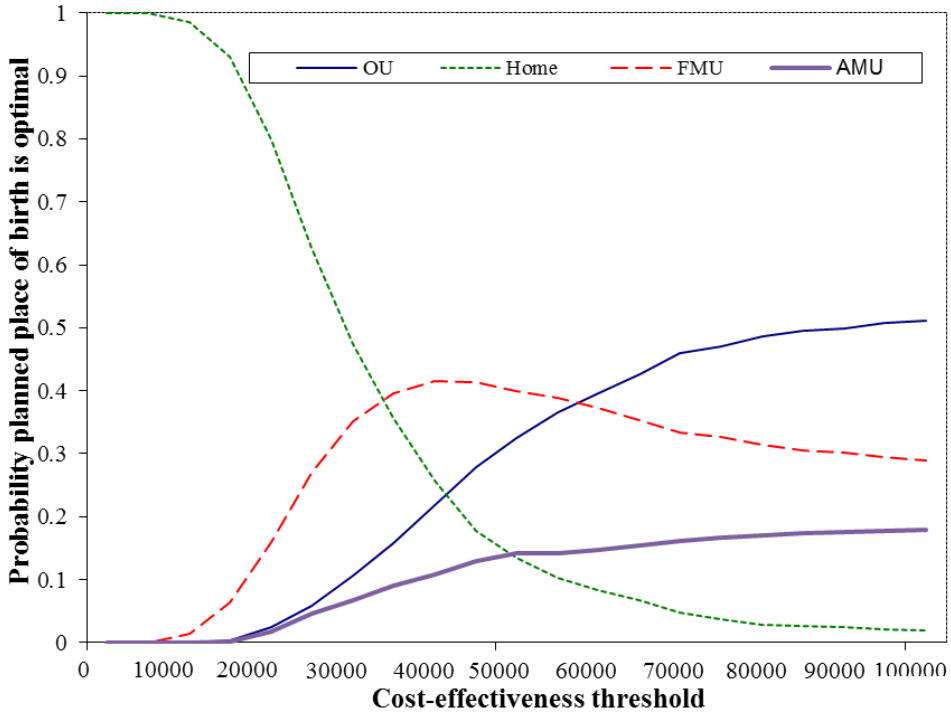


Table 22. Net benefit statistics for 'low risk' nulliparous women without complicating conditions for adverse perinatal outcome avoided

Ceiling ratio	Probability cost-effective			
	OU	HB	FMU	AMU
0	0	1	0	0
5000	0	1	0	0
10000	0	0.986	0.014	0
15000	0.004	0.93	0.064	0.002
20000	0.024	0.8	0.159	0.017
25000	0.059	0.626	0.269	0.046
30000	0.107	0.474	0.352	0.067
35000	0.157	0.356	0.396	0.091
40000	0.219	0.257	0.416	0.108
45000	0.279	0.178	0.413	0.13
50000	0.324	0.135	0.399	0.142
55000	0.366	0.103	0.389	0.142
60000	0.396	0.083	0.373	0.148
65000	0.426	0.067	0.353	0.154
70000	0.459	0.047	0.333	0.161
75000	0.471	0.037	0.326	0.166
80000	0.487	0.029	0.314	0.17
85000	0.496	0.026	0.305	0.173
90000	0.499	0.025	0.301	0.175
95000	0.507	0.021	0.295	0.177
100000	0.512	0.019	0.29	0.179

Figure 32. Cost effectiveness acceptability curves for planned place of birth for 'low risk' nulliparous women without complicating conditions at the start of care in labour for adverse perinatal outcome avoided



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Finally, a system of seemingly unrelated regression equations for prognostic factor adjustment had little effect on cost-effectiveness outcomes (table 23). Seemingly unrelated regression is used as a method for prognostic factor adjustment in economic evaluations with individual level data, to adjust the analysis for baseline covariates and to allow a robust method for exploring important sub-group effects. This table was produced in addition to the previous regression on costs and ICERS as an additional test on the robustness of the results, and had little effect on cost-effectiveness outcomes.

Table 23. Seemingly unrelated regression on cost-effectiveness outcomes

Total cost:

Covariate	Coefficient	Standard Error	*P* value	(95% CI)
Planned place birth: OU (referent)	-			
Planned place birth: home	-318.7	14.0	0.000	(-346.2, -291.2)
Planned place birth: FMU	-117.4	15.1	0.000	(-146.9, -87.8)
Planned place birth: AMU	-123.7	13.4	0.000	(-149.9, -97.4)
Parity: 0 previous pregnancies (referent)	-			
Parity: 1 previous pregnancy	-949.8	11.7	0.000	(-972.7, -926.9)
Parity: 2 previous pregnancies	-1094	15.8	0.000	(-1125.0,-1062.9)
Parity: 3+ previous pregnancies	-1109.9	20.7	0.000	(-1150.5, -1069.2)
37 weeks gestation	-51.7	30.4	0.089	(-111.2, 7.8)
38 weeks gestation	-154.3	18.1	0.000	(-189.8, -118.8)
39 weeks gestation	-122.1	13.0	0.000	(-147.5, -96.6)
40 weeks gestation (referent)	-			
41 weeks gestation	186.4	13.0	0.000	(160.8, 211.9)
42-44 weeks gestation	554.4	38.6	0.000	(478.7, 630.1)
Married (referent)	-			
Single/unsupported partner	16.3	19.8	0.411	(-22.6, 55.2)
BMI not recorded	35.3	13.8	0.010	(8.3, 62.3)
BMI 10-18	-61.6	32.8	0.060	(-125.8, 2.6)
BMI 19-24 (referent)	-			
BMI 25-29	39.0	12.6	0.002	(14.2, 63.8)
BMI 30-35	41.6	18.9	0.028	(4.6, 78.5)
White British (referent)	-			
Indian/Bangladeshi	126.5	31.8	0.000	(64.2, 188.9)
Pakistani	88.1	36.3	0.015	(17.0, 159.2)
Black Caribbean	-97.5	50.7	0.054	(-196.9, 1.9)
Black African	80.0	35.2	0.023	(11.1, 148.9)
Mixed	37.7	40.2	0.349	(-41.1, 116.5)
Other	69.5	27.9	0.013	(14.9, 124.1)
Maternal age <20	-275.9	25.2	0.000	(-325.3, -226.6)
Maternal age 20-24	-92.8	15.3	0.000	(-122.8, -62.8)

Maternal age 25-29 (referent)	-			
Maternal age 30-34	70.7	13.2	0.000	(44.7, 96.7)
Maternal age 35-39	106.8	15.8	0.000	(75.8, 137.7)
Maternal age 40-60	221.9	32.1	0.000	(158.9, 284.9)
IMD 0.37-8.31 (least deprived)	52.4	16.9	0.002	(19.3, 85.5)
IMD 8.32-13.73	43.2	16.5	0.009	(10.9, 75.6)
IMD 13.74-21.21	38.1	16.0	0.017	(6.7, 69.5)
IMD 21.22-34.41	30.5	15.6	0.051	(-0.1, 61.0)
IMD 34.42-85.46 (most deprived-referent)	-			
Fluent in English (referent)	-			
Some English	4.4	27.1	0.871	(-48.7, 57.5)
No English	-36.1	49.0	0.462	(-132.1, 60.0)
Constant	2018.2	19.2	0.000	(1980.6, 2055.9)

Adverse perinatal outcome:

Covariate	**Coefficient**	**Standard Error**	***P* value**	**(95% CI)**
Planned place birth: OU (referent)	-			
Planned place birth: home	-0.001	0.001	0.084	(-0.002, 0.000)
Planned place birth: FMU	0.000	0.001	0.726	(-0.002, 0.001)
Planned place birth: AMU	0.000	0.001	0.762	(-0.001, 0.002)
Parity: 0 previous pregnancies (referent)	-			
Parity: 1 previous pregnancy	0.003	0.001	0.000	(0.002, 0.004)
Parity: 2 previous pregnancies	0.004	0.001	0.000	(0.003, 0.006)
Parity: 3+ previous pregnancies	0.004	0.001	0.000	(0.002, 0.006)
37 weeks gestation	-0.003	0.002	0.100	(-0.006, 0.000)
38 weeks gestation	0.000	0.001	0.851	(-0.002, 0.002)
39 weeks gestation	0.000	0.001	0.730	(-0.001, 0.002)
40 weeks gestation (referent)	-			
41 weeks gestation	-0.002	0.001	0.011	(-0.003, 0.000)
42-44 weeks gestation	-0.003	0.002	0.101	(-0.007, 0.001)
Married (referent)	-			
Single/unsupported partner	-0.002	0.001	0.017	(-0.004, 0.000)
BMI not recorded	-0.001	0.001	0.044	(-0.003, 0.000)
BMI 10-18	0.000	0.002	0.810	(-0.003, 0.004)
BMI 19-24 (referent)	-			
BMI 25-29	-0.002	0.001	0.063	(-0.002, 0.000)

BMI 30-35	-0.003	0.001	0.003	(-0.005, -0.001)
White British (referent)	-			
Indian/Bangladeshi	-0.002	0.002	0.305	(-0.005, 0.002)
Pakistani	-0.002	0.002	0.320	(-0.005, 0.002)
Black Caribbean	0.001	0.003	0.779	(-0.004, 0.006)
Black African	-0.007	0.002	0.000	(-0.010, -0.003)
Mixed	0.002	0.002	0.399	(-0.002, 0.006)
Other	0.000	0.001	0.791	(-0.002, 0.003)
Maternal age <20	0.001	0.001	0.488	(-0.002, 0.003)
Maternal age 20-24	0.000	0.001	0.961	(-0.002, 0.001)
Maternal age 25-29 (referent)	-			
Maternal age 30-34	-0.002	0.001	0.001	(-0.004, -0.001)
Maternal age 35-39	-0.002	0.001	0.021	(-0.003, 0.000)
Maternal age 40-60	-0.005	0.002	0.001	(-0.008, -0.002)
IMD 0.37-8.31 (least deprived)	0.000	0.001	0.829	(-0.002, 0.001)
IMD 8.32-13.73	0.001	0.001	0.534	(-0.001, 0.002)
IMD 13.74-21.21	-0.001	0.001	0.313	(-0.002, 0.001)
IMD 21.22-34.41	-0.001	0.001	0.439	(-0.002, 0.001)
IMD 34.42-85.46 (most deprived-referent)	-			
Fluent in English (referent)	-			
Some English	0.000	0.001	0.742	(-0.003, 0.002)
No English	-0.002	0.002	0.341	(-0.007, 0.003)
Constant	0.997	0.001	0.000	(0.995, 0.999)

BMI denotes body mass index; IMD denotes index of multiple deprivation.
Breusch-Pagan test of independence: chi2(1) = 5257.540, Pr = 0.0000.

5.5 Discussion and conclusions

5.5.1 Summary of main findings

This chapter aimed to determine the cost-effectiveness of different settings for birth; at home, in freestanding midwifery units, in alongside midwifery units and in obstetric units for women and babies at ‘low risk’ of complications prior to the onset of labour, based on individual level data collected in the cohort study within Birthplace. The three effectiveness measures used were ‘intrapartum stillbirth, early neonatal mortality and specific neonatal morbidity’ avoided (a composite measure of perinatal mortality and intrapartum related morbidity and the primary outcome in the cohort study), ‘maternal morbidity avoided’ (a composite of some of the secondary outcomes in the cohort study) and ‘normal birth’.

With regards to the baby; the incidence of adverse perinatal outcomes was low in all settings. The results of the cost-effectiveness analyses show that a change from planned place of birth in an OU to a FMU or AMU will generate incremental cost savings with uncertainty around the cases of adverse perinatal outcome averted. In all bootstrapped samples, for these comparisons, the scatterplots of mean ICERs fell across both the south west and south east quadrants of the cost-effectiveness planes. This implies a lower cost attributable to a non-OU midwifery setting planned place of birth, but represents uncertainty surrounding the impact on perinatal outcomes. For births planned at home for nulliparous ‘low risk’ women, the cost-effectiveness analyses reflected a less effective and less-costly option for intrapartum care than birth planned in an OU. For births planned at home for multiparous low risk women, the cost-effectiveness analyses reflected lower costs and considerable uncertainty surrounding the impact on perinatal outcomes.

With regards to the mother, planned place of birth in all non-OU settings generated incremental cost savings and improved maternal outcomes. There is uncertainty around the cost savings for planned birth in an AMU, but planned birth in an AMU still showed cost savings and more positive maternal outcomes.

Planned births in an OU had a longer duration of labour per episode, as well as higher rates of epidural use, general anaesthesia, augmentation of labour and instrumental delivery. In addition to the greater burden of overheads for the OU, these interventions for women are costly and would have increased the mean total cost per woman planning a birth in an OU. The costs and outcomes for the AMU seemed to lie between those for the OU and FMU or home. Some of the characteristics of the women who had planned a birth in an AMU were similar to the planned OU birth group and these included higher rates of epidural use, augmentation of labour and active management of labour and a longer total duration of labour. They were more similar to the FMU and home groups in their mode of birth, use of a general anaesthetic, and rates of perineal trauma. Planned birth at home or in a FMU generates more effective and less costly maternal outcomes. This finding was repeated for the analysis of incremental cost per additional ‘normal birth’.

5.5.2 Strengths and weaknesses

This chapter provides evidence for the cost-effectiveness of planned place of birth in four different settings. ‘Bottom up’ and ‘top down’ cost data were applied to resource use estimation which included all significant resource items collected from a health service perspective. All unit costs employed followed guidelines on costing health services as part of economic evaluation, including the calculation of these costs being underpinned by the concept of opportunity cost, which can be

defined as the value of the next best alternative for using these resources (Brouwer et al., 2001). A comprehensive strategy for handling uncertainty surrounding individual parameters and the value of the cost-effectiveness threshold was conducted.

Robust and detailed collection of effectiveness data was conducted through the prospective cohort study. An integrated multi-disciplinary programme of research of this size and design has not been undertaken before. The prospective cohort study identified maternal, intrapartum and neonatal outcomes for the different settings of planned place of birth, including the proportion of mothers and babies requiring transfer and the duration of transfer. The cost-effectiveness analysis was made possible by this rigorously designed and conducted observational study.

The cost-effectiveness analysis was mainly designed to capture costs and outcomes attributed to intrapartum care. This was difficult to undertake because it required the disaggregation of trust based maternity service data as well as 'within hospital/unit' maternity data for both cost and resource use analyses. The collection of cost data was limited by patchy and incomplete data returns from finance and other maternity service managers. Consequently, some of the cost data inputs were modelled from other sources. Although varied in sensitivity analyses, one should be cautious when interpreting these cost data. Routinely collected clinical and cost data should be available in a disaggregated form so that trusts can access their data and so that comprehensive national research and audit can be conducted to better inform service configuration and management.

Low throughput has tended to cause health professionals to assume that FMUs might be less cost-effective than OUs. This study used occupancy rates which were modelled from data from the Healthcare Commission survey of maternity units and primary sources collected from finance managers. On average, FMUs did have a much lower occupancy rate than AMUs and OUs. The average

occupancy rates used in the model for this analysis were: OUs (65.1%), FMUs (30.4%) and AMUs (56.5%). The occupancy rates were then varied in sensitivity analyses, which included an increase of 50% occupancy rates for the AMUs and FMUs. Median, minimum and maximum occupancy rates were also calculated for the units. Irrespective of these rates, the OUs tended to carry a higher burden of overheads than FMUs once non-pay inputs and indirect costs were included (theatre, pathology etc). Should occupancy rates rise in FMUs they would become an increasingly cost-effective source of provision of maternity care. The cost calculations in this analysis are susceptible to changes in occupancy rates and relative cost-effectiveness will vary accordingly. A key cost driver will be the overheads apportioned across the unit for intrapartum care. Fixed costs will include estate and capital investment costs and variable costs will include midwifery staffing directly apportioned to each intrapartum episode. Should changes to maternity service configuration be planned for cost-effectiveness purposes, then commissioners would have to consider the resource use and related cost implications on the maternity service as a whole. This would require economic modelling and forecasting of occupancy rates, overheads, patient safety and transfer in view of fixed and variable costs, and the relative disinvestment in one form of maternity service provision in preference for another. The cost-effectiveness analysis presented here is most relevant for the duration of data collection of the Birthplace prospective cohort study and the context of the NHS maternity service for that time period.

The limited time horizon of the study meant that the follow up of outcomes for both mother and the baby did not extend beyond the time period of labour care, or higher level postnatal or neonatal care when this was received. Serious adverse outcomes can result in associated life-long health and societal costs, as shown by the size of damages paid in obstetric litigation cases, which represent a

substantial cost to the NHS. Less serious, but more frequent, morbidities associated with labour and birth and its management affect women and babies. Follow up over weeks or longer to monitor recovery, or a future assessment of the outcomes for mothers and babies at a later date, would shed more light on long term cost-effectiveness.

The effectiveness data used in the cost-effectiveness analysis are composites of perinatal and maternal outcomes. Although necessary for this study, the use of a composite measure does not capture the complexities of weighting for individual components. The methods of analysis employed in this cost-effectiveness analysis could not explore these complexities further. This is a particular weakness in this study. Furthermore, the study has an innate tension in holding the outcomes for both the mother and the baby in synergy as the cost-effectiveness analysis is limited by its inability to link the effectiveness outcomes together. In keeping with the prospective cohort study report, the results show cost-effectiveness for only the baby or only the mother separately according to planned place of birth, but not both together in the same analysis. This might be counter-intuitive because it would be invidious to 'trade' the outcomes for the mother with the outcomes for the baby. A decision analytic model has therefore been designed to synthesise available published data with data collected from Birthplace to look at combined outcomes for both the mother and baby in a single analysis. This is described in the next chapter.

Assumptions based on primary research were made about midwifery 'staff to woman' ratios during labour. This was recorded as intermittent or continuous support that midwifery staff were able to offer women in different birth settings. The assumptions were generated from primary research conducted as part of the costing study. Birth at home, and in a FMU and AMU was attributed continuous midwifery care during labour, with 65% intermittent midwifery support attributed to

OUs. These were varied in the sensitivity analyses, but for cost-effectiveness purposes only. In this report, it is not possible to comment on the 'quality of care' consequences from these proportional changes in dedicated staff time, but this is noted by others, such as the HealthCare Commission (now CQC) who identified the need for adequate staffing levels, continuity of care for women during labour and support for women after the birth of their baby. Clearly, more 1:1 continuous midwifery care is an additional benefit for women in the planned home, FMU and AMU groups (Hodnett et al., 2010).

Furthermore, this study only used clinically defined outcomes to determine the cost-effectiveness of planned place of birth. Although these outcomes were rigorously collected and reviewed, outcomes which are also of importance to women and decision-makers, such as the quality of care offered, women's experiences and support with early initiation of breastfeeding were not addressed in the analysis. A broader economic approach to the measurement of outcomes, such as stated preference discrete choice modelling might have provided more information to decision makers, but this had not been practically possible given the size and anonymity of the study design. Within Birthplace, however, separate research was undertaken which aimed to describe women's experiences of care, management and experiences of transfer between services, and organisational and workforce issues, which may each impact on the quality of care in different locations.

Although represented as costs, the findings shown here reflect the duration of labour, proportion of women and babies requiring transfer, mode of birth, levels of intervention required and admissions to postnatal and neonatal care according to their planned place of birth. Planned birth at home is shown to be the most cost-saving option, reflecting reduced medical intervention and a higher incidence of 'normal birth'. This requires deeper analysis. When compared to women planning

to give birth in an OU, women planning a birth at home were more likely to be white and have a fluent understanding of English, be married or living with a partner, to be living in a more socioeconomically advantaged area, and were markedly more likely to have had one or more previous pregnancies. Each of the above characteristics are associated with being cost-saving. The most marked contrast between the home birth group and the three other groups was in the distribution of parity, as far more women planning a birth at home were multiparous compared to the FMU, AMU and OU groups, consequently as the proportion of all births that are first births increases, the mean cost of a birth will increase. The regression on cost showed that being multiparous was associated with a significant and substantial cost-saving effect, and that this was apparent for each additional previous pregnancy.

Analyses conducted in the cohort study adjusting for differences in the characteristics of women planning birth in different settings, showed significantly increased odds of an adverse perinatal outcome for 'low' risk' nulliparous women in the planned home birth group. For births planned at home in nulliparous 'low risk' women, the cost-effectiveness analyses reflected a less effective and less-costly option, on average, for maternity care than birth planned in an OU. For multiparous women, the cost-effectiveness analyses reflect lower costs and improved perinatal outcomes, on average, in the planned non-OU settings, though with considerable uncertainty around the latter. Overall for the baby, planned place of birth in FMU and AMU settings generate cost savings with uncertainty around the cases of adverse perinatal outcome averted. For the mother, planned place of birth in all non-OU settings generated cost savings and improved maternal outcomes. The analyses described in the next chapter combine outcomes for both the mother and baby using decision-analytic modelling techniques and explore these complexities further.

6 Birthplace cost-effectiveness analysis of planned place of birth: decision analytic model

Introduction

> 'The increasing use of economic evaluation for decision-making has placed some very clear requirements on researchers in terms of analytic methods. These include the need to incorporate all appropriate evidence into the analysis, to compare new technologies with the full range of alternative options and to reflect uncertainty in evidence into the analysis. The need to satisfy these requirements provides a strong rationale for decision modeling as a framework for economic evaluation' (Briggs et al., 2006).

Briggs and Sculpher (1998) describe iterative phases of the 'cycle of economic evaluation' using both individual level data and modelling. These include an early assessment of the economic characteristics of a new technology (stage 1), the use of modelling to scope whether the intervention could be more cost-effective than existing interventions (stage 2), an RCT or meta-analyses of the intervention (stage 3) and evaluating the cost-effectiveness of interventions when they are used in routine clinical practice (stage 4). In each stage the design and sources of data required to undertake analyses or to populate a model may differ (Briggs and Sculpher, 1998) .

The individual level cost-effectiveness analysis for Birthplace was described in chapter 5. It was limited by the short time horizon of the cohort study and by the study's analytical strategy which was not designed to link the effectiveness outcomes for the baby and the mother together. The cost-effectiveness analysis

fitted fairly neatly into ‘stages three or four of the life-cycle’. Briggs and Schulpher note that ‘given the desire not to overload trials with enormous amounts of data collection and to increase the generalizability of results, trials may not be the ideal vehicle for economic analysis.’ Furthermore and relevant to Birthplace, trials may only be concerned with short or intermediate outcomes whereas models can then estimate outcomes for longer-term cost-effectiveness (Briggs and Sculpher, 1998).

This thesis attempted to use individual level data to design a template for the decision-analytic modelling of longer term cost-effectiveness when relevant evidence to populate the template becomes available. The template therefore synthesises the cost-effectiveness evidence from Birthplace to calculate outcomes for both the mother and baby in a single analysis and is presented in this chapter.

6.1 Model aims

The original aim of this chapter was to develop a decision analytic model, including longer term economic costs, to determine the life-long cost-effectiveness of planned place of birth in terms of a preference based measure that combined outcomes for both the mother and baby. It was intended to fill an important gap in the evidence relating to the longer term costs and consequences of intrapartum care. As will be shown in the chapter, the paucity of available evidence meant that this model could not be populated with data on longer-term costs and consequences. The aims of the study were therefore revised. The design described in this chapter provides a template for short-term cost-effectiveness for the mother and baby combined in a single outcome metric, and populated with data from the cohort study. It is now most useful as a template for the design of future economic models about planned place of birth.The chapter additionally

highlights the evidence that is currently available and the additional evidence needed to model the longer-term cost-effectiveness of alternative planned birth settings. The template's parameter inputs can be updated when data on longer-term costs and consequences become available.

6.2 Methods

6.2.1 Model structure

The structure of the decision model template is shown as a decision tree. It is designed to reflect 'pathways of care' experienced by women as they progress through the stages of labour, and mirrors clinical experience observed within the cohort study and the parallel costing components of the individual level cost-effectiveness analysis. This design is the same, though more detailed, than the decision tree developed by the National Institute for Health and Clinical Excellence (NICE) Intrapartum Care Guidelines Group (National Collaborating Centre for Women's and Children's Health, 2007). It includes all planned places of birth originally described by the NICE intrapartum care cost-effectiveness model and subsequently identified by the maternity care review conducted by the Healthcare Commission in 2007; to include birth at home, in alongside midwifery units (AMU), freestanding midwifery units (FMU) and obstetric units (OU) (British Association of Perinatal Medicine, 2010). The template explores planned place of birth at the start of care in labour for women at 'low risk' of complications and measures the combined outcomes for both the mother and baby in one analysis. An overview of the design which was developed for the model can be viewed in table 24 and figure 33 shows the structure presented as a decision tree.

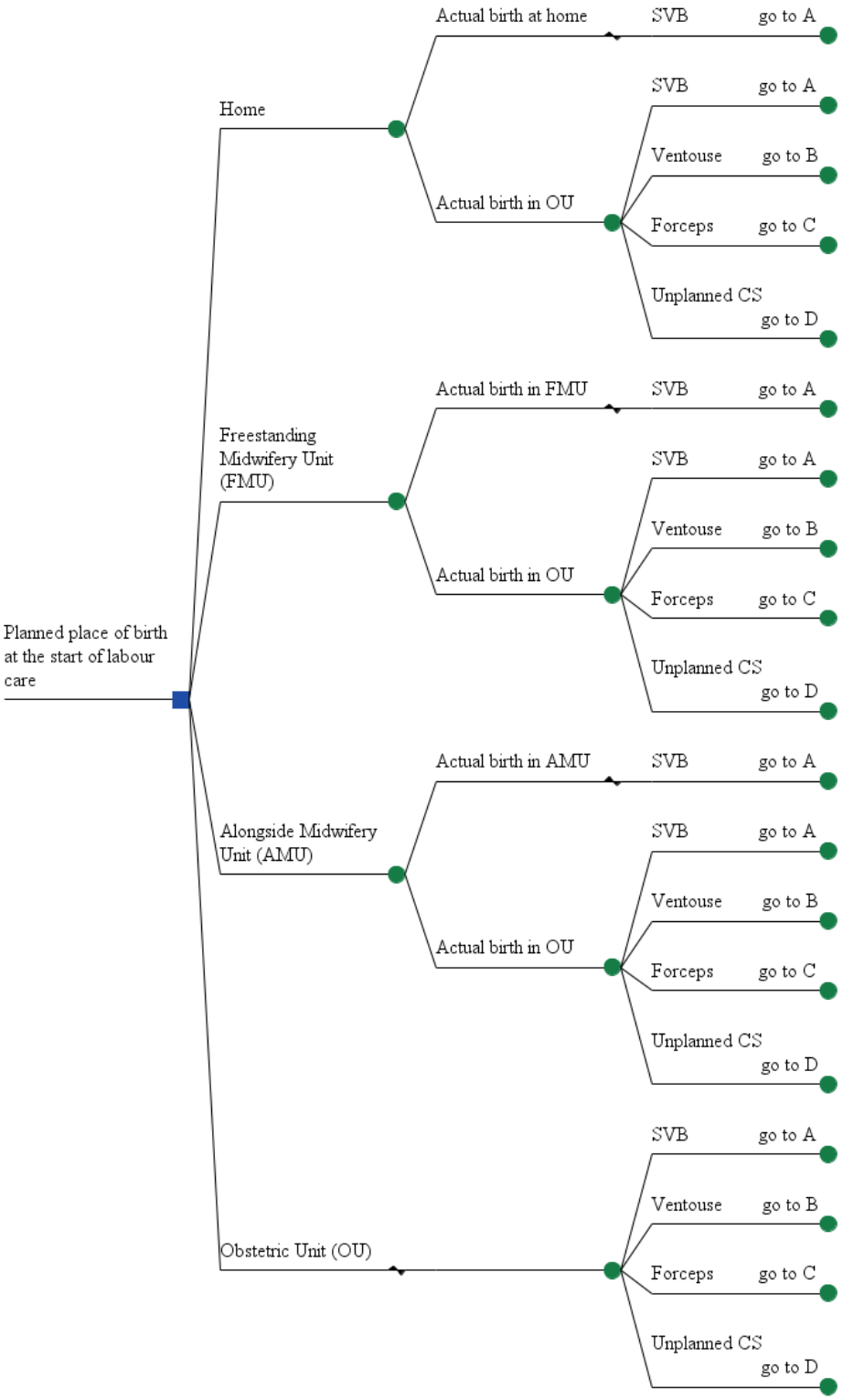
Table 24. Overview of the decision model

Decision	Branch (1) Planned birth setting	Branch (2) Intrapartum labour care	Branch (3) Mode of birth	Branch (4) Post birth outcomes for mother and baby dyad
Planned place of birth at the start of care in labour	Home Alongside midwifery unit Freestanding midwifery unit Obstetric Unit	Actual birth in planned setting, or with transfer after birth to Obstetric unit Actual birth in Obstetric unit, with transfer prior to birth	Spontaneous vertex birth Birth with ventouse Birth with forceps Unplanned caesarean section	Mother well[1] baby well[2] Mother well baby not well Mother not well baby well Mother not well baby not well

[1] Defined as having none of the following: general anaesthetic; instrumental birth; caesarean section, third or fourth degree perineal trauma; blood transfusion; admission to an intensive therapy unit, high dependency unit or specialist unit; or maternal death (within 42 days of giving birth). This is a composite measure and was the secondary outcome of interest in the Birthplace individual level cost-effectiveness analysis.

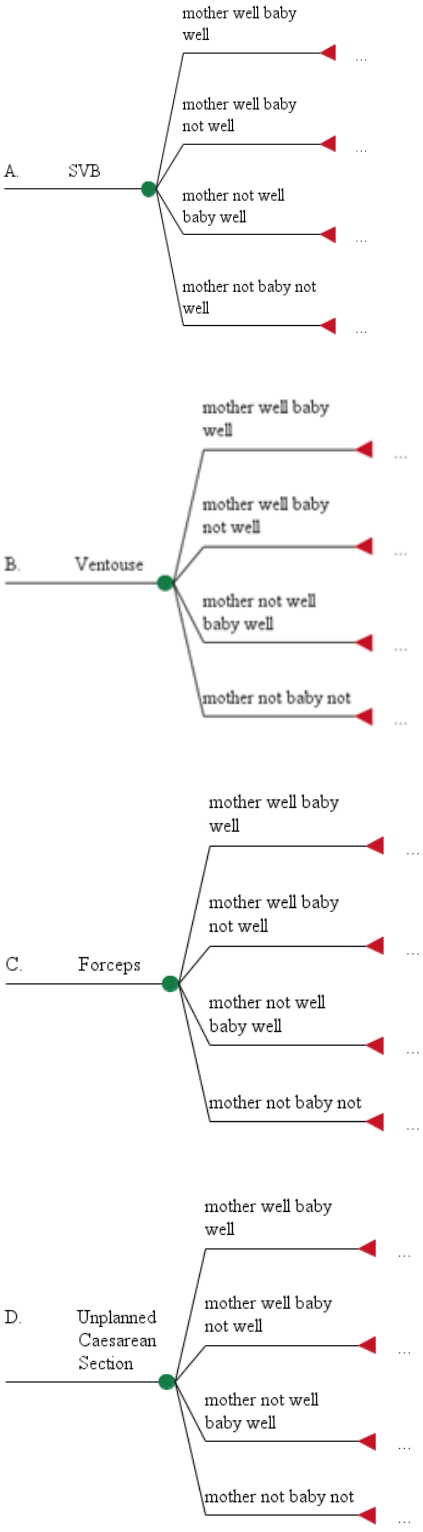
[2] Defined as having none of the following: stillbirth after the start of care in labour, early neonatal death, neonatal encephalopathy, meconium aspiration syndrome, brachial plexus injury, fractured humerus, or fractured clavicle. This is a composite measure of perinatal mortality and specified neonatal morbidities and was the primary outcome of interest in the Birthplace prospective cohort study.

Figure 33. Decision tree, from labour onset to completion of intrapartum care episode



Continued overleaf….

Decision tree, from labour onset to completion of intrapartum care episode continued



6.2.2 Care pathways for planned place of birth as depicted in the decision tree

Decision trees tend to represent chains of events because of their explicit systematic framework. They are oriented from left to right, with the decision to be analyzed on the left, the probable events in the centre and the clinical (and related economic) outcomes on the right. The tree itself is made up of nodes, branches and outcomes. The decision node (depicted here as a blue square) occurs on the left hand side of the tree, identifying the primary decision to be addressed. The pathways that follow each planned place of birth represent a series of logically-ordered events, denoted by branches emanating from chance nodes (drawn here as green circular symbols). The alternatives at each chance node must be mutually exclusive and their probabilities should sum exactly to one. The endpoints of each pathway are denoted by terminal nodes (drawn here as red triangular symbols) to which values or payoffs, such as costs and outcomes, are assigned (Briggs et al., 2006).

The **decision node** represents the choice for a decision-maker, in this case, where a woman who is at 'low risk' of complications prior to the onset of labour plans to give birth.

Chance nodes are located on care pathways at points when uncertain events may occur. Branches issue from each chance node and represent the possible events that patients may experience at that point in the pathway. The likelihood of an event occurring is represented by a probability attached to the branch. In general, these are informed by relevant primary or secondary evidence. The scale for probability estimates ranges from 0 (impossible) to 1.0 (absolutely certain).

Probabilities are assigned to each branch following a chance node, and the sum of probabilities following a chance node must add to 1.0. (Briggs et al., 2006).

The decision tree in this chapter is populated with data derived from the cohort study described in chapter 2. The tree shows all of the options that may be available to women of 'low risk' given the different configurations of services in trusts and government maternity care policy support for offering women with straightforward pregnancies a choice of settings for birth, (Campbell and Macfarlane, 1994, Department of Health, 2004a) and as specified in previous chapters, include an OU, AMU, FMU or home. In the tree, all 'low risk' births completed in 'out of hospital' (non-obstetric unit) settings would result in a spontaneous vertex birth. The design did not include births that resulted in a breech delivery. Transfers for additional medical care may be required following birth for the mother, baby or both. This additional care pathway for transfer after birth is not made explicit although the costs of transfer are included, because the cost-effectiveness of planned place of birth is modelled by whether the actual birth occurred in the planned setting or not. If women transfer to an obstetric unit prior to birth then an instrumental (ventouse or forceps) or operative (unplanned caesarean section) delivery becomes an option.

Terminal nodes represent the final endpoints of the model. Values or payoffs, such as costs, life years or quality-adjusted life years (QALYs), are usually assigned to terminal nodes. Once the probabilities and payoffs have been entered, the decision tree is 'averaged out' and 'folded back' (or rolled back), allowing the expected values of each option (here each planned place of birth) to be calculated.

Four possible composite clinical outcome measures are shown in the decision tree for the mother-baby dyad at the time of discharge after birth or immediate post-natal care or higher level care where this is needed. These are ‘mother well baby well’, ‘mother well baby not well’, ‘mother not well baby well’ and finally, ‘mother not well baby not well’. The components of the composite outcomes for the mother and baby are listed in appendix 17 and are also briefly defined in a footnote after table 24. With regards to the cost payoffs, analyses of the economic data collected as part of the cohort study were conducted by ‘intention to treat’, so the final costs incurred are attributed to the setting where the woman planned to give birth at the start of care in labour and included costs when she transferred care.

For reasons discussed in the cohort study report and mentioned in the previous chapter, obstetric units unexpectedly contained more women where complicating conditions at the start of care in labour, which suggests that the risk profile of ‘low risk women’ varied between the settings (Hollowell et al., 2010). To ensure that women with comparable risk status were compared, the model’s analyses were repeated for ‘low risk’ women without complicating conditions at the start of care in labour.

The decision tree does not reflect two potential clinical pathways for ‘low risk’ women. In the first instance, a transfer from home to a midwifery unit and then to an obstetric unit (multiple transfer) may occur, though this happened infrequently (less than 20 events) during the period of data collection for the cohort study. Second, unsuccessful vaginal delivery may lead to an attempted ventouse or forceps delivery, and finally to an unplanned caesarean section. These multiple modes of delivery are not reflected as the data were not collected for the cohort study; however, small scale studies have previously been published that

attempted to identify risk factors that increase the likelihood of perinatal morbidities following failed instrumental delivery during the second stage of labour and unplanned caesarean sections (Murphy DJ et al., 2001, Murphy et al., 2003).

The results are presented by parity and are replicated for nulliparous and multiparous women. In the individual level cost-effectiveness analysis, subgroup analyses by parity had been conducted as part of the pre-specified statistical analysis plan. Logistic regression had also been used to adjust for maternal age, ethnic group, understanding of English, marital or partner status, body mass index (BMI) in pregnancy, Index of Multiple Deprivation (IMD) score, parity and gestational age at birth. Adjustments of total cost for parity in the individual level cost-effectiveness analysis resulted in sizable and significant cost differences, which overshadowed all other adjustments for confounding. Consequently, in the individual level analyses, all analyses were repeated by parity sub-group for cost-effectiveness purposes. This strategy was replicated in the modelling work, and results are presented for nulliparous and multiparous women separately.

6.2.3 Time horizon and study perspective

The analysis is conducted from a health system perspective and consequently only direct costs to the NHS are included. The time horizon primarily mirrors the duration of follow-up of the cohort study, which identified women at the start of their care in labour and was completed when the intrapartum, after birth and immediate postnatal care for both mother and baby ended, be it at home or discharge from an FMU, AMU or OU. Typically, this might be anytime between a few hours or a few days after the birth of the baby, but could be weeks or months in the case of a serious adverse outcome. If higher level care following the birth was required for either the mother or the baby, or both, this was included.

Adverse perinatal events can result in associated longer term health and broader societal costs as shown by the size of damages paid in obstetric litigation cases. The Kings Fund estimates around sixty percent of all litigation payments to be for obstetric and gynaecological cases (King's Fund, 2008). Cost estimates which utilise follow up data over weeks or longer to monitor recovery may differ from more limited costs associated with the intrapartum and immediate postnatal period. Reviews of the clinical effectiveness, epidemiological and economic literature to estimate longer term outcomes for maternity care were undertaken. The searches concentrated on all the adverse clinical outcomes measured in the cohort study such as neonatal encephalopathy (typically following cerebral hypoxia-ischaemia during labour), or post-partum haemorrhage; to obtain evidence on longer-term outcomes which could be reflected as lifetime costs or QALYs. The full literature searches can be viewed in appendix 18. These focused on all the adverse perinatal events which were included in the composite primary outcome and the subset of maternal morbidity outcomes that were included in the Birthplace individual level cost-effectiveness analysis. The searches confirm the paucity of evidence previously noted in the NICE 2007 guidelines (National Collaborating Centre for Women's and Children's Health, 2007). The studies that were identified and evaluated for suitability were typically small, with design limitations and the interventions and outcomes reported were followed up to different clinical endpoints, typically measured two to five years after birth. Furthermore, they tended to depict the natural history and prevalence of an adverse health outcome or a case diagnosis of an isolated adverse event.

In addition to searches of available evidence, primary data that might inform a longer term cost-effectiveness mode were identified. Within the NPEU archives, data were assessed from the PROGRAMS trial (Prophylactic Granulocyte-

Macrophage Colony Stimulating Factor to reduce sepsis in growth restricted preterm neonates) for longer term consequences of sepsis; TOBY (Total Body Hypothermia for the Treatment of Perinatal Asphyxial Encephalopathy) for longer term consequences of Perinatal Asphyxial Encephalopathy; the INIS trial (Treatment of Neonatal Sepsis with Intravenous Immune Globulin); and in-house NPEU managed registers for the prevalence and severity of cerebral palsy by birthweight (Marlow et al., in press, Azzopardi et al., 2009, Edwards et al., 2010, Rutherford et al., 2010, INIS Collaborative Group et al., 2011, Surman et al., 2009). In none of these studies were the outcomes for babies assessed over a sufficient time period to inform longer term outcomes for our model. The economic information contained in the Oxford Record Linkage Study was viewed and it was concluded that it was out of date for this study. Sources of the Hospital Episode Statistics data for the baseline diagnostic variables for the linked mother and baby dyad were located but a clean dataset containing these variables (from the HES maternity 'mother tails' and 'baby tails') is currently not available. Consequently, given these data limitations, it was not feasible to populate a longer-term model. Instead, short-term cost-effectiveness model for planned place of birth was constructed, populated by the robust evidence collected from the cohort study which would represent the most appropriate model design. The template presented here can be further developed into a decision analytic model estimating the longer-term cost effectiveness of planned placed of birth informed by observational data when the evidence for longer-term outcomes becomes available.

6.2.4 Model parameters

Parameters in the model were derived from the Birthplace individual level cost-effectiveness analysis and the definitions of birth settings, clinical outcomes and

other terminology are consistent with those reported in the cohort study report (Hollowell et al., 2010). The probabilities that populate the branches of the model are derived from the cohort study and reflect weighted data based on the average probable events captured from the start of labour until after birth care was completed (i.e. derived from the average weighted probabilities shown in appendix 19) and aggregated in the care pathways. They are similar but less precise than estimates generated by the individual level cost-effectiveness analysis.

As previously described, the cohort study included 62,036 women at 'low risk' of complications prior to the onset of labour, where the primary outcome data and potential confounders were not missing. Probability weights were incorporated in the analysis to adjust for the probability of selection of each woman. Weighted probabilities for intrapartum events for women with and without complicating conditions at the start of care in labour. *Subgroup analysis by parity* was used to estimate the separate models parameter inputs, costs, effectiveness and cost-effectiveness. The differences in the weighted probabilities for the models care pathways for 'low risk' nulliparous and multiparous women can be viewed in appendix 19.

6.2.5 Resource Use

The collection of resource use data was presented in chapter 5. In brief, data collection captured the pathways of care experienced by individual women progressing through the stages of labour and after birth care, and their associated resource inputs. Data collection forms, designed as part of the individual level cost-effectiveness analysis, documented duration of labour, mode of delivery, some forms of pain relief, active management of the third stage of labour, whether

an episiotomy was performed, clinical complications, length of stay for both mother and infant by type of ward and level of care, and transfers by duration and mode. Supplemental data collection was also carried through interviews with senior midwives from different geographic regions in England (see appendices 2, 6, 7,14 and 15).

6.2.6 Unit cost data

A detailed account of the collection of unit costs within the care pathways/components of the model was given in chapter 5. Unit cost estimation involved a combination of bottom-up and top-down costing methods and followed guidance on costing health care services as part of economic evaluation (Brouwer et al., 2001, Mugford et al., 1998, Wordsworth et al., 2005). All unit costs in this study were expressed in pounds sterling and valued at 2009-10 prices. The detailed bottom up costing and results are described in Appendix 15 of the Birthplace individual level cost-effectiveness report (Schroeder et al., 2012b).

Combined unit cost and resource use data was used to calculate cost payoffs in the model, following the care pathways within the decision tree. The detailed model data, shown by parity, reflects weighted average probabilities for all documented maternity procedures or events, as well as overall cost-effectiveness and cost pay-offs, and are also described in appendix 19 of this report. This information may be of interest to maternity managers and commissioners as it shows the likelihood of events and procedures (such as transfer, epidural use, management of the third stage of labour and perineal trauma) on all the key pathways modelled from the cohort study.

6.2.7 Representation of cost-effectiveness in decision analytic modelling

The costs and effectiveness payoffs are shown in appendix 19 and were attached to each terminal node within the model. The decision tree was then 'averaged out' and 'folded back' (or rolled back), allowing the expected values of each planned place of birth to be calculated. The process of averaging out and folding back is performed twice, first for cost and then effectiveness data. These are then synthesised in incremental cost effectiveness ratios (Briggs et al., 2006).

In the decision analytic modelling framework, the comparator for cost-effectiveness analysis is the least costly setting, determined by computational modelling when the expected value of each planned place of birth is calculated. The ICERs are calculated from the least costly setting to the most costly setting, with the least costly setting shown as the referent. All alternative settings for birth are represented together on the north east quadrant of the cost-effectiveness plane; the y-axis shows increasing cost and the x-axis increasing effectiveness, with the origin of the 'graph' set to (0.0). In this analysis, an attempt was made to fit all the vertical and horizontal axes to the same scale (x axis: +0.0, y axis: +£2500), but this caused several ICER estimates to shrink out of view, so the axes were individually adjusted to maximise presentation. They have been standardised to common scales (x axis: +0.076 to +0.99, y axis: +£750 to +£2500).

In the absence of QALY data, effectiveness in the model was measured on a scale of 0 to 1 where '1' translates to 'a healthy mother and baby dyad' outcome, and '0' translates to all other states where there is not a 'healthy mother and baby dyad' outcome . A change in effectiveness is then interpreted as a unit change in probability on the 0 to 1 scale. The ICER thus reflects the incremental cost per

unit increase on the effectiveness scale. The statistical complexity of this modelling presents a challenge for the interpretation of the numeric results, and would be clearer (for policy purposes) were QALY data available. However, standard principles of dominance can be applied to the results of the analyses for cost-effectiveness purposes.

When the cost-effectiveness analyses are presented, each intervention is compared to the next most effective alternative by calculating the incremental cost-effectiveness ratio. The decision maker prefers the more effective intervention with a lower incremental cost-effectiveness ratio. If the cost-effectiveness plane includes more than one option that is not dominated, these are connected by a line called the ‘cost-effectiveness frontier’, showing a set of possibly optimal choices. The lowest cost option will always form part of the frontier and if it reflects ‘strong’ dominance over all its comparators, then the graph will not have a frontier. With more than one optimal option however, a frontier will be presented.

6.2.8 Dealing with uncertainty

In the individual level cost-effectiveness analysis (described in chapter 5), sensitivity analyses were performed for stochastic uncertainty using bootstrapping techniques. Uncertainty had remained about the modelled overheads costs, identified as the main generic cost driver relevant to all unit-based settings for birth. Estimates of effects (adverse perinatal or maternal outcomes) were held constant when adjusted in sensitivity analyses around overheads. Occupancy rates, which were modelled from secondary data sources and were very variable in FMUs and AMUs were both increased and decreased to assess how this

affected cost differences between the settings. Higher throughput in these units showed cost-savings due to improved ‘efficiency’. Assumptions based on primary research had been made about midwifery staff to woman ratios during labour across different settings. This had been recorded as either intermittent or continuous midwifery support. It is impossible to comment on the ‘quality of care’ impact that these proportional changes in dedicated staff time could have, but this would be valuable to ascertain in future research. The findings were generally robust to the sensitivity analyses which shed more light on the nature of the main cost drivers defined as overheads, occupancy rates and midwifery support during labour. Thus the cost-effectiveness results responded to changes in these variables in a manner consistent with our expectations.

For the purposes of this chapter, deterministic sensitivity analyses were conducted on the effectiveness payoffs in the model by adjusting the key parameters and related resource use shown in appendix 21. The probabilities that populate the branches of the three reflect weighted data based on the average probable events captured from the start of labour until after birth care was completed (i.e. derived from the average weighted probabilities). They are similar but less precise than estimates generated by the individual level cost-effectiveness analysis and were aggregated in the care pathways to produce the effectiveness and cost payoffs (appendix 21). Upper and lower (95%) confidence limits were derived from the cohort data to generate new estimates of effectiveness payoffs for both ‘low risk’ nulliparous and multiparous women. Deterministic sensitivity analyses were conducted on the effectiveness payoffs in the model by adjusting the average probable events aggregated in the care pathways to the lower and upper (95%) confidence limits. Using these sensitivity analyses, it was possible to explore the implications of uncertainty surrounding the final health states in the models.

expected probabilities of the mother-baby dyad in each final health state ('mother well baby well', 'mother well baby not well', 'mother not well baby well', 'mother not well baby not well'). Cost-effectiveness estimates were recalculated following the sensitivity analyses.

All analyses for obtaining the model parameters were performed using Stata version 11 and Microsoft Excel (Microsoft, Seattle, WA) 2010 software. The decision analytic modelling was performed using TreeAge Pro, version 1988-2010 (TreeAge Software, Inc).

6.3 Results

6.3.1 Probabilities of care pathways

Ninety-four percent of 'low risk' multiparous women who planned to give birth at home actually gave birth at home compared with sixty-five percent of nulliparous 'low risk' women. Of those who were transferred prior to birth, seventy-three percent of multiparous 'low risk' women subsequently had a spontaneous vertex birth in an OU compared with forty percent of nulliparous 'low risk' women. These estimates of transfer and completed birth events were similar to estimates for the midwifery units. Ninety-five percent of multiparous women compared with seventy two percent of nulliparous women completed their second stage of labour as planned in FMUs. Ninety-percent of multiparous women completed the second stage of labour in AMUs compared with sixty-six percent of nulliparous women. On average, twenty two percent of nulliparous women who transfer into the OU prior to birth had an unplanned caesarean section, twenty-percent a forceps delivery and seventeen percent a ventouse delivery. With regards to multiparous

women who transferred into the OU, on average eleven percent had an unplanned caesarean section, and instrumental births with forceps varied between 11% (AMU) and with a ventouse between 7% (FMU and home), and 11% (AMU).

6.3.2 Costs and effectiveness payoffs

Ninety-four percent of nulliparous women who planned birth at home and who did not transfer prior to birth had a spontaneous vertex birth with both mother and baby outcomes defined as ‘well’. The average cost attributed to this whole pathway of care was £925.75. Similar estimates were generated for nulliparous women who planned birth in a FMU and an AMU and were not transferred prior to birth, though the average cost attributed to this pathway of care was higher [95.8%, £1,272.07(FMU) and 94.6%, £1,215.82 (AMU)], and slightly higher again (94.5%, £1,334.25) for an OU. For multiparous women, estimates of these combined ‘mother well baby well’ outcomes following a completed birth in the planned setting for birth were home (98.5%, £675.95), FMU (98.6%, £848.94), AMU (97.8%, £823.6) and OU (97.7%, £901.52).

The costs of a birth resulting in an adverse outcome for both mother and baby varied broadly, with the most costly being approximately £14,700 for a nulliparous ‘unwell’ mother-baby dyad transferred from home and having an unplanned caesarean section and £11,900 for a multiparous ‘unwell’ mother-baby dyad who also transferred from home and had an unplanned caesarean section.

6.3.3 Cost-effectiveness results

6.3.3.1 Cost-effectiveness for 'low risk' nulliparous women

Table 25 summarises the combined costs, effects and incremental cost-effectiveness for mothers and babies together for 'low risk' nulliparous women by planned place of birth generated by the decision analytic model. The costs shown here are weighted average values for all resource inputs and associated costs estimated within the model. Using the cost of planned birth at home as the referent, the weighted incremental costs are estimated at FMU (£91.5), AMU (£254.2) and OU (£394.8). For 'low risk nulliparous women', births planned in FMUs (0.89) and AMUs (0.86) were more effective for combined mother-baby outcomes, with births planned at home (0.81) and in OUs (0.77) less effective when measured on the 0-1 effectiveness scale. The combined outcome measure reflected here however masks an increased incidence of adverse perinatal outcomes associated with planned birth at home in nulliparous 'low risk' women, previously identified in the cohort study and the individual level cost-effectiveness analysis. For comparison, the costs presented in the template resemble the costs estimated in the individual level analysis which used individual-level estimates of resource use and associated costs and approximated as follows: home £1,793.7, FMU £1,912.5, AMU £1,983.1 and OU £2,075.2. In this template, average costs are estimated as home £1,573.07, FMU £1,664.61, AMU £1,918.83 and OU £2,059.5.

Table 25. Costs, effects and cost-effectiveness ratios for combined mother-baby outcomes for 'low risk' nulliparous women

Strategy Name	Cost	Effectiveness	Average cost effectiveness	Incremental Cost	Incremental effect	Incremental cost effectiveness
Home	1573.07	0.806	1951.53	referent	referent	referent
FMU	1664.61	0.887	1874.76	91.53	0.081	1130.00
AMU	1918.83	0.861	2226.64	345.76	0.055	6286.55
OU	2059.46	0.779	2640.35	486.39	-0.027	-18014.44

Table 25 shows that planned births in AMUs generate greater costs and an increased probability of effectiveness than planned births at home; and planned births in OUs show higher costs and lower effectiveness outcomes than all the other alternatives. FMUs show both higher costs and higher effectiveness than the referent, planned home birth.

Figure 34. Incremental cost-effectiveness for combined mother-baby outcomes for 'low risk' nulliparous women

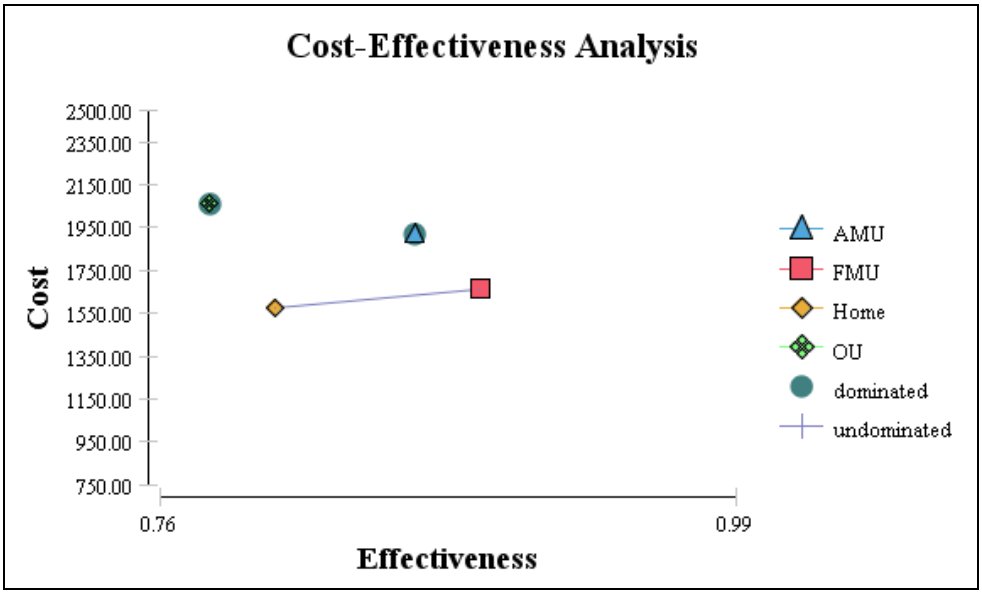


Figure 34 represents these cost-effectiveness outcomes graphically on the north-east quadrant of the cost-effectiveness plane.

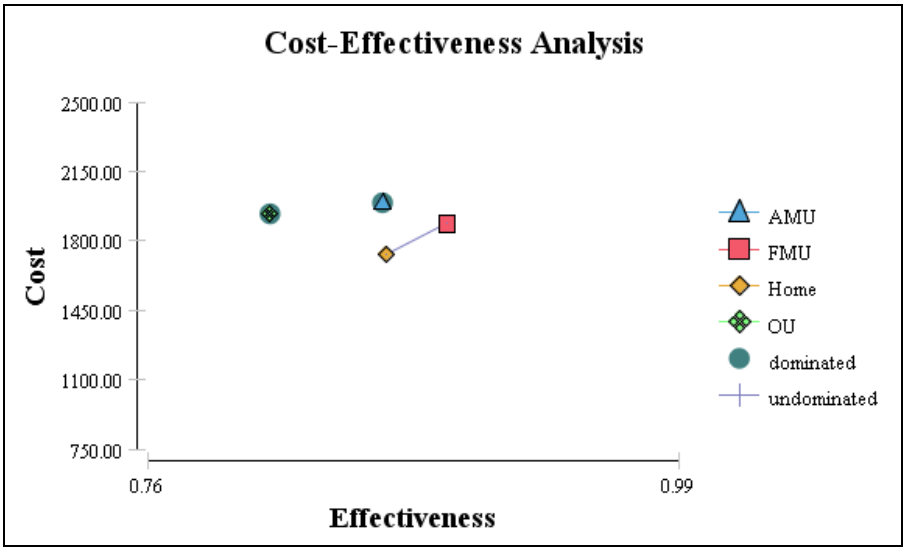
6.3.3.2 Cost-effectiveness for 'low risk' nulliparous women without complicating conditions at the start of care in labour

When women with complicating conditions at the start of care in labour are removed from the analysis (table 26 and figure 35), modelled cost data shows the average total cost to be £56 less for births planned in an obstetric unit (than in an AMU), such that planned birth in an obstetric unit is shown to be less costly on average than planned birth in an AMU. This confirms additional calculations in the individual level analysis, which showed that when nulliparous women with complicating conditions were removed from the analyses, the costs between OUs, FMUs and AMUs narrowed; hence this finding is not surprising. Furthermore, this analysis reflects weighted modelled data, which is based on the average probable events and costs attached to the care pathways (see appendix 21) and it is similar but less precise than estimates generated by the individual level cost-effectiveness analysis. Planned birth at home and in a FMU are still shown to be the cheapest options however, with planned birth at home once again the referent for the analysis.

Table 26. Costs, effects and cost-effectiveness ratios for 'low risk' nulliparous women without cc

Strategy Name	Cost	Effectiveness	Average cost effectiveness	Incremental Cost	Incremental effect	Incremental cost effectiveness
Home	1735.95	0.863	2010.57	referent	referent	referent
FMU	1887.09	0.890	2120.95	151.14	0.026	5813.08
AMU	1992.20	0.862	2311.95	256.25	-0.001	-265250.00
OU	1936.93	0.813	2382.49	200.98	-0.05	-4019.60

Figure 35. Incremental cost-effectiveness for combined mother-baby outcomes for 'low risk' nulliparous women without cc



6.3.3.3 Cost-effectiveness for 'low risk' multiparous women

The weighted average costs constructed within the template broadly reflect the costs estimated in the individual level cost-effectiveness analysis. Total mean costs per 'low risk' multiparous woman were much lower than for nulliparous 'low risk women'. Total mean costs for multiparous women were estimated as OU £964.9, AMU £986.3, FMU £979.4 and home £784.8. Modelled costs show very little cost difference between the planned OU, FMU and AMU settings but are generally less precise than estimates generated by the individual level cost-effectiveness analysis which combined individual-level resource use and unit cost data. Births planned at home (0.98) and in FMUs (0.98) were shown to be more effective for combined mother-baby outcomes, than births planned in AMUs (0.97) and in OUs (0.92) (probabilities of outcomes on the effectiveness scale shown in parentheses). For comparison, in the individual level analysis, total mean costs

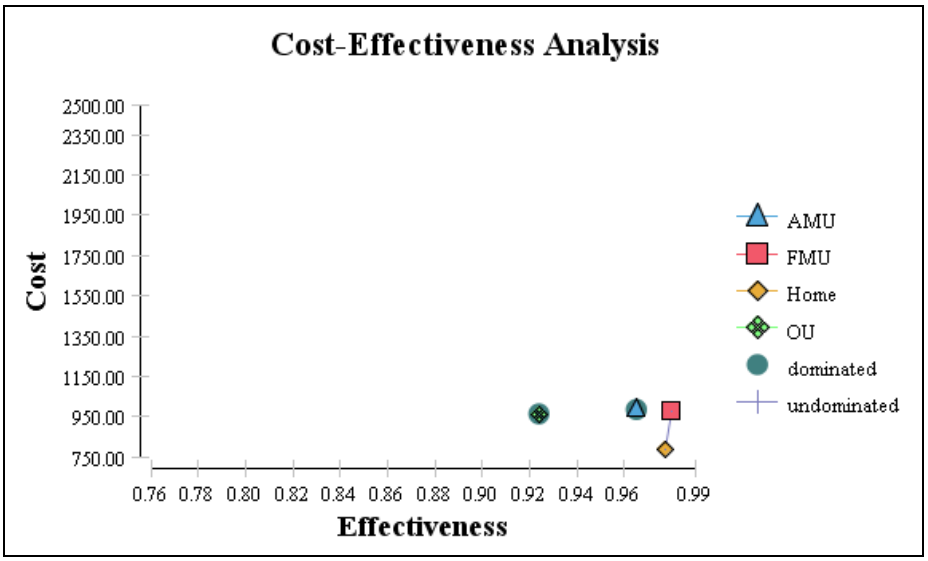
approximated as follows: OU £1,142.4, AMU £991.3, FMU £968.9 and home £780.4.

Table 27. Costs, effects and cost-effectiveness ratios for 'low risk' multiparous women

Strategy Name	Cost	Effectiveness	Average cost effectiveness	Incremental Cost	Incremental effect	Incremental cost effectiveness
Home	784.81	0.977	803.09	referent	referent	referent
FMU	979.32	0.979	999.53	194.51	0.002	97255.00
AMU	986.27	0.965	1021.90	201.46	-0.012	-16788.33
OU	964.94	0.923	1044.40	180.13	-0.054	-3335.74

Planned birth at home and in FMUs both generated greater effectiveness compared to births planned in OUs as shown in table 27 and figure 36.

Figure 36. Incremental cost-effectiveness for combined mother-baby outcomes for 'low risk' multiparous women



6.3.3.4 Cost-effectiveness for 'low risk' multiparous women without complicating conditions at the start of care in labour

As stated earlier, obstetric units contained more women where complicating conditions were unexpectedly observed, which suggests that the risk profile of 'low risk women' at the start of care in labour varied between the settings (Hollowell et al., 2010). To ensure that women with comparable risk status were compared, women with complicating conditions at the start of care in labour were removed in a repeat analysis. The results shown here (table 28 and figure 37) confirm that there was little difference between the initial and restricted analyses for probability estimates of effectiveness for non-OU settings, which approximate as follows: home (0.977 compared with 0.979), FMU (0.979 compared with 0.980) and AMU (0.965 compared with 0.967). There is however a marked increase in the probability of effectiveness for planned births in obstetric units when a restricted analysis is applied to all 'low risk' multiparous women.

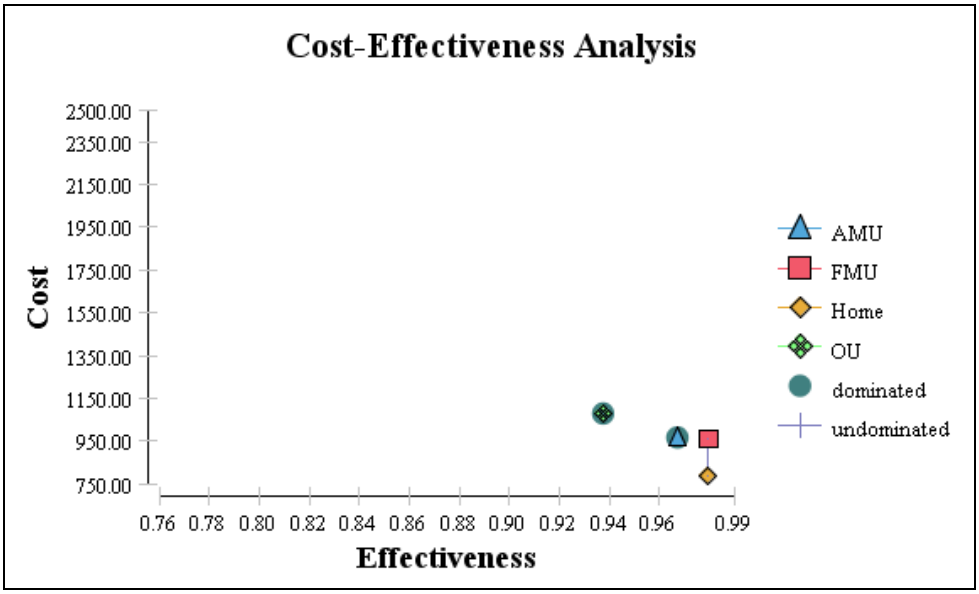
Table 28. Costs, effects and cost-effectiveness ratios for 'low risk' multiparous women without cc

Strategy Name	Cost	Effectiveness	Average cost effectiveness	Incremental Cost	Incremental effect	Incremental cost effectiveness
Home	787.35	0.979	804.10	referent	referent	referent
FMU	962.21	0.980	982.30	174.86	0.001	174860.00
AMU	967.28	0.967	1000.04	179.93	-0.012	-14994.17
OU	1079.71	0.938	1151.67	292.36	-0.041	-7130.73

With regards to costs, the individual level cost-effectiveness analysis showed that obstetric units generated the highest average total cost which was largely attributable to higher overheads and running costs. Thereafter, overheads and running costs were higher in FMUs than AMUs as a result of greater estate costs

and substantially lower occupancy rates, but the contribution to total cost per woman for overheads and staffing was higher in AMUs than FMUs because women in AMUs had longer labour episodes on average, more transfers to the OU and more medical intervention during birth than women planning birth in FMUs.

Figure 37. Incremental cost-effectiveness for combined mother-baby outcomes for 'low risk' multiparous women without cc



6.3.4 Sensitivity Analyses

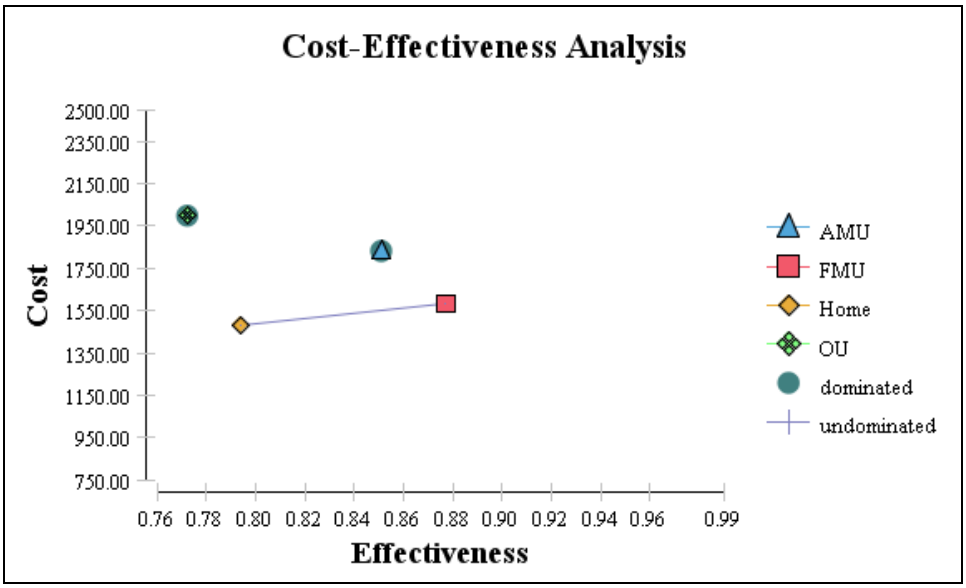
6.3.4.1 Deterministic sensitivity analyses

As discussed previously, sensitivity analyses were used to explore the implications of uncertainty surrounding key cost drivers in the individual level analysis. In this modelling work, deterministic sensitivity analyses were conducted on the effectiveness payoffs in the model by adjusting the average probable events aggregated in the care pathways to lower and upper 95% confidence limits. When lower confidence interval estimates were used to estimate the combined mother-baby outcomes in each final health state, as shown in table 29, both the costs and probabilities of effectiveness of the planned settings for birth reduced in comparison to the average estimates generated for 'low risk' nulliparous. The scale of differences in incremental cost and incremental effects between the planned settings remained broadly similar, and so there was little change in the graphical presentation of cost-effectiveness between the alternative settings for planned birth (figure 38).

Table 29. Sensitivity Analyses: Costs, effects and cost-effectiveness ratios for combined mother-baby outcomes for 'low risk' nulliparous women using lower confidence interval estimates for effectiveness

Strategy name	Cost	Effectiveness	Average cost effectiveness	Incremental cost	Incremental effect	Incremental cost effectiveness
Home	1481.66	0.794	1866.04	referent	referent	referent
FMU	1581.91	0.877	1803.59	100.25	0.083	1207.83
AMU	1831.75	0.851	2152.75	350.09	0.057	6141.93
OU	1998.16	0.772	2587.99	516.50	-0.022	-23477.27

Figure 38. Sensitivity Analysis: Incremental cost-effectiveness for combined mother-baby outcomes for 'low risk' nulliparous women using lower confidence interval estimates for effectiveness

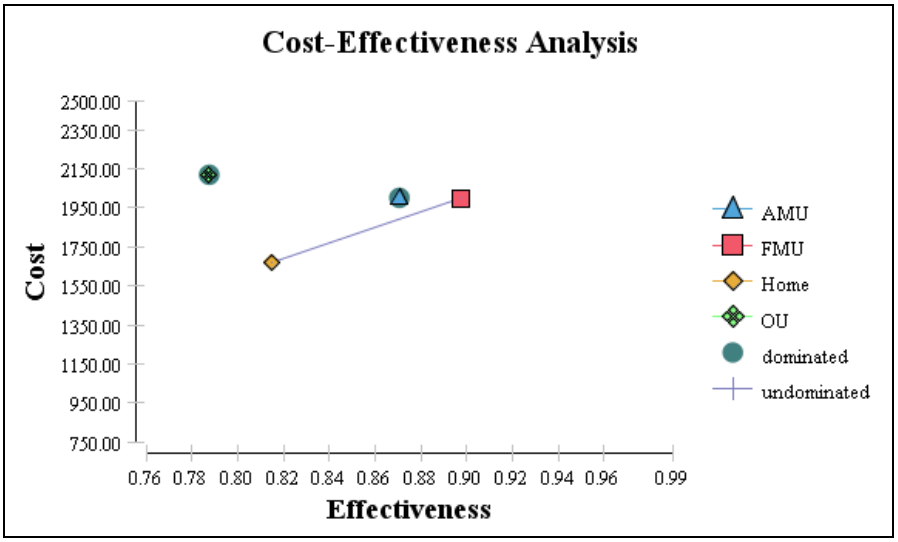


When upper confidence interval estimates were used to estimate the combined mother-baby outcomes in each final health state, (as shown in table 30 and figure 39 – see overleaf), both costs and probabilities of effectiveness of the planned settings for birth increased in comparison to the average estimates generated for 'low risk' nulliparous women. The scale of differences in incremental cost and incremental effects between the planned settings remained broadly similar, and so there was little change in the graphical presentation of the difference in cost-effectiveness between the alternative settings.

Table 30. Sensitivity Analyses: Costs, effects and cost-effectiveness ratios for combined mother-baby outcomes for 'low risk' nulliparous women using upper confidence interval estimates for effectiveness

Strategy Name	Cost	Effectiveness	Average cost effectiveness	Incremental cost	Incremental effect	Incremental cost effectiveness
Home	1668.07	0.815	2047.16	referent	referent	referent
FMU	1997.80	0.897	2225.97	329.73	0.083	3972.65
AMU	2000.74	0.871	2298.22	332.67	0.056	5940.54
OU	2119.04	0.787	2691.13	450.97	-0.028	-16106.07

Figure 39. Sensitivity Analysis: Incremental cost-effectiveness for combined mother-baby outcomes for 'low risk' nulliparous women using upper confidence interval estimates for effectiveness



6.3.4.2 Probabilistic sensitivity analyses

Probabilistic sensitivity analyses are usually performed on decision analytic models where model parameters are assigned distributions. Parameter uncertainty is then propagated through the model allowing the robustness of base-case results to be assessed. Probability data (weighted point estimates) from the cohort study was used to populate this template, although standard distributions from the individual level data can identify distributions for cost and parameter inputs. In the absence of longer-term outcomes data however, the individual level analysis provides more useful evidence for the cost-effectiveness of alternative planned place of birth. When longer term evidence becomes available, then this template can be developed into a full decision analytic model to include a full probabilistic sensitivity analysis.

6.4 Discussion

6.4.1 Summary of findings

This research provides a template for future research into the long-term cost-effectiveness of planned place of birth for women and babies together.

The very detailed breakdown of parameter inputs for the mother-baby dyad, collated in this template and shown by parity, may be of interest to maternity managers and commissioners. These included the likelihood of events, such as the average duration of labour, the rates of transfer before birth, epidural use, augmentation, mode of birth, the use of syntometrine for the active management

of the third stage of labour, medical interventions required and admissions to postnatal and neonatal care. They vary substantially between birth settings and by parity and can now be compared between the birth settings.

6.4.2 Strengths and weaknesses of the modelling approach

The study was limited because maternal and perinatal outcomes are not equally severe; and this is a problem if different places of birth are associated with a higher proportion of more or less severe outcomes. Although necessary for Birthplace, the use of a composite measure does not capture the differences in the relative importance of individual components. *A key limitation of the template for the decision analytic model* is that the measure of effectiveness combined common but not necessarily life-threatening maternal outcomes with uncommon but more serious outcomes for the baby, including death and complications such as neonatal encephalopathy. This approach therefore gives each of these outcomes equal weight and is unable to capture differences which could be important to decision-makers.

Litigation costs potentially reflect the future costs associated with adverse outcomes and the loss of quality of life (Karnon et al., 2009) . There is a difficulty in using these as a source of data for proxies for QALYs in the modelling of combined longer term outcomes for both mother and baby, particularly as this analysis illustrated that the perinatal and maternal outcomes moved in different directions (higher perinatal adverse events at home relative to planned OUs, but reduced maternal adverse events and increased normal births). Modeling longer-term cost-effectiveness will require evidence on all longer-term costs and health consequences for both the mother and the baby in the study population. Long

term data are not available for the full range of adverse outcomes that we included in the template. Although we possess some information about the costs associated with neonatal encephalopathy, for example cerebral palsy, costs are not currently available for all of the consequences of the outcomes that we measured. In addition, the numbers of babies born with neonatal encephalopathy is relatively small with no statistically significant differences between the different groups, and only a small proportion of these babies will develop cerebral palsy. In comparison, other outcomes, such as emergency or unplanned caesarean section, were much more frequent than encephalopathy (over 40 times more frequent overall) and these can have implications for subsequent pregnancies. Once again, these long term consequences are just beginning to be quantified and we have no information about the costs associated with these later events. The cohort study did not find evidence of any significant differences in perinatal outcome by planned place of birth for multiparous women; thus, the intrapartum cost-effectiveness analyses are relevant even though limited to a short-term time horizon. (Hollowell et al., 2010) The intrapartum care costs documented for multiparous women do therefore have some value to decision makers despite the lack of long term data. For example, the findings capture the fact that the higher intervention rates in obstetric units contribute to the higher overall costs of OU births and, for multiparous women, these higher costs are not associated with better outcomes for the mother or baby.

In an ideal world, a QALY metric would have been used to capture the health related quality of life of both the mother and baby, which in turn would have increased the utility of the model outputs for cost-effectiveness comparative purposes. In the absence of QALY data, the ICERs generated by the modelling were statistically complex to interpret. Given that the cohort study relied on

anonymised data from maternity service providers, no individual-level QALY data were collected. If a standardised instrument measuring preference-based health-related quality of life outcomes to be available in a maternity context, then a single index value for health status could be calculated and compared between the alternative planned birth settings. The need for this type of analysis is illustrated by the findings of the individual patient level cost-effectiveness analysis which showed that the perinatal and maternal outcomes moved in different directions. Thus any QALY measure used in a decision analytic model of this design would have to capture negative and positive effects on mothers and babies.

A key limitation of this study is the time horizon covered by the template. Cost estimates which include follow up data over weeks, months or years will differ from more limited costs associated with a shorter time horizon covered here. A model which could measure longer term cost-effectiveness would be very informative of the true incremental cost-effectiveness of planned birth to clinical and service decision-makers. Extensive literature searches were undertaken to provide data on longer-term outcomes but no other data sources proved useful for inclusion in this template. Robust decision analytic modelling should rely on more evidence than one observational data source to predict care pathways and payoffs. The lack of prevalence and other statistical data to inform this template meant that all probability estimates were obtained from this one data source and the parameter inputs should be updated when this information becomes available. Consequently, the template was forwarded to health economists at NICE commissioned to update the intrapartum care guidelines with further economic evidence for cost-effectiveness of planned birth between 2012 and 2014.

Although the model's composite clinical outcomes were rigorously collected, outcomes which are also of importance to women and decision-makers, such as the quality of care offered were not addressed in the analysis. A broader economic approach to the measurement of outcomes, such as stated preference discrete choice modelling might have provided more information to decision makers. Additional information such as this could be included in the commissioning practices of local maternity service configurations.

Decision makers may find the individual level analysis presented in the previous report more useful since that analysis makes explicit the impact of the separate effectiveness measures for the mother and the baby. The template presented here provides a framework which can be further developed into a full decision-analytic model. Owing to the lack of data with which to populate it, the economic template presented here can be used to inform discussion and further research.

Chapter 7

7 Discussion

7.1 Overview of the main findings

This research took place over a number of years within a changing international and national context that impacted on the NHS and its maternity services and within an evidence framework where the configuration of the different maternity services were ad hoc, and without uniformly agreed benchmarks and quality standards. The overarching aim of this research was to provide evidence about the efficiency and cost-effectiveness of intrapartum care in England, so to contribute to planning for the configuration of maternity services, provide guidance for clinical practice, and for information to support decision-making about planned place of birth for pregnant women and their families.

7.1.1 Efficiency

Data envelopment techniques identified gains to be made for ‘productive efficiency’ purposes using ‘top down’ data at a unit level. Overall, approximately a third of units functioned at full efficiency and with another third functioning at between 70-90% of capacity relative to their peers. The larger OUs tended to be more efficient than the smaller OUs, possibly as a result of economies of scale, though efficiency improvements could be generated from changes in the deployment of managerial and administrative staffing. Less than half of FMUs were operating at full efficiency, and ratios of midwifery staffing to women delivered, working hours per year and unit closures, equipment and in-utero transfers contributed to inefficiencies in the provision of care in FMUs.

The research demonstrated that DEA techniques can identify differences in the relative efficiency of maternity units when they are stratified according to the scale and type of unit and furthermore, that improvements in productive efficiency can be recommended for units that are underperforming, relative to other units. It found that a reconfiguration of intrapartum care inputs could generate greater efficiency and consequently cost-savings in the future.

7.1.2 Cost-minimisation

A cost-minimisation analysis of women who planned birth in a FMU compared with an OU in a small scale study adjunct to Birthplace enabled the collection of detailed resource use data for intrapartum care, and access to local management protocols and care profiles which informed data collection for both the case study and ultimately for the Birthplace individual level cost-effectiveness analysis. The research showed that at an individual level, the FMU was associated with fewer interventions for mothers, increased breastfeeding rates and cost-savings.

7.1.3 Costs, effectiveness and cost effectiveness at an individual level

The largest chapter of the thesis explored the cost-effectiveness of different settings for birth: at home, in freestanding midwifery units, in alongside midwifery units and in obstetric units for women and babies at ‘low risk’ of complications prior to the onset of labour, based on individual level data collected in the cohort study within Birthplace.

With regards to the baby; the incidence of adverse perinatal outcomes was low in all settings. The results of the cost-effectiveness analyses show that a change from planned place of birth in an OU to a FMU or AMU will generate incremental cost savings with uncertainty surrounding the cases of adverse perinatal outcome averted. In all bootstrapped samples, for these comparisons, the scatterplots of mean ICERs fell across both the south west and south east quadrants of the cost-effectiveness planes. This implies a lower cost attributable to a non-OU midwifery setting planned place of birth, but represents uncertainty surrounding the impact on perinatal outcomes. For births planned at home for nulliparous 'low risk' women, the cost-effectiveness analyses reflected a less effective and less-costly option for intrapartum care than birth planned in an OU. For births planned at home for multiparous low risk women, the cost-effectiveness analyses reflected lower costs and considerable uncertainty surrounding the impact on perinatal outcomes.

With regards to the mother, planned place of birth in all non-OU settings generated incremental cost savings and improved maternal outcomes. There is uncertainty around the cost savings for planned birth in an AMU, but planned birth in an AMU still showed cost savings and more positive maternal outcomes.

Planned births in an OU had a longer duration of labour per episode, as well as higher rates of epidural use, general anaesthesia, augmentation of labour and instrumental delivery. In addition to the greater burden of overheads for the OU, these interventions for women are costly and would have increased the mean total cost per woman planning a birth in an OU.

Overall for the short-term individual level analysis, planned place of birth at home was found to be the most cost-saving option; however, more women planning a birth at home were multiparous compared to the planned FMU, AMU and OU groups.

7.1.4 Costs, effectiveness and cost effectiveness for combined mother baby outcomes

When combined outcomes were compared, planned birth at home generated lower costs and a lower probability of effectiveness for combined outcomes when compared to planned births in FMUs. This research provided a template for longer-term decision analytic modelling.

7.2 Implications of findings for policy and practice

The findings presented in this thesis are most relevant for the time horizon of the Birthplace cohort study and the context of the NHS maternity service for that time period, efficiency within the service and costs and cost-effectiveness may change if maternity services are reconfigured.

At the time of the research, an obstetric unit was the most common form of maternity provision, with staff in OUs caring for more than 95% of women giving birth in an institutional setting (for the year ending 31 March 2007), with 1% in FMUs and 3% in AMUs. Although this configuration has been changing over time to provide women of ‘low risk’ with more choice, a change in the provision of

maternity settings will not necessarily result in immediate cost-savings or efficiencies.

Larger obstetric units functioned at greater levels of efficiency relative to other obstetric units of a smaller scale. Less than half of FMUs functioned at full capacity, and inefficiencies were associated with staffing ratios, unit closures and transfers.

Should changes to maternity service configuration be planned to maximise cost-effectiveness, then commissioners would have to consider the resource use and related cost implications on the maternity service as a whole. Overheads were the greatest cost driver in the obstetric unit. Obstetric units carry the highest cost burden of service delivery due to the more costly hospital services they provide for obstetric and other maternity care support, such as pharmacy, theatre, high care observation and pathology. In addition, they provide the more costly medical interventions, procedures and staffing for women of ‘high risk’ and for women of ‘low risk’ whose labours become more complex. Capital costs in OUs will always be generated because of the need to have an OU in place so that transfers can take place from non-OU to OU birth settings.

The creation of more FMUs would generate greater capital costs for maternity services unless their occupancy rates (volume) increased dramatically to off-set the investment costs in the obstetric units which currently provide intrapartum care for the majority of women. Occupancy rates in FMUs were generally more varied and substantially lower than in OUs and AMUs, but should these increase they would probably become more cost-effective.

7.3 Implications for future research

FMUs have emerged as a cost-effective option, thus future research should assess the financial viability of FMUs as the utilisation of broader maternity services is a complex issue. Occupancy rates in FMUs are lower than in other settings and units overheads were an important cost driver for FMUs. It may be that the findings of Birthplace may encourage women, particularly women having a second or subsequent baby to request an 'out of hospital' birth, and the potential for cost savings could make offering women more choice an attractive option for the NHS, but the complex factors that encourage or discourage women to opt for birth in freestanding midwifery units are not yet fully understood. This would be important and valuable research to undertake as it would inform commissioning and the appropriate configuration and provision of these services.

Following this, current findings suggest that modelling the financial impact on intrapartum care service delivery will be important should more non-OU settings be provided for pregnant women. The cost calculations in this analysis are susceptible to changes in occupancy rates and relative cost-effectiveness will adjust accordingly. A key cost driver is the overheads apportioned for intrapartum care. The fixed costs include estate and capital investment costs and variable costs will include midwifery staffing directly apportioned to each intrapartum episode. Should changes to maternity service configuration be planned for cost-effectiveness purposes, then commissioners would have to consider the resource use and related cost implications on the maternity service as a whole, including the safety of maternity which depends on the availability of an OU to which women can transfer. Average costs conceal the local variability in occupancy rates in different settings. The development of a trust-based forecasting model to quantify

the costs and benefits of service reconfiguration is recommended. Forecasting cost-effectiveness at a local level could include the safety, risk of transfer, occupancy rates, overheads, geographical access including urban and rural differences, diverse population's needs, staffing capacity and related skills and training issues relevant to each local trust in view of fixed and variable costs, and the relative disinvestment in one form of maternity service provision in preference for another.

Research to explore how the intervention rates and outcomes for mothers and babies in OU settings will differ should they receive continuous midwifery support during labour could quantify the impact of intermittent midwifery support provided in OUs. Birth at home, and in a FMU and AMU was attributed continuous midwifery care during labour, with 65% intermittent midwifery support attributed to OUs. These were varied in the sensitivity analyses, but for cost-effectiveness purposes only. In this report, it is not possible to comment on the differences in the 'quality of care' available to mothers because of the differences in dedicated staff time, but this has been noted by others, such as the HealthCare Commission who identified the need for adequate staffing levels, continuity of care for women during labour and support for women after the birth of their baby. (Healthcare Commission, 2008)

Additional research which could forecast how the results of the study would change if outcomes that are also of importance to women and decision-makers, are reflected in a broader economic evaluation framework. These would include women's experiences, the quality of care offered and support with breastfeeding . A broader economic approach to the measurement of outcomes, such as stated

preference discrete choice modelling could provide more information to decision makers.

Further modelling will be required to document the longer-term cost-effectiveness of alternative planned birth settings for both the serious adverse perinatal and maternal outcomes identified at birth, and also for the less serious but more frequent morbidities. Modelling longer-term cost-effectiveness will require evidence on all longer-term costs and health consequences for both the mother and the baby. Data which could be converted into a QALY metric would be most relevant for future modelling research. This measure could cover the range of maternal and perinatal outcomes including common but not necessarily life-threatening maternal outcomes with uncommon but more serious outcomes for the baby, including death and complications.

7.4 Concluding remarks

The research conducted in this thesis set out to fill important gaps in the evidence relating to the organisation, efficiency, costs and cost-effectiveness of intrapartum maternity services provided for women in labour in four birth settings, and this had not been evaluated before. The Birthplace in England Research programme and the adjunct Barkantine study provided data which enabled the costs and cost-effectiveness of births planned in each setting to be estimated. Although the efficiency and cost-effectiveness analyses were developed from rigorously designed epidemiological studies, the findings described here highlighted evidence that is currently available and the additional evidence needed to model the longer-term cost-effectiveness of alternative planned birth settings. This paucity of evidence for the longer term consequences of birth for both mother and

baby remains and further research on life-time economic estimates for the linked mother-baby dyad should be a priority for research in this field. The principal conclusion of this thesis is that a mixed-methods approach of analysis incorporating ‘top down’ and ‘bottom up’ methods can estimate different but complementary aspects of service configuration, efficiency and cost-effectiveness. More importantly, evidence gaps have been filled regarding the safety and cost-effectiveness of planned birth for women with straightforward pregnancies, however more work remains to be undertaken in the area of modelling the longer-term outcomes of planned birth.

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Appendix 1 Literature search strategy

Search strategy

The following electronic databases were searched from 1980 onwards or the start of the database if after 1980:

Medline

EMBASE

Cochrane Libarary

OVID: Maternity and Infant Care

Health Economic Evaluations Database (HEED)

Biomed Central

British Nursing Index (BNI)

RCN Journals Database

Health Management Information Consortium (HMIC)

Cumulative Index to Nursing and Allied Health Literature (CINAHL)

The search terms included:

1. maternity
2. cost$ maternity
3. cost-effectiveness maternity
4. efficiency maternity
5. preferences maternity
6. models of care (citation + abstract)
7. care pathways maternity
8. data envelopment analysis maternity
9. service configuration maternity

Current OVID search terms for monthly alerts:

Maternity OVID

Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations and Ovid

Ovid MEDLINE(R) Corrections (updates since 2008-03-31)

Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations and Ovid

Ovid MEDLINE(R) <2006 > (updates since 2008-03-31)

Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations and Ovid

Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <April 30, 2010> (updates since 2010-03-31)

MaternityEMB

EMBASE <1996 to 2008 Week 17>

EMBASE (updates since 2008-03-25)

MaternityGLO

Global Health <1973 >

Global Health (updates since 2008-03-03)

Appendix 2 Birthplace cohort study data collection forms

Barcode/Number

Birthplace
In England Research Programme

Home Birth
Data collection form

Instructions

- **Please complete** this form for each woman you attend at home in labour who plans to give birth at home or who is undecided about her place of birth and who gives birth in the same clinical episode.
  i. **Do not complete** this form for an unplanned home birth.
  ii. **Do not complete** this form for women who have had no antenatal care.
  iii. Please start this form during labour care.
  iv. Please write clearly using a black pen.

- If this woman transfers to a midwifery unit or an obstetric unit, please complete as much of the form as you can and then transfer the form with the woman.
- If you start this form and the woman **does not** give birth in the same clinical episode, please tick this box ☐ and return the form to the Local Co-ordinating Midwife.

- When the form is complete return it in the attached envelope to the Local Co-ordinating Midwife. Please ensure the return address on the back cover of this form is aligned with the window of the envelope.
- If you have any questions about the form or about this study please contact:

Birthplace Project Manager
birthplace@npeu.ox.ac.uk
Tel: 01865 289748
Fax: 01865 289701

Thank you for your contribution to Birthplace

The Royal College of Midwives

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Royal College of Obstetricians and Gynaecologists
Setting standards to improve women's health

Birthplace
in England Research Programme

Section A: Woman's identifying details

This page will be detached from the rest of the form and kept in a secure location in your Trust by the Local Co-ordinating Midwife (LCM). This allows the LCM to deal with any inconsistencies or mistakes in the form or find missing information before sending non-identifying information (pages 2-6) to the study team in Oxford.

Please stick woman's address label here:

OR complete the following details:

A1. Woman's full name: *Please print* _____

A2. Woman's date of birth: D D / M M / Y Y

A3. Woman's NHS number:

A4. Woman's home address: *Please print*

_____

_____

_____

_____

A5. Woman's full postcode:

A6. Section A completed by: *Please print full name* _____

Office use only

After birth

Please fill in this box once the labour episode is complete

A7. Date of delivery: D D / M M / Y Y

A8. Baby's NHS number: *(If known)*

Birthplace Home Birth
In England Research Programme

Section B: Woman's details

B1. Woman's age at delivery: *(Years)* ☐☐

B2. Woman's ethnic group: *(As recorded in her maternity notes)*

☐☐ *Please write in one code from the list below*

01 White British	09 Pakistani
02 White Irish	10 Bangladeshi
03 Any other White background	11 Any other Asian background
04 Mixed White & Black Caribbean	12 Black Caribbean
05 Mixed White & Black African	13 Black African
06 Mixed White & Asian	14 Any other Black background
07 Any other Mixed background	15 Chinese
08 Indian	16 Any other ethnic group

B3. Woman's understanding of English language:

☐1 Fluent

☐2 Some understanding / Able to communicate verbally

☐3 No understanding / Not able to communicate verbally

B4. Woman's marital / partner status:

☐1 Married / Living with a partner

☐2 Single / Unsupported by partner *(this includes single woman living with family)*

B5. Woman's BMI in pregnancy: ☐☐.☐ *If not recorded tick here* ☐

For LCM use only

B6. IMD score: ☐☐.☐☐

B7. Tick this box if this form was not started around the time of birth and was filled in retrospectively by the LCM: ☐

Section C: Pregnancy history

Previous pregnancies

C1. Number of pregnancies of ≥ 24 weeks, prior to this pregnancy: *If none, write 0* ☐☐

This pregnancy

C2. Expected date of delivery: ☐☐/☐☐/☐☐

C3. Immediately prior to the onset of labour, was this woman known to have any of the medical conditions or obstetric history items listed opposite?

☐ No

☐ Yes *Please write in code(s) below from tables opposite*

Example: For a woman with previous pre-eclampsia requiring preterm birth, the condition is found in the 'Obstetric history' table under 'Previous complications' and coded '12 C'. For a woman with a condition that is not listed in the tables opposite, please enter the code for 'Other' and write in the condition in the space provided.

12	C	

Code		If Other, please write name of condition clearly

C4. At the start of care in labour, did this woman have any of the following conditions? *Please tick all that apply*

☐ Prolonged rupture of membranes greater than 18 hours

☐ If membranes are ruptured, any meconium stained liquor

☐ Proteinuria of 1+ or more

☐ Hypertension with either:
- diastolic blood pressure of ≥ 90mm Hg on more than one occasion 20 minutes apart or ≥ 100mm Hg on one occasion
- systolic blood pressure ≥ 160mm Hg on at least one occasion

☐ Abnormal vaginal bleeding

☐ Non-cephalic presentation

☐ Abnormal fetal heart rate

☐ Other complications *Please specify* _____

☐ **None of the above**

Medical conditions

Type of condition	Code	Additional information
Cardiovascular	01	A: Confirmed cardiac disease B: Hypertensive disorders
Respiratory	02	A: Asthma requiring an increase in treatment or hospital treatment B: Cystic fibrosis
Haematological	03	A: Haemoglobinopathies – sickle-cell disease, beta-thalassaemia major B: History of thromboembolic disorders C: Immune thrombocytopenia purpura or other platelet disorder or platelet count below 100 000/cubic mm D: Von Willebrand's disease E: Bleeding disorder in the woman or unborn baby F: Atypical antibodies which carry a risk of haemolytic disease of the newborn
Infective	04	A: Risk factors associated with group B streptococcus whereby antibiotics in labour would be recommended B: Hepatitis B/C with abnormal liver function tests C: Infected with HIV D: Toxoplasmosis – woman receiving treatment E: Current active infection of chicken pox/rubella/genital herpes in the woman or baby F: Tuberculosis under treatment
Immune	05	A: Systemic lupus erythematosus B: Scleroderma
Endocrine	06	A: Hyperthyroidism B: Diabetes
Renal	07	A: Abnormal renal function B: Renal disease requiring supervision by a renal specialist
Neurological	08	A: Epilepsy B: Myasthenia gravis C: Previous cerebrovascular accident
Gastrointestinal	09	A: Liver disease associated with current abnormal liver function tests
Psychiatric	10	A: Psychiatric disorder requiring current inpatient care
Other	11	A: Please write in condition or diagnosis

Obstetric history

Type of condition	Code	Additional information
Previous complications	12	A: Unexplained stillbirth/neonatal death or previous death related to intrapartum difficulty B: Previous baby with neonatal encephalopathy C: Pre-eclampsia requiring preterm birth D: Placental abruption with adverse outcome E: Eclampsia F: Uterine rupture G: Primary postpartum haemorrhage requiring additional treatment or blood transfusion H: Retained placenta requiring manual removal in theatre I: Caesarean section J: Shoulder dystocia
Current pregnancy	13	A: Multiple birth B: Placenta praevia C: Pre-eclampsia or pregnancy-induced hypertension D: Preterm labour or preterm prelabour rupture of membranes E: Placental abruption F: Anaemia – haemoglobin less than 8.5 g/dl at onset of labour G: Confirmed intrauterine death H: Induction of labour I: Substance misuse J: Alcohol dependency requiring assessment or treatment K: Onset of gestational diabetes L: Malpresentation – breech or transverse lie M: Body mass index at booking of greater than 35 kg/m^2 N: Recurrent antepartum haemorrhage
Fetal indications	14	A: Small for gestational age in this pregnancy (less than fifth centile or reduced growth velocity on ultrasound) B: Abnormal fetal heart rate (FHR)/Doppler studies C: Ultrasound diagnosis of oligo-/polyhydramnios
Previous gynaecological history	15	A: Myomectomy B: Hysterotomy
Other	16	A: Please write in condition or diagnosis

Section D: Labour and birth

If multiple pregnancy, please complete for the first baby only

D1. **Did this woman make her final decision about place of birth during labour?** ☐ Yes ☐ No

D2. **Date and time midwife started labour care:** D D / M M / Y Y h h : m m (24hr)

D3. **Cervical dilatation at start of labour care:** ☐☐ *(0-10cm)* ☐ Not assessed

D4. **Was this woman transferred to a midwifery unit or an obstetric unit at any time during labour care or immediately after the birth?** ☐ Yes ☐ No

If No, please go to question D5

Maternal Transfer

If woman transferred more than once, please tick this box ☐ *and complete the questions below for care received during the first transfer only*

T1. **Date and time of decision to transfer:** D D / M M / Y Y h h : m m (24hr)

T2. **Primary reason for transfer:** *Please write in one code from list* ☐☐

01 Failure to progress (1st stage)
02 Fetal distress (1st stage)
03 Meconium staining
04 Epidural request
05 Hypertension
06 Malposition
07 Malpresentation
08 Antepartum haemorrhage
09 Failure to progress (2nd stage)
10 Fetal distress (2nd stage)
11 Postpartum haemorrhage
12 Retained placenta
13 Repair of perineal trauma
14 Other *Please specify*

_____

T3. **Date and time of start of transfer:** D D / M M / Y Y h h : m m (24hr)

T4. **Mode of transfer:** ☐1 Private car ☐2 Ambulance ☐3 Other

If Other, please specify _____

T5. **Full name of unit woman transferred to:** _____

T6. **Date and time of start of midwifery care in transfer unit:** D D / M M / Y Y h h : m m (24hr)

T7. **Date and time of first clinical assessment by obstetrician:** D D / M M / Y Y h h : m m (24hr)

Tick if not assessed by an obstetrician ☐

T8. **Was labour augmented with syntocinon?** ☐ Yes ☐ No

T9. **Did this woman have an epidural or spinal?** ☐ Yes ☐ No

T10. **Did this woman have a general anaesthetic?** ☐ Yes ☐ No

D5. **Date and time of delivery:** D D / M M / Y Y h h : m m (24hr)

D6. **Place of birth:** ☐1 Home ☐2 Obstetric unit ☐3 Other

If Other, please specify _____

D7. **Mode of birth:** *Please tick one box only*
If caesarean section after failed forceps/ventouse, tick caesarean section

☐1 Spontaneous vertex birth ☐2 Vaginal breech
☐3 Ventouse ☐4 Forceps ☐5 Caesarean section

Primary reason for instrumental or caesarean delivery _____

D8. **At any time during labour did this woman use immersion in water for pain relief?** ☐ Yes ☐ No

D9. **Did this woman have active management of the 3rd stage?** ☐ Yes ☐ No

D10. **Did this woman have an episiotomy?** ☐ Yes ☐ No

D11. **Was there any perineal trauma involving the anal sphincter?** *(3rd/4th degree tear)* ☐ Yes ☐ No

D12. **Birth outcome:** ☐1 Live birth ☐2 Stillbirth

D13. **Sex of baby:** ☐1 Male ☐2 Female ☐3 Unknown

D14. **Birthweight:** ☐☐☐☐ g

D15. **Apgar at 5 minutes:** ☐☐

D16. **When was the episode of labour care completed?** ☐☐/☐☐/☐☐☐☐ ☐☐:☐☐ (24hr)
See back cover for guidance

Please place this form in the woman's postnatal notes.

Section E: After birth

*To be completed by the **midwife** on or after the 5th postnatal day and before transfer to the health visitor*

E1. **Within the first 48 hours after birth was this woman admitted to:** *Please tick all that apply*
Do not include recovery ward for operative delivery

☐ High Dependency Area ☐ ICU ☐ Specialist unit *e.g. dialysis unit*

Primary reason for admission _____

If Specialist unit, please specify _____

E2. **Did this woman receive a blood transfusion within 48 hours of birth?** ☐ Yes ☐ No

E3. **Date and time woman discharged home:** ☐☐/☐☐/☐☐☐☐ ☐☐:☐☐ (24hr)

Not yet discharged ☐

Not applicable, delivered at home ☐

E4. **Did this woman breastfeed her baby at least once?** ☐ Yes ☐ No

E5. **Was the baby admitted to a neonatal unit within 48 hours of birth?** ☐ Yes ☐ No

If Yes, to where was the baby admitted? *Please tick one box only*

☐1 Special Care Baby Unit ☐2 High Dependency Unit ☐3 Neonatal Intensive Care

Date baby was discharged from neonatal unit: ☐☐/☐☐/☐☐☐☐

Not yet discharged ☐

E6. **Were any of the following identified in the baby within 48 hours after birth?** *Please tick all that apply*

☐ Meconium aspiration syndrome
☐ Neonatal encephalopathy
☐ Brachial plexus injury
☐ Fractured humerus
☐ Fractured clavicle
☐ Fractured skull
☐ Neonatal sepsis
☐ **No morbidity identified**
☐ Cephalohaematoma
☐ Cerebral haemorrhage
☐ Kernicterus
☐ Seizures
☐ Admission to neonatal unit within 48 hrs of birth for at least 48 hrs with evidence of feeding difficulties or respiratory distress
☐ Other morbidity
Please specify _____

E7. **Was the baby known to have died at the time this form was completed?** ☐ Yes ☐ No

E8. **Section E completed by:** *Please print full name* _____

☐☐/☐☐/☐☐☐☐ ☐☐:☐☐ (24hr)

Please fill in the After birth section on page 1

Barcode/Number

Thank you for completing this form.

Please return this form to the Local Co-ordinating Midwife in the envelope provided using the internal post.

Guidance

D16.

For women who give birth at home, the episode of labour care is completed when the midwife leaves the woman's home.

For women who give birth in a freestanding midwifery unit, an alongside midwifery unit, or in hospital, the episode of labour care is completed when the woman is discharged from the delivery room or when the midwife begins the postnatal notes, whichever occurs first.

MREC reference number: 07/H0505/151
Version1
14 February 2008

Planned OU data collection form

Barcode/Number

Birthplace
In England Research Programme

Obstetric Unit
Data collection form

Instructions

- **Please complete** this form for each woman who plans to give birth in your obstetric unit (OU) and who is receiving care from a midwife during labour, and who you expect to give birth in this clinical episode.
  i. Please start this form during labour care.
  ii. Please do not use abbreviations.

- If this woman transfers to another obstetric unit, please complete as much of the form as you can and then transfer the form with the woman.
- When the form is complete return it in the attached envelope to the Local Co-ordinating Midwife. Please ensure the return address on the back cover of this form is aligned with the window of the envelope.
- If you have any questions about the form or about this study please contact:

Birthplace Project Manager
birthplace@npeu.ox.ac.uk
Tel: 01865 289756
Fax: 01865 289758

Thank you for your contribution to Birthplace

www.npeu.ox.ac.uk/birthplace

The Royal College of Midwives

nct

Royal College of Obstetricians and Gynaecologists
Setting standards to improve women's health

Section A: Birthplace obstetric unit eligibility criteria

A1. **Is this woman having a caesarean section before the onset of labour?** ☐ Yes ☐ No

A2. **Is this a multiple pregnancy?** ☐ Yes ☐ No

A3. **Is the gestation of this pregnancy 36^{+6} weeks or less?** ☐ Yes ☐ No

A4. **Is this woman "unbooked"?** *i.e. has had no antenatal care* ☐ Yes ☐ No

If you answered 'Yes' to ANY of these questions:

- Do NOT complete the remainder of this form.
- Place the form in the 'Birthplace box' or appropriate location for it to be returned to the Local Coordinating Midwife (LCM).

If you answered 'No' to ALL of these questions:

- Continue completing this form.
- Once you have completed Section D, at the end of the episode of labour, place the form in the woman's postnatal notes so that section E can be completed on or after the 5th postnatal day.

Woman's identifying details

This page will be detached from the rest of the form and kept in a secure location in your Trust by the Local Co-ordinating Midwife (LCM).

Please stick woman's address label here:

OR complete the following details:

A5. **Woman's full name:** *Please print* _____

A6. **Woman's date of birth:** D D / M M / Y Y

A7. **Woman's NHS number:**

A8. **Woman's home address:** *Please print*

_____

_____

_____

A9. **Woman's full postcode:**

A10. **Section A completed by:** *Please print full name* _____

Office use only

After birth

Please fill in this box once the labour episode is complete

A11. **Date of delivery:** D D / M M / Y Y

A12. **Baby's NHS number:** *(If known)*

Birthplace Obstetric Unit
in England Research Programme

Section B: Woman's details

B1. Woman's age at delivery: *(Years)* ☐☐

B2. Woman's ethnic group: *(As recorded in her maternity notes)*

☐☐ *Please write in one code from the list below*

01 White British	09 Pakistani
02 White Irish	10 Bangladeshi
03 Any other White background	11 Any other Asian background
04 Mixed White & Black Caribbean	12 Black Caribbean
05 Mixed White & Black African	13 Black African
06 Mixed White & Asian	14 Any other Black background
07 Any other Mixed background	15 Chinese
08 Indian	16 Any other ethnic group

B3. Woman's understanding of English language:

☐1 Fluent

☐2 Some understanding/Able to communicate verbally

☐3 No understanding/Not able to communicate verbally

B4. Woman's marital/partner status:

☐1 Married/Living with a partner

☐3 Single/Unsupported by partner *(this includes single woman living with family)*

B5. Woman's BMI in pregnancy: ☐☐.☐ *If not recorded tick here* ☐

For LCM use only

B6. IMD score: *(www.npeu.ox.ac.uk/birthplace/lcm/imd)* ☐☐.☐☐

B7. Tick this box if this form was not started around the time of birth and was filled in retrospectively by the LCM: ☐

Section C: Pregnancy history

Previous pregnancies

C1. Number of pregnancies of ≥ 24 weeks, prior to this pregnancy: *If none, write 0* ☐☐

This pregnancy

C2. Expected date of delivery: ☐☐/☐☐/☐☐

C3. Immediately prior to the onset of labour, was this woman known to have any of the complications listed opposite?

☐ No

☐ Yes *Please write in code(s) below from tables opposite*

Example: For a woman with previous pre-eclampsia requiring preterm birth, the condition is found in the 'Obstetric history' table under 'Previous complications' and coded '12 C'. For a woman with a condition that is not listed in the tables opposite, please enter the code for 'Other' and write in the condition in the space provided.

12	C	

Code		If Other, please write name of condition clearly

C4. At the start of care in labour, did this woman have any of the following conditions? *Please tick all that apply*

☐ Prolonged rupture of membranes greater than 18 hours

☐ If membranes are ruptured, any meconium stained liquor

☐ Proteinuria of 1+ or more

☐ Hypertension with either:
- diastolic blood pressure of ≥ 90mm Hg on more than one occasion 20 minutes apart or ≥ 100mm Hg on one occasion
- systolic blood pressure ≥ 160mm Hg on at least one occasion

☐ Abnormal vaginal bleeding

☐ Non-cephalic presentation

☐ Abnormal fetal heart rate

☐ Other complications *Please specify* _____

☐ **None of the above**

Medical conditions

Type of condition	Code	Additional information
Cardiovascular	01	A: Confirmed cardiac disease B: Hypertensive disorders
Respiratory	02	A: Asthma requiring an increase in treatment or hospital treatment B: Cystic fibrosis
Haematological	03	A: Haemoglobinopathies – sickle-cell disease, beta-thalassaemia major B: History of thromboembolic disorders C: Immune thrombocytopenia purpura or other platelet disorder or platelet count below 100 000/cubic mm D: Von Willebrand's disease E: Bleeding disorder in the woman or unborn baby F: Atypical antibodies which carry a risk of haemolytic disease of the newborn
Infective	04	A: Risk factors associated with group B streptococcus whereby antibiotics in labour would be recommended B: Hepatitis B/C with abnormal liver function tests C: Infected with HIV D: Toxoplasmosis – woman receiving treatment E: Current active infection of chicken pox/rubella/genital herpes in the woman or baby F: Tuberculosis under treatment
Immune	05	A: Systemic lupus erythematosus B: Scleroderma
Endocrine	06	A: Hyperthyroidism B: Diabetes
Renal	07	A: Abnormal renal function B: Renal disease requiring supervision by a renal specialist
Neurological	08	A: Epilepsy B: Myasthenia gravis C: Previous cerebrovascular accident
Gastrointestinal	09	A: Liver disease associated with current abnormal liver function tests
Psychiatric	10	A: Psychiatric disorder requiring current inpatient care
Other	11	A: Please write in condition or diagnosis

Obstetric history

Type of condition	Code	Additional information
Previous complications	12	A: Unexplained stillbirth/neonatal death or previous death related to intrapartum difficulty B: Previous baby with neonatal encephalopathy C: Pre-eclampsia requiring preterm birth D: Placental abruption with adverse outcome E: Eclampsia F: Uterine rupture G: Primary postpartum haemorrhage requiring additional treatment or blood transfusion H: Retained placenta requiring manual removal in theatre I: Caesarean section J: Shoulder dystocia
Current pregnancy	13	A: Multiple birth B: Placenta praevia C: Pre-eclampsia or pregnancy-induced hypertension D: Preterm labour or preterm prelabour rupture of membranes E: Placental abruption F: Anaemia – haemoglobin less than 8.5 g/dl at onset of labour G: Confirmed intrauterine death H: Induction of labour I: Substance misuse J: Alcohol dependency requiring assessment or treatment K: Onset of gestational diabetes L: Malpresentation – breech or transverse lie M: Body mass index at booking of greater than 35 kg/m^2 N: Recurrent antepartum haemorrhage
Fetal indications	14	A: Small for gestational age in this pregnancy (less than fifth centile or reduced growth velocity on ultrasound) B: Abnormal fetal heart rate (FHR)/Doppler studies C: Ultrasound diagnosis of oligo-/polyhydramnios
Previous gynaecological history	15	A: Myomectomy B: Hysterotomy
Other	16	A: Please write in condition or diagnosis

Section D: Labour and birth

D1. **Date and time midwife started labour care:** DD/MM/YY HH:MM (24hr)

D2. **Cervical dilatation at start of labour care:** ☐☐ *(0-10cm)* ☐ Not assessed

D3. **Was this woman transferred to another obstetric unit at any time during labour care or immediately after birth?** ☐ Yes ☐ No

D4. **Was labour augmented with syntocinon?** ☐ Yes ☐ No

D5. **At any time during labour did this woman use immersion in water for pain relief?** ☐ Yes ☐ No

D6. **Did this woman have an epidural or spinal?** ☐ Yes ☐ No

D7. **Did this woman have a general anaesthetic?** ☐ Yes ☐ No

D8. **Date and time of delivery:** DD/MM/YY HH:MM (24hr)

D9. **Place of birth:** ☐1 Obstetric unit ☐2 Other

If Other, please specify _____

D10. **Mode of birth:** *Please tick one box only*
If caesarean section after failed forceps/ventouse, tick caesarean section

☐1 Spontaneous vertex birth ☐2 Vaginal breech
☐3 Ventouse ☐4 Forceps ☐5 Caesarean section

Primary reason for instrumental or caesarean delivery _____

D11. **Did this woman have active management of the 3rd stage?** ☐ Yes ☐ No

D12. **Did this woman have an episiotomy?** ☐ Yes ☐ No

D13. **Was there any perineal trauma involving the anal sphincter?** *(3rd/4th degree tear)* ☐ Yes ☐ No

D14. **Birth outcome:** ☐1 Live birth ☐2 Stillbirth

D15. **Sex of baby:** ☐1 Male ☐2 Female ☐3 Unknown

D16. **Birthweight:** ☐☐☐☐ g

D17. **Apgar at 5 minutes:** ☐☐

D18. **When was the episode of labour care completed?** DD/MM/YY HH:MM (24hr)
See back cover for guidance

Please place this form in the woman's postnatal notes.

Section E: After birth

*To be completed by the **midwife** on or after the 5th postnatal day and before transfer to the health visitor*

E1. Within the first 48 hours after birth was this woman admitted to: *Please tick all that apply*
Do not include recovery ward for operative delivery

☐ High Dependency Area ☐ ICU ☐ Specialist unit *e.g. dialysis unit*

Primary reason for admission _____

If Specialist unit, please specify unit type _____

E2. Did this woman receive a blood transfusion within 48 hours of birth? ☐ Yes ☐ No

E3. Date and time woman discharged home: D D / M M / Y Y Y Y H H : M M (24hr)

Not yet discharged ☐

E4. Did this woman breastfeed her baby at least once? ☐ Yes ☐ No

E5. Was the baby admitted to a neonatal unit within 48 hours of birth? ☐ Yes ☐ No

If Yes, to where was the baby admitted? *Please tick one box only*

☐ Special Care Baby Unit ☐ High Dependency Unit ☐ Neonatal Intensive Care

Date baby was discharged from neonatal unit: D D / M M / Y Y

Not yet discharged ☐

E6. Were any of the following identified in the baby within 48 hours after birth? *Please tick all that apply*

☐ Meconium aspiration syndrome
☐ Neonatal encephalopathy
☐ Brachial plexus injury
☐ Fractured humerus
☐ Fractured clavicle
☐ Fractured skull
☐ Neonatal sepsis
☐ Cephalohaematoma
☐ Cerebral haemorrhage
☐ Kernicterus
☐ Seizures
☐ Admission to neonatal unit within 48 hrs of birth for at least 48 hrs with evidence of feeding difficulties or respiratory distress

☐ **No morbidity identified**

☐ Other morbidity
Please specify _____

E7. Was the baby known to have died at the time this form was completed? ☐ Yes ☐ No

E8. Section E completed by: *Please print full name* _____

E9. Date and time Section E completed: D D / M M / Y Y Y Y H H : M M (24hr)

Please fill in the After birth section on page 1

Barcode/Number

Thank you for completing this form.

Please return this form to the Local Co-ordinating Midwife in the envelope provided using the internal post.

Guidance

D18.

The episode of labour care is completed when the woman is discharged from the delivery room or when the midwife begins the postnatal notes, whichever occurs first.

MREC reference number: 07/H0505/151
Version 2
1 October 2008

Obstetric unit transfer form

Birthplace in England Research Programme

LCM no.: _____

Woman's DCF no.: _____

Obstetric Unit Transfer Form

- This form must be completed for each woman who is transferred from one obstetric unit to another between the time the midwife begins the labour notes to the end of labour care, before postnatal care begins.*(see back page for guidance)*.

Maternal Transfer

T1. Date and time of decision to make this transfer: DD/MM/YY hh:mm (24hr)

T2. Primary reason for this transfer: *Please write in one code from list* ☐☐

01 Failure to progress (1st stage)
02 Fetal distress (1st stage)
03 Meconium staining
04 Epidural request
05 Hypertension
06 Malposition
07 Malpresentation
08 Antepartum haemorrhage
09 Failure to progress (2nd stage)
10 Fetal distress (2nd stage)
11 Postpartum haemorrhage
12 Retained placenta
13 Repair of perineal trauma
14 Other *Please specify* _____

T3 Date and time of start of this transfer: DD/MM/YY hh:mm (24hr)

T4. Mode of transfer: ☐ Private car ☐ Ambulance ☐ Other

If Other, please specify _____

T5. Full name of unit woman transferred from: _____

T6. Full name of unit woman transferred to: _____

T7. Date and time of start of midwifery care in transfer unit: DD/MM/YY hh:mm (24hr)

T8. Date and time of first clinical assessment by obstetrician: DD/MM/YY hh:mm (24hr)

Tick if not assessed by an obstetrician ☐

Please write any comments in the box below:

Thank you for your contribution to Birthplace

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Thank you for completing this form.

Please return this form to the Birthplace co-ordinating office.

FREEPOST RRKH-XXAB-JJLK
Birthplace in England Research Programme
NPEU
University of Oxford
Old Road Campus
Headington
Oxford, OX3 7LF

Guidance

Definition of End of Labour Care

The episode of labour care is completed when the woman is discharged from the delivery room or when the midwife begins the postnatal notes, whichever occurs first.

MREC reference number: 07/H0505/151
Version 1
October 2008

Multiple maternal transfer form

Birthplace in England Research Programme

LCM no.: _____

Woman's DCF no.: _____

Multiple Maternal Transfer Form

This form relates to maternal transfers occurring between the time that the midwife started labour care through to the end of labour care.

- **INCLUDE** transfers between units during labour (e.g. from home to a freestanding midwifery unit (MU) or from an alongside MU to an obstetric unit).
- Do **NOT INCLUDE** transfers within a unit (e.g. from the labour ward/delivery room to the operating theatre).
- Do **NOT INCLUDE** transfers occurring at or after the end of labour care (e.g. to the postnatal ward or ICU).

Section A: First maternal transfer

From: ☐ Home ☐ Freestanding MU ☐ Alongside MU ☐ Obstetric Unit

1. **Name of unit transferred to:** _____
2. **Type of unit:** ☐ Freestanding MU ☐ Alongside MU ☐ Obstetric Unit
3. **Was the woman transferred more than once (before the end of labour care)?** ☐ Yes ☐ No

If No, *please go to section D*

Section B: Second maternal transfer

4. **Date and time of decision to make this transfer:** D D / M M / Y Y h h : m m (24hr)
5. **Primary reason for this transfer:** *Please write in one code from list* ☐☐

01 Failure to progress (1st stage)	07 Malpresentation	13 Repair of perineal trauma
02 Fetal distress (1st stage)	08 Antepartum haemorrhage	14 Other *Please specify:*
03 Meconium staining	09 Failure to progress (2nd stage)	_____
04 Epidural request	10 Fetal distress (2nd stage)	
05 Hypertension	11 Postpartum haemorrhage	
06 Malposition	12 Retained placenta	

6. **Date and time of start of this transfer:** D D / M M / Y Y h h : m m (24hr)
7. **Mode of transfer:** ☐1 Ambulance ☐2 Other

If Other, *please give details* _____

8. **Name of unit transferred to:** _____
9. **Type of unit:** ☐ Freestanding MU ☐ Alongside MU ☐ Obstetric Unit
10. **Date and time of start of care in this unit:** D D / M M / Y Y h h : m m (24hr)
11. **Was the woman transferred a third time?** ☐ Yes ☐ No

If No, *please go to section D*

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Section C: Third maternal transfer

12. Date and time of decision to make this transfer: D D / M M / Y Y H H : M M (24hr)

13. Primary reason for this transfer: *Please write in one code from list* ☐☐

01 Failure to progress (1st stage)
02 Fetal distress (1st stage)
03 Meconium staining
04 Epidural request
05 Hypertension
06 Malposition
07 Malpresentation
08 Antepartum haemorrhage
09 Failure to progress (2nd stage)
10 Fetal distress (2nd stage)
11 Postpartum haemorrhage
12 Retained placenta
13 Repair of perineal trauma
14 Other *Please specify*: _____

14. Date and time of start of this transfer: D D / M M / Y Y H H : M M (24hr)

15. Mode of transfer: ☐1 Ambulance ☐2 Other

If Other, *please give details* _____

16. Name of unit transferred to: _____

17. Type of unit: ☐ Freestanding MU ☐ Alongside MU ☐ Obstetric Unit

18. Date and time of start of care in this unit: D D / M M / Y Y H H : M M (24hr)

Section D: Intrapartum care

19. Date and time of first clinical assessment by an obstetrician:

D D / M M / Y Y H H : M M (24hr)

Tick if not assessed by an obstetrician: ☐

20. Was labour augmented with syntocinon? ☐ Yes ☐ No

21. Did the woman have an epidural or spinal? ☐ Yes ☐ No

22. Did the woman have a general anaesthetic? ☐ Yes ☐ No

Section E: Other details

23. Please record any other information that you think may be relevant

Completed by: _____

Thank you for completing this form.
Please return this form to the Birthplace Co-ordinating Office.

FREEPOST RRKH-XXAB-JJLK
Birthplace in England Research Programme
NPEU, University of Oxford
Old Road Campus
Oxford, OX3 7LF

MREC reference number: 07/H0505/151
Version 2, March 2010

Neonatal morbidity form

Birthplace
in England Research Programme

Affix FRONT PAGE sticker here

Neonatal morbidity/mortality follow-up

This form relates to a baby who was part of the Birthplace cohort study. This study is designed to compare outcomes of births planned at home, in different types of midwifery units and in hospital obstetric units (**www.npeu.ox.ac.uk/birthplace**).

Our study records show that this baby was admitted to a neonatal unit and/or experienced significant morbidity. We now need further information about the baby whose details are given above. ***Further guidance on completing this form is given on the inside of the front page.***

Instructions for the Birthplace Local Coordinating Midwife:

Please complete the relevant stickers and attach to the front and back of this form.

☐ tick here if the baby was **admitted to a neonatal or paediatric unit**. This form should be completed by, or with the help of, a member of the clinical team on the admitting unit, with the agreement of the clinical director for neonatal services.

☐ tick here if the baby was ***not admitted*** **to a neonatal or paediatric unit** – please complete this form yourself.

After completion, please:

☐ **Tick here if no relevant morbidity/mortality has been recorded (see page 6)**

- Remove this front page and store securely with the Birthplace documents.
- Return the rest of the form to the Birthplace office using the Freepost envelopes provided.

Thank you

The Royal College of Midwives

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Royal College of Obstetricians and Gynaecologists
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Instructions to the person completing this form

Please complete this form and return to the Birthplace Local Coordinating midwife (LCM). See back page for return address.

Please enter your name and contact details here in case the LCM has any queries.

Name: _____ Phone/email: _____

The LCM will check the completed form and remove the front page and all identifying details before returning to the Birthplace office. The front page will be kept in a secure location by the LCM in the Trust where this baby was born.

Thank you for your help.

If you have any questions about the form or about this study please contact:

- the Birthplace Local Coordinating midwife (LCM) whose address is given on the back page of this form; or
- the Birthplace Project Manager

  Tel: 01865 289748
  Fax: 01865 289758
  Email: birthplace@npeu.ox.ac.uk

MREC reference number: 07/H0505/151

Definitions: Levels of neonatal care

Intensive care: for babies with the most complex problems, receiving any respiratory support via a tracheal tube and in the first 24 hours after its withdrawal; receiving NCPAP for any part of the day and less than five days old; below 1000g current weight and receiving NCPAP for any part of the day and for 24 hours after withdrawal; less than 29 weeks gestational age and less than 48 hours old; requiring major emergency surgery, for the pre-operative period and post-operatively for 24 hours; requiring full exchange transfusion, peritoneal dialysis, infusion of an inotrope, pulmonary vasodilator or prostaglandin and for 24 hours afterwards; any other very unstable baby considered by the nurse-in-charge to need 1:1 nursing; a baby on the day of death.

High dependency care: babies receiving NCPAP for any part of the day and not fulfilling any of the criteria for intensive care; below 1000g current weight and not fulfilling any of the criteria for intensive care; receiving parenteral nutrition; having convulsions; receiving oxygen therapy and below 1500g current weight; requiring treatment for neonatal abstinence syndrome; requiring specified procedures that do not fulfil any criteria for intensive care: care of an intra-arterial catheter or chest drain, partial exchange transfusion, tracheostomy care until supervised by a parent; requiring frequent stimulation for severe apnoea.

Special care: provided for all other babies who could not reasonably be expected to be looked after at home by their mother.

Normal care: provided for babies who themselves have no medical indication to be in hospital.

Section A: Neonatal or paediatric unit admission

1. **Was this baby admitted to a neonatal or paediatric unit for intensive care, high dependency care, special care or transitional care within 48 hours of birth?** Yes ☐ No ☐

   If No, *please go to section B.*

2. **Date of admission:** D D / M M / Y Y

3. **Type of unit**

Neonatal unit	☐
Other	☐

   If Other, please specify unit type: _____

4. **How many days care did the baby receive at each level of care?**
   Include part of any day as 1 day

Intensive care	☐☐☐ days
High dependency care	☐☐☐ days
Special care	☐☐☐ days
Normal care (including on postnatal ward)	☐☐☐ days
Total days:	☐☐☐ days

See definitions of levels of care inside front page of this booklet.

5. **Did this baby have any respiratory support (ventilator or continuous positive airway pressure, CPAP) during their admission?** Yes ☐ No ☐

   If Yes, for how many days? *Include part of any day as 1 day*

Total number of days receiving respiratory support	☐☐☐ days
Total number of days receiving supplemental oxygen	☐☐☐ days

6. **Has the baby been discharged home?** Yes ☐ No ☐

   If Yes, please give date: D D / M M / Y Y

7. **What were the main reasons for admission?**

_____

_____

_____

_____

Section B: Meconium aspiration

1. **Was this baby diagnosed with meconium aspiration syndrome?** Yes ☐ No ☐

   If No, *please go to section C.*

2. **Date of diagnosis:** D D / M M / Y Y

3. **Did this baby receive ECMO during admission?** Yes ☐ No ☐

If Yes, please give total number of days baby received ECMO: ☐☐ days

4. **Were any of the following diagnosed at any time during the baby's stay in the unit, in addition to the diagnosis of meconium aspiration syndrome?** *Please tick all that apply*

Pneumonia	☐
Pulmonary air leak	☐
Pulmonary haemorrhage	☐
Pulmonary hypertension	☐

Section C: Encephalopathy

1. **Was this baby diagnosed with neonatal encephalopathy?** Yes ☐ No ☐

If No, *please go to section D.*

2. **Date of diagnosis:** D D / M M / Y Y

3. **What was the most severe grade of encephalopathy recorded?**

Mild	☐
Moderate	☐
Severe	☐

4. **Was a specific cause of the encephalopathy identified?** Yes ☐ No ☐

If Yes, please give details of any causes identified, in addition to presumed perinatal asphyxia.

5. **Did the baby have seizures requiring treatment?** Yes ☐ No ☐

6. **Was the baby treated with hypothermia (cooling)?** Yes ☐ No ☐

Section D: Seizures

1. **Was this baby diagnosed with isolated seizures?** Yes ☐ No ☐

If No, *please go to section E.*

2. **Date of diagnosis:** D D / M M / Y Y

3. **Was a specific cause of the isolated seizures identified?** Yes ☐ No ☐

If Yes, please give details of any causes identified, in addition to presumed perinatal asphyxia.

4. **Was the baby prescribed medication to control seizures at any time?** Yes ☐ No ☐

Section E: Sepsis

1. **Was this baby diagnosed with neonatal sepsis (proven or suspected)?** Yes ☐ No ☐
   If No, *please go to section F.*

2. **Date of diagnosis:** D D / M M / Y Y

3. **Clinical risk factors for infection:**

   Did the mother have a diagnosis of clinical chorioamnionitis? Yes ☐ No ☐

   What was the duration of membrane rupture prior to delivery? ☐☐☐ days ☐☐☐ hours

   OR ☐ Not Known

   Was the mother known to be a carrier of GBS prior to birth? Yes ☐ No ☐

4. **Up to and including the 5th postnatal day, did the baby have?**

   A positive blood culture Yes ☐ No ☐

   If Yes, please specify organism: _____

   Evidence of infection in CSF Yes ☐ No ☐

   If Yes, please specify white cell count: _____

   Please specify organism: _____

   A positive culture from another site (not blood or CSF)? Yes ☐ No ☐

   If Yes, please specify usually sterile site(s) and organism(s): _____

   Bowel perforation or definite necrotising enterocolitis? Yes ☐ No ☐

   Chest X-ray changes consistent with pneumonia? Yes ☐ No ☐

Section F: Cephalhaematoma

1. **Was this baby diagnosed with cephalhaematoma or subaponeurotic bleeding?**

   Cephalhaematoma Yes ☐ No ☐

   Subaponeurotic bleeding Yes ☐ No ☐

   If No to both, *please go to section G.*

2. **Date of diagnosis:** D D / M M / Y Y

Section G: Cerebral haemorrhage

1. **Was this baby diagnosed with an intracranial haemorrhage?** Yes ☐ No ☐
   If No, *please go to section H.*

2. **Date of diagnosis:** D D / M M / Y Y

3. **What kind of intracranial haemorrhage was this?**

- Subdural haemorrhage ☐
- Subarachnoid haemorrhage ☐
- Intracerebral haemorrhage ☐
- Intraventricular haemorrhage ☐
- Other ☐

If Other, please give details: _____

Section H: Injuries

1. **Was this baby diagnosed with any of the injuries listed below?** Yes ☐ No ☐

If No, *please go to section I.*

Date of diagnosis and cause. *Please tick all that apply.*

Injury	Data of diagnosis	Cause of injury
☐ Brachial plexus injury	D D / M M / Y Y	
☐ Fractured humerus	D D / M M / Y Y	
☐ Fractured clavicle	D D / M M / Y Y	
☐ Fractured skull	D D / M M / Y Y	
☐ Other injury *(give details)* _____	D D / M M / Y Y	

Section I: Kernicterus

1. **Was this baby diagnosed with kernicterus?** Yes ☐ No ☐

If No, *please go to section J.*

2. **Date of diagnosis:** D D / M M / Y Y
3. **What was the maximum SBR recorded for this baby?** ☐☐☐☐ µmol/l
4. **Did the baby require an exchange transfusion?** Yes ☐ No ☐
5. **How many days of phototherapy did the baby receive?**
   Include part of any day as 1 day ☐☐ days

Section J: Feeding difficulties

1. **Was this baby diagnosed with feeding difficulties which required admission to a neonatal or paediatric unit for 48 hours or more?** Yes ☐ No ☐

If No, *please go to section K.*

2. **Date of diagnosis:** D D / M M / Y Y

3. **Did this baby require parenteral feeding?** Yes ☐ No ☐

If Yes, please give the total number of days: ☐☐☐ days

4. **Did this baby require tube (orogastric or nasogastric) feeding?** Yes ☐ No ☐

If Yes, please give the total number of days: ☐☐☐ days

5. **How was the baby being fed at time of discharge (or current method of feeding if not yet discharged)?**

Please tick all that apply.

Intravenously	☐
Naso-gastric	☐
Oro-gastric route	☐
Oral sucking feeding	☐

Section K: Neonatal death

1. **Was the baby known to have died at the time this form was completed?** Yes ☐ No ☐

If No, *please go to section L.*

2. **Date and time of baby's death:** D D / M M / Y Y Y Y h h : m m (24hr)

3. **Was this baby registered as a neonatal death?** Yes ☐ No ☐

4. **If this was a neonatal death, where did the baby die?**

Obstetric unit postnatal room	☐
Alongside midwifery unit labour room	☐
Alongside midwifery unit postnatal room	☐
Freestanding midwifery unit labour room	☐
Home	☐
Neonatal unit	☐
Paediatric unit	☐
Other	☐

If Other, please give details: _____

5. **Has a cause of death been identified?** Yes ☐ No ☐

If Yes, please provide details:

_____

_____

_____

6. **Has a postmortem been performed?** Yes ☐ No ☐

Section L: Other details

For all babies: please check all sections and add any additional information that you think might be relevant regarding this baby's condition:

_____

_____

_____

_____

Confirmation of significant neonatal morbidity or mortality

1. Have at least one of the outcomes listed below been identified for this baby? Yes ☐ No ☐

- Neonatal or paediatric unit admission (Section A)
- Meconium aspiration (Section B)
- Encephalopathy (Section C)
- Seizures (Section D)
- Sepsis (Section E)
- Cephalhaematoma (Section F)
- Cerebral haemorrhage (Section G)
- Injuries (Section H)
- Kernicterus (Section I)
- Feeding difficulties (Section J)
- Neonatal death (Section K)

If No, were any of the above conditions suspected but not confirmed on investigation? Yes ☐ No ☐

If Yes, please give details

_____

_____

_____

If No, please tick the **blue** box on the front page and give any relevant details below

_____

_____

_____

Job title of person completing this form _____

Date form completed D D / M M / Y Y

Please return this form to the Birthplace Local Coordinating Midwife (see back cover for the address details)

Affix BACK PAGE sticker here

Return instructions for the person completing this form

Please return this form to the Birthplace Local Coordinating Midwife at the above address. ***Do NOT return to the Birthplace office.***

Thank you very much for completing this form.

If you have any questions, please contact the Birthplace office:

Birthplace Project Manager
Birthplace in England Research Programme
National Perinatal Epidemiology Unit
University of Oxford
Old Road Campus
Oxford
OX3 7LF

Tel: 01865 289748
Fax: 01865 289758
Email: birthplace@npeu.ox.ac.uk

MREC ref: 07/H0505/151
V1 01/2010

Maternal morbidity form

Birthplace in England Research Programme

Affix FRONT PAGE sticker here

Maternal morbidity/mortality follow-up

The Birthplace data collection form for this woman indicates that significant maternal morbidity or mortality may have occurred, or that the baby was stillborn.

Please complete this form to provide additional details about these events.

If you are not sure how to answer any of the questions, please contact the Birthplace office (tel: 01865 289748; email: birthplace@npeu.ox.ac.uk; fax: 01865 289758).

Instructions for completing this form:

Please complete the relevant stickers and attach to the front and back of this form.

After completion, please:

☐ **Tick here if no relevant morbidity/mortality has been recorded (see page 4)**

- Before returning, remove this front page and store securely with the Birthplace documents.
- Return the rest of the form to the Birthplace office using the Freepost envelopes provided.

Thank you

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Setting standards to improve women's health

Section A: Blood transfusion

1. **Did this woman receive a blood transfusion within 48 hours of the birth?** Yes ☐ No ☐

   If No, *please go to section B.*

2. **When was the first blood transfusion given?**

   Was this? *Please tick one box*

   - Intrapartum ☐
   - End of third stage – 23 hours after birth ☐
   - 24 – 48 hours after birth ☐

3. **How many units of whole blood or packed cells did this woman receive?** ☐☐

4. **Was a cell saver used?** Yes ☐ No ☐

   If Yes, please give the volume of patient's blood transfused: ☐☐☐☐ ml

5. **What was the lowest postnatal haemoglobin recorded for this woman?** ☐☐.☐ g/dl

6. **What was the primary reason for the blood transfusion?** *Please tick one only*

   - Uterine atony ☐
   - Genital tract trauma ☐
   - Morbidly adherent placenta ☐
   - Infection ☐
   - Anaemia ☐
   - Retained products ☐
   - Other ☐

   If Other, please give details _____

Section B: High dependency, intensive or specialist care

1. **Within the first 48 hours after the birth was this woman admitted to a higher level of care?** Yes ☐ No ☐

   If No, *please go to section C.*

2. **What type of higher level care did this woman receive?** *Please tick all that apply*

   - High dependency unit or area ☐
   - Intensive care unit ☐
   - Specialist unit e.g. dialysis unit ☐

   Type of specialist unit _____

   If you have ticked any of the above boxes, *please continue completing this section.*

   If Not, *please go to next section.*

3. Please give details of length of stay and reasons for admission to higher level care:

Type of unit	Date of admission	Date of discharge	Main reason for admission	Treatment(s) received
	D D / M M / Y Y	D D / M M / Y Y		
	D D / M M / Y Y	D D / M M / Y Y		
	D D / M M / Y Y	D D / M M / Y Y		
	D D / M M / Y Y	D D / M M / Y Y		
	D D / M M / Y Y	D D / M M / Y Y		

Section C: Maternal mortality

1. Was this woman registered as a maternal death (within 42 days of giving birth)? Yes ☐ No ☐

   If No, *please go to section D.*

2. Date and time of maternal death D D / M M / Y Y h h : m m

3. Where did this woman die?

- Obstetric unit ☐
- Alongside midwifery unit ☐
- Freestanding midwifery unit ☐
- Home ☐
- High dependency unit/area ☐
- Intensive care unit ☐
- Other hospital ward or department ☐

If Other, please give details _____

4. Has a cause of death been identified? Yes ☐ No ☐

   If Yes, please provide details:

   _____

   _____

   _____

5. Has a postmortem been performed? Yes ☐ No ☐

Section D: Stillbirth

1. **Was this baby registered as a stillbirth?** Yes ☐ No ☐
   If No, *please go to section E.*

2. **Was a fetal heartbeat heard at labour onset?** Yes ☐ No ☐

3. **If this was an intrapartum stillbirth, was stillbirth diagnosed in?**

   - First stage of labour ☐
   - Second stage of labour ☐
   - Other ☐

   If Other, please give details: _____

4. **Has a cause of death been identified?** Yes ☐ No ☐

   If Yes, please provide details:

   _____

   _____

   _____

5. **Has a postmortem been performed?** Yes ☐ No ☐

Section E: Other details

Please check the form and add any additional information that you think might be relevant about this delivery, the mother or the fetus/baby.

_____

_____

_____

_____

Form continues on next page. P.T.O.

Confirmation of significant maternal morbidity or mortality

1. **Have at least one of the outcomes listed below been identified for this woman or baby?** Yes ☐ No ☐
   - Blood transfusion (Section A)
   - Maternal admission or mortality (Sections B & C)
   - Stillbirth (Section D)

   If No, were any of the above conditions suspected but not confirmed on investigation? Yes ☐ No ☐

   If Yes, please give details

   _____

   _____

   _____

   If No, please tick the **blue** box on the front page and give any relevant details below

   _____

   _____

   _____

Job title of person completing this form _____

Date form completed D D M M Y Y

Affix BACK PAGE sticker here

Thank you very much for completing this form.

If you have any questions, please contact the Birthplace office:

Birthplace Project Manager
FREEPOST RRKH-XXAB-JJLK
Birthplace in England Research Programme
National Perinatal Epidemiology Unit
University of Oxford
Old Road Campus
Oxford
OX3 7LF

Tel: 01865 289748
Fax: 01865 289758
Email: birthplace@npeu.ox.ac.uk

MREC ref: 07/H0505/151
V1 01/2010

Appendix 3 Publication

BMJ

BMJ 2012;344:e2292 doi: 10.1136/bmj.e2292 (Published 19 April 2012)

RESEARCH

Cost effectiveness of alternative planned places of birth in woman at low risk of complications: evidence from the Birthplace in England national prospective cohort study

OPEN ACCESS

Elizabeth Schroeder health economist[1], Stavros Petrou health economist[1 2], Nishma Patel health economist[1], Jennifer Hollowell epidemiologist[1], David Puddicombe researcher[1], Maggie Redshaw senior research fellow/social scientist[1], Peter Brocklehurst professor of perinatal epidemiology[1 3], on behalf of the Birthplace in England Collaborative Group

[1]National Perinatal Epidemiology Unit, Department of Public Health, University of Oxford, Oxford OX3 7LF, UK; [2]Warwick Clinical Trials Unit, Warwick Medical School, University of Warwick, Coventry; [3]Institute for Women's Health, University College London, London

Abstract

Objectives To estimate the cost effectiveness of alternative planned places of birth.

Design Economic evaluation with individual level data from the Birthplace national prospective cohort study.

Setting 142 of 147 trusts providing home birth services, 53 of 56 freestanding midwifery units, 43 of 51 alongside midwifery units, and a random sample of 36 of 180 obstetric units, stratified by unit size and geographical region, in England, over varying periods of time within the study period 1 April 2008 to 30 April 2010.

Participants 64 538 women at low risk of complications before the onset of labour.

Interventions Planned birth in four alternative settings: at home, in freestanding midwifery units, in alongside midwifery units, and in obstetric units.

Main outcome measures Incremental cost per adverse perinatal outcome avoided, adverse maternal morbidity avoided, and additional normal birth. The non-parametric bootstrap method was used to generate net monetary benefits and construct cost effectiveness acceptability curves at alternative thresholds for cost effectiveness.

Results The total unadjusted mean costs were £1066, £1435, £1461, and £1631 for births planned at home, in freestanding midwifery units, in alongside midwifery units, and in obstetric units, respectively (equivalent to about €1274, $1701; €1715, $2290; €1747, $2332; and €1950, $2603). Overall, and for multiparous women, planned birth at home generated the greatest mean net benefit with a 100% probability of being the optimal setting across all thresholds of cost effectiveness when perinatal outcomes were considered. There was, however, an increased incidence of adverse perinatal outcome associated with planned birth at home in nulliparous low risk women, resulting in the probability of it being the most cost effective option at a cost effectiveness threshold of £20 000 declining to 0.63. With regards to maternal outcomes in nulliparous and multiparous women, planned birth at home generated the greatest mean net benefit with a 100% probability of being the optimal setting across all thresholds of cost effectiveness.

Conclusions For multiparous women at low risk of complications, planned birth at home was the most cost effective option. For nulliparous low risk women, planned birth at home is still likely to be the most cost effective option but is associated with an increase in adverse perinatal outcomes.

Introduction

Since the early 1990s, government policy on maternity care in England has moved towards policies designed to give women with straightforward pregnancies a choice of settings for birth.[1 2] In this context, freestanding midwifery units, midwifery units located in the same building or on the same site as an obstetric unit (hereafter referred to as alongside midwifery units), and home birth services have increasingly become relevant to the configuration of maternity services under consideration in England.[3] The relative benefits and risks of birth in these

Correspondence to: E Schroeder liz.schroeder@npeu.ox.ac.uk

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Appendix 1: Resource use during intrapartum care
Appendix 2: Unit costs per resource item
Appendix 3: Cost per woman adjusted for sociodemographic and other factors: generalised linear regression

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alternative settings have been widely debated in recent years.[4-10] Lower rates of obstetric interventions and other positive maternal outcomes have been consistently found in planned births at home and in midwifery units, but clear conclusions regarding perinatal outcome have been lacking. Moreover, robust evidence on the cost effectiveness of birth in alternative settings is a priority, as was highlighted by the recent National Institute for Health and Clinical Excellence (NICE) clinical guidance on intrapartum care.[11] The Birthplace in England research programme was designed to fill gaps in research evidence about the processes and outcomes associated with different settings for birth in the NHS in England. The results of the safety outcomes generated by the Birthplace in England national prospective cohort study (hereafter referred to as the cohort study) are reported elsewhere.[12] We report on the cost effectiveness of alternative planned places of birth based on data collected by the research programme.

Methods

Study population

The study population included all "low risk" women who participated in the cohort study, as described elsewhere.[12] In brief, the cohort study was designed to compare outcomes in women judged to be at low risk of complications before the onset of labour. Outcomes were compared by planned place of birth: at home, in freestanding midwifery units, in alongside midwifery units, or in obstetric units. The cohort study aimed to collect data in every NHS trust in England that provides home birth services, every free standing midwifery unit, every alongside midwifery unit, and a random sample of obstetric units, stratified by unit size and geographical region, over varying periods of time within the study period (1 April 2008 to 31 April 2010). The target sample size was at least 57 000 women: 17 000 planned home births, 5000 planned births in free standing midwifery units, 5000 planned births in alongside midwifery units, and 30 000 planned births in obstetric units, of which we estimated 20 000 would be low risk. The definition of low risk used in the cohort study was based on criteria contained in the NICE Intrapartum Care Guidelines.[11] The primary clinical outcome was a composite measure of adverse perinatal outcomes encompassing perinatal mortality and specified neonatal morbidities (box). Other outcomes considered were adverse maternal morbidity and "normal birth" (box). Further design details for the cohort study, including the eligibility criteria, sample size calculations, derivation of risk status, outcome measures, and ethical procedures, are reported elsewhere.[13]

Type of economic evaluation, study perspective, and time horizon

The economic evaluation took the form of a cost effectiveness analysis in which we estimated the incremental costs (ΔC) and incremental effects (ΔE) attributable to planned birth at home, in a free standing midwifery unit, or in an alongside midwifery unit, with reference to planned birth in an obstetric unit, and expressed each in terms of an incremental cost effectiveness ratio (ICER; $\Delta C/\Delta E$). The obstetric unit group contained the largest number of eligible births and was therefore used as the reference to maximise statistical efficiency. Estimates of cost effectiveness were made for the primary clinical outcome—adverse perinatal outcome—and for two secondary outcomes—namely, adverse maternal morbidity and normal birth. The economic evaluation was conducted from a health system perspective and consequently we have included only direct costs to the NHS.[15] The time horizon primarily mirrored the duration of follow-up of the cohort study, which identified women at the start of their care in labour and was completed when the intrapartum and immediate after birth care for both mother and baby ended, be it at home or at discharge from a midwifery unit or hospital. If higher level care after the birth was required for the mother or the baby, or both, this was included in the economic evaluation.

Measurement of resource use

Individual data collection forms, designed as part of the cohort study, documented duration of labour, mode of delivery, some forms of pain relief, active management of the third stage of labour, whether an episiotomy was performed, clinical complications, length of stay for both mother and baby by type of ward and level of care, and transfers by duration and mode.

To estimate additional resource use not captured on an individual level in the cohort study, we developed supplemental data collection forms after five focus groups held with midwives from all parts of England early in the project. These forms were designed to capture the pathways of care experienced by individual women progressing through the stages of labour and care after birth and their associated resource inputs. For the purposes of this economic evaluation, the forms were initially used in a related study funded by the National Institute of Health Research (NIHR) research for patient benefit programme "assessing the impact of a new birth centre on choice and outcome of maternity care in an inner city area," which will be reported in full elsewhere, comparing the costs of care in a free standing midwifery unit with care in an obstetric unit in the same trust.[16] The data collected included details of staffing levels, treatments, surgeries, diagnostic imaging tests, scans, drugs, and other resource inputs associated with each stage of the pathway through intrapartum and after birth care. Interviews with senior midwives from different geographical regions in England were then conducted to standardise the supplemental resource profiles.

Unit cost estimation

Unit cost estimation involved a combination of bottom-up and top-down costing methods and followed guidance on costing healthcare services as part of an economic evaluation.[15 17] Detailed unit costs, derived from the finance departments of participating trusts and information provided by senior midwives, were estimated for resource inputs into the following components of intrapartum and after birth care for all settings: homebirth delivery packs; NHS reimbursement for midwifery travel; some forms of pain relief; alternative modes of delivery; active management of the third stage of labour; suturing for episiotomy; suturing third and fourth degree perineal tears; manual removal of the placenta; blood transfusions; and care after a stillbirth or neonatal death. Unit overheads were estimated through the same finance departments for all settings and covered management and administrative costs, operational costs (including heating and lighting, training, building maintenance), indirect overheads (including personnel and finance functions), and capital costs based on the new build and land requirements of NHS facilities, accounting for unit occupancy rates. These data were used to generate an overheads cost per place of birth per hour. Midwifery staffing and attributable on-costs, with the addition of contributions to the Clinical Negligence Scheme for Trust (CNST), were derived from national sources and were weighted for length of labour care for all planned places of birth.[18 19] These midwifery costs were considered to be a major cost driver across all settings for birth and were allocated directly

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Definitions of key variables

- Adverse perinatal outcome: a composite of perinatal mortality and specified neonatal morbidities: stillbirth after the start of care in labour, early neonatal death, neonatal encephalopathy, meconium aspiration syndrome, brachial plexus injury, fractured humerus, or fractured clavicle
- Adverse maternal morbidity: defined as at least one of: general anaesthetic; instrumental birth; caesarean section; third or fourth degree perineal trauma; blood transfusion; admission to an intensive treatment unit, high dependency unit, or specialist unit; or maternal death (within 42 days after giving birth)
- Normal birth: defined by the Maternity Care Working Party[14] as birth without any of: induction of labour; epidural or spinal analgesia; general anaesthetic; episiotomy; forceps, ventouse, or caesarean section
- Complicating conditions identified at the start of care in labour: prolonged rupture of membranes (>18 hours), meconium stained liquor, proteinuria (1+ or more), hypertension, abnormal vaginal bleeding, non-cephalic presentation, abnormal fetal heart rate, or other complications.

to the duration (hours) of the labour episode per woman. This included the midpoint salary for a band 6 or 7 midwife, including salary on-costs, direct and indirect overheads, and contributions to qualifications, adjusted for working hours a week and study and leave days. Drug costs were supplemented with data from the British National Formulary, number 61.[20] Similarly, the costs of medical supplies were supplemented with data from the NHS Supply Chain Catalogue, April 2009 version.[21] Costs per day for each level of neonatal care, as well as high dependency or intensive care for the mother, were derived from national reference costs from the Department of Health.[22] Costs of emergency and non-emergency transfers were derived from secondary sources but weighted by individual level data on duration and mode of transport.[23] All unit costs in this study were expressed in pounds sterling (£) and valued at 2009-10 prices.

Cost effectiveness analytical methods

We estimated differences in resource use and costs with the independent samples t test procedure and differences in effects with odds ratios and weighted incidence rates from the cohort study. Cost effectiveness was expressed as incremental cost per adverse perinatal outcome avoided, per maternal morbidity avoided, and per additional "normal birth." For reasons explained in the cohort study report, obstetric units contained more women in whom complicating conditions were an unexpected observation, which suggests that the risk profile of low risk women varied between the settings. To ensure that women we compared had comparable risk status, we repeated all of these analyses for low risk women without complicating conditions at the start of care in labour (see box for the list of complicating conditions).[12 13] We used non-parametric bootstrapping, involving 1000 bias corrected replications of each of the incremental cost effectiveness ratios, to calculate uncertainty around all cost effectiveness estimates.[33 34] This was represented on four quadrant cost effectiveness planes. Though cost effectiveness estimates were weighted, neither costs nor effects were adjusted for potential confounders in the baseline analyses. Weighting accounted for each unit's duration of participation in the study and took into account the clustered nature of the data within the cohort study. Probability weights were incorporated in the analysis to adjust for the probability of selection of each woman. The weight applied to each observation was inversely proportional to the probability of selection of the unit and the duration of data collection in that unit. The weights were recalculated for each bootstrapped sample. Decision uncertainty was examined by estimating net benefit statistics and constructing cost effectiveness acceptability curves across cost effectiveness threshold values of between £0 and £100 000 for the health outcomes of interest.

In a series of subgroup analyses we repeated all analyses by parity subgroup for the primary cost effectiveness outcome—namely, incremental cost per adverse perinatal outcome avoided. In addition, we undertook a series of sensitivity analyses to explore the implications of uncertainty surrounding key drivers of cost in intrapartum care and the variables for which there was the most uncertainty surrounding the resource use parameters. These included varying the overheads, occupancy rates, and staffing costs attributed to the duration of labour care. We recalculated the incremental cost effectiveness ratios after these sensitivity analyses.

We used multiple regression to estimate the differences in total cost between the settings for birth and to adjust for potential confounders, including maternal age, parity, ethnicity, understanding of English, marital status, BMI, index of multiple deprivation score, parity, and gestational age at birth, which could each be associated with planned place of birth and with adverse outcomes.[12] For the generalised linear model on costs, we selected a γ distribution and identity link function in preference to alternative distributional forms and link functions on the basis of its low Akaike's information criterion (AIC) statistic. All analyses were performed with Stata version 11, SPSS version 17 (SPSS, Chicago, IL), and Microsoft Excel (Microsoft, Seattle, WA) 2010 software.

Results

The cohort study recruited 79 774 eligible women, 64 538 of whom were at low risk of complications before the onset of labour. The women were recruited from 142 of 147 trusts providing home birth services, 53 of 56 freestanding midwifery units, 43 of 51 alongside midwifery units, and a stratified random sample of 36 of 180 obstetric units. Analyses reported in detail elsewhere[12] found that, overall, there were no significant differences in the odds of adverse perinatal outcome for planned births in any of the non-obstetric unit settings compared with the obstetric units. Complicating conditions identified at the start of care in labour, however, were more common among low risk women in the planned obstetric unit group, suggesting that the groups were not homogeneous with regard to risk. In further analyses restricted to women without complicating conditions at the start of care in labour, the adjusted odds of adverse perinatal outcomes were higher for births planned at home compared with those planned in obstetric units (adjusted odds ratio 1.59, 95% confidence interval 1.01 to 2.52). In the restricted analyses, we did not find an increase in adverse perinatal outcomes for births planned in either free standing midwifery units or alongside midwifery units. Subgroup analyses by parity showed a significantly increased adjusted odds of adverse perinatal outcome for nulliparous women for births planned at home compared with those planned in obstetric units (1.75, 1.07 to 2.86); the strength of this association increased among women without complicating conditions at the start of care in labour (2.80, 1.59 to 4.92). The adjusted odds of the secondary maternal outcomes—namely, maternal morbidity

avoided and "normal birth"—were significantly increased for planned births in all three non-obstetric unit settings compared with those planned in obstetric units. Further details on the characteristics of the recruited women, and their clinical and safety outcomes, are reported in the cohort paper and the fuller report.[12 13]

Profiles of resource use, and their associated unit costs, for each planned place of birth are reported in detail in appendices 1 and 2 on bmj.com.[25] The total mean costs per low risk woman planning birth in the various settings at the start of care in labour were £1631 (€1950, $2603) for an obstetric unit, £1461 (€1747, $2332) for an alongside midwifery unit, £1435 (€1715, $2290) for a free standing midwifery unit, and £1067 (€1274, $1701) for the home (table 1⇓). Unit overheads and staffing costs were the key drivers of cost in these analyses. Restriction of the analyses to low risk women without complicating conditions at the start of care in labour narrowed the cost differences between planned places of birth: total mean costs were £1511 for an obstetric unit, £1426 for an alongside midwifery unit, £1405 for a free standing midwifery unit, and for £1027 the home (table 2⇓). The generalised linear model on costs showed that, even after adjustment for clinical and sociodemographic confounders, planned birth in settings other than obstetric units remained cost saving compared with the reference category of the obstetric unit: savings averaged £134, £130, and £310 for planned births in alongside midwifery units, free standing midwifery units, and at home, respectively (P<0.001) (see appendix 3 on bmj.com). This model also showed that being multiparous or married was associated with reduced costs, while birth after 40 weeks' gestation, being overweight or obese, and maternal age of 30 or more were each associated with increased costs.

Table 3⇓ presents incremental cost effectiveness ratios and net benefit statistics for the primary clinical outcome—namely, adverse perinatal outcome avoided for low risk women. For all low risk women, bootstrapped estimates showed that planned birth in settings other than an obstetric unit was associated with cost savings and considerable stochastic uncertainty surrounding adverse perinatal outcomes. Consequently, for all shifts to settings other than an obstetric unit from planned birth in obstetric units, the bootstrapped incremental cost effectiveness ratios fell across both the south east (representing reduced costs and improved outcomes) and south west (representing reduced costs and worse outcomes) quadrants of the cost effectiveness plane.[26] Switching from planned birth in an obstetric unit to home birth was on average cost saving, while the average increase in adverse perinatal outcomes was not significant. Switching from planned birth in an obstetric unit to midwifery units was on average cost saving and associated with a non-significant decrease in adverse perinatal outcomes. Differences in perinatal effects were small; however these are magnified in the incremental cost effectiveness ratio calculations, as the mean differences in effects are used as the denominators of the incremental cost effectiveness ratios. Thus, the mean incremental cost effectiveness ratios ranged from −£296 400 to £7 950 356, reflecting sizable reductions in cost and small changes in perinatal outcome when assessing shifts from planned birth in obstetric unit to settings other than an obstetric unit. When the cost effectiveness outcomes were analysed by parity, planned birth at home in nulliparous low risk women was associated with significant cost savings and a significant increase in adverse perinatal outcomes; bootstrapped incremental cost effectiveness ratios largely fell in the south west quadrant of the cost effectiveness plane (representing, on average, reduced costs and worse outcomes).[26] There was a 0.63 probability of home birth being the most cost effective option and a 0.35 probability of free standing midwifery units being the most cost effective option at a £20 000 cost effectiveness threshold for avoiding an adverse perinatal outcome (fig 1⇓). This decision uncertainty surrounding the most cost effective option was not found for place of birth in multiparous low risk women, on whom planned home birth had a 100% probability of being the most cost effective option across all cost effectiveness thresholds between £0 and £100 000 (table 3).⇓

For low risk women without complicating conditions at the start of care in labour, the mean incremental cost effectiveness ratios associated with switches from planned birth in obstetric unit to non-obstetric unit settings fell in the south west quadrant of the cost effectiveness plane (representing, on average, reduced costs and worse outcomes).[26] The mean incremental cost effectiveness ratios ranged from £143 382 (alongside midwifery units) to £497 595 (home) (table 4⇓). Planned birth at home in low risk women without complicating conditions at the start of care in labour was associated with significant cost savings and a significant decrease in adverse perinatal outcomes avoided. Differences in adverse perinatal outcome were not significant for planned births in midwifery units. When we analysed the cost effectiveness outcomes by parity, all bootstrapped incremental cost effectiveness ratios for planned birth at home in nulliparous low risk women without complicating conditions fell in the south west quadrant of the cost effectiveness plane (less costly, less effective) (fig 2⇓). At a £20 000 cost effectiveness threshold for avoiding an adverse perinatal outcome, there was a 0.80 probability of home birth being the most cost effective option and a 0.16 probability of free standing midwifery units being the most cost effective option (fig 3⇓). This decision uncertainty surrounding the most cost effective option was not found for place of birth in multiparous low risk women without complicating conditions, in whom planned home birth had a 100% probability of being the most cost effective option across all thresholds of cost effectiveness (table 4).⇓

When we analysed the effects of planned place of birth on maternal outcomes, all shifts to non-obstetric unit settings were associated with significant cost savings and significant improvements in terms of maternal morbidity avoided (table 5⇓) or additional normal birth (table 6⇓). This was replicated for women without complicating conditions at the start of care in labour. The mean net monetary benefit associated with shifts to non-obstetric unit settings varied from £2486 (£2259 to £2692) (alongside midwifery units) to £4498 (£4306 to £4669) (home) at a £20 000 cost effectiveness threshold for avoiding a maternal morbidity (table 5⇓), and from £3828 (£3600 to £4052) (alongside midwifery units) to £6609 (£6411 to £6810) (home) at a £20 000 cost effectiveness threshold for achieving an additional normal birth (table 6⇓). Birth at home generated the greatest mean net monetary benefit with a 100% probability of being the optimal setting across all thresholds of cost effectiveness (varied between £0 and £100 000 for the maternal outcomes of interest).

Finally, sensitivity analyses showed that the mean incremental cost effectiveness ratios remained relatively robust to variations in overheads and staffing costs attributed to labour care but were sensitive to unit occupancy rates.[25]

Discussion

Summary of main findings

In this study of the cost effectiveness of alternative planned places of birth in England in women at low risk of complications

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before the onset of labour, we found that the cost of intrapartum and after birth care, and associated related complications, was less for births planned at home, in a free standing midwifery unit, or in an alongside midwifery unit compared with planned births in an obstetric unit. The total mean unadjusted costs per low risk woman before the onset of labour varied between £1066 for births planned at home and £1631 for births planned in obstetric units. Cost differences between alternative planned places of birth narrowed when we restricted the study population to women without complicating conditions at the start of care in labour or to nulliparous women. Overall, and for multiparous women, planned birth at home generated the greatest mean net benefit with a 100% probability of being the optimal setting across all thresholds of cost effectiveness when perinatal outcomes were considered. There was, however, an increased incidence of adverse perinatal outcomes associated with planned birth at home in nulliparous low risk women, resulting in the probability of it being the most cost effective option at a threshold of £20 000 declining to 0.63. With regards to maternal outcomes, planned birth at home generated the greatest mean net benefit with a 100% probability of being the optimal setting across all cost effectiveness thresholds.

Strengths and weaknesses

This economic evaluation was based on a rigorously conducted cohort study of sufficient size to detect clinically important differences in adverse perinatal outcomes. Other strengths of the underpinning cohort study include high participation by midwifery units and trusts in England; the minimisation of selection bias through achievement of a high response rate and absence of self selection bias because of non-consent; and the ability to compare groups that were similar in terms of identified clinical risk.[12] The economic evaluation was conducted according to nationally agreed design and reporting guidelines.[15 26] Collection of primary unit cost data was thorough and accounted for regional differences in care patterns. We had a comprehensive strategy for handling uncertainty surrounding individual parameters and the value of the cost effectiveness threshold.

The study does have limitations. Firstly, some components of the available resources. Fourthly, and related, an attempt to the unit cost data collection were based on limited returns from finance departments and had to be modelled with data from secondary sources.[25] Nevertheless, with the exception of variations in unit occupancy rates, sensitivity analyses that varied the values of key cost drivers had little effect on the results. Secondly, the limited time horizon of the study meant that the follow-up of outcomes for both mother and baby did not extend beyond the time period of labour and care immediately after birth, or higher level postnatal or neonatal care when this was received. Perinatal events can result in associated longer term health and broader societal costs, as shown by the size of damages paid in obstetric litigation cases, which represent a substantial cost to the NHS.[27] Follow-up over weeks or longer to monitor recovery, or a future assessment of the outcomes for mothers and babies at a later date, would act as a vehicle for estimating costs and consequences beyond the perinatal period and shed more light on long term cost effectiveness. Thirdly, this study used only clinically defined outcomes to determine the cost effectiveness of planned place of birth. A broader economic approach to the measurement of outcomes, such as stated preference discrete choice modelling, might have captured women's preferences for alternative attributes of planned place of birth and might have been more informative to decision makers,[28] but this was not practically possible given the anonymity involved in the study design and value outcomes in terms of quality adjusted life years (QALYs) in preference to clinical endpoints should make the findings of this cost effectiveness research more relevant to decision makers for obstetric care in the NHS. The paucity of evidence for the longer term consequences of adverse events and other health outcomes after birth for both mother and baby remains and further research to generate combined QALY estimates for the linked mother-baby dyad should be a priority for research in this specialty. Finally, the remit of our research covered only intrapartum and immediate after birth care. Midwifery units also provide important aspects of antenatal care and postnatal care in the community, the cost effectiveness of which was not examined in our study.

Interpretation

Our economic evaluation broadly supports a policy of choice of planned place of birth for low risk women. This cost effectiveness information, however, should be considered in the light of an increased risk of adverse perinatal outcome associated with planned home birth in low risk nulliparous women. Our cost calculations are likely to be susceptible to changes in unit occupancy rates and relative cost effectiveness might alter accordingly. Moreover, the analysis presented here reflects cost effectiveness at the time of the Birthplace national prospective cohort study and the context of the NHS during that period. Should changes to the configuration of maternity services be planned to optimise cost effectiveness, then commissioners would have to consider the resource and related cost implications for the maternity services as a whole. This would require comprehensive economic assessments of the opportunity costs (that is, foregone benefits) associated with investments and disinvestments in alternative forms of provision of maternity services; this in turn will probably require economic modelling and forecasting of occupancy rates, overheads, patients' safety, and transfer in view of fixed and variable costs.

The Birthplace in England Collaborative Group includes the wider group of coinvestigators, researchers, project staff, and coordinating midwives who contributed to the research programme. Members are listed in the cohort paper.[12]

Contributors: LS undertook all the economic analyses and contributed to the writing of the paper. SP led the study design and writing of the paper. NP collected the bulk of the unit cost data. JH was the Birthplace lead researcher who led the cohort study team and contributed to the study design, analyses, writing, and revisions of the paper. DP, PB, and MR contributed to the study design and the writing of the paper. PB was the chief investigator for Birthplace in England and had overall responsibility for the research programme. All members of the Birthplace in England Co-investigators Group contributed at various stages to the design and conduct of the economic evaluation and drafts of the paper. SP is guarantor.

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What is already known on this topic

Robust evidence on the cost effectiveness of planned birth in alternative settings is lacking

What this study adds

Planned birth at home, in a free standing midwifery unit, or in an alongside midwifery unit generates incremental cost savings compared with planned birth in an obstetric unit

For nulliparous low risk women, planned birth at home generates incremental cost savings but increases adverse perinatal outcomes

For multiparous low risk women, planned birth at home generates incremental cost savings with no significant effect on adverse perinatal outcomes

For maternal outcomes, planned birth at home was the most cost effective option

the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

Ethical approval: Not required.

Data sharing: No additional data available.

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Tables

Table 1| Mean cost (£) per woman according to planned place of birth for all women at low risk of complications (2009-10 prices)

	Mean (SE) cost (£)					Bootstrap mean difference (95% CI)		
Cost category	Obstetric unit (OU)	Home	Free standing midwifery unit (FMU)	Alongside midwifery unit (AMU)	P value*	OU−home	OU−FMU	OU−AMU
Overheads	569 (2.9)	93 (1.9)	426 (3.1)	451 (2.8)	<0.001	−475.6 (−482.0 to −468.8)	−143.3 (−152.2 to −134.9)	−118.7 (−126.9 to −110.6)
Midwifery staffing	472 (2.4)	581 (2.8)	578 (3.8)	611 (3.4)	<0.001	108.1 (100.2 to 116.4)	105.2 (95.9 to 114.4)	138.7 (130.4 to 147.2)
Homebirth resources	0 (0)	112 (0.2)	0	0	<0.001	111.7 (111.2 to 112.1)	0	0
Transfers	0 (0)	34 (0.7)	49 (1.0)	<0.01 (0.0)	<0.001	33.7 (32.4 to 35.1)	49.1 (46.9 to 51.2)	0.0036 (0.0034 to 0.0037)
Procedures after transfer	0 (0)	53 (0.9)	36 (0.7)	43 (0.6)	<0.001	53.0 (51.2 to 54.8)	36.4 (34.9 to 37.8)	42.9 (41.8 to 44.2)
Birth	207 (2.5)	77 (1.5)	94 (2.1)	114 (1.9)	<0.001	−130.1 (−135.8 to −124.7)	−113.4 (−119.9 to −107.2)	−92.9 (−99.2 to −86.6)
Procedures during labour care	174 (1.9)	50 (1.3)	65 (1.7)	84 (1.5)	<0.001	−122.8 (−127.1 to −118.2)	−109.3 (−114.2 to −104.4)	−89.9 (−94.9 to −85.1)
Postnatal care	122 (0.6)	18 (0.4)	127 (0.9)	102 (0.6)	<0.001	104.3(−105.9 to −102.5)	5.1 (2.7 to 7.6)	−20.1 (−22.1 to −18.3)
Higher care-mother	22 (0.9)	8 (0.8)	9 (0.9)	11.8 (0.6)	<0.001	−13.2 (−15.5 to −10.8)	−11.9 (−14.3 to −9.8)	−9.6 (−11.8 to −7.6)
Admission to higher care-baby	64 (5.2)	42 (4.3)	50 (7.5)	45 (6.2)	0.037	−21.9 (−36.6 to −9.4)	−15.0 (−32.8to −3.7)	−19.6 (−35.6 to −1.9)
Total cost	1631 (10.1)	1067 (8.9)	1435 (13.5)	1461 (11.1)	<0.001	−564.6 (−591.7 to −533.9)	−195.4 (129.1 to −157.4)	−169.5 (−199.7 to −137.4)

*Estimated though analysis of variance.

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Table 2| Mean cost (£) per woman according to planned place of birth for women at low risk and without complicating conditions at start of care in labour (2009-10 prices)

	Mean (SE) cost (£)					Bootstrap mean difference (95% CI)		
Cost category	Obstetric unit (OU)	Home	Free standing midwifery unit (FMU)	Alongside midwifery unit (AMU)	P value*	OU−home	OU−FMU	OU−AMU
Overheads	545 (3.1)	81 (1.8)	420 (3.2)	442 (2.8)	<0.001	−463.2 (−473.6 to −453.8)	−125.2 (−138.8 to −111.5)	−103.2 (−115.7 to −90.2)
Midwifery staffing	452 (2.6)	574 (2.9)	573 (3.9)	603 (3.5)	<0.001	121.9.0 (109.8 to 133.3)	−120.9 (107.7 to 137.6)	151.1 (136.9 to 165.2)
Homebirth resources	0 (0)	112 (0.2)	0 (0)	0 (0)	<0.001	111.7 (111.2 to 112.1)	0.0 (0.0 to 0.0)	0.0 (0.0 to 0.0)
Transfers	0 (0)	32 (0.7)	46 (1.0)	<0.01 (0.0)	<0.001	31.6 (29.1 to 33.8)	46.2 (42.2 to 49.2)	0.0036 (0.0034 to 0.0037)
Procedures after transfer	0 (0)	49 (0.9)	34 (0.7)	40 (0.6)	<0.001	49.4 (47.6 to 51.2)	33.9 (32.5 to 35.4)	40.2 (38.9 to 41.5)
Birth	175 (2.5)	71 (1.5)	89 (2.1)	108 (1.9)	<0.001	−104.4 (−113.3 to −95.8)	−86.2 (−95.9 to −76.2)	−67.4 (−76.1 to −56.1)
Procedures during labour care	152 (2.0)	46 (1.2)	62 (1.7)	80 (1.5)	<0.001	−105.3 (−112.7 to −96.1)	−90.1 (−98.2 to −82.4)	−71.8 (−78.9 to −63.3)
Postnatal care	114 (0.7)	16 (0.4)	126 (0.9)	100 (0.6)	<0.001	−98.8 (−101.3 to −96.1)	11.5 (7.63 to 14.9)	−14.23 (−17.7 to −11.7)
Admission to higher care-mother	19 (0.9)	7 (0.8)	9 (0.9)	11 (0.6)	<0.001	−11.3 (−15.3 to −7.6)	−9.6 (−15.4 to −5.1)	−7.6 (−10.8 to −4.5)
Admission to higher care-baby	54 (5.8)	38 (4.3)	47 (7.8)	43 (6.4)	0.037	−16.9 (−39.5 to 5.5)	−7.02 (−38.9 to −35.1)	−11.7 (−27.1 to 20.3)
Total cost	152 (10.1)	1027 (8.8)	1405 (13.7)	1426 (11.3)	<0.001	−483.8 (−537.5 to −435.6)	−105.1 (−165.4 to −45.6)	−84.0 (−114.4 to −55.2)

*Estimated though analysis of variance.

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Table 3| Incremental cost effectiveness ratios and net benefit statistics for primary outcome (adverse perinatal outcome avoided) for all women at low risk of complications according to planned place of birth: home, freestanding midwifery unit (FMU), or alongside midwifery unit (AMU) with obstetric unit (OU) as reference

	Home	FMU	AMU
All low risk women			
Cost difference (95% CI)	−565 (−591 to −538)	−196 (−229 to −163)	−170 (−199 to −141)
Difference in adverse perinatal outcome* avoided (95% CI)	−0.00007 (−0.0014 to 0.0013)	0.0004 (−0.0010 to 0.0019)	0.0005 (−0.0007 to 0.0019)
Mean ICER†	7 950 356	−431 873	−296 400
Quadrant on cost effectiveness plane	South west	South east	South east
Mean net benefit (95% CI)‡	592 (547 to 639)	263 (211 to 315)	167 (111 to 224)
Mean net benefit (95% CI)§	593 (535 to 654)	270 (205 to 334)	174 (99 to 244)
Nulliparous low risk women			
Cost difference (95% CI)	−281 (−343 to −217)	−163 (−217 to −108)	−92 (−142 to −33)
Difference in adverse perinatal outcome* avoided (95% CI)	−0.004 (−0.008 to −0.00001)	0.0008 (−0.002 to 0.003)	0.0005 (−0.003 to 0.003)
Mean ICER†	69761	−98136	−47995
Quadrant on cost effectiveness plane	South west	South east	South east
Mean net benefit (95% CI)‡	204 (77 to 319)	179 (98 to 259)	103 (9 to 189)
Mean net benefit (95% CI)§	165 (−2 to 321)	188 (87 to 289)	110 (−10 to 217)
Multiparous low risk women			
Cost difference (95% CI)	−362 (−390 to −335)	−173 (−208 to −139)	−151 (−184 to −117)
Difference in adverse perinatal outcome* avoided (95% CI)	0.001 (−0.0004 to 0.0025)	0.0005 (−0.0015 to 0.0024)	0.0007 (−0.001 to 0.003)
Mean ICER†	−323 037	−128 134	−119 618
Quadrant on cost effectiveness plane	South east	South east	South east
Mean net benefit (95% CI)‡	382 (336 to 427)	182 (120 to 244)	165 (115 to 222)
Mean net benefit (95% CI)§	391 (335 to 451)	186 (107 to 267)	172 (108 to 244)

*Composite of perinatal mortality and specified neonatal morbidities: stillbirth after start of care in labour, early neonatal death, neonatal encephalopathy, meconium aspiration syndrome, brachial plexus injury, fractured humerus, or fractured clavicle.
†95% CI not provided because bootstrapped replicates of incremental cost effectiveness ratios fell across more than one quadrant of cost effectiveness plane.
‡Estimated at £20 000 cost effectiveness threshold.
§Estimated at £30 000 cost effectiveness threshold.

Table 4| Incremental cost effectiveness ratios and net benefit statistics for primary outcome (adverse perinatal outcome avoided) in women without complications at start of care in labour according to planned place of birth: home, freestanding midwifery unit (FMU), or alongside midwifery unit (AMU) with obstetric unit (OU) as reference

	Home	FMU	AMU
All low risk women without complicating conditions			
Cost difference (95% CI)	−484 (−511 to −456)	−105 (−139 to −71)	−84 (−115 to −53)
Difference in adverse perinatal outcome* avoided (95% CI)	−0.0009 (−0.0023 to −0.0003)	−0.0003 (−0.0017 to 0.0011)	−0.0005 (−0.0019 to 0.0007)
Mean ICER†	497 595	313 886	143 382
Quadrant on cost effectiveness plane	South west	South west	South west
Mean net benefit (95% CI)‡	483 (434 to 534)	143 (92 to 193)	58 (5 to 114)
Mean net benefit (95% CI)§	473 (410 to 536)	140 (74 to 200)	53 (−13 to 121)
Nulliparous low risk women without complicating conditions			
Cost difference (95% CI)	−222 (−281 to −157)	−598 (−117 to −3)	−8 (−61 to 48)
Difference in adverse perinatal outcome* avoided (95% CI)	−0.006 (−0.011 to −0.002)	−0.001 (−0.004 to 0.0012)	−0.00099 (−0.0041 to 0.0013)
Mean ICER	39 178 (16 734 to 103 511)	30 169†	1631†
Quadrant on cost effectiveness plane	South west	South west	South west
Mean net benefit (95% CI)‡	98 (−35 to 210)	35 (−34 to 127)	−13 (−99 to 64)
Mean net benefit (95% CI)§	38 (−142 to 180)	23 (−85 to 135)	−22 (−138 to 73)
Multiparous low risk women without complicating conditions			
Cost difference (95% CI)	−311 (−340 to −285)	−124 (−158 to −88)	−98 (−64 to −132)
Difference in adverse perinatal outcome* avoided (95% CI)	0.0005 (−0.0008 to 0.0019)	0.0003 (−0.0015 to −0.0020)	−0.00009 (−0.00196 to 0.00162)
Mean ICER†	−315420	−92180	47222
Quadrant on cost effectiveness plane	South east	South east	South west
Mean net benefit (95% CI)‡	321 (271 to 367)	128 (71 to 183)	98 (41 to 151)
Mean net benefit (95% CI)§	327 (262 to 384)	132 (59 to 200)	97 (24 to 165)

*Composite of perinatal mortality and specified neonatal morbidities: stillbirth after start of care in labour, early neonatal death, neonatal encephalopathy, meconium aspiration syndrome, brachial plexus injury, fractured humerus, or fractured clavicle.

†95% CI not provided because bootstrapped replicates of incremental cost effectiveness ratios fell across more than one quadrant of cost effectiveness plane.

‡Estimated at £20 000 cost effectiveness threshold.

§Estimated at £30 000 cost effectiveness threshold.

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Table 5| Incremental cost effectiveness ratios and net benefit statistics for maternal morbidity avoided in women at low risk of complications according to planned place of birth: home, freestanding midwifery unit (FMU), or alongside midwifery unit (AMU) with obstetric unit (OU) as reference

	Home	FMU	AMU
All low risk women			
Cost difference (95% CI)	−590 (−618 to −563)	−247 (−280 to −211)	−154 (−190 to −118)
Difference in maternal morbidity* avoided (95% CI)	0.195 (0.187 to 0.204)	0.172 (0.168 to 0.182)	0.116 (0.106 to 0.126)
Mean ICER (95% CI)	−3024 (−3138 to −2912)	−1442 (−1600 to −1284)	−1322 (−1572 to −1049)
Quadrant on cost effectiveness plane	South east	South east	South east
Mean net benefit (95% CI)†	4498 (4306 to 4669)	3683 (3451 to 3904)	2486 (2259 to 2692)
Mean net benefit (95% CI)‡	6451 (6175 to 6705)	5403 (5068 to 5716)	3651 (3322 to 3950)
Low risk women without complicating conditions			
Cost difference (95% CI)	−504 (−535 to −474)	−150 (−186 to −115)	−69 (−105 to −36)
Difference in maternal morbidity* avoided (95% CI)	0.165 (0.156 to 0.174)	0.139 (0.131 to 0.149)	0.088 (0.078 to 0.098)
Mean ICER (95% CI)	−3052 (−3215 to −2902)	−1075 (−1285 to −843)	−782 (−1130 to −431)
Quadrant on cost effectiveness plane	South east	South east	South east
Mean net benefit (95% CI)†	3808 (3620 to 4012)	2942 (2743 to 3166)	1828 (1605 to 2059)
Mean net benefit (95% CI)‡	5459 (5181 to 5754)	4340 (4051 to 4658)	2706 (2382 to 3040)

*Defined as at least one of: general anaesthetic; instrumental birth; caesarean section; third or fourth degree perineal trauma; blood transfusion; admission to intensive treatment unit, high dependency unit, or specialist unit; and maternal death (within 42 days of giving birth). This is composite measure and was also secondary outcome of interest in cohort study.
†Estimated at £20 000 cost effectiveness threshold.
‡Estimated at £30 000 cost effectiveness threshold.

Table 6| Incremental cost effectiveness ratios and net benefit statistics for normal birth outcome in women at low risk of complications according to planned place of birth: home, freestanding midwifery unit (FMU), or alongside midwifery unit (AMU) with obstetric unit (OU) as reference

	Home	FMU	AMU
All low risk women			
Cost difference (95% CI)	−590 (−618 to −563)	−247 (−280 to −211)	−154 (−190 to −118)
Difference in normal birth* (95%	0.300 (0.290 to 0.310)	0.256 (0.245 to 0.268)	0.184 (0.173 to 0.194)
CI) Mean ICER (95% CI)	−1960 (−2034 to −1890)	−956 (−1076 to −847)	−836 (−1002 to −664)
Quadrant on cost effectiveness plane	South east	South east	South east
Mean net benefit (95% CI)†	6609 (6411 to 6810)	5377 (5133 to 5618)	3828 (3600 to 4052)
Mean net benefit (95% CI)‡	9618 (9334 to 9909)	7941 (7585 to 8298)	5663 (5332 to 5992)
Low risk women without complicating conditions			
Cost difference (95% CI)	−504 (−535 to −474)	−150 (−187 to −116)	−69 (−105 to −36)
Difference in normal birth* (95%	0.266 (0.256 to 0.275)	0.218 (0.207 to 0.229)	0.149 (0.138 to 0.160)
CI) Mean ICER (95% CI)	−1897 (−1985 to −1812)	−689 (−823 to −538)	−464 (−685 to −254)
Quadrant on cost effectiveness plane	South east	South east	South east
Mean net benefit (95% CI)†	5822 (5612 to 6036)	4507 (4285 to 4766)	3042 (2812 to 3307)
Mean net benefit (95% CI)‡	8483 (8178 to 8788)	6688 (6367 to 7057)	4526 (4188 to 4911)

*Normal birth defined by Maternity Care Working Party as birth without any of induction of labour; epidural or spinal analgesia; general anaesthetic; episiotomy; forceps, ventouse, or caesarean section.
†Estimated at £20 000 cost effectiveness threshold.
‡Estimated at £30 000 cost effectiveness threshold.

Figures

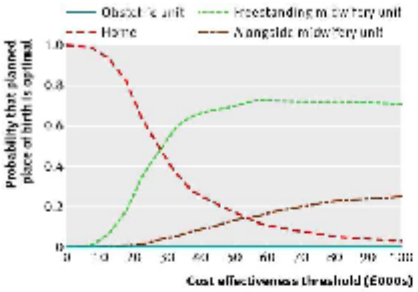


Fig 1 Cost effectiveness acceptability curves for planned place of birth for all low risk nulliparous women for adverse perinatal outcome avoided. At all £10 000 intervals, obstetric units were dominated by other settings and were found to have zero probability of cost effectiveness

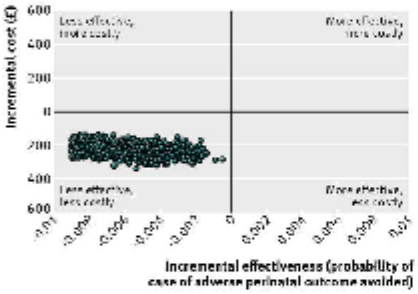


Fig 2 Cost effectiveness plane: planned birth at home compared with planned birth in obstetric units for nulliparous low risk women without complicating conditions at start of care in labour

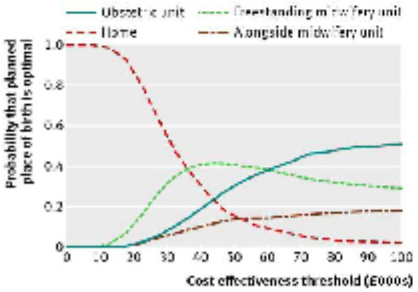


Fig 3 Cost effectiveness acceptability curves for planned place of birth for nulliparous low risk women without complicating conditions at start of care in labour for adverse perinatal outcome avoided

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Appendix 4 Unit cost derivation for DEA

Table 4.1A: Unit costs per resource items (£ sterling, 2007/2008 prices)

Resource Variable	Unit cost	Unit cost range	Explanation	Source of Unit Cost
Midwifery and Allied Health Professional Staffing				
In post midwives (per band) per annum				
midwife band 8cd	52007	50616-75114	band c near pt 43 on spine	AfC NHS pay rates 07
midwife band 8ab	43221	36112-52002	overlap of band 8ab near pt 39 on spine	AfC NHS pay rates 07
midwife band 7	33603	28313-37326		AfC NHS pay rates 07
midwife band 6	28141	23458-31779		AfC NHS pay rates 07
midwife band 5	22797	19683-25424		AfC NHS pay rates 07
Extra staffing midwifery *per band per hour*				
mw - overtime	32.92		for band 5-8, used top band 7 equating to PSSRU hourly rate nurse. £37326 per annum working 37.5 hrs pw ~ £22.7 PSSRU normal charge. Overtime unsociable hours ~time + 30%, Sunday and PH ~time+60%. Average is time + 45% = £32.92 per hour	AfC NHS pay rates 07 PSSRU Unit Costs of Health and Social Care 2007 RCN unsociable hours
mw - agency	32.92		as per O/T, cannot locate Agency rates from any primary source	AfC NHS pay rates 07
mw - bank	13.23		bank is paid at a band less than current rate for normal hours: therefore use overlap band 5 and 6 used spine pt 23 -22328/ 37.5 hrs pw	AfC NHS pay rates 07
In post midwifery support workers *(per band) per annum*				
msw band 4	19038	16853-20261	band 4 spine 24	AfC NHS pay rates 07
msw band 3	16307	14437-17257	band 3 spine 16	AfC NHS pay rates 07
msw band 2	14023	12577-15523	band 2 spine 9	AfC NHS pay rates 07
msw band 1	12922	12182-13253	band 1 spine 3	AfC NHS pay rates 07

In post midwifery support workers *(per band) per hour*				
msw - overtime	15.21		bands 1-4 averaged to top band 2: £14739 per year, works 37.5 hours per week = 9 pounds per hour. This equates to the PSSRU data base 2006/2007 of MSW time per hr normal charge. Unsociable hours are time plus 74% and Sunday PH are time plus 50-88%. This average is time plus 69% = £15.21 per hour	AfC NHS pay rates 07 PSSRU 2007 RCN unsociable hours
msw - agency	15.21		as per O/T, cannot locate Agency rates from any primary source	AfC NHS pay rates 07 PSSRU 2007 RCN unsociable hours
msw - bank	8.4		bank is paid at a band less than current for normal hours: therefore use band 2 used pt 9 - 14189/ 37.5 hrs pw =8.4	AfC NHS pay rates 07
Nurse staffing *(per band per annum or per hour)*				
in post nurses	20225.00	16853-25424	taken from NHS AFC pay rates - nurse band 4 or 5 so near bottom of band 5 here	AfC NHS pay rates 07
nurse - overtime	26.1		bands 5-6 took top band 6: £30247 per yearworks 37.5 hours per week = 18 pounds per hour. This equates to the PSSRU data base 2006/2007 of Nurse time per hr = 20, Unsociable hours are time plus 30% and Sunday PH are time plus 60%. This average is time (18) plus 45%	AfC NHS pay rates 07
nurse - agency	26.1		as per O/T, cannot locate Agency rates from any primary source	AfC NHS pay rates 07 PSSRU 2007 RCN unsociable hours
nurse - bank	9.5		bank is paid at a band less than current for normal hours: therefore use near top band 3 used pt 11 -1600437.5 hrs pw =9.5	AfC NHS pay rates 07
Management, admin and other				

unit mgt inpost	38352	36112-43335	The NHS AFC notes managers (nurse managers and midwife team managers as being on band 7). Confusing as this is unit manager. Top of band 7 point 36 is lower band 8 so using that - equates to midwife consultant level. This would equate to £24 p hr, the PSSRU db has them at £28 p hr or £24 p hr.	AfC NHS pay rates 07
admin staff	16389	14437-17257	ward clarks and admin personnel range from band 2 to band 5. We therefore use near the top of band 3 which is: £16389	AfC NHS pay rates 07
other staff	16389	14437-17257	as per admin, cannot locate these rates from any primary source	AfC NHS pay rates 07
Medical staffing per annum				
Consultant obstetricians	123543	73403-173683	PSSRU costs were 117800 excl training and on-costs and 149 906 including, used a midpoint	NHS Employer Medical and Dental Pay Circulars & adjusted byPSSRU *
Associate Obstetricians	73403		lowest point of consultant range	NHS Employer Medical and Dental Pay Circulars & adjusted byPSSRU *
Specialist Registrar Obstetricians	69946		PSSRU costs for a specialty registrar incl training and on-costs, NHS pay circular approximates 64632	NHS Employer Medical and Dental Pay Circulars & adjusted byPSSRU *
SHO Obstetrician	54774	35000-65000	NHS Employer Medical and Dental Pay Circulars range 35000 and 65000. PSSRU incl training and on-costs 54774	NHS Employer Medical and Dental Pay Circulars & adjusted byPSSRU *
Consultant Obsteric Anaesthetist	123543	73403-173683	PSSRU costs were 117800 excl training and on-costs and 149 906 including, used a midpoint	NHS Employer Medical and Dental Pay Circulars & adjusted byPSSRU *

Obsteric Anaesthetist Registrar	69946		PSSRU costs for a specialty registrar incl training and on-costs, NHS pay circular approximates 64632	NHS Employer Medical and Dental Pay Circulars & adjusted byPSSRU *
Equipment	***ORIGINAL***	***INFLATED****	****(used for this analysis)***	
cardiotocograph	2695.88	4677.35	Original prices from the UKNSS then inflated, Cross checked with current sale prices with finance managers from Birthplace regional sites, the Barkantine researchers and the STOPPIT (NPEU) data collection	Primary costing from various sources
fetal blood gas machines	22633.09	39268.41	Original prices from the UKNSS then inflated, Cross checked with current sale prices with finance managers from Birthplace regional sites, the Barkantine researchers and the STOPPIT (NPEU) data collection	Primary costing from various sources
ultrasound	88417.42	101922.1	Original prices from the UKNSS then inflated, Cross checked with current sale prices with finance managers from Birthplace regional sites, the Barkantine researchers and the STOPPIT (NPEU) data collection	Primary costing from various sources
flexible height cots	344.69	598.04	Original prices from the UKNSS then inflated, Cross checked with current sale prices with finance managers from Birthplace regional sites, the Barkantine researchers and the STOPPIT (NPEU) data collection	Primary costing from various sources
adult resus equipment	13623.46	31408.56	Original prices from the UKNSS then inflated, Cross checked with current sale prices with finance managers from Birthplace regional sites, the Barkantine researchers and the STOPPIT (NPEU) data collection	Primary costing from various sources
resusitaires for babies	7852.44	13623.46	Original prices from the UKNSS then inflated, Cross checked with current sale prices with finance managers from Birthplace regional sites, the Barkantine researchers and the STOPPIT (NPEU) data collection	Primary costing from various sources
phototherapy units	1986.35	3446.31	Original prices from the UKNSS then inflated, Cross checked with current sale prices with finance managers from Birthplace regional sites, the Barkantine researchers and the STOPPIT (NPEU) data collection	Primary costing from various sources

Drugs *(per unit)*				
Pethidine	Pamergan Injection, pethidine hydrochloride 50 mg, promethazine hydrochloride 25 mg/mL. Net price 2-mL amp = £1.44			British National Formulary 2008
Diamorphine	Injection, powder for reconstitution, diamorphine hydrochloride.			British National Formulary 2008
Meptid	Injection, meptazinol 100 mg (as hydrochloride)/mL, net price 1-mL amp = £1.92			British National Formulary 2008
Syntocinon	Injection, oxytocin, net price 5 units/mL, 1-mL amp = 89p; 10 units/mL, 1-mL amp = £1.01			British National Formulary 2008
Propess	Pessaries (within retrieval device), releasing dinoprostone approx. 10 mg over 24 hours; net price 1-pessary pack = £30.00			British National Formulary 2008
Prostin	Intravenous solution, alprostadil 500 micrograms/mL in alcohol. For dilution and use as an infusion. Net price 1-mL amp = £75.19 (hosp. only)			British National Formulary 2008
Hemabate	Injection, carboprost as trometamol salt (tromethamine salt) 250 micrograms/mL, net price 1-mL amp = £18.20 (hosp. only)			British National Formulary 2008
Ergometrine	Injection, ergometrine maleate 500 micrograms/mL. Net price 1-mL amp = 60p			British National Formulary 2008
Syntometrine	Injection, ergometrine maleate 500 micrograms, oxytocin 5 units/mL. Net price 1-mL amp = £1.31			British National Formulary 2008
Transfer *(per mile or per journey)*				
intrapartum and neonatal	10.31 per mile		£257~38 minute journey~£6.7 per minute	PSSRU 2007
	209	167-236	Paramedic Services per journey for Pregnancy / Childbirth / Miscarriage; Gynaecological (rural)	DH Reference Costs
	210	185-239	Paramedic Services per journey for Pregnancy / Childbirth / Miscarriage; Gynaecological (urban)	
Mode of delivery *(per episode)*				
Normal delivery	740	641-878	cost estimate include capital costs but exclude staffing, equipment and medication. Cross-referenced with Birthplace bottom up costing	DH reference costs Birthplace bottom up costing
Delivery with ventouse	755	511-1026	cost estimate include capital costs but exclude staffing, equipment and medication. Cross-referenced with Birthplace bottom up costing	DH reference costs Birthplace bottom up costing
Delivery with forceps	1070	892-1248	Used mid-range costs for reference costs of Assisted Delivery with and without complications	DH reference costs Birthplace bottom up costing
Non-elective caesarean section	1485	899-2504	caesarean section without complications as our cost estimate include capital costs but exclude	DH reference costs Birthplace bottom

			staffing, equipment and medication. Cross-referenced with Birthplace bottom up costing	up costing
Elective caesarean section	1481	1335-1628	Used mid-range costs for reference costs of Caesarean section with and without complications	DH reference costs Birthplace bottom up costing
Postnatal care *(per day)*				
Mother and baby combined	375	248 - 470	Used mid-range costs for reference costs of postnatal care	DH reference costs

Appendix 5 Tables of results for DEA

Table 5.1A Efficiency scores for all units combined

All units		Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Model Inputs and outputs		no med staff no transfer no intrapartum care no meds			.+ no postnatal care		
Model type		Output max	Inpt min CRS	Inpt min VRS	Output max	Inpt min CRS	Inpt min VRS
Efficiency scores (%)	Number of units analysed	156	156	156	175	175	175
100		51	40	51	46	35	46
91-99		14	10	8	18	12	12
81-89		31	23	30	32	24	28
71-79		22	29	31	27	30	36
61-69		17	26	24	20	35	31
51-59		10	11	8	16	14	14
41-49		5	4	3	4	6	6
< 39		7	13	1	11	19	2

Table 5.2A Summary chart of input and output contributions to efficiency for all units combined

Categories	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Model type	Output max	Inpt min CRS	Inpt min VRS	Output max	Inpt min CRS	Inpt min VRS
Inputs						
all midwives	-0.17	-12.25	-10.89	-0.56	-14.6	-15.17
extra midwives	-3.71	-14.27	-13.11	-4.17	-16.53	-17.18
all midwifery support workers	-2.69	-14.38	-12.94	-3.45	-15.87	-16.35
management	-8.08	-17.78	-16.95	-24.02	-22.49	-25.3
equipment	-7.81	-15.67	-15.99	-15.16	-18.29	-20.24
working hours	0.46	-12.28	-0.81	-0.6	-12.22	-0.88
Outputs						.
numbers of babies delivered	26.38	2.53	5.91	52.03	0	4.87
postnatal care	50.71	10.84	23.41			

Table 5.3A: Contribution of each variable to potential efficiency improvement for all units combined

		no med staff no transfer no intrapartum care no meds			CC	.+ no postnatal care		
		Model 1	**Model 2**	**Model 3**		**Model 4**	**Model 5**	**Model 6**
	Number of units analysed	**156**	**156**	**156**		**175**	**175**	**175**
Variables	**Categories (%)**							
all midwives	0 to 10	155	49	59	**0.93**	171	47	56
	11 to 20	1	22	29		2	22	27
	21 to 30		29	32		1	30	36
	31 to 40		27	24			35	33
	41 to 50		11	8			16	14
	51 to 60		4	1			6	4
	61 to 70		6	3			19	3
	71 to 80		3					1
	>80		5					
extra midwives	0 to 10	133	47	56	**0.42**	162	46	58
	11 to 20	5	19	24		1	19	21
	21 to 30	5	23	27		0	26	32
	31 to 40	1	28	26		2	33	30
	41 to 50	5	11	8		2	14	15
	51 to 60	3	5	6		2	7	8
	61 to 70	1	7	5		3	6	4
	71 to 80	2	7	3		1	11	3
	>80	1	9	1		1	13	3
all midwifery support workers	0 to 10	131	45	55	**0.84**	154	42	54
	11 to 20	9	17	20		9	22	24
	21 to 30	7	24	28		7	27	32
	31 to 40	4	25	29		2	37	38
	41 to 50	5	15	11		1	15	14
	51 to 60		13	12		0	12	9
	61 to 70		5	1		1	18	2
	71 to 80		5					
	>80		7					

management	0 to 10	108	46	56	**0.58**	101	40	52
	11 to 20	6	12	16		8	10	16
	21 to 30	7	16	23		5	18	20
	31 to 40	11	17	11		13	20	15
	41 to 50	8	12	14		6	10	10
	51 to 60	7	7	9		12	10	16
	61 to 70	5	19	16		14	24	13
	71 to 80	3	10	7		13	15	20
	>80	1	15	4		2	28	12
equipment	0 to 10	96	47	57	**0.52**	104	41	52
	11 to 20	17	13	14		21	13	15
	21 to 30	12	19	20		16	22	26
	31 to 40	16	21	19		11	30	28
	41 to 50	5	21	24		9	26	28
	51 to 60	4	13	7		7	12	8
	61 to 70	5	6	6		3	5	7
	71 to 80	0	6	5		2	10	7
	>80	1	10	4		1	16	3
working hours	0 to 10	154	82	149	**0.2**	173	98	167
	11 to 20	2	7	6		1	9	5
	21 to 30		13	1			9	2
	31 to 40		15				13	
	41 to 50		9				12	
	51 to 60		5				4	
	61 to 70		6				9	
	71 to 80		1				1	
	>80		18				20	
numbers of babies delivered	0 to 10	67	142	142		64	175	164
	11 to 20	20	5	2		26		2
	21 to 30	14	2	2		19		2
	31 to 40	14	2	3		14		1
	41 to 50	9	1	1		11		2
	51 to 60	7	0	2		8		1
	61 to 70	5	1	1		5		1
	71 to 80	5	0	1		5		0
	>80	0	1					1

postnatal care	0 to 10	54	117	123		.	.	.
	11 to 20	15	14	9		.	.	.
	21 to 30	15	8	10		.	.	.
	31 to 40	14	7	5		.	.	.
	41 to 50	14	2	2		.	.	.
	51 to 60	10	2	1		.	.	.
	61 to 70	6	1	1		.	.	.
	71 to 80	2	1	1		.	.	.
	>80	26	4	4		.	.	.

All units at a scale of <2499 women delivered per year, staffing contributions to 'numbers of babies delivered'

Table 5.4A Efficiency scores for all units at a scale of <2499 women delivered per year

		All units, with obstetric units at a corresponding scale					
Model Inputs and outputs		**.Scale efficiency** **OU: <2499 numbers of women delivered** **no extra mw staff** **no mgt staff** **no med staff** **no transfer** **no intrapartum care** **no equipment** **no meds**			**.Scale efficiency** **OU: <2499 numbers of women delivered** **no extra mw staff** **no mgt staff** **no med staff** **no transfer** **no intrapartum care** **no equipment** **no meds** **no pnc**		
All units		**Model 7**	**Model 8**	**Model 9**	**Model 10**	**Model 11**	**Model 12**
Model type		**Output max**	**Inpt min CRS**	**Inpt min VRS**	**Output max**	**Inpt min CRS**	**Inpt min VRS**
	Number of units analysed	**87**	**87**	**87**	**101**	**101**	**101**
Efficiency scores (%)							
100		25	11	25	25	7	25
91-99		4	6	4	4	6	6
81-89		8	5	2	10	8	7
71-79		7	10	15	6	9	12
61-69		14	16	20	16	17	21
51-59		4	8	12	5	12	18
41-49		7	7	7	8	5	7
< 39		18	24	2	27	37	5

Table 5.5A: Summary chart of input and output contributions to efficiency for all units restricted to <2499 numbers of women delivered

Categories	Model 7	Model 8	Model 9	Model 10	Model 11	Model 12
	.Scale efficiency OU: <2499 numbers of women delivered no extra mw staff no mgt staff no med staff no transfer no intrapartum care no equipment no meds			.Scale efficiency OU: <2499 numbers of women delivered no extra mw staff no mgt staff no med staff no transfer no intrapartum care no equipment no meds no pnc		
Inputs						
all midwives	-0.09	-16.9	-11.7	-0.15	-20.83	-25.26
extra midwives	-4.92	-26.7	-15.7	-7.23	-32.92	-32.67
all midwifery support workers	-0.93	-19.5	-11.6	-3.31	-24.49	-25.78
working hours	-0.77	-16.6	-1.87	-1.46	-21.76	-7.27
Outputs						
numbers of babies delivered	34.32	0.9	16.58	87.87	0	9.02
postnatal care	58.97	19.32	42.43			

Table 5.6A Contribution of each variable to potential efficiency improvement for all units at a scale of <2499 women delivered per year

		.Scale efficiency OU: <2499 numbers of women delivered no extra mw staff no mgt staff no med staff no transfer no intrapartum care no equipment no meds				.Scale efficiency OU: <2499 numbers of women delivered no extra mw staff no mgt staff no med staff no transfer no intrapartum care no equipment no meds no pnc			
Variables			**Model 7**	**Model 8**	**Model 9**			**Model 10**	**Model 11**	**Model 12**
all midwives	0 to 10	**0.95**	86	17	28		**0.95**	100	13	30
	11 to 20		0	5	2			1	8	7
	21 to		1	10	16				9	12

	30									
	31 to 40			16	19				17	20
	41 to 50			8	11				12	19
	51 to 60			7	7				5	7
	61 to 70			8	2				8	5
	71 to 80			16	2				16	1
	>80								13	
extra midwives	0 to 10	**0.54**	62	15	29		**0.54**	82	11	30
	11 to 20		0	3	1			0	4	6
	21 to 30		2	5	10			5	5	8
	31 to 40		4	5	14			4	5	15
	41 to 50		5	2	8			1	2	12
	51 to 60		2	5	8			2	5	7
	61 to 70		4	5	4			2	1	4
	71 to 80		1	5	2			3	6	10
	>80		7	42	11			2	63	9
all midwifery support workers	0 to 10	**0.9**	77	15	29		**0.89**	79	11	31
	11 to 20		3	3	2			11	4	6
	21 to 30		4	8	13			6	7	10
	31 to 40		2	15	21			4	15	23
	41 to 50		0	7	10			0	10	13
	51 to 60		1	9	10			1	8	12
	61 to 70			6	2				7	5
	71 to 80			9					11	1
	>80			15					28	

working hours	0 to 10	**0.19**	80	36	73		**0.22**	93	33	74
	11 to 20		5	5	8			3	5	8
	21 to 30		0	2	3			4	4	6
	31 to 40		0	5	3			0	5	9
	41 to 50		1	3				1	7	4
	51 to 60		0	1					0	
	61 to 70		1	5					3	
	71 to 80			7					4	
	>80			23					40	
numbers of babies delivered	0 to 10		28	84	73				101	
	11 to 20		8	1	1					
	21 to 30		5	0	2					
	31 to 40		3	0	2					
	41 to 50		7	0	1					
	51 to 60		6	0	2					
	61 to 70		3	0	1					
	71 to 80		2	0	1					
	>80		1	0	0					
			24	2	4					
postnatal care	0 to 10	**0.95**	28	28	55					
	11 to 20		3	3	11					
	21 to 30		4	4	2					
	31 to 40		3	3	5					
	41 to 50		7	7	3					
	51 to		3	3	3					

	60									
	61 to 70		1	1	1					
	71 to 80		5	5	1					
	>80		47	47	20					

All obstetric units

Table 5.7A Efficiency scores for all obstetric units

		Model 13	Model 14	Model 15	Model 16
		no extra msw no transfer no intrapartum care	**.+ no working hours**	**.+ no meds (low cost)**	**.+ no postnatal care**
Efficiency scores	**Number of units analysed**	**134**	**134**	**139**	**159**
100		69	62	57	54
91-99		19	20	22	26
81-89		25	26	26	23
71-79		11	15	21	36
61-69		6	7	8	14
51-59		4	4	5	6
41-49					
31-39					

Table 5.8A Summary chart of input and output contributions to efficiency for all obstetric units

	Categories	Model 13	Model 14	Model 15	Model 16
		no extra msw no transfer no intrapartum care	**.+ no working hours**	**.+ no meds (low cost)**	**.+ no postnatal care**
	all midwives	-1.29	-1.18	-1.04	-1.75
	extra midwives	-8.74	-8.23	-7.53	-7.71
	all midwifery support workers	-5.03	-5.11	-2.01	-3.81
	management	-17.17	-16.21	-19.66	-34.49
	medical staff	-3.2	-3.04	-3.3	-5.49
	equipment	-12.11	-12.27	-13.67	-18.13
	medication	-10.74	-12.14		
	working hours	-0.53			
	numbers of babies delivered	.+16.26	17.01	21.53	28.61
	postnatal care	.+24.93	24.82	31.25	

Table 5.9A Contribution of each variable to potential efficiency improvement for all obstetric units

Variables	Categories (%)	**Model 13**	**Model 14**	**Model 15**	**Model 16**
		no extra msw no transfer no intrapartum care	**.+ no working hours**	**.+ no meds (low cost)**	**.+ no postnatal care**
	Number of units analysed	**134**	**134**	**139**	**159**
all midwives	0 to 10	128	128	133	150
	11 to 20	4	4	6	8
	21 to 30	2	2		1
	31 to 40				
	41 to 50				
	51 to 60				
	61 to 70				
	71 to 80				
	>80				
extra midwives	0 to 10	116	115	120	142
	11 to 20	3	3	2	4
	21 to 30	2	1	4	3
	31 to 40	2	4	6	1
	41 to 50	5	5	2	0
	51 to 60	1	1	1	3
	61 to 70	2	2	1	3
	71 to 80	2	3	2	3
	>80	1		1	
all midwifery support workers	0 to 10	113	111	129	146
	11 to 20	10	11	6	7
	21 to 30	5	6	3	2
	31 to 40	6	5	0	1
	41 to 50		1	1	2
	51 to 60				1
	61 to 70				
	71 to 80				
	>80				
management	0 to 10	98	97	96	93
	11 to 20	4	3	5	4

	21 to 30	6	7	3	5
	31 to 40	8	9	10	11
	41 to 50	5	3	8	12
	51 to 60	5	7	5	9
	61 to 70	6	6	8	13
	71 to 80	1	1	3	10
	>80	1	1	1	2
medical staff	0 to 10	121	121	125	137
	11 to 20	8	7	7	11
	21 to 30	2	3	3	6
	31 to 40	3	3	4	5
	41 to 50				
	51 to 60				
	61 to 70				
	71 to 80				
	>80				
equipment	0 to 10	101	96	94	106
	11 to 20	9	11	14	15
	21 to 30	5	6	10	12
	31 to 40	10	11	9	10
	41 to 50	4	5	7	8
	51 to 60	2	2	1	3
	61 to 70	2	2	3	3
	71 to 80	1	1	0	1
	>80			1	1
medication	0 to 10	113	109		
	11 to 20	2	2		
	21 to 30	2	3		
	31 to 40	5	5		
	41 to 50	5	4		
	51 to 60	1	3		
	61 to 70	4	4		
	71 to 80	1	3		
	>80	1	1		
working hours	0 to 10	134			
	11 to 20				
	21 to 30				
	31 to 40				
	41 to 50				
	51 to 60				
	61 to 70				
	71 to 80				

	>80				
numbers of babies delivered	0 to 10	88	81	77	81
	11 to 20	18	20	17	18
	21 to 30	13	15	19	25
	31 to 40	6	7	13	15
	41 to 50	5	6	7	8
	51 to 60	0	0	0	6
	61 to 70	3	3	2	1
	71 to 80	1	2	1	2
	>80			3	3
postnatal care	0 to 10	78	72	77	
	11 to 20	17	18	17	
	21 to 30	15	17	19	
	31 to 40	4	5	13	
	41 to 50	5	5	7	
	51 to 60	4	4	2	
	61 to 70	6	6	1	
	71 to 80	3	5	3	
	>80	2	2		

All obstetric units shown by scale

Table 5.10A Efficiency scores for all obstetric units shown by scale

		Model 17	Model 18	Model 19	Model 20	Model 21	Model 22
		.Scale efficiency OU >4000 numbers of women delivered Output max model	Input min model	.Scale efficiency OU: 2500-3999 numbers of women delivered Output max model	Input min model	.Scale efficiency OU: <2499 numbers of women delivered Output max model	Input min model
Efficiency scores	**Number of units analysed**	**37**	**37**	**63**	**63**	**41**	**41**
100		26	20	31	22	25	23
91-99		7	9	8	9	7	2
81-89		4	5	15	17	5	8
71-79			2	7	12	2	5

61-69			1	2	2	1	2
51-59					1	1	1
41-49						1	

Table 5.11A Summary chart of input and output contributions to efficiency for all obstetric units shown by scale

Categories	Model 17	Model 18	Model 19	Model 20	Model 21	Model 22
	.Scale efficiency OU >4000 numbers of women delivered Output max model	Input min model	.Scale efficiency OU: 2500-3999 numbers of women delivered Output max model	Input min model	.Scale efficiency OU: <2499 numbers of women delivered Output max model	Input min model
Inputs						
all midwives	-2.69	-8.79	-4.3	-12.4	-3.4	-12.8
extra midwives	-7.43	-11.93	-9.4	-13.9	-16.6	-20.7
all midwifery support workers	-5.48	-17.29	-11.2	-15.5	-4.6	-14.5
management	-19.3	-19.01	-16.2	-22.4	-23.9	-21.3
medical staff	-7.29	-8.72	-3.6	-11.6	-10.5	-13.2
equipment	-19.18	-18.8	-14.1	-19.6	-7.1	-14.4
Outputs						
numbers of babies delivered	8.06	0.83	14.5	0	14.1	0.4
postnatal care	30.56	14.63	26.6	4.73	19.8	2.6

Table 5.12A Contribution of each variable to potential efficiency improvement for all obstetric units shown by scale

Variables	Categories (%)	Model 17	Model 18	Model 19	Model 20	Model 21	Model 22
		.Scale efficiency OU >4000 numbers of women delivered Output max model	Input min model	.Scale efficiency OU: 2500-3999 numbers of women delivered Output max model	Input min model	.Scale efficiency OU: <2499 numbers of women delivered Output max model	Input min model

	Number of units analysed	37	37	63	63	41	41
all midwives	0 to 10	36	29	57	29	37	23
	11 to 20	1	4	3	16	3	6
	21 to 30		2	1	13	1	9
	31 to 40		2	2	1		2
	41 to 50				4		1
extra midwives	0 to 10	35	28	53	29	32	25
	11 to 20	1	4	3	15	0	8
	21 to 30	1	1	2	10	1	0
	31 to 40		2	0	4	5	1
	41 to 50		1	3	2	1	2
	51 to 60		0	0	2	2	0
	61 to 70		1	1	0		1
	71 to 80			1	1		4
	>80						
all midwifery support workers	0 to 10	36	24	48	27	35	
	11 to 20	1	4	1	10	4	
	21 to 30		3	10	12	1	
	31 to 40		1	1	7	1	
	41 to 50		4	3	7		
	51 to 60		0				
	61 to 70		1				
	71 to 80						
	>80						
management	0 to 10	31	24	49	24	30	25
	11 to 20	2	2	3	10	2	4
	21 to 30	1	4	0	11	0	3
	31 to 40	1	1	4	2	2	0
	41 to 50	2	2	1	7	3	2
	51 to 60		3	1	1	2	1
	61 to 70		1	4	1	2	5
	71 to 80			0	3		1
	>80			1	4		
medical staff	0 to 10	33	28	57	29	33	25
	11 to 20	2	5	4	16	2	6

	21 to 30	2	3	1	14	2	5
	31 to 40		1	1	3	3	3
	41 to 50				1	0	1
	51 to 60					1	1
	61 to 70						
	71 to 80						
	>80						
equipment	0 to 10	30	23	43	25	37	25
	11 to 20	2	5	8	5	1	7
	21 to 30	1	3	4	12	1	4
	31 to 40	2	1	5	0	0	3
	41 to 50	0	3	1	10	1	0
	51 to 60	1	0	1	7	1	1
	61 to 70	0	1	0	1		1
	71 to 80	1	1	1	1		
	>80				2		
numbers of babies delivered	0 to 10	33	36	41	63	30	41
	11 to 20	4	1	12		6	
	21 to 30			7		2	
	31 to 40			1		1	
	41 to 50			2		1	
	51 to 60						
	61 to 70						
	71 to 80						
	>80						
postnatal care	0 to 10	28	30	35	54	31	
	11 to 20	4	3	10	5	3	
	21 to 30	2	1	7	1	1	
	31 to 40	1	1	0	1	1	
	41 to 50	1	2	4	0	0	
	51 to 60	1		3	1	5	
	61 to 70			1	1		
	71 to 80			2			
	>80			1			

All free-standing midwifery units

All FMUs

Table 5.13A Efficiency scores for all FMUs

		Model 23	Model 24	Model 25
		output max VRS	input min CRS	input minVRS
Efficiency scores	**Number of units analysed**	**47**	**47**	**47**
100		19	14	19
91-99		5	3	5
81-89		4	4	6
71-79		7	4	6
61-69		2	7	6
51-59		5	2	3
41-49		0	6	1
31-39		1	7	1

Table 5.14A Summary chart of input and output contributions to efficiency for all FMUs

	Categories	Model 1	Model 2	Model 3
inputs				
	all midwives	-9.31	-26.76	-25.24
	equipment	-5.08	-23	-21.76
	in-utero transfers	-1.28	-22.91	-18.9
	working hours per year	-2.37	-20.31	-9.09
	intrapartum care provided prior to labour	.+33.64	.+.39	.+5.52
outputs				
	numbers of babies delivered	.+48.32	.+6.62	.+19.5

Table 5.15A Contribution of each variable to potential efficiency improvement for all FMUs

Variables	Categories (%)	**Model 1**	**Model 2**	**Model 3**
		no med staff no transfer no intrapartum care no meds		
	Number of units analysed			
all midwives	0 to 10	32	16	22
cc=0.61	11 to 20	6	4	4
	21 to 30	2	2	6
	31 to 40	4	6	6
	41 to 50	0	2	4
	51 to 60	0	5	1
	61 to 70	3	3	3
	71 to 80		9	1
	>80			
equipment	0 to 10	43	17	23
cc=0.31	11 to 20	0	3	6
	21 to 30	0	4	6
	31 to 40	0	6	6
	41 to 50	1	2	2
	51 to 60	1	7	1
	61 to 70	1	6	2
	71 to 80	1	2	0
	>80	0		1
in utero transfers	0 to 10	44	17	24
	11 to 20	2	3	6
	21 to 30	0	4	6
	31 to 40	1	7	6
	41 to 50		2	3
	51 to 60		6	1
	61 to 70		6	1
	71 to 80		1	
	>80		1	
working hours per year	0 to 10	43	24	35
	11 to 20	1	3	2
	21 to 30	1	3	5

	31 to 40	2	0	4
	41 to 50		3	1
	51 to 60		4	
	61 to 70		4	
	71 to 80		2	
	>80		4	
intrapartum care provided prior to transfer	0 to 10	24	46	44
	11 to 20	3	0	1
	21 to 30	3	1	1
	31 to 40	1		1
	41 to 50	2		
	51 to 60	6		
	61 to 70	1		
	71 to 80	1		
	>80	6		
numbers of babies delivered	0 to 10	21	40	35
	11 to 20	4	2	4
	21 to 30	4	1	2
	31 to 40	3	1	3
	41 to 50	1	0	0
	51 to 60	2	2	0
	61 to 70	1	0	1
	71 to 80	2	0	1
	>80	9	1	1

Appendix 6 Data collection for a FMU for the Barkantine study

DATA COLLECTION FORM
BARKANTINE BIRTH CENTRE – FREE STANDING MIDWIFERY UNIT
(ALL QUESTIONS)

Date form completed | | | | | | | |

Demographic data

Q1 **Woman's age at delivery: *(years)***

Q2 **Woman's ethnic group: *(as recorded in her maternity notes)***

Q3 **Father's occupation OPCS code**

Q4 **Mother's occupation OPCS code**

Q5 **Woman's understanding of English language - if a problem:**

- Mother tongue ❑
- Good English ❑
- Medium English ❑
- Minimal English ❑
- None ❑

Q6 **Woman's marital / partner status:**

- Husband ❑
- Partner ❑
- Single ❑

Q7 **Woman's BMI at any time in pregnancy *or height/weight***

Q8 **Woman's full postcode:**

Current Pregnancy

Q9 **Expected date of delivery**

Patient history / Previous pregnancy

Q10 **Number of pregnancies of ≥ 24 weeks, prior to this pregnancy:** *If none, write 0*

Admission to BBC for purpose of labour and delivery

Q11 **Patient self-reported reason for arrival at BBC**

Antenatal in labour ❑
Antenatal not in labour ❑

Q12 **Did the patient give birth in the same episode of care?**

No ❑ ***Go to Q13***
Yes ❑ ***Go to Q14 – Q18***

Q13 **If No, please give reason and do not continue with the form**

Delivered already ❑
In labour ❑
Returned home ❑
Other ❑

If other, specify

Q14 **If Yes, date of admission**

Q15 **Time of admission *(using 24 hour clock)***

Q16 **Place admitted to**

Q17 **Date of first cervical assessment if done**

Time *(using 24 hour clock)*

Q18 **Other procedures performed after admission and before 'establishment of labour' (EOL)? (e.g. EOL as marked by moving from a/n assessment to labour ward or receiving 1:1 care)[3]**

Yes ❑
No ❑

If Yes, please report procedures

[3] Guidance: EOL is hereby defined as moving from a/n assessment to labour ward in prepartion for the delivery of the baby - or when a woman begins to receive 1:1 care

Augmentation

Q19 **Was an ARM performed?**

Yes ❑
No ❑

Q20 **Date**

Q21 **Time *(using 24 hour clock)***

Q22 **Was labour augmented in any other way?**

Spontaneous ❑
Induced ❑

Pain relief

Q23 **Water**

Yes ❑
No ❑

Q24 **Massage (by midwife)**

Yes ❑
No ❑

Q25 **Tens machine**

Yes ❑
No ❑

Q26 **Entonox**

Yes ❑
No ❑

Q27 **Opiates**

Yes ❑
No ❑

If Yes, total dose of opiates

Midwifery support

Q28 **Did the woman receive continuous or intermittent midwifery support during established labour?**

Continuous ❑

Intermittent ❑ If intermittent, proportion for midwifery time allocated to the mother during established labour

❑ 0-20%

❑ 21-40%

❑ 41-60%

❑ 61-80%

❑ 81-100%

Q29 **Number of midwives / midwifery support workers in total caring for patient in established labour?**

Midwives		Midwifery support workers	
	1 ❑		1 ❑
	2 ❑		2 ❑
	3 ❑		3 ❑
	4 ❑		4 ❑
	≥ 5 ❑		≥ 5 ❑

Duration of first stage of labour

Q30 **Duration first stage labour (minutes)**

Date, time and duration of second stage of labour- Delivery of the baby

Q31 **Date**

Q32 **Time *(using 24 hour clock)***

Q33 **Mode of delivery**

Ventouse ❑
Forceps ❑
Water birth ❑
SVD ❑
CS ❑

Q34 **Where did the birth take place?**

On the bed ❑
On the mat ❑
On the birth stool ❑
In the pool ❑
Other ❑

Q35 **Birth position**

Sitting supported by pillows ❑
On the side ❑
Standing ❑
Squatting ❑
All fours ❑
Laying down ❑
Laying with legs supported in stirrups ❑

Q36 **Total number of vaginal examinations performed during labour?**

1 ❑
2 ❑
3 ❑
4 ❑
5 ❑
6 ❑
≥7 ❑

Q37 **Number of babies delivered**

1 ❑
2 ❑
3 ❑

Q38 **Type of presentation of the baby**

Vertex ❑
Breech ❑
Oblique ❑
Transfers ❑
Face ❑

Q39 **Duration second stage of labour *(minutes)***

The third stage of labour

Q40 **Was syntometrin/ syntocinon used for the third stage of labour?**

Yes ❑ No ❑
Syntometrin (amples) ❑
Syntocinon (I.U) ❑
If Yes, total dose _____

Q41 **Duration of third stage of labour *(minutes)***

Baby Outcome: Vital statistics

Q42 **Birth outcome**

Live birth ❑
Still birth ❑

Q43 **Sex of baby**

Male ❑
Female ❑

Q44 **Birthweight**

				g

Q45 **Apgar at 5 minutes**

Q46 **Apgar at 10 minutes**

Q47 **Time when this episode of care was completed** [4] *(see footnote)*

	Hours		*Minutes*

Fetal outcome: Breastfeeding

Q48 **Intended feeding**

Breast ❑
Bottle ❑
Mixed feeding ❑

Q49 **Was the baby breastfed for the first feed?**

Yes ❑
No ❑

Q50 **Date of first feed**

Q51 **Time of first feed *(using 24 hour clock)***

Q52 **Type of feeding established**

Breast ❑
Bottle ❑
Mixed feeding ❑

Q53 **Did the mother receive health care support for breastfeeding ?**

Yes ❑ If so by whom
No ❑

Q54 **Did the baby have skin to skin contact at delivery?**

Yes ❑
No ❑

Discharge

Q55 **Date and time of discharge from BBC for mother**

Date:							
Time:		(Using 24 hour clock)					

Q56 **Estimated total length of stay for mother**

Length of stay		*Days*		*Hours*

Q57 **Destination on discharge from RLH**

Usual residence ❑
Other residence ❑
Other ❑

[4] Guidance: the episode of labour care is completed when the woman and baby are discharged from the delivery room or when the midwife begins to complete the post-natal notes, whichever occurs first

Q58 **Date and time of discharge of baby from the BBC**

Date: | | | | | | |

Time: | | (Using 24 hour clock)

Maternal Transfers

Q59. **Date and time of decision to transfer:** :

Q60. **Primary reason for transfer:** *Please write in one code from list*

01 Failure to progress (1st stage)
02 Fetal distress (1st stage)
03 Meconium staining
04 Epidural request
05 Hypertension
06 Malposition
07 Antepartum haemorrhage
08 Failure to progress (2nd stage)
09 Fetal distress (2nd stage)
10 Postpartum haemorrhage
11 Retained placenta
12 Repair of perineal trauma
13 Other maternal indication
Please specify _____
14 Other fetal indication
Please specify _____

Q61. **Date and time of start of transfer:**

Q62. **Mode of transfer:**

Private car Ambulance Wheelchair/Trolley/Bed Walking Other

If Other, please specify _____

Q63. **Full name of unit woman transferred to:** _____

Q64. **Date and time of start of midwifery care in obstetric unit:**

Q65. **Date and time of first clinical assessment by obstetrician:**

Or tick if not assessed by an obstetrician

Q66. **Was labour augmented with syntocinon?** Yes No

Q67. **Did this woman have an epidural or spinal?** Yes No

Q68. **Did this woman have a general anaesthetic?** Yes No

Maternal Outcome: Postpartum Complications In Hospital

Q69 **Did the women have episiotomy?**

Yes ❑
No ❑

Q70 **Was there perineal trauma involving the anal sphincter (3th/ 4th degree tear)**

Yes ❑
No ❑

Q71 **Did the woman receive perineal suturing after delivery?**

No ❑

Yes ❑ If yes,

❑ Suturing episiotomy

❑ Suturing first degree tear

❑ Suturing second degree tear

❑ Suturing third degree tear

❑ Suturing fourth degree tear

Q72 **Maternal complication 1**

Q73 **Maternal complication 2**

Q74 **Maternal complication 3**

Q75 **Maternal complication 4**

Q76 **Other maternal injury**

Q77 **Estimate blood loss (mls)**

Q78 **Did the woman have a blood transfusion?**

No ❑

Yes ❑ If yes, complete medication form

Q79 **Did the woman receive antibiotics after delivery?**

No ❑

Yes ❑ If yes, complete medication form

Q80 **Was a surgical procedure performed as a result of a complication?**

No ❑

Yes ❑ If yes, specify

_____

Q81 **Were diagnostic imaging tests performed as a result of a complication?**

No ❑

Yes ❑ If yes,

Type: _____ Number of examinations: _____

Type: _____ Number of examinations: _____

Q82 **Were additional consultants seen as a result of a complication?**

No ❑

Yes ❑ If yes,

Specify: _____ Number of visits: _____

Specify: _____ Number of visits: _____

Postnatal care - mother in hospital

Q83 **Admission to postnatal care in hospital**

Yes ❑ *If Yes, length of stay* [ ] *Days* [ ] *Hours*

No ❑

Q84 **Admission to ICU**

Yes ❑ *If Yes, length of stay* [ ] *Days* [ ] *Hours*

No ❑

Q85 **Admission to HDU**

Yes ❑ *If Yes, length of stay* ____ *Days* ____ *Hours*

No ❑

Q86 **Admission to Specialist Unit**

Yes ❑ *If Yes, length of stay* ____ *Days* ____ *Hours*

No ❑

Q87 **Did the women stay in any other ward other than those above after labour?**

Yes ❑ *If Yes, length of stay* ____ *Days* ____ *Hours*

No ❑

Infant complications in hospital

Q88 **Resuscitation using bag and mask**

Yes ❑

No ❑

Q89 **Resuscitation using endotrachael tube**

Yes ❑

No ❑

Q90 **Drugs used during resuscitation**

No ❑

Yes ❑ If yes, complete medication form

Q91 **Neonatal complication 1**

Q92 **Neonatal complication 2**

Q93 **Neonatal complication 3**

Q94 **Congenital malformation observed in baby 1**

Yes ❑
No ❑

Q95 **Congenital malformation observed in baby 2**

Yes ❑
No ❑

Q96 **Congenital malformation observed in baby 3**

Yes ❑
No ❑

Q97 **Congenital malformation observed in baby 4**

Yes ❑
No ❑

Postnatal care – baby in hospital

Q98 **Admission to NICU**

Yes ❑ *If Yes, length of stay* _____ *Days* _____ *Hours*

No ❑

Q99 **Admission to SCBU**

Yes ❑ *If Yes, length of stay* _____ *Days* _____ *Hours*

No ❑

Q100 **Date and time of infant death**

Date: | | | | | | | |

Time: | | (Using 24 hour clock)

MEDICATION FORM

Check recipient		Medication used	Route	Dose given	Total number of doses administered
Mother	Baby				

Appendix 7 Data collection for an OU for the Barkantine study

DATA COLLECTION FORM
ROYAL LONDON HOSPITAL – OBSTETRIC UNIT
(ALL QUESTIONS)

Date form completed | | | | | | | |

Demographic data

Q1 **Woman's age at delivery:** ***(years)***

Q2 **Woman's ethnic group:** ***(as recorded in her maternity notes)***

Q3 **Father's occupation OPCS code**

Q4 **Mother's occupation OPCS code**

Q5 **Woman's understanding of English language - if a problem:**

- Mother tongue ❑
- Good English ❑
- Medium English ❑
- Minimal English ❑
- None ❑

Q6 **Woman's marital / partner status:**

- Husband ❑
- Partner ❑
- Single ❑

Q7 **Woman's BMI at any time in pregnancy**

Q8 **Woman's full postcode:**

Q9 **Expected date of delivery**

Patient history / Previous pregnancy

Q10 **Number of pregnancies of ≥ 24 weeks, prior to this pregnancy:** *If none, write 0*

Admission to RLH for purpose of labour and delivery

Q11 **Patient self-reported reason for arrival at RLH**

Antenatal in labour ❑
Antenatal not in labour ❑

Q12 **Did the patient give birth in the same episode of care?**

No ❑ ***Go to Q13***
Yes ❑ ***Go to Q14 – Q21***

Q13 **If No, please give reason and do not continue with the form**

Delivered already ❑
In labour ❑
Returned home ❑
Other ❑

If other, specify

Q14 **If Yes, date of admission**

Q15 **Time of admission *(using 24 hour clock)***

Q16 **Place admitted to *(e.g. triage /antenatal assessment/ delivery ward/birthing room/theatre)***

Q17 **Date of first cervical assessment if done**

Q18 **Time *(using 24 hour clock)***

Q19 **Cardiotocography on admission**

Yes ❑
No ❑

Q20 **Other procedures performed after admission and before 'establishment of labour' (EOL)? (e.g. EOL as marked by moving from a/n assessment to labour ward or receiving 1:1 care)[5]**

Yes ❑
No ❑

If Yes, please report procedures

Q21 **Number of tests**

1 ❑
2 ❑
3 ❑
4 ❑
≥ 5 ❑

[5] Guidance: EOL is hereby defined as moving from a/n assessment to labour ward in prepartion for the delivery of the baby - or when a woman begins to receive 1:1 care

Induction/ Augmentation

Q22 **Was an ARM performed?**

Yes ❑
No ❑

Q23 **Date of establishment of labour**

Q24 **Time *(using 24 hour clock)***

Q25 **Mode of onset of labour**

Spontaneous ❑
Induced ❑

Pain relief

Q26 **Water**

Yes ❑
No ❑

Q27 **Massage (by midwife)**

Yes ❑
No ❑

Q28 **Tens machine**

Yes ❑
No ❑

Q29 **Entonox**

Yes ❑
No ❑

Q30 **Opiates**

Yes ❑
No ❑

If Yes, total dose of opiates

Q31 **Epidural/ Spinal**

Yes ❑
No ❑

Q32 **General Anaesthetic**

Yes ❑

No ❑

Q33 **Other**

Yes ❑
No ❑
If other, specify

Midwifery support

Q34 **Did the woman receive continuous or intermittent midwifery support during established labour?**

Continuous ❑

Intermittent ❑ If intermittent, proportion for midwifery time allocated to the mother during established labour

❑ 0-20%
❑ 21-40%
❑ 41-60%
❑ 61-80%
❑ 81-100%

Q35 **Number of midwives / midwifery support workers in total caring for patient in established labour?**

Midwives		Midwifery support workers	
	1 ❑		1 ❑
	2 ❑		2 ❑
	3 ❑		3 ❑
	4 ❑		4 ❑
	≥ 5 ❑		≥ 5 ❑

Duration of first stage of labour

Q36 **Duration first stage labour (minutes)**

Q37 **Surgical or other medical procedures performed during first stage of labour?**

Yes ❑
No ❑
If yes, specify

Date, time and duration of second stage of labour- Delivery of the baby

Q38 **Date**

Q39 **Time *(using 24 hour clock)***

Q40 **Mode of delivery**

Ventouse ❑
Forceps ❑
Water birth ❑
SVD ❑

CS ❑

Q41 **Where did the birth take place?**

On the bed ❑
On the mat ❑
On the birth stool ❑
In the pool ❑
Other ❑

Q42 **Birth position**

Sitting supported by pillows ❑
On the side ❑
Standing ❑
Squatting ❑
All fours ❑
Laying down ❑
Laying with legs supported in stirrups ❑

Q43 **Total number of vaginal examinations performed during labour?**

1 ❑
2 ❑
3 ❑
4 ❑
5 ❑
6 ❑
≥7 ❑

Q44 **Number of babies delivered**

1 ❑
2 ❑
3 ❑

Q45 **Type of presentation of the baby**

Vertex ❑
Breech ❑
Oblique ❑
Transfers ❑
Face ❑

Q46 **Reason for emergency CS 1**

Q47 **Reason for emergency CS 2**

Q48 **Duration *(hours, minutes)***

The third stage of labour: ROP

Q49 **Date**

Q50 **Time *(using 24 hour clock)***

Q51 **Was syntometrin/ syntocinon used for the third stage of labour?**

Yes ❑ No ❑

Syntometrin (amples) ❑

Syntocinon (I.U) ❑

If Yes, total dose _____

Q52 **Did the woman have a manual removal of the placenta following vaginal delivery?**

No ❑

Yes ❑

Q53 **Duration *(minutes)***

Maternal Outcome: Postpartum Complications

Q54 **Did the women have episiotomy?**

Yes ❑

No ❑

Q55 **Was there perineal trauma involving the anal sphincter (3th/ 4th degree tear)**

Yes ❑

No ❑

Q56 **Did the woman have perineal suturing after delivery?**

No ❑

Yes ❑ If yes,

❑ Suturing episiotomy

❑ Suturing first degree tear

❑ Suturing second degree tear

❑ Suturing third degree tear

❑ Suturing fourth degree tear

Q57 **Maternal complication 1**

Q58 **Maternal complication 2**

Q59 **Maternal complication 3**

Q60 **Maternal complication 4**

Q61 **Other maternal injury**

Q62 **Estimate blood loss (mls)**

Q63 **Did the woman have a blood transfusion?**

No ❑

Yes ❑ If yes, complete medication form

Q64 **Did the woman receive antibiotics after delivery?**

No ❑

Yes ❑ If yes, complete medication form

Q65 **Was a surgical procedure performed as a result of a complication?**

No ❑

Yes ❑ If yes, specify

_____

Q66 **Were diagnostic imaging tests performed as a result of a complication?**

No ❑

Yes ❑ If yes,

Type: _____ Number of examinations: _____

Type: _____ Number of examinations: _____

Q67 **Were additional consultants seen as a result of a complication?**

No ❑

Yes ❑ If yes,

Specify: _____ Number of visits: ___

Specify: _____ Number of visits: ___

Postnatal care- mother

Q68 **Admission to postnatal care**

Yes ❑ *If Yes, length of stay* [ ] *Days* [ ] *Hours*

No ❑

Q69 **Date when postnatal care started**

[ ][ ][ ][ ][ ][ ]

Q70 **Time *(using 24 hour clock)***

[ ]

Q71 **Admission to ICU**

Yes ❑ *If Yes, length of stay* [ ] *Days* [ ] *Hours*

No ❑

Q72 **Admission to HDU**

Yes ❑ *If Yes, length of stay* [ ] *Days* [ ] *Hours*

No ❑

Q73 **Admission to Specialist care**

Yes ❑ *If Yes, length of stay* [ ] *Days* [ ] *Hours*

No ❑

Q74 **Did the women stay in any other ward other than those above after labour?**

Yes ❑ *If Yes, length of stay* [ ] *Days* [ ] *Hours*

No ❑

Maternal discharge

Q75 **Date and time of discharge from hospital**

Date: [ ][ ][ ][ ][ ][ ]

Time: [ ] (Using 24 hour clock)

Q76 **Estimated total length of stay**

Length of stay [ ] *Days* [ ] *Hours*

Q77 **Destination on discharge from RLH**

Usual residence ❑
Other residence ❑
Other ❑

Baby outcome: Vital statistics

Q78 **Birth outcome**

Live birth ❑
Still birth ❑

Q79 **Sex of baby**

Male ❑
Female ❑

Q80 **Birthweight**

				g

Q81 **Apgar at 5 minutes**

Q82 **Apgar at 10 minutes**

Q83 **Resuscitation using bag and mask**

Yes ❑
No ❑

Q84 **Resuscitation using endotrachael tube**

Yes ❑
No ❑

Q85 **Drugs used during resuscitation**

No ❑

Yes ❑ If yes, complete medication form

Q86 **Neonatal complication 1**

Q87 **Neonatal complication 2**

Q88 **Neonatal complication 3**

Q89 **Congential malformation observed in baby 1**

Yes ❑
No ❑

Q90 **Congential malformation observed in baby 2**

Yes ❑
No ❑

Q91 **Congential malformation observed in baby 3**

Yes ❑
No ❑

Q92 **Time when this episode of care was completed[6] *(see footnote)***

[ ] *Hours* [ ] *Minutes*

Fetal outcome: Breastfeeding

Q93 **Intended feeding**

Breast ❑
Bottle ❑
Mixed feeding ❑

Q94 **Was the baby breastfed for the first feed?**

Yes ❑
No ❑

Q95 **Date of first feed**

[ ][ ][ ][ ][ ][ ]

Q96 **Time of first feed *(using 24 hour clock)***

[ ]

Q97 **Type of feeding established**

Breast ❑
Bottle ❑
Mixed feeding ❑

Q98 **Did the mother receive health care support for breastfeeding ?**

Yes ❑ If so by whom
No ❑

Q99 **Did the baby have skin to skin contact at delivery?**

Yes ❑
No ❑

Postnatal care - baby

Q100 **Admission to NICU**

Yes ❑ *If Yes, length of stay* [ ] *Days* [ ] *Hours*
No ❑

[6] Guidance: the episode of labour care is completed when the woman and baby are discharged from the delivery room or when the midwife begins to complete the post-natal notes, whichever occurs first

Q101 **Admission to SCBU**

Yes ❑ *If Yes, length of stay* [ ] *Days* [ ] *Hours*

No ❑

Q102 **Date and time of discharge of baby**

Date: [ ][ ][ ][ ][ ][ ]

Time: [ ] (Using 24 hour clock)

Q103 **Date and time of infant death**

Date: [ ][ ][ ][ ][ ][ ]

Time: [ ] (Using 24 hour clock)

MEDICATION FORM

Check recipient		Medication used	Route	Dose given	Total number of doses administered
Mother	Baby				

Appendix 8 Sociodemographic characteristics of study participants

Table 8.1A

	Barkantine	Royal London	
	167 (100)	**164 (100)**	***p*-value***
Marital Status:			
Living with Partner/married	123 (73.6)	90 (54.8)	<0.001
Partner living away from home	8 (4.8)	7 (4.3)	
Single/ no partner	1 (0.6)	0 (0.0)	
Missing	35 (21.0)	67 (40.9)	
Mother's Ethnic Group:			
White British	72 (43.1)	10 (6.1)	0.05
Black	10 (6.0)	5 (3.0)	
Mixed	8 (4.8)	0 (0.0)	
White European	18 (10.8)	6 (3.7)	
White Other	3 (1.8)	4 (2.4)	
Asian (India/Pakistan/Bangladeshi)	33 (19.8)	127 (77.4)	
Other	17 (10.2)	6 (3.7)	
Chinese	4 (2.4)	0 (0.0)	
Missing	2 (1.1)	6 (3.7)	
Language Spoken:			
English	155 (92.8)	50 (30.5)	0.81
Polish	1 (0.6)	3 (1.8)	
Bengali	3 (1.8)	50 (30.5)	
Urdu	6 (3.6)	1 (0.6)	
Other	2 (1.2)	3 (1.8)	
Missing	0 (0.0)	57 (34.8)	
Interpreter needed:			<0.001
Yes	5 (3.0)	43 (26.2)	
No	155 (92.8)	61 (37.2)	
Missing	7 (4.2)	60 (36.6)	

***** χ^2 test.

*Data represent number (%)

Table 8.1 A continued: Sociodemographic characteristics of study participants

	Barkantine	Royal London	
	167 (100)	**164 (100)**	***p*-value***
Fathers Occupation NS-SEC:			
Managerial and Professional	54 (32.3)	10 (6.1)	<0.001
Intermediate	35 (21.0)	22 (13.4)	
Small employer	11 (6.6)	6 (3.7)	
Lower supervisory and technical	19 (11.4)	2 (1.2)	
Semi routine and routine	19 (11.4)	43 (26.2)	
Unemployed	9 (5.4)	15 (9.1)	
Student	3 (1.8)	2 (1.2)	
Missing	17 (10.1)	64 (39.1)	

Appendix 9 Resource use values for the Barkantine study

Table 9.1 A: Resource use values from admission to discharge. Values are given as means (standard deviations).

Resource item (unit)	Barkantine (n = 167)	Royal London (n=164)
	Mean (SD)	Mean (SD)
Procedures occurring during 1st stage of labour		
Vaginal examination	2.21 (1.8)	1.93 (2.1)
Artificial rupture of membranes	0.13 (0.3)	0.21 (0.4)
Augmentataion with Syntocinon	0.14 (.03)	0.15 (0.4)
Fetal Heart Monitoring no CTG	0.74 (0.4)	0.45 (0.5)
Pain relief: birth pool	0.71 (0.5)	0.01 (0.1)
Pain relief: tens machine	0.10 (0.3)	0.01 (0.1)
Pain relief: paracetamol	0.05 (0.2)	0.04 (0.2)
Pain relief: co-codamol	0.23 (0.4)	0.04 (0.2)
Pain relief: pethidine	0.13 (0.3)	0.23 (0.4)
Pain relief: epidural	0.09 (0.3)	0.18 (0.4)
Transfer (at any point during or after labour)	0.32 (0.5)	0.00 (0.0)
Procedures occurring during 2nd stage of labour		
Epidural for LSCS		
General anaesthetic	0.08 (0.4)	0.11 (0.3)
Spontaneous vaginal delivery	0.01 (0.1)	0.02 (0.2)
Assisted delivery with ventouse	0.85 (0.4)	0.73 (0.4)
Assisted delivery with forceps	0.05 (0.2)	0.06 (0.2)
	0.04 (0.2)	0.04 (0.2)
Lower section caesarean section	0.07 (0.3)	0.17 (0.4)

Table 9.1 A continued: Resource use values from admission to discharge continued

Procedures occurring during 3rd stage of labour		
Perinatal Suturing	0.49 (0.5)	0.41 (0.5)
Indwelling catheter	0.17(0.4)	0.21 (0.4)
Wound drain	0.03 (0.2)	0.04 (0.2)
Care after Birth		
Postnatal care (no of days)	2.0 (1.6)	1.2 (1.1)
ICU mother (no of days)	0.0 (0.0)	1.0 (0.0)
HDU mother (no of days)	0.0 (0.0)	0.14 (0.3)
NICU (no of days)	0.0 (0.0)	0.01 (0.1)
SCBU (no of days)	0.03 (0.2)	0.07 (0.6)

Appendix 10 Unit costs of resource items

Table 10.1A Unit costs of resource items (UK £ sterling, 2008 prices)

Resource item (unit)	Unit cost or range[a]	Source of unit cost
Procedures occurring during 1st stage of labour		
Vaginal examination	6.70 - 7.24	Primary cost data
Artificial rupture of membranes	5.43 - 5.56	Primary cost data
Fetal heart monitoring no CTG	15.14 – 24.66	Primary cost data
Pain relief: birth pool	141.70	Primary cost data
Pain relief: tens machine	4.19 - 8.39	Primary cost data
Pain relief: epidural	378.93	Primary cost data
Transfer (at any point during or after labour)	255.16	Primary cost data
Transfer of baby separately		DH Reference costs
	230.00	Primary cost data
		DH Reference costs
Procedures occurring during 2nd stage of labour		
Epidural for LSCS	383.77	Primary cost data
Spontaneous vaginal delivery	34.60	Primary cost data
Assisted delivery with ventouse	136.52	Primary cost data
Assisted delivery with forceps	140.33	Primary cost data
Lower section caesarean section	1231.34	Primary cost data

Table 10.1 A: continued Unit costs of resource items (UK £ sterling, 2008 prices)

Procedures occurring during 3rd stage of labour				
Perinatal suturing episiotomy	12.19 (88.0)	14.07	4.03 (51.6)	Primary cost data 0.31
Indwelling catheter	48.9 (170.8)	3.28	15.4 (63.4)	Primary cost data 0.01
Wound drain	0.2 (0.4)	21.32	0.7 (1.3)	Primary cost data 0.43
	0.6 (3.6)		0.8 (4.0)	0.73
	3.0 (13.5)			0.33
			4.6 (16.5)	
	4.0 (7.4)			0.89
			3.8 (18.2)	
Hospital admission				
Adult intensive care (per day)	1148.0			DH reference costs
Adult high dependency care (per day)	617.0 (462.0-703.0)			DH reference costs
Postnatal care (per day)	247			DH reference costs
Neonatal intensive care (per day)	974.0 (637.0-1002.0)			DH reference costs
Neonatal high dependency care (per day)	544.0 (462.0-703.0)			DH reference costs
Special baby care (per day)	421.0			DH reference costs

a Ranges of unit costs are specified where unit costs varied according to location or intensity of care provided.

Appendix 11 Intrapartum care costs from admission to discharge for the Barkantine study

See overleaf

Table 11.1A Intrapartum care costs from admission to discharge. Values are given as means (standard deviations) unless otherwise stated.

Cost category	Barkantine (n= 167)	Royal London (n=164)	*p*-value*	Arithmetic mean difference (bootstrap 95% CI)[a]
Costs associated with admission	**99.1 (114.2)**	**743.5 (1207.4)**		**649.4 (226.5, 1291.0)**
Midwifery care from admission	99.1 (114.2)	0.0 (0.0)		
Patient stay in admission area (RLH)	0.0 (0.0)	743.5 (1207.4)		
Costs associated with first stage of labour	**373.1 (343.6)**	**376.3 (314.5)**		**1.25 (-207.2, 217.0)**
Artificial rupture of membranes	0.7 (1.8)	0.8 (2.1)	<0.001	
Syntocinon	1.9 (0.5)	0.2 (0.5)	0.8	
Fetal heart monitoring without CTG	73.9 (76.7)	71.3 (85.2)	0.77	
Fetal monitoring with CTG	131.3 (265.9)	115.4 (162.7)		
Fetal blood sampling	5.4 (40.6)	33.8 (118.7)		
Pain relief water	101.0 (64.3)	1.0 (8.1)	0.01	
Pain relief tens machine	0.4 (1.3)	0.1 (0.1)	0.01	
Pain relief paracetamol	0.0014 (0.006)	0.001 (0.006)		
Pain relief cocodamol	0.009 (0.016)	0.0017 (0.008)		
Pain relief pethidine	0.69 (1.8)	1.2 (2.2)		
Pain relief epidural	34.0 (108.7)	69.3 (146.9)	0.14	
Staffing care during 1st stage				

labour	29.8 (22.3)	27.0 (22.1)	0.43	
				-116.2 (-203.71, -44.67)
Costs associated with transfer				
Transfer	**114.33 (178.2)**			
Care provided by RLH				
transfer on admission	93.5(147.9)			
	66.8 (69.6)			
Procedures occurring during 2nd stage of labour	**232.2 (460.7)**	**316.1 (563.7)**		**83.9 (-228.7, 400.4)**
Epidural for LSCS	32.2 (148.4)	42.1 (120.3)	0.50	
General anaesthetic	4.5 (41.3)	9.2 (58.6)	0.40	
Spontaneous vaginal delivery	29.4 (12.4)	25.1 (15.5)	0.01	
Assisted delivery with ventouse	6.5 (29.2)	7.5 (31.2)	0.77	
Assisted delivery with forcep	5.0 (26.1)	5.9 (28.5)	0.75	
Lower section caesarean section	81.1 (306.3)	210.2 (464.7)	0.01	
Staffing care during 2nd stage labour	8.6 (20.19)	15.9 (58.3)	<0.001	
Procedures occurring during 3rd stage of labour	**73.9 (225.2)**	**62.5 (146.9)**		**-14.5 (-142.8, 94.6)**
Manual removal of the placenta	12.19 (88.0)	4.03 (51.6)	0.31	
Epidural for suturing	6.8 (50.5)	20.7 (86.6)		

Perinatal Suturing	48.9 (170.8)	15.4 (63.4)	0.01	
Indwelling catheter	0.2 (0.4)	0.7 (1.3)	0.43	
Wound drain	0.6 (3.6)	0.8 (4.0)	0.73	
Neonatal resuscitation	3.0 (13.5)	4.6 (16.5)	0.33	
Staffing care during 3rd stage of labour	4.0 (7.4)	3.8 (18.2)	0.89	
Care after birth	**456.0 (1180.2)**	**702.4 (737.5)**		**249.6 (-490.4, 794.0)**
Postnatal care	321.3 (789.2)	577.5 (520.8)	0.00	
ICU mother	0.0 (0.0)	7.0 (0.0)	0.19	
HDU mother	59.1 (182.1)	83.6 (162.0)	0.31	
NICU	0.0 (0.0)	5.9 (76.1)	0.39	
SCBU	75.6 (678.1)	28.2 (247.3)		
Total costs	**1348.6 (1850.8)**	**2200.7 (1896.5)**	**<0.001**	**850.3 (-265.9, 2032.9)**

Appendix 12 Additional resource use data

Table 12.1 A Resource use data identified as part of the Birthplace prospective cohort study

Birthplace DCF section	Questions asked in the Birthplace data collection forms	Resource variable identified	Data collected in addition to the Birthplace DCFs	Source of additional data collection for detailed resource use
Prospective Cohort Study Data Collection forms from OUs, AMUs FMUs and homebirth				
Section B and C: Mother's details and pregnancy history	Age Ethnic group Fluency Marital status BMI at booking (if recorded) Pregnancy history Medical conditions	Demographic information		
Section D: Labour and birth	Date and time midwife started/finished labour care	'episode of care' to which a staff time cost will be attributed	More midwifery or other health professional time to be included	Structured questionnaire for OU, AMU, FMU and HB in the 4 regional Birthplace centres with the 4 RLMs. See Appendices 9 and 10
Section D: Maternal Transfer	Mode of transfer, date and time of transfer		Duration of transfer: miles; minutes; networks Extra staff required for transfer	Structured questionnaire with paramedic services in the 4 regional Birthplace centres. Appendix 9
Section D: Maternal Transfer	Date and time midwife started/finishes labour care in OU	Change to staffing Start of midwifery and additional care in the OU	Care continuous or intermittent Numbers of health professionals in attendance	Structured questionnaire for OU in the 4 regional Birthplace centres with the 4 RLMs. Appendix 9
Section D: Maternal Transfer	Date and time women receives first clinical assessment –	Start of (possibly) clinical care in OU	Care continuous or intermittent Numbers of health professionals in attendance	Structured questionnaire for OU in the 4 regional Birthplace centres with the 4 RLMs. Appendix 9

Birthplace DCF section	Questions asked in the Birthplace data collection forms	Resource variable identified	Data collected in addition to the Birthplace DCFs	Source of additional data collection for detailed resource use
Section D: Maternal Transfer	Meconium staining Postpartum haemorrhage dural nal General Anaesthetic Repair of perineal trauma		Costing of each clinical event – detailed bottom up costing	Structured questionnaire for OU in the 4 regional Birthplace centres with the 4 RLMs. Appendix 9
Section D: Labour and birth	Mode of delivery		We anticipated attributing a cost to each mode of birth which would reflect the resource use and staffing requirements throughout the labour, based on primary costing	Structured questionnaire for OU, AMU, FMU and HB in the 4 regional Birthplace centres with the 4 RLMs. Appendices 9 and 10
Section D: Labour and birth	Active management of the third stage of labour			
Section D: Labour and birth	Episiotomy			
Section D: Labour and birth	Perineal Trauma involving the anal sphincter			
Section D: Labour and birth and **Section D:** Maternal Morbidity Data Collection Form	Stillbirth	Time of stillbirth Stage of labour Post-mortem details		
Section E: After Birth and Section A: Maternal Morbidity Data Collection Form	Mother received blood transfusion within 48 hours after birth	Units of blood or packed cells given, cell saver used		

Birthplace DCF section	Questions asked in the Birthplace data collection forms	Resource variable identified	Data collected in addition to the Birthplace DCFs	Source of additional data collection for detailed resource use
Section E: After Birth and **Section B:** Maternal Morbidity Data Collection Form	Mother admitted to high dependency area within 48 hours after birth	Date of admission, time of admission, date of discharge, treatment received		
Section E: After Birth and **Section B:** Maternal Morbidity Data Collection Form	Mother admitted to ITU within 48 hours after birth	Date of admission, time of admission, date of discharge, treatment received		
Section E: After Birth and **Section B:** Maternal Morbidity Data Collection Form	Mother admitted to Specialist care within 48 hours after birth	Date of admission, time of admission, date of discharge, treatment received		
Section E: After Birth and **Section A:** Neonatal Morbidity Mortality Follow up Form	Baby receiving special care	Date of admission, time of admission, date of discharge, days of/and treatment received including method of feeding		
Section E: After Birth and **Section A:** Neonatal Morbidity /Mortality Follow up Form	Baby receiving high dependency care	Date of admission, time of admission, date of discharge, days of/and treatment received, respiratory support (ventilator or CPAP)		
Section E: After Birth and **Section A:** Neonatal Morbidity /Mortality Follow up Form	Baby receiving intensive care	Date of admission, time of admission, date of discharge, days of/and treatment received, respiratory support (ventilator or CPAP)		

Birthplace DCF section	Questions asked in the Birthplace data collection forms	Resource variable identified	Data collected in addition to the Birthplace DCFs	Source of additional data collection for detailed resource use
Section E: After Birth and **Section K:** Neonatal Morbidity Mortality Follow up Form	Baby died			
Maternal Morbidity / Mortality Follow-up Data Collection forms				
Section C: Maternal Mortality	Date and time of death, place of death, cause of death			
Neonatal Morbidity / Mortality Follow-up Data Collection forms				
Section B: Meconium Aspiration	Baby receiving ECMO	No of days of treatment / medication		
Section C: Encephalopathy	Baby having seizures requiring cooling treatment	No of days of treatment / medication		

Appendix 13 Structured questionnaire

Table 13.1 A Unit Cost and Resource Use Structured Questionnaire

Top Down Costing
Unit Cost and Resource Use Structured Questionnaire for design of unit cost database and related unit cost sensitivity analysis

Interviews conducted with:

Trust	Unit names	Units within trust	Geographic location in England	RLCM	Place of Interview	Dates of interviews
Liverpool Women's Hospital NHS Foundation Trust	Liverpool Women's NHS Foundation Trust Liverpool Women's NHS Foundation Trust	OU AMU	North	Chelsea McDonough	Liverpool	Tuesday 24th March
Oxford Radcliffe Hospitals NHS Trust	Horton Hospital Chipping Norton Hospital Wallingford Hospital Wantage Hospital	OU FMU FMU FMU	South east	Laura Stewart-Maunder	University of Oxford Richards building, DPHPC	Wednesday 29th April and Wednesday 20th May
Taunton and Somerset NHS Trust	Mary Stanley Wing Bridgewater Bracken Birthing Centre	FMU AMU	South west	Carol Puckett	Musgrove Park Hospital, Taunton	Wednesday 16th April
Kings College Hospital NHS Foundation Trust	Kings College Hospital	OU	London	June Grant	Kings College London	Friday 6th March 2009 and Friday 30th April 2009
Barts and the London Trust	Royal London Hospital Barkantine Birth centre	OU FMU	London	Ali Herron Jude Piper	Royal London Hospital or Barkantine Birth Centre	Numerous meetings between Jan 2008 and Dec 2009. Monthly structured meetings and informal meetings one-on-one with members of the team.

Unit Cost and Resource Use Structured Questionnaire for design of unit cost database

We'd like to have a discussion about the way the OU, AMU and FMU manage the following scenario's (i.e. what happens - usually / least complex scenario / most complex scenario)

Where applicable we need to know about the ratio of staff to women

Transfer: questions to FMU and AMU

In utero transfer of mother

What are the typical least complex and then most complex scenarios that lead to a decision to transfer a mother?
When this happens what do you do, what processes do you follow?
Could you talk us through the whole process from start to when you would consider an 'in-utero transfer' to be finished?

(Extra Q – are these covered in what they describe?)

Who do you contact? (Name, contact details)
What does the person you called do?
Who else do you contact if you can't get through the person? *(Name, contact details)*
Are additional nurses or other health care professionals called in? *(Grade)*
If assistance is requested who is contacted? *(Name, contact details)*
Who is in the assistance team?
Does the woman's partner/next of kin ever use their own transport?
In the first instance which hospital is the woman normally transferred to?
Does the midwife accompany the woman to hospital?
When is there a handover of care in the OU?

After birth: transfer of mother and /or baby

after birth: if you need to transfer the mother what happens: Could you talk us through the whole process from start to when you would consider a 'post-natal maternal transfer' to be completed:

after birth: if you need to transfer the baby what happens: Could you talk us through the whole process from start to when you would consider a 'post-natal baby transfer' to be completed:

after birth: if you need to transfer the mother and baby what happens: Could you talk us through the whole process from start to when you would consider a 'post-natal baby transfer' to be completed:

(Extra Q – are these covered in what they describe?)

What are the typical least complex scenario/ most complex scenarios that lead to transfers?
When something goes wrong what do you do?
Who do you call? (Name, contact details)
What does the person you called do?
Who else do you contact if you can't get through the person? *(Name, contact details)*
Are additional nurses or other health care professionals called in? *(Grade)*
If assistance is requested who is contacted? *(Name, contact details)*
Who is in the assistance team?
Does the woman's partner/next of kin ever use their own transport?
In the first instance which hospital is the woman normally transferred to?
Does the midwife accompany the woman to hospital?

-Other
Can you think of other scenarios that take place not discussed here and lead to transferring women?
What are the typical least complex scenario/most complex scenarios?
When something goes wrong what do you do?
Who do you call? (Name, contact details)
What does the person you called do?
Who else do you contact if you can't get through the person? *(Name, contact details)*
Are additional nurses or other health care professionals called in? *(Grade)*
If assistance is requested who is contacted? *(Name, contact details)*
Who is in the assistance team?
Does the woman's partner/next of kin ever use their own transport?
In the first instance which hospital is the woman normally transferred to?
Does the midwife accompany the woman to hospital? Does anyone else? When is care and handover completed?

Financial structure of OU, AMU, FMU

AMU / FMU:
Who manages the finances at the unit? *(Name and contact details)*

How do they do this:

What needs to be done to financially run the unit?
What do they do to financially oversee the unit?
Who assists them? *(Name and contact details*)
Who manages the finances in their absence? *(Name and contact details*)
What expenses are attributed to the unit?
What expenses /running costs are not attributed to the unit?

OU:
Who manages the finances at the unit? *(Name and contact details)*

How do they do this:

What do they do to financially oversee the unit?
Who assists them? *(Name and contact details*)
Who manages the finances in their absence? *(Name and contact details*)
What expenses are attributed separately to the OU maternity and neonatal departments?
What expenses /running costs are not attributed to the OU maternity and neonatal departments?

Please could you complete an overview of the running costs for this unit (OU/AMU/FMU) to include the following:

A. Wages/salary

B. Salary on-costs employer's contribution to superannuation.

C. Qualifications

D. Training

E. Management and administrative costs, operational costs (e.g. vehicle running costs) and overheads (including heating and lighting, training, building maintenance and so on).
Direct overheads: Includes mobile phones, uniform replacement, stationery, thermometers, energy.

Indirect overheads £ per year
Include the personnel and finance functions. Costs need to be uprated by the HCHS Pay and Prices Inflator.

G. Capital overheads
£ per year Based on the new build and land requirements of NHS facilities.
Office size. Capital to be annuitised at 3.5 per cent.

Buildings and land
Capital costs associated with the buildings and land

H. Equipment costs

Pharmacy and Drug Costs for the OU, FMU and AMU

FMU/AMU/OU

Do you have your own pharmacy for drugs that are used in the unit?
What happens when you run low on drugs and don't have certain drugs available?
Where do you go? *(Name and contact details)*

Pharmacy Drugs

Who manages the drugs? *(Name and contact details)*
How do they manage the drugs / What do they do to manage the drugs?

Equipment

Who manages the maintenance of the equipment? *(Name and contact details)*
How do they manage it?
What do they do?
Who manages the replacing equipment? *(Name and contact details)*
How do they manage it?
What do they do?
In a worst case scenario what do you do in event of equipment not suddenly working? *(Details if possible)*
Who would manage the situation?
How do they manage it? *(Name and contact details)*
Any charity sponsored pieces that might not be included?

Other activities the OU/FMU offer to the community (in addition to intrapartum and p/n care)

What other activities are offered by FMU / AMU in addition to intrapartum and p/n care?

What other activities are offered by the OU maternity and neonatal section in addition to intrapartum and p/n care?

(Extra Q – are these covered in what they describe?)

What other activities are offered to the community?
Who organises these activities *(Name and contact details)*
How do they manage it?
What do they do?
Is additional staff required? Who are they?
What type external training is provided to staff for these activities?
If so, by who?
Who are the external health care professionals that participate in activates? *(Name and contact details)*
How do they participate?

Appendix 14 Design of micro-costing spreadsheet

Table 14.1 A Example of micro-costing of labour and post-natal care

Place admitted to

What happens in the following places as a general description - from our perspective of needing to cost staff (numbers and staff time commitment to this place)

Triage

Staff title and grade	Length of time with staff	Cost (£) of staffing	comments/ assumptions for costing	Equipment	Cost (£)	comments/ assumptions for costing	Drug	Dose	Mode of administration	Cost (£)	comments/ assumptions for costing	Length of time of procedure	Cost (£)	comments/ assumptions for costing	Total Cost (£)

Antenatal assessment

Staff title and grade	Length of time with staff	Cost (£) of staffing	comments/ assumptions for costing	Equipment	Cost (£)	comments/ assumptions for costing	Drug (come from pharmacist)	Dose	Mode of administration	Cost (£)	comments/ assumptions for costing	Length of time of procedure	Cost (£)		Total Cost (£)

Birthing room

Staff title and grade	Length of time with staff	Cost (£) of staffing	comments/ assumptions for costing	Equipment	Cost (£)	comments/ assumptions for costing	Drug	Dose	Mode of administration	Cost (£)	comments/ assumptions for costing	Length of time of procedure	Cost (£)	Length of time of procedure	Total Cost (£)

Theatre

Staff title and grade	Length of time with staff	Cost (£) of staffing	comments/ assumptions for costing	Equipment	Cost (£)	comments/ assumptions for costing	Drug	Dose	Mode of administration	Cost (£)	comments/ assumptions for costing	Length of time of procedure	Cost (£)		Total Cost (£)

Appendix 15 Micro-costing of resource use variables

Table 15.1 A Micro-costing of resource variables for labour and post-natal care

Staffing : Midwives						
Resource Use Variable	**Cost calculation: salary**	**RLM interview**	**Assumption made**	**Unit cost**	**Total**	**Source of Unit cost**
Staffing: first midwife	Band 6/7 mid-point =£32704, Base year 2009/2010 Agenda for change	B6 & 7 mw: tends to be 1 for labour duration with second arrival for baby's birth for a homebirth	Time spent with woman = duration of labour	£63 (£70) per hour of patient contact. £11.31 CNST contribution	variable depending on duration of labour: hourly cost attributed to labour duration	PSSRU: Unit costs of Health and Social care 2010 Primary cost data collection for CNST contributions
	Salary on-costs: £7523 per annum (Employer's NI plus 14% superannuation)					
	Qualifications: £4801 per annum Education investment cost annuitied over working life					
	Overheads: £3130 per annum Indirect staffing overheads					
	Working time: 41.4 weeks per annum 37.5 hours per week. Includes: 29 days A/L. 8 days statutory leave. 5 study days. 12 days sick leave. Hours per annum: 1547					

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Homebirth						
Resource Use Variable	Cost calculation: salary	RLM interview	Assumption made	Unit cost	Total	Source of Unit cost
Staffing: first midwife	Band 6/7 mid point =£32704, Base year 2009/2010 Agenda for change	B6 & 7 mw: tends to be 1 for labour duration with second arrival for baby's birth	Time spent with woman = duration of labour	£81.31 per hour	variable depending on duration of labour: hourly cost attributed to labour duration	PSSRU: Unit costs of Health and Social care 2010
	Salary oncosts: £7523 per annum (Employer's NI plus 14% superannuation)					Primary cost data collection for CNST
	Qualifications: £4801 per annum Education investment cost annuitied over working life					
	Overheads: £3130 per annum Indirect staffing overheads					
	Working time: 41.4 weeks per annum 37.5 hours per week. Includes: 29 days A/L. 8 days statutory leave. 5 study days. 12 days sick leave. Hours per annum: 1547					
Staffing: second midwife	as above	time spent 1 hour approx	Time spent with woman = 1 extra hour to cover birth of baby and intial support and clean up	£81.31 per hour	variable depending on duration of labour: hourly cost attributed to labour duration	PSSRU: Unit costs of Health and Social care 2010

Homebirth Delivery pack: relevant resource items : given to woman at 38 weeks			
sterile single use instrument delivery pack:	1 8" lotion bowl, 5 xrd swabs 10 10 cm , 1 trolley cover, 2 artery forceps, 1 mayo scissors, 1 umbilical scissors	£9.14	Taken from NHS supply chain catalogue 2009, page 322 code EVX111
sterile delivery pack:	1 placenta dish, 2 pulp kidney dishes, cord clamp, 2 wound pads, quilted baby wrap, 2 dressing towels crepe white sterile filed, 1 60ml galipot, 1 underbuttock drape, 1 120ml galipot, 2 polybowls 500ml, 1 yellow poly bag	£7.01	Taken from NHS supply chain catalogue 2009, page 322 code EVC019 and code EVI010
surgical gloves		£0.41	Taken from NHS supply chain catalogue 2009, page 195 code FTE883
lidocaine hydrochloride		£0.88	BNF 60: lidocaine hydrochloride 5%, net price 15 g = 88p
vitamin k injection		£0.95	Konakion® MM Paediatric (Roche) Injection, phytomenadione 10 mg/mL in a mixed micelles vehicle, net price 0.2-mL amp = 95p
gas and air mouthpiece		£2.05	Taken from NHS supply chain catalogue 2009, page 698 code FDQ501
sharps box		£0.76	Taken from NHS supply chain catalogue 2009, page 179 codeFSL493
amnihook		£0.86	Taken from NHS supply chain catalogue 2009, page 961 code FFY007
Perineal suture pack:	3 drapes 75*90 com, instrument table cover, 5 gauze 22.5 ply xray, 1 needle 21g green, 1 gown standard, 2 leggings 75*114cm blue absorbant impervious materieal, 1 xtray, jwire, 1 maternity pad looped	£12.26	Taken from NHS supply chain catalogue 2009, page 319 code EVX122
Total cost of pack:		£34.32	

The homebirth pack itself consists of :						
sterile delivery pack	Sterile single use instrument delivery pack: 1 8" lotion bowl, 5 xrd swabs, 10 10 cm, 1 trolley cover, 2 artery forceps, 1 mayo scissors, 1 umbillical scissors					
	Pack sterile delivery: 1 placenta dish, 2 pulp kidney dishes, cord clamp, 2 wound pads, quilted baby wrap, 2 dressing towels crepe white sterile field, 1* 60 ml galipot, 1 underbuttock drape					
	Pack sterile delivery: 1* 120 ml galipot, 2 poly bowls 500ml, 1 yellow poly bag					
surgical gloves						
lydocaine hydochloride						
plastic aprons						
vitamin k injection						
gas and air mouthpiece						
clinical waste bags						
sharps box						
'detectable' guaze swabs (blue						
amniotomy hook						
bowl						
forceps scissors						
maternity pads						
sterile perinial suture pack	3 drapes 75 * 90cm, instrument table cover, 5 gauze 22.5*22.5 12 ply xray, 1 needle 21g green, 1 gown large standard, 2 leggings 75*114cm blue absorbant impervious material, 1 xtray, jwire, 1 maternity pad looped					
disposable stitches						
materity mats						

Resource Variable	Unit cost	Unit cost range	Explanation	Source of Unit Cost	Total cost applied to travel to and from homebirth	
NHS reimbursement of homebirth travel costs for midwife						
Cost of collection of car after a transfer and homebound journey	50.41 pence per mile	36.09-110.35 pence per mile	Standing charges and running costs per mile (pence) Used 23 miles as the distance mw had to travel to homebirths. Used the average distance between homebirth and Ous from Birthplace data equating to about 42. This is similar to the PSSRU ave ambulance journey (38 minutes)minutes.	AA Petrol car running costs – basic guide for 2010 http://www.theaa.com/allaboutcars/advice/advice_rcosts_petrol_table.jsp Accessed 22 March 2010	23.1886	

Resource Variable	*Unit cost*	*Unit cost range*	*Explanation*	*Source of Unit Cost*
Transfer				
intrapartum and neonatal ambulance transfers	£6,7 per minute	£257~38 minute journey~£6.7 per minute		averaged costs using PSSRU 2007 and DH reference costs
	A successful vehicle journey is equivalent to transporting a single patient for A&E services.			
	Included in the costs are: Overheads and management: management and administrative costs, operational costs (e.g. vehicle running costs) and overheads (including heating and lighting, training, building maintenance and so on).			
	Buildings and land: Capital costs associated with the buildings and land invested in the ambulance service were estimated by discounting their capital value over 60 years at 3.5 per cent.			
	Ambulances and equipment: Paramedic Units (PU) and Emergency Ambulances (EA) use exactly the same type of vehicle with similar equipment on board. The ambulances cost £47,297 new and standard equipment including defibrillators costs £11,824 per vehicle. Vehicles and the equipment are expected to last five years. Discounting at 3.5 per cent the annual cost of an EA is £13,095. The average number of journeys per emergency ambulance was 1,152.			
	Crew salaries and wages: A crucial distinguishing characteristic of the different services is the type of crew. A PU carries one paramedic (average salary £31,926 pa) and one technician (average salary £29,945). An EA is crewed by two technicians and a PTS by two care assistants (average salary £16,354). Once national insurance and pension payments are included the average annual crew cost is £67,077 for a PU; £69,173 for an EA; and £36,632 for a PTS. The average number of journeys per EA and PU crew is 480 per year, PTS crews provides an average of 339 journeys per PTS crew.			

Resource Variable	***Unit cost***	***Unit cost range***	***Explanation***	***Source of Unit Cost***
Transfer	per journey	interquartile range (per journey)		
Paramedic Services per journey for Pregnancy / Childbirth / Miscarriage/ Gynaecological (rural)	184	150- 169.5		DH Reference Costs
Paramedic Services per journey for Pregnancy / Childbirth / Miscarriage/ Gynaecological (urban)	194	136-153		DH Reference Costs
Emergency transfers	240	206-362		DH Reference Costs
Resource Variable	***Unit cost per hour***	***Unit cost range***	***Explanation***	***Source of Unit Cost***
Private car	0		cost not attributed to the NHS	
Walking	0			
Wheelchair / trolley / bed	0.01		£170 per active user per chair per year	PSSRU
Rapid response ambulance car	214	214 -241	lower interquartile range for ambulance transfer	
Helicopter	144.5	83-206 per hour	Between £60 000 per month and £1.8 million per year to run, but NHS do not pay running costs - only the cost of consultants. Rest raised by donations.	http://www.emas.nhs.uk/our-services/air-ambulances/ or http://news.bbc.co.uk/1/hi/england/oxfordshire/7907106.stm
Taxi	0		cost not attributed to the NHS	

ENTONOX		**comments/ assumptions and source of cost data**	**Cost (£)**
2.5 cylinders for homebirth		Scottish data: Cylinder size DD 460 litres (portable oxygen) http://www.lothianrespiratorymcn.scot.nhs.uk/wp-content/uploads/2010/01/Lothian-Guideline-for-the-Domiciliary-Oxygen-Therapy-Service-for-COPD.pdf Accessed 18 March	£57.45
Mobile equipment with mask, mouth piece		Taken from NHS supply chain catalogue 2009, page 621 code FDC115 (ENTONOX KIT) AND delivery circuit mask code FDC346	£ 10.53
filter or tubing		Taken from NHS supply chain catalogue 2009, page 677 CODE FDD254, FDE101, FDD148, FDD954	£ 0.47
rubber gloves		Taken from NHS supply chain catalogue 2009, page 195 code FTE883	£ 0.20
Total			**68.65**

Resource Variable	*Unit cost*	*Unit cost range*	*Explanation*	*Source of Unit Cost*
NHS reimbursement of homebirth transfer costs for midwife				
Cost of collection of car after a transfer and homebound journey	50.41 per mile	36.09-110.35	Standing charges and running costs per mile (pence)	AA Petrol car running costs – basic guide for 2010 http://www.theaa.com/allaboutcars/advice/advice_rcosts_petrol_table.jsp Accessed 22 March 2010

AUGMENTATION		comments/ assumptions and source of cost data	Cost (£)
1 hour of FS doctor		PSSRU adjusted for direct patient time and CNST contributions	£141.78
ALARIS PUMP + cannulae equipment (8 hour duration)		primary cost data - Kings £2015 new	£0.40
Imed or Ivac titration machine			
Appropriate giving set		Taken from NHS supply chain catalogue 2009, page 843 code FFSC087	£3.05
Venflon cannula		Taken from NHS supply chain catalogue 2009, page 59 code FSP033	£0.83
Syringe and needle		Taken from NHS supply chain catalogue 2009, page 352 code FWC032	£0.05
Swabs		Taken from NHS supply chain catalogue 2009, page 769 code HHD090	£0.06
Sterile dressing		Taken from NHS supply chain catalogue 2009, page 736 code EKG035	£2.48
Syntocinon		oxytocin, net price 5 units/mL, 1-mL amp = 76p; 10 units/mL, 1-mL amp = 86p	£0.86
Bag of fluid (dextrosaline)		Intravenous infusion, usual strength sodium chloride 0.9% (9 g, 150 mmol each of Na+ and Cl-/litre), this strength being supplied when normal saline for injection is requested. Net price 2-mL amp = 35p; 5-mL amp = 42p; 10-mL amp = 57p; 20-mL amp = £1.04; 50-mL amp = £2.01	£2.01
Local anaesthetic		Taken from BNF 59, 26/04/10 Naropin, injection (2mg/mL= £1.78)	£1.78
Monitors and graph paper		Taken from NHS supply chain catalogue 2009, page 242 code FDI058	£0.07
top up:		as above	£0.86
top up:		as above	£2.01
top up:		as above	£0.86
top up:		as above	£2.01
TOTAL			**£159.11**

EPIDURAL						
Staff title and grade	**Cost (£) of staffing**	**comments/ assumptions and source of cost data**	**Equipment**		**Comments/ assumptions and source of cost data**	**Total**
			Epidural pack		Taken from NHS supply chain catalogue 2009, page 328 code FYB062	£32.10
Anaesthetist	194.68	PSSRU 2010, page 218 (medical consultant), Assumption- time spent 30 MINUTES	Inco pad		Taken from NHS supply chain catalogue 2009, page 961 code EAO500	£0.09
extra midwife	40.65	Band 7 mid-point =£32704, Base year 2007/2008, Assumption- time spent 30 minutes	Gloves		Taken from NHS supply chain catalogue 2009, page 200 code FTE888	£4.68
			chlorhexodine 0.5%		BNF: methyl salicylate 0.5 mL, diethyl phthalate 2%, castor oil 2.5%, in industrial methylated spirit, net price 100 mL = 20p. Label: 15	£0.02
			Syringe 10ml (1)		Taken from NHS supply chain catalogue 2009, page 352 code FWC031	£0.05
			Ampoule 10 ml local anaesthetic		Taken from BNF 59, 26/04/10 Naropin, injection (10mg/mL= £3.20)	£3.20
			Syringe 2ml		Taken from NHS supply chain catalogue 2009, page 352 code FWC032	£0.05
			Ampoule 2ml local anaesthetic		Taken from BNF 59, 26/04/10 Naropin, injection (2mg/mL= £1.78)	£1.78
			Drugs - marcaine 10ml		Taken from BNF 59, 26/04/10 injection (10-mL= £1.21)	£1.21
					Taken from NHS supply chain catalogue 2009, page 764 code EHH027	£1.90
			Hyperfix tape		Taken from NHS supply chain catalogue 2009, page 764 code EHH028	£1.57
			Blenderm tape		Taken from NHS supply chain catalogue 2009, page 766 code ECH011	£0.36
			Transpore tape		Taken from NHS supply chain catalogue 2009, page 764 code EHU009	£0.28
			Opcite spray		Xylocaine® (AstraZeneca) Spray (= pump spray), lidocaine 10% (100 mg/g) supplying 10 mg lidocaine/spray; 500 spray doses per container. Net price 50-mL bottle = £3.13	£0.06
			Mask (2 or 3)		Taken from NHS supply chain catalogue 2009, page 479 code BWM042	£0.05

EPIDURAL CONT……/2			Hats (2 or 3)		Taken from NHS supply chain catalogue 2009, page 479 code BWF036	£0.02
			Gowns		Taken from NHS supply chain catalogue 2009, page 410 code BWK201	£1.36
			IV form		Taken from NHS supply chain catalogue 2009, page 293 code FFF171	£1.04
			Povidine iodine spray		Taken from BNF 59, 21/04/10 spray (150g= £2.63)	£2.63
			Paper tray		Taken from NHS supply chain catalogue 2009, page 162 code FWK121	£0.27
			Water 10ml			£0.00
			Syringe label			£0.00
			Ephedrine 5ml ampoule		Ephedrine Hydrochloride (Non-proprietary) Injection, ephedrine hydrochloride 3 mg/mL, net price 10-mL amp = £2.83; 30 mg/mL, net price 1-mL amp = 50p	£0.50
			Needles: including filter needles		Taken from NHS supply chain catalogue 2009, page 332 code FTR394	£4.07
			If women does not have IV drip:			
			Fluid - Hartmans Solution		Intravenous infusion, usual strength sodium chloride 0.9% (9 g, 150 mmol each of Na+ and Cl-/litre), this strength being supplied when normal saline for injection is requested. Net price 2-mL amp = 35p; 5-mL amp = 42p; 10-mL amp = 57p; 20-mL amp = £1.04; 50-mL amp = £2.01	£0.35
			Giving set		Taken from NHS supply chain catalogue 2009, page 843 code FSC090	£3.05
			Venflon		Taken from NHS supply chain catalogue 2009, page 59 code FSP033	£0.83
			Local anaesthetic		Taken from BNF 59, 26/04/10 Naropin, injection (2mg/mL= £1.78)	£1.78
			Syringe and needle		Taken from NHS supply chain catalogue 2009, page 352 code FWC032	£0.05
			Swabs		Taken from NHS supply chain catalogue 2009, page 769 code HHD090	£0.06

EPIDURAL CONT……/3			sterile dressing		Taken from NHS supply chain catalogue 2009, page 736 code EKG035	£2.48
			If not already monitored:			
			Electronic fetal monitor		Primary data collection Fin Mger Kings £13500 per CTG	£2.88
			Fetal scalp electrodes		Taken from NHS supply chain catalogue 2009, page 960 code FDK314: £106.71 FOR BOX 25	£4.27
			Monitor graph paper		Taken from NHS supply chain catalogue 2009, page 242 code FDI058	£0.07
			Patient controlled Epidural Analgesia		Taken from NHS supply chain catalogue 2009, page 410 code BWK201	£1.36
			PCEA pump		Injection, prefilled disposable syringe, atropine sulphate 200 micrograms/mL, net price 5 mL = £5.90; 300 micrograms/mL, 10 mL = £5.91; 600 micrograms/mL, 1 mL = £5.91	£5.91
			syringe 10 mls			
						£0.08
			1% Bupiricaine		Taken from BNF 59, 26/04/10 injection (10-mL= £1.21)	£1.21
			2mcg Fenlanys		Fentanyl (Non-proprietary) Injection, fentanyl (as citrate) 50 micrograms/mL, net price 2-mL amp = 30p, 10-mL amp = 64p	£0.64
			Top ups:			
			1% Bupiricaine		Taken from BNF 59, 26/04/10 injection (10-mL= £1.21)	£1.21
			2mcg Fenlanys		Fentanyl (Non-proprietary) Injection, fentanyl (as citrate) 50 micrograms/mL, net price 2-mL amp = 30p, 10-mL amp = 64p	£0.64
Total						**£319.49**

SPINAL Staff title and grade	Length of time with staff	comments/ assumptions for costing	Cost (£) of staffing	Equipment	Comments/ assumptions and source of cost data	Total Cost (£)
				1 dressing	Taken from NHS supply chain catalogue 2009, page 736 code EKG035	£ 2.48
Anaesthetist	20-30 mins	PSSRU 2010, page 218 (medical consultant), Assumption- time spent 30 MINUTES	£194.68	Sleek tape	Taken from NHS supply chain catalogue 2009, page 764 code EHH027	£ 1.90
ODA	20-30 mins	Band 7 mid-point =£32704, Base year 2007/2008, Assumption- time spent 30 minutes	£40.65	Hyperfix tape	Taken from NHS supply chain catalogue 2009, page 764 code EHH028	£ 1.57
				Blenderm tape	Taken from NHS supply chain catalogue 2009, page 766 code ECH011	£ 0.36
				Transpore tape	Taken from NHS supply chain catalogue 2009, page 764 code EHU009	£ 0.28
				Epidural pack	Taken from NHS supply chain catalogue 2009, page 328 code FYB062	£ 32.10
				Inco pad	Taken from NHS supply chain catalogue 2009, page 961 code EAO500	£ 0.09
				Gloves	Taken from NHS supply chain catalogue 2009, page 200 code FTE888	£ 4.68
				Spirit solution - chlorhexidine 0.5%	BNF: methyl salicylate 0.5 mL, diethyl phthalate 2%, castor oil 2.5%, in industrial methylated spirit, net price 100 mL = 20p. Label: 15	£ 0.02
				Syringe 10ml (1)	Taken from NHS supply chain catalogue 2009, page 352 code FWC031	£ 0.05
				Ampoule 10 ml local anaesthetic	Taken from BNF 59, 26/04/10 Naropin, injection (10mg/mL= £3.20)	£ 3.20
				Syringe 2ml	Taken from NHS supply chain catalogue 2009, page 352 code FWC032	£ 0.05
				Ampule 2ml local anaesthetic	Taken from BNF 59, 26/04/10 Naropin, injection (2mg/mL= £1.78)	£ 1.78
				Drugs - marcaine 10ml	Taken from BNF 59, 26/04/10 injection (10-mL= £1.21)	£ 1.21
				Opcite spray	Xylocaine® (AstraZeneca) Spray (= pump spray), lidocaine 10% (100 mg/g) supplying 10 mg lidocaine/spray; 500 spray doses per container. Net price 50-mL bottle = £3.13	£ 0.06
				Mask (2 or 3)	Taken from NHS supply chain catalogue 2009, page 479 code BWM042	£ 0.05
				Hats (2 or 3)	Taken from NHS supply chain catalogue 2009, page 479 code BWF036	£ 0.02
				Gowns	Taken from NHS supply chain catalogue 2009, page 410 code BWK201	£ 1.36
				IV form	Taken from NHS supply chain catalogue 2009, page 293 code FFF171	£ 1.04
				Povidine iodine spray	Taken from BNF 59, 21/04/10 spray (150g= £2.63)	£ 2.63
				Paper tray	Taken from NHS supply chain catalogue 2009, page 162 code FWK121	£ 0.27
				Water 10ml		0
				Ephedrine 5ml ampoule	Ephedrine Hydrochloride (Non-proprietary) Injection, ephedrine hydrochloride 3 mg/mL, net price 10-mL amp = £2.83; 30 mg/mL, net price 1-mL amp = 50p	£ 0.50

SPINAL CONT..					Injection, phenylephrine hydrochloride 10 mg/mL (1%), net price 1-mL amp = £5.50	£ 5.50
				marcaine (for top ups)	Taken from BNF 59, 26/04/10 injection (10-mL= £1.21)	£ 6.05
					Injection, powder for reconstitution, ceftriaxone (as sodium salt), net price 1-g vial = £10.17; 2-g vial = £20.36times 5 - many top ups: Ceftrioxone	£ 0.17
Total Cost			**235.33**			**302.75**

ACTIVE MANAGEMENT OF THE THIRD STAGE OF LABOUR			
Equipment	**Cost (£)**	**Comments/ assumptions and source of cost data**	**Total Cost (£)**
Ampoule of Syntometrine *2	2.70	Injection, ergometrine maleate 500 micrograms, oxytocin 5 units/mL, net price 1-mL amp = £1.35	£2.70
Ampoule of Syntocinon	1.35	Injection, ergometrine maleate 500 micrograms, oxytocin 5 units/mL, net price 1-mL amp = £1.35	£1.35
TOTAL			**£4.05**

GENERAL ANAESTHETIC							
Staff title and grade	**Length of time with staff**	**Cost (£) of staffing**	**comments/ assumptions for costing**	**Equipment**		**Source**	**Cost**
Scrub midwife band 6 or 7 *1		£ 8.13	Band 7 mid-point =£32704. Base year 2007/2008, Assumption- time spent 10 MINUTES	CTG in OU (per 8 hour Birthplace average labour duration)		Primary data collection Fin Mger Kings £13500 per CTG	£ 2.88
HCA *1		£ 3.36	Band 6 mid-point =£27388, Base year 2007/2008, Assumption- time spent 10 MINUTES	Thiopentone		Injection, powder for reconstitution, thiopental sodium, net price 500-mg vial = £3.06	£ 3.06
Obstetrician *2		£ 648.98	PSSRU 2010, page 218 (medical consultant). Assumption 50 minutes CNST added to calculation	N/Saline		intravenous infusion, usual strength sodium chloride 0.9% (9 g, 150 mmol each of Na+ and Cl-/litre), this strength being supplied when normal saline for injection is requested. Net price 2-mL amp = 35p; 5-mL amp = 42p; 10-mL amp = 57p; 20-mL amp = £1.04; 50-mL amp = £2.01	£ 2.01
Anaesthetist *1		£ 38.94	PSSRU 2010, page 218 (medical consultant),, Assumption- time spent 10 MINUTES	Vecuronium		Injection, powder for reconstitution, vecuronium bromide, net price 10-mg vial = £3.38 (with water for injections)	£ 3.38
ODA *1 (assists anaesthetist)		£ 36.50	PSSRU 2010, page 218 (medical consultant),	Syntocinon		oxytocin, net price 5 units/mL, 1-mL amp = 76p; 10 units/mL, 1-mL amp = 86p	£ 0.86
Pediatrician *1		£ 38.94	PSSRU 2010, page 218 (medical consultant),),, Assumption- time spent 10 MINUTES	Suxamenthonium		injection, suxamethonium chloride 50 mg/mL, net price 2-mL amp = 71p	£ 0.71
				Atropine		Injection, atropine sulphate 600 micrograms/mL, net price 1-mL amp = 68p	£ 0.68
				Pain relief:		Injection, fentanyl (as citrate) 50 micrograms/mL, net price 2-mL amp = 30p, 10-mL amp = 64p	£ 0.30
				Morphine		Intravenous infusion, morphine sulphate 1 mg/mL, net price 50-mL vial = £5.00; 2 mg/mL, 50-mL vial = £5.89	£ 5.00
				Lignocaine for insertion of IVI		Injection 2%, lidocaine hydrochloride 20 mg/mL, net price 2-mL amp = 31p; 5-mL amp = 31p; 10-mL amp = 60p; 20-mL amp = 80p	£ 0.31
				Neostigmine and atrophine or		Injection, neostigmine metilsulfate 2.5 mg/mL, net price 1-mL amp = 58p	£ 0.58
				Hartmann's 500ml		Intravenous infusion, usual strength sodium chloride 0.9% (9 g, 150 mmol each of Na+ and Cl-/litre), this strength being supplied when normal saline for injection is requested. Net price 2-mL amp = 35p; 5-mL amp = 42p; 10-mL amp = 57p; 20-mL amp = £1.04; 50-mL amp = £2.01	£ 0.35

GENERAL ANAESTHETIC CONT..				Equipment:			
				Oximeter for mother		primary costing, minimal - set to 0.01	£ 0.01
				ECG for mother		Taken from NHS supply chain catalogue 2009, page 222 code FDK129	£ 2.04
				Defibrilator		primary costing, minimal - set to 0.01	£ 0.01
				Datascope		primary costing, Equipment worth £3000 new	£ 0.10
				Syringes:			
				20ml (1)		Taken from NHS supply chain catalogue 2009, page 352 code FWC030	£ 0.05
				10ml (1)		Taken from NHS supply chain catalogue 2009, page 352 code FWC031	£ 0.05
				5ml (1)		Taken from NHS supply chain catalogue 2009, page 352 code FWD063	0.06
				2ml (6)		Taken from NHS supply chain catalogue 2009, page 352 code FWC032	£ 0.31
				Needles:		Taken from NHS supply chain catalogue 2009, page 764 code EHH028	£ 1.57
				21G		Taken from NHS supply chain catalogue 2009, page 337 code FTR167	£ 0.01
				23G		Taken from NHS supply chain catalogue 2009, page 337 code FTR163	£ 0.01
				27G		Taken from NHS supply chain catalogue 2009, page 337 code FTR348	£ 0.02
				Electronic fetal monitor		Primary data collection Fin Mger Kings £13500 per CTG	£2.88
				Fetal scalp electrodes		Taken from NHS supply chain catalogue 2009, page 960 code FDK314: £106.71 FOR BOX 25	£4.27
				Monitor graph paper		Taken from NHS supply chain catalogue 2009, page 242 code FDI058	£ 0.07
				Antiseptic wipe		Taken from NHS supply chain catalogue 2009, page 362 code VJT041	£ 0.06
				Sticky tape and vetafix/micropore		Taken from NHS supply chain catalogue 2009, page 764 code EHH028	£ 1.57
				14G or 16G Venflon		Taken from NHS supply chain catalogue 2009, page 59 code FSP033	£ 0.83

GENERAL ANAESTHETIC CONT..							
				Giving set(1)		Taken from NHS supply chain catalogue 2009, page 843 code FSC090	£ 3.05
				Endotracheal tube size 8.0		Taken from NHS supply chain catalogue 2009, page 646 code FDH745	£ 1.36
				Connector/Catheter mount/Introducer		Taken from NHS supply chain catalogue 2009, page 623 code FDB145	£ 1.48
				Laryngoscope		Taken from NHS supply chain catalogue 2009, page 236 code FSM109	£ 12.10
				Dommete Bandage		Taken from NHS supply chain catalogue 2009, page 711 code EBA075	£ 3.04
				Oro gastric tube + litmus		Taken from NHS supply chain catalogue 2009, page 353 code FWM871	£ 3.15
				Suction liner		Taken from NHS supply chain catalogue 2009, page code FDR447	£ 2.07
				Urinary catheter/Bag/Catheter pack		Taken from NHS supply chain catalogue 2009, page 1551 code FSS620, £44.67 for pack of 5	£ 8.93
				Masks		Taken from NHS supply chain catalogue 2009, page 479 code BWM042	£ 0.05
				Gowns		Taken from NHS supply chain catalogue 2009, page 479 code BWF036	£ 0.02
				Shoes		Taken from NHS supply chain catalogue 2009, page 293 code FFF171	£ 1.04
				Hats		Taken from NHS supply chain catalogue 2009, page 410 code BWK201	£ 1.36
Total:		**£ 774.85**					**£ 846.54**

SPONTANEOUS VERTEX BIRTH			
Equipment		**comments/ assumptions and source of cost data**	**Total Cost (£)**
OU:			
Delivery pack		Taken from NHS supply chain catalogue 2009, page 318 code EVX111 (sterile single use instrument delivery pack) + EVC019 (pack sterile delivery) + EVI010 (pack sterile delivery) (pack 8=£73.09) AND page 317 code ECV019 (pack 20=£55.69)	£ 16.15
Gloves		Taken from NHS supply chain catalogue 2009, page 200 code FTE888	£ 4.68
Maternity pads		Taken from NHS supply chain catalogue 2009, page 961 code EAO500	in delivery pack
Inco pads		Taken from NHS supply chain catalogue 2009, page 961 code EAO500	£ 0.09
Syringe Needle		Taken from NHS supply chain catalogue 2009, page 352 code FWC032	£ 0.05
Plastic cord clamp		Taken from NHS supply chain catalogue 2009, page 960 code FFK535	in delivery pack
			£ 0.02
		primary data collection	£ 0.08
		Taken from NHS supply chain catalogue 2009, page 123 code FWC082	£ 0.04
Materials for cord blood gases		Taken from NHS supply chain catalogue 2009, page 344 code FWC124	£ 2.14
Heparinised syringes x2		Taken from NHS supply chain catalogue 2009, page 136 code FSL491	in delivery pack
2 needles 1:10000			in delivery pack
2 wide syringes		primary data collection	£ 0.10
lydocaine hydochloride		lidocaine hydrochloride 5%, net price 15 g = 88p	£ 0.88
vitamin k injection		phytomenadione 10 mg/mL in a mixed micelles vehicle, net price 0.2-mL amp = 95p	0.95
amniotomy hook		Taken from NHS supply chain catalogue 2009, page 961 code FFY007	£ 0.86
TOTAL:			**£ 26.03**

SVB CONT….			
AMU AND FMU			
Delivery pack		Taken from NHS supply chain catalogue 2009, page 318 code EVX111 (sterile single use instrument delivery pack) + EVC019 (pack sterile delivery) + EVI010 (pack sterile delivery) (pack 8=£73.09) AND page 317 code ECV019 (pack 20=£55.69)	£ 16.15
Gloves		Taken from NHS supply chain catalogue 2009, page 200 code FTE888	£ 4.68
Maternity pads		Taken from NHS supply chain catalogue 2009, page 961 code EAO500	in delivery pack
Inco pads		Taken from NHS supply chain catalogue 2009, page 961 code EAO500	£ 0.09
Syringe Needle: giving drugs + taking cord blood		Taken from NHS supply chain catalogue 2009, page 352 code FWC032	£ 0.05
Plastic cord clamp			in delivery pack
Large disposal bag			in delivery pack
plastic draw sheet			in delivery pack
Catheter if required		Taken from NHS supply chain catalogue 2009, page 1551 code FST248, £46.69 for pack of 10	£ 4.69
lydocaine hydochloride		lidocaine hydrochloride 5%, net price 15 g = 88p	£ 0.88
vitamin k injection		phytomenadione 10 mg/mL in a mixed micelles vehicle, net price 0.2-mL amp = 95p	0.95
amniotomy hook		Taken from NHS supply chain catalogue 2009, page 961 code FFY007	£ 0.86

TOTAL			**29.53**

SVB CONT…			
HOMEBIRTH			
Vaginal examination pack		Taken from NHS supply chain catalogue 2009, page 324 code EVC011	£0.41
KY jelly		Taken from NHS supply chain catalogue 2009, page 144 code FTM113	£1.08
handwash		Taken from NHS supply chain catalogue 2009, page180 code MRB116, 75ml	£0.25
Inco pads		Taken from NHS supply chain catalogue 2009, page 961 code EAO500	£0.09
Paracetamol		http://bnf.org/bnf/bnf/current/3470.htm#_3470: paracetamol 500 mg, net price 16-tab pack = 17p	£0.06
Sociaide* hourly cost mulitplied by average duration labour		Sonicaid: http://www.medisave.co.uk/sonicaid-one-p-8466.html:	£0.08
Urine test		Taken from NHS supply chain catalogue 2009, page 123 code KFK391	£0.09
Blood pressure monitor		http://www.medisave.co.uk/blood-pressure-validated-c-50_366.html	£0.01
placenta bag + transportation box		Taken from NHS supply chain catalogue 2009, page 187 code FAL024	£ 21.80
Catheter if required		Taken from NHS supply chain catalogue 2009, page 1551 code FST248, £46.69 for pack of 10	£ 4.69
TOTAL			**£28.55**

ASSISTED DELIVERY: VENTOUSE						
Staff title and grade	**Cost (£) of staffing**	**comments/ assumptions and source of cost data**	**Equipment**		**comments/ assumptions and source of cost data**	**Total Cost (£)**
			Assisted delivery pack		Taken from NHS supply chain catalogue 2009, page 318 code EVX111 (sterile single use instrument delivery pack) + EVC019 (pack sterile delivery) + EVI010 (pack sterile delivery) (pack 8=£73.09) AND page 317 code ECV019 (pack 20=£55.69)	£ 16.15
obstetrician	£ 97.34	PSSRU 2008, page 160 (surgical consultant), Assumption- time spent 15				£ 97.34
Pediatrician	£ 194.68	PSSRU 2010, page 218 (medical consultant), Assumption- time spent 30				£ 194.68
Registrar teaching a FS	£ 97.34	PSSRU 2008, page 160 (surgical consultant), Assumption- time spent 15 MINUTES	Ventouse machine		Primary costing, annuitized multiplied by average labour duration	£ 1.32
			Inco pads		Taken from NHS supply chain catalogue 2009, page 961 code EAO500	£ 0.09
			Urinary Catheter		Taken from NHS supply chain catalogue 2009, page 1551 code FST248, £46.69 for pack of 10	£ 4.69
			Gloves		Taken from NHS supply chain catalogue 2009, page 200 code FTE888	£ 4.68
			Obstetric cream		http://www.shelfpharmacy.co.uk/products/more/KY-Jelly-82g/565.aspx: £3.25 for 82g, assumption one third of a tube used	£ 1.08
			Swabbing solution		BNF: methyl salicylate 0.5 mL, diethyl phthalate 2%, castor oil 2.5%, in industrial methylated spirit, net price 100 mL = 20p. Label: 15	£ 0.02
			Syringe 20ml (if not numbed)		Taken from NHS supply chain catalogue 2009, page 352 code FWC032	£ 0.10
			Vial of lignocaine (1%)		lidocaine hydrochloride 5%, net price 15 g = 88p	£ 0.88
			Needle (green)		Taken from NHS supply chain catalogue 2009, page 338 code FTR058	£ 0.13
			Pudendal needle (if no epidural)		Taken from NHS supply chain catalogue 2009, page 339 code FTR016	£ 4.58
			Materials for cord blood gases:			
			Heparinised syringe*2		Taken from NHS supply chain catalogue 2009, page 109 code FWL061	£ 5.67
			Blood gas machine		Primary costing - annuitized	£ 0.49
Total						**£ 429.23**

ASSISTED DELIVERY : FORCEPS							
Staff title and grade	**Length of time with staff**	**Cost (£) of staffing**	**comments/ assumptions and source of cost data**	**Equipment**		**comments/ assumptions and source of cost data**	**Total Cost (£)**
obstetrician	**30 mins**	£ 194.68	PSSRU 2010, page 160 (surgical consultant)	Assisted delivery pack		Taken from NHS supply chain catalogue 2009, page 318 code EVX111 (sterile single use instrument delivery pack) + EVC019 (pack sterile delivery) + EVI010 (pack sterile delivery) (pack 8=£73.09) AND page 317 code ECV019 (pack 20=£55.69)	£ 16.15
Pediatrician		£ 194.68	PSSRU 2008, page 160 (surgical consultant)	Rotational, midcavity or wringley forceps		Taken from NHS supply chain catalogue 2009, page 233 code FFI562+ FFI563 (pack 8=£73.09) AND page 317 code ECV019 (pack 20=£55.69)	£ 52.36
Registrar		£ 89.75	PSSRU 2008,pg 159	Inco pads		Taken from NHS supply chain catalogue 2009, page 961 code EAO500	£ 0.09
				Urinary catheter, not a retaining one		Taken from NHS supply chain catalogue 2009, page 1551 code FST248, £46.69 for pack of 10	£ 4.69
				Gloves		Taken from NHS supply chain catalogue 2009, page 200 code FTE888	£ 4.68
				ky jelly		http://www.shelfpharmacy.co.uk/products/more/KY-Jelly-82g/565.aspx: £3.25 for 82g, assumption one third of a tube used	£ 1.08
				Swabbing solution		BNF: methyl salicylate 0.5 mL, diethyl phthalate 2%, castor oil 2.5%, in industrial methylated spirit, net price 100 mL = 20p. Label: 15	£ 0.02
				Heparinised syringe		Taken from NHS supply chain catalogue 2009, page 352 code FWC032	£ 0.10
				Syringe 20ml (if not numbed) + needle		Taken from NHS supply chain catalogue 2009, page 352 code FWC032	£ 0.05
				Vial of lignocaine (10%)		lidocaine hydrochloride 5%, net price 15 g = 88p	£ 0.88
				Pudendal needle (if no epidural)		Taken from NHS supply chain catalogue 2009, page 339 code FTR016	£ 4.58
				Materials for cord blood gases:		primary costing	£ 0.10
				Heparainised syringe		Injection, prefilled disposable syringe, atropine sulphate 200 micrograms/mL, net price 5 mL = £5.90; 300 micrograms/mL, 10 mL = £5.91; 600 micrograms/mL, 1 mL = £5.91	£5.91
				Blood gas machine		primary costing	£ 0.10
							£ 569.89
Total:		**£ 479.11**					

CESEAREAN SECTION						
Staff title and grade	**Cost (£) of staffing**	**comments/ assumptions for costing**	**Equipment**	**Cost (£)**	**comments/ assumptions for costing**	**Total Cost (£)**
HCA *1	£ 14.05	Band 6 mid-point =£27388, Base year 2010, Assumption- time spent 1 hour	Epidural: see previous	£ 84.15	THIS EXCLUDES THE PREVIOUS STAFFING COST	£ 84.2
Obstetrician *2	£ 389.36	PSSRU 2010, page 218 (medical consultant), Assumption- time spent 30 minutes	Spinal needles	£ 5.91	Injection, prefilled disposable syringe, atropine sulphate 200 micrograms/mL, net price 5 mL = £5.90; 300 micrograms/mL, 10 mL = £5.91; 600 micrograms/mL, 1 mL = £5.91	£ 5.91
Anesthetist *1	£ 198.68	PSSRU 2010, page 218 (medical consultant), Assumption- time spent 30 MINUTES	Skin prep for surgeon and patient	£ 0.02	BNF: methyl salicylate 0.5 mL, diethyl phthalate 2%, castor oil 2.5%, in industrial methylated spirit, net price 100 mL = 20p. Label: 15	£ 0.02
ODA *1 (assists anaesthetist)	£ 89.75	PSSRU 2010, page 218 (medical consultant), Assumption- time spent 30 MINUTES	Caesarean section pack	£ 26.08	Taken from NHS supply chain catalogue 2009, page 608 code EHC007	£ 26.08
Pediatrician *1	£ 198.68	PSSRU 2010, page 218 (medical consultant), Assumption- time spent 30 MINUTES	Selection of needles	£ 0.10	Taken from NHS supply chain catalogue 2009, page 337 code FTR167, FTR163 and FTR348	£ 0.10
			Suction machine, tubing and attachment	£ 2.07	Taken from NHS supply chain catalogue 2009, page code FDR447	£ 2.07
****only included medical staff (excluded runner/ porter)**			Diathermy sets +pad	£ 3.75	Taken from NHS supply chain catalogue 2009, page 217 code FGP799	£ 3.75
			Betadine solution	£ 2.39	povidone–iodine 1.14% in a pressurised aerosol unit, net price 50-mL unit = £2.39	£ 2.39
			Surgical spirits	£ 0.02	BNF: methyl salicylate 0.5 mL, diethyl phthalate 2%, castor oil 2.5%, in industrial methylated spirit, net price 100 mL = 20p. Label: 15	£ 0.02
			Gloves	£ 4.68	Taken from NHS supply chain catalogue 2009, page 200 code FTE888	£ 4.68
			Electronic Mucus extractor	£ 0.16		£ 0.16
			Urinary catheter and bag	£ 8.93	Taken from NHS supply chain catalogue 2009, page 1551 code FSS620, £44.67 for pack of 5	£ 8.93
			Vaginal examination pack	£ 0.41	Taken from NHS supply chain catalogue 2009, page 324 code EVC011	£ 0.41
			Obstetric cream	£ 1.08	http://www.shelfpharmacy.co.uk/products/more/KY-Jelly-82g/565.aspx: £3.25 for 82g, assumption one third of a tube used	£ 1.08
			Inco pads	£ 0.09	Taken from NHS supply chain catalogue 2009, page 961 code EAO500	£ 0.09

C/S CONT….						
			Sanitary towels	£ 0.09	Taken from NHS supply chain catalogue 2009, page 961 code EAO500	£ 0.09
			Razor	£ 0.15	Taken from NHS supply chain catalogue 2009, page 219 code MRA033	£ 0.15
			Tape, to go over jewellery			
			Hospital gown	£ 1.36	Taken from NHS supply chain catalogue 2009, page 410 code BWK201	£ 1.36
			Support stockings	£ 1.04	Taken from NHS supply chain catalogue 2009, page 293 code FFF171	£ 1.04
				£ 5.44	Taken from NHS supply chain catalogue 2009, page 410 code EGD192	£ 5.44
			Materials for cord blood gases:	£ 2.14	Taken from NHS supply chain catalogue 2009, page 344 code FWC124	£ 2.14
			Heparainised syringe	£ 5.91	Injection, prefilled disposable syringe, atropine sulphate 200 micrograms/mL, net price 5 mL = £5.90; 300 micrograms/mL, 10 mL = £5.91; 600 micrograms/mL, 1 mL = £5.91	£ 5.91
			Spencer Wells forceps	included in packs		included in packs
			Blood gas machine			
			4 sutures	£ 3.20	Taken from Barkantine purchase report 24/11/09	£ 3.20
			needle protector pad	£ 0.33	Taken from NHS supply chain catalogue 2009, page 122 code KFK310	£ 0.33
			sterile bed liner	£ 0.04	Taken from NHS supply chain catalogue 2009, page 674 code FDE384	£ 0.04
			sterile water 1 litre	£ 2.55	Taken from NHS supply chain catalogue 2009, page 674 code FDE384	£ 2.55
TOTAL	**£ 890.52**			**£162.08**		**£ 1052.60**

SUTURING EPISIOTOMY					
Staff title and grade	**Length of time with staff**		**Cost (£)**	**Comments/ assumptions for costing**	**Total**
MW, band 6 or 7 (NOT INCLUDED)	**60 minutes**	Perineal suture pack	£ 12.26	Taken from NHS supply chain catalogue 2009, page 319 code EVX122	£ 12.26
		Selection of threads, vicryl sutures 2.0 rapide *2	£ 3.20	Taken from Barkantine purchase report 24/11/09	£ 3.20
		Inco pads	£ 0.09	Taken from NHS supply chain catalogue 2009, page 961 code EAO500	£ 0.09
		Swabbing solution	£ 0.02	BNF: methyl salicylate 0.5 mL, diethyl phthalate 2%, castor oil 2.5%, in industrial methylated spirit, net price 100 mL = 20p. Label: 15	£ 0.02
		Gloves	£ 0.20	Taken from NHS supply chain catalogue 2009, page 195 code FTE883	£ 0.20
		Syringe 20ml if not numbed + needles	£ 0.05	Taken from NHS supply chain catalogue 2009, page 352 code FWC031	£ 0.05
		1% 10 ml lignocaine	£ 0.88	lidocaine hydrochloride 5%, net price 15 g = 88p	£ 0.88
		lighting source			
		gown	£ 1.36	Taken from NHS supply chain catalogue 2009, page 410 code BWK201	£ 1.36
		Tray	£ 4.63	Taken from NHS supply chain catalogue 2009, page 143 code ij3097	£ 4.63
		lithohony set	£ 6.51	Taken from NHS supply chain catalogue 2009, page 387 code VJD782	£ 6.51
Total					**£ 24.57**

SUTURING FIRST AND SECOND DEGREE TEAR					
Staff title and grade	**Length of time with staff**	**Equipment**	**Cost (£)**	**Comments/ assumptions for costing**	**Total**
MW, band 6 or 7	30 - 45 mins				
		delivery pack (PS pack FMU)	£ 12.26	Taken from NHS supply chain catalogue 2009, page 319 code EVX122	£ 12.26
		Selection of threads : Vicryl 2.0	£ 3.20	Taken from Barkantine purchase report 24/11/09	£ 3.20
		10 ml 1% lignocaine	£ 0.88	lidocaine hydrochloride 5%, net price 15 g = 88p	£ 0.88
		Gloves	£ 0.20	Taken from NHS supply chain catalogue 2009, page 195 code FTE883	£ 0.20
		Syringe 20ml + needles	£ 0.05	Taken from NHS supply chain catalogue 2009, page 352 code FWC031	£ 0.05
		Tray	£ 4.63	Taken from NHS supply chain catalogue 2009, page 143 code ilj3097	£ 4.63
		Swabs	£ 0.06	Taken from NHS supply chain catalogue 2009, page 769 code HHD090	£ 0.06
TOTAL					**£21.28**

SUTURING THIRD AND FOURTH DEGREE TEAR						
Staff title and grade	**Length of time with staff**	**Cost**	**Equipment**	**Cost (£)**	**comments/ assumptions for costing**	**Total**
Consultant obstetrician	45 mins	£ 175.21	Perineal suture pack	£ 12.26	Taken from NHS supply chain catalogue 2009, page 319 code EVX122	£ 12.26
Registrar	45 mins	£ 134.61	Selection of sutures: PDS + vicryl 2.0	£ 3.20	Taken from Barkantine purchase report 24/11/09	£ 3.20
Anaesthetist	45 mins	£ 175.21	SPINAL	£ 67.41		£ 67.41
scrub nurse	45 mins	£ 13.95	urinary catheter (if needed)	£ 1.91	Taken from NHS supply chain catalogue 2009, page 1551 code FSS394	£ 1.91
			Catheter bag	£ 8.93	Taken from NHS supply chain catalogue 2009, page 1551 code FSS620, £44.67 for pack of 5	£ 8.93
			10mls syringe	£ 0.05	Taken from NHS supply chain catalogue 2009, page 352 code FWC031	£ 0.05
			Water	£ 2.55	Taken from NHS supply chain catalogue 2009, page 134 code VMC019	£ 2.55
Total		£ 498.98		£ 96.31		**£595.30**

MANUAL REMOVAL OF THE PLACENTA						
Staff title and grade	**Length of time with staff**	**Cost**	**Equipment**	**Cost (£)**	**Source**	**Total**
Extra MW band 6 or 7	30 - 60 mins	£ 60.98	Theatre greens and shoes	£ 0.09	Taken from NHS supply chain catalogue 2009, page 479 code BWT028	£ 0.09
Consultant obstetrician	45 mins	£ 175.21	Sterile field/drapes	£ 3.93	Taken from NHS supply chain catalogue 2009, page 479 code BWP053	£ 3.93
Registrar	45 mins	£ 134.61	MRP pack/uterine pack	£ 16.15	Taken from NHS supply chain catalogue 2009, page 318 code EVX111 (sterile single use instrument delivery pack) + EVC019 (pack sterile delivery) + EVI010 (pack sterile delivery) (pack 8=£73.09) AND page 317 code ECV019 (pack 20=£55.69)	£ 16.15
Anaesthetist	45 mins	£ 175.21	Urinary catheter	£ 8.93	Taken from NHS supply chain catalogue 2009, page 1551 code FSS620, £44.67 for pack of 5	£ 8.93
scrub nurse	45 mins	£ 13.95	Perineal suture pack	£ 12.26	Taken from NHS supply chain catalogue 2009, page 319 code EVX122	£ 12.26
			Long gloves	£ 4.68	Taken from NHS supply chain catalogue 2009, page 200 code FTE888	£ 4.68
			Cleaning fluid	£ 0.02	BNF: methyl salicylate 0.5 mL, diethyl phthalate 2%, castor oil 2.5%, in industrial methylated spirit, net price 100 mL = 20p. Label: 15	£ 0.02
			Antibiotics	£ 15.04	Primary costing of AP	£ 15.04
			Syntocinon Infusion	£ 0.86	oxytocin, net price 5 units/mL, 1-mL amp = 76p; 10 units/mL, 1-mL amp = 86p	£ 0.86
			SPINAL	£ 67.41		£ 67.41
Total:		**£ 559.96**		**£ 129.36**		**£ 689.32**

BLOOD TRANSFUSION						
Staff title and grade	**Cost (£) of staffing**	**comments/ assumptions for costing**	**Equipment**	**Cost (£)**		**Total**
Obstetrician	£ 38.94	PSSRU 2010, page 218 (medical consultant),, Assumption- time spent 10 MINUTES	Cross matching at path lab	£ 43.34	Primary Cost data collection: Pricing of blood and red blood cell for 2020	£ 43.34
Anesthetist	£ 38.94	PSSRU 2010, page 218 (medical consultant),, Assumption- time spent 10 MINUTES	Blood tubes	£ 0.46	Taken from NHS supply chain catalogue 2009, page 113 code KFK294	£ 0.46
			Blood bottles	£ 0.41	Taken from NHS supply chain catalogue 2009, page 113 code KFK395	£ 0.41
			Syringe/needle	£ 0.05	Taken from NHS supply chain catalogue 2009, page 352 code FWC032	£ 0.05
			Swabs	£ 0.06	Taken from NHS supply chain catalogue 2009, page 769 code HHD090	£ 0.06
			Giving sets	£ 0.36	Taken from NHS supply chain catalogue 2009, page 56 CODE FSB531	£ 0.36
			Filters	£ 4.62	Taken from NHS supply chain catalogue 2009, page 142 CODE FTC235	£ 4.62
			Venflon	£ 0.83	Taken from NHS supply chain catalogue 2009, page 59 code FSP033	£ 0.83
			Sterile dressing	£ 0.13	Taken from NHS supply chain catalogue 2009, page 764 code EHU019	£ 0.13
			IV infusion	£ 15.04	primary costing	£ 15.04
			Fluids	£ 2.01	intravenous infusion, usual strength sodium chloride 0.9% (9 g, 150 mmol each of Na+ and Cl-/litre), this strength being supplied when normal saline for injection is requested. Net price 2-mL amp = 35p; 5-mL amp = 42p; 10-mL amp = 57p; 20-mL amp = £1.04; 50-mL amp = £2.01	£ 2.01
			Blood packs	167.31 for intra-uterine transfusion of red cells, £330.30 for platelets	Primary Cost data collection: Pricing of blood and red blood cell for 2020167.31 for intra-uterine transfusion of red cells, £330.30 for platelets	167.31 for intra-uterine transfusion of red cells, £330.30 for platelets
Total :	**£ 77.87**			**£ 67.32**		**£145.19 plus units of cells transfused**

STILLBIRTH AND NEONATAL DEATH			
Procedures	**Details**	**Cost (£)**	**Comments/ assumptions for costing**
Real time ultrasonography Post-mortem / Autopsy			RCOG Greentop guidelines 55
Real time ultrasonography Post-mortem / Autopsy	"babygram by faxitron, genetic testing, micro, histo and placenta (usually around 30 blocks total for a SB+placenta), it's a consultant led service in most depts, so factor in the cost of a consultant-takes about 2-3 hours to do the PM, and about an hour to report, probably more, so that's one full session of consultant time. Cost of an MTO, cost of lab BMS processing..."	£600	Primary costing from the Royal College of Pathologists
Total			
COUNSELLING ASSISTANCE			
Hospital bereavement midwife or counsellor: salary	**Assumption made**	**Unit cost**	**Source of Unit cost**
	Direct patient contact time of 1 hour		SANDS: Stillbirth and Neonatal Death Charity: primary costing : discussion about the availability of bereavement care following a baby death RCOG Greentop guidelines 55
Band 7 mid at £35184, Base year 2009/2010 Agenda for change January to March 2010 NHS Staff Earnings estimates.		£44 per hour direct contact	PSSRU: Unit costs of Health and Social care 2010
Salary oncosts: £8698 per annum (Employer's NI plus 14% superannuation)			
Qualifications: £4801 per annum Education investment cost annuitied over working life			
Overheads: £4388 per annum Indirect staffing /administration overheads			
Working time: 41.4 weeks per annum 37.5 hours per week. Includes: 29 days A/L. 8 days statutory leave. 5 study days. 12 days sick leave.			
TOTAL:		**£ 644**	

Appendix 16 Resource use measurement

Table 16.1 A Resource use during intrapartum care[e]

Resource use variable	OU n=18847	Home n=16187	FMU n=10971	AMU n=16031
HOME				
Homebirth packs	0.0 (0.0)	1.0	0.0 (0.0)	0.0 (0.0)
Staff travel to homebirth – distance 23 miles return trip	0.0 (0.0)	1.0	0.0 (0.0)	0.0 (0.0)
ALL 'non-OU' units				
Duration of labour care prior to transfer	0.0 (0.0)	1.20 (2.92)	1.45 (3.36)	1.72 (3.61)
Transfer duration	0.0 (0.0)	0.10[§] (0.24)	0.13[§] (0.27)	0.05[§] (0.12)
Mode of transfer				
Ambulance	0.0 (0.0)	0.17 (0.38)	0.21 (0.41)	0.0 (0.0)
Private car	0.0 (0.0)	0.031 (0.17)	0.005 (0.069)	0.0013 (0.0036)
Wheelchair or trolley	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.21 (0.41)
Bed	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.021 0.143
Rapid response ambulance car	0.0 (0.0)	0.00025 (0.016)	0.0 (0.0)	0 .0 (0.0)
Helicopter	0.0 (0.0)	0.00006 (0.008)	0.0 (0.0)	0.0 (0.0)
Taxi	0.0 (0.0)	0.0003 (0.019)	0.00009 (0.0009)	0.0 (0.0)
No physical transfer	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0011 (0.034)

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Resource use variable	OU n=18847	Home n=16187	FMU n=10971	AMU n=16031
Duration of labour care after transfer (hours)	0.0 (0.0)	6.8 (3.71)	6.6 (3.58)	6.8 (4.01)
ALL UNITS				
Duration of labour care from start to finish if no transfer (hours)	9.01 (6.22)	6.61 (5.31)	7.49 (5.68)	7.92 (5.92)
Procedures related to intrapartum care				
Augmentation	0.235 (0.42)	0.054 (0 .23)	0.071 (0 .26)	0.103 (0 .30)
Epidural/Spinal	0.307 (0.45)	0.083 (0.27)	0.106 (0.31)	0.153 (0.35)
General Anaesthetic	0.015 (1.12)	0.005 (0.067)	0.005 (0.073)	0.006 (0.07)
Active Management of the third stage of labour	0.939 (0.23)	0.687 (0.46)	0.779 (0.42)	0.859 (0.46)
Episiotomy	0.193 (0.39)	0.054 (0.23)	0.086 (0.28)	0.131 (0.33)
Perineal trauma	0.032 (0.17)	0.19 (0.14)	0.023 (0.14)	0.032 (0.17)
ECMO	0.0001 (0.014)	0.00018 (0.002)	0.00018 (0.19)	0.00049 (0.04)
Total body cooling	0.0005 (0.02)	0.00045 (0.02)	0.00032 (0.02)	0.00031 (0.017)
Care for a stillbirth	0.0002 (0.012)	0.0003 (0.018)	0.0004 (0.019)	0.0001 (0.007)
Neonatal death	0.0003	0.0003 (0.027)	0.0004 (0.02)	0.0001 (0.0176)

Resource use variable	OU n=18847	Home n=16187	FMU n=10971	AMU n=16031
Mode of birth				
Spontaneous vertex birth	0.738 (0 .49)	0.928 (0.31)	0.907 (0.29)	0.859 (0.47)
Vaginal breech birth	0.002 (0.04)	0.004 (0.06)	0.004 (0.058)	0.002 (0.03)
Ventouse	0.081 (0.26)	0.021 (0.14)	0.027 (0.16)	0.048 (0.21)
Forceps	0.068 (0.24)	0.021 (0 .15)	0.029 (0 .17)	0.047 (0.20)
Caesarean section	0.11 (0.31)	0.028 (0 .16)	0.035 (0.18)	0.044 (0.36)

Resource use variable	OU n=18847	Home n=16187	FMU n=10971	AMU n=16031
HIGHER LEVEL OF POST NATAL CARE FOR MOTHER				
Postnatal care (hours)	30.8 (22.7)	4.47 (14.4)	32.11 (25.4)	25.7 (20.3)
High dependency care following birth provided within the labour ward (days)	0.18 (0.38)	0.05 (0.23)	0.07 (0.26)	0.09 (0.29)
Admission to intensive care unit (days)	0.002 (0.034)	0.0009 (0.036)	0.0007 (0.021)	0.001 (0.023)
Admission to high dependency unit (days)	0.0057 (0.09)	0.003 (0.077)	0.0035 (0.101)	0.0038 (0.0062)
Admission to specialist care (days)	0.002 (0.003)	0.0009 (0.036)	0.0007 (0.0021)	0.0010 (0.0023)
HIGHER LEVEL OF CARE FOR THE BABY				
Admission to neonatal intensive care unit (days)	0.01 (0.24)	0.01 (0.246)	0.007 (0.210)	0.009 (0.329)
Admission to neonatal high dependency unit (days)	0.01 (0.376)	0.006 (0.229)	0.012 (0.312	0.007 (0.209)
Admission to neonatal specialist care (days)	0.094 (0.873)	0.0537 (0.616)	0.057 (0.785)	0.058 (0.801)

[e] *Values are given as means (standard deviations). Where numbers are extremely small they are shown to up to 5 decimal places, otherwise to three decimal places to reflect consistency in presentation of the results with the prospective cohort study. Includes all 'low risk' women where the primary outcome and potential confounders are not missing. n = 62036*

[¥] *when women who were not transferred from their planned place of birth were excluded from this analysis: duration of labour care (hours) prior to transfer was calculated as: 5.71 (home), 6.68 (FMU), 6.5 (AMU)*

[§] *when women who were not transferred from their planned place of birth were excluded from this analysis: duration of transfer (hours) was calculated as: 0.487 (home), 0.592 (FMU), 0.175 (AMU) which is 29 minutes (home), 35 minutes (FMU) and 10 minutes (AMU) respectively*

€ when women who were not transferred from their planned place of birth were excluded from this analysis: duration of labour care (hours) after transfer was calculated as: 6.8 (home), 6.6 (FMU), 6.89 (AMU)

Appendix 17 Components of clinical outcome measure for mother and baby

Combined maternal and neonatal outcomes (Hollowell et al., 2010)	
Mother not well baby well	
Mother: any of the following	third or fourth degree perineal trauma unplanned caesarean section blood transfusion admission to an intensive therapy unit, high dependency unit or specialist unit maternal death (within 42 days of giving birth)
Baby: none of the following	stillbirth after presentation in labour early neonatal death (< 7 days) 'neonatal encephalopathy' a clinical diagnosis of neonatal encephalopathy admission to a neonatal unit within 48 hours of birth for at least 48 hours with evidence of feeding difficulties or respiratory distress meconium aspiration syndrome brachial plexus injury fractured humerus fractured clavicle fractured skull apgar score less than seven at five minutes cephalohaematoma cerebral haemorrhage early onset neonatal sepsis (within 48 hours of birth) kernicterus (severe bilirubin encephalopathy) seizures
Mother not well baby not well	
Mother: any of the following	third or fourth degree perineal trauma unplanned caesarean section blood transfusion admission to an intensive therapy unit, high dependency unit or specialist unit maternal death (within 42 days of giving birth)
Baby: any of the following	stillbirth after presentation in labour early neonatal death (< 7 days) 'neonatal encephalopathy' a clinical diagnosis of neonatal encephalopathy admission to a neonatal unit within 48 hours of birth for at least 48 hours with evidence of feeding difficulties or respiratory distress meconium aspiration syndrome brachial plexus injury fractured humerus fractured clavicle fractured skull apgar score less than seven at five minutes cephalohaematoma cerebral haemorrhage early onset neonatal sepsis (within 48 hours of birth) kernicterus (severe bilirubin encephalopathy) seizures

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Mother well baby not well	
Mother: none of the following	third or fourth degree perineal trauma unplanned caesarean section blood transfusion admission to an intensive therapy unit, high dependency unit or specialist unit maternal death (within 42 days of giving birth)
Baby: any of the following	stillbirth after presentation in labour early neonatal death (< 7 days) 'neonatal encephalopathy' a clinical diagnosis of neonatal encephalopathy admission to a neonatal unit within 48 hours of birth for at least 48 hours with evidence of feeding difficulties or respiratory distress meconium aspiration syndrome brachial plexus injury fractured humerus fractured clavicle fractured skull apgar score less than seven at five minutes cephalohaematoma cerebral haemorrhage early onset neonatal sepsis (within 48 hours of birth) kernicterus (severe bilirubin encephalopathy) seizures
Mother well baby well	
Mother: none of the following	third or fourth degree perineal trauma unplanned caesarean section blood transfusion admission to an intensive therapy unit, high dependency unit or specialist unit maternal death (within 42 days of giving birth)
Baby: none of the following	stillbirth after presentation in labour early neonatal death (< 7 days) 'neonatal encephalopathy' a clinical diagnosis of neonatal encephalopathy admission to a neonatal unit within 48 hours of birth for at least 48 hours with evidence of feeding difficulties or respiratory distress meconium aspiration syndrome brachial plexus injury fractured humerus fractured clavicle fractured skull apgar score less than seven at five minutes cephalohaematoma cerebral haemorrhage early onset neonatal sepsis (within 48 hours of birth) kernicterus (severe bilirubin encephalopathy) seizures

Appendix 18 Literature searches to inform the decision analytic model

A comprehensive literature search strategy was developed in 2007 and was undertaken between October and December 2007 and again from September 2011 to December 2011. The strategy was applied to a number of bibliographic databases. Published reports in the search included original data on the outcomes of interest. Exclusion criteria included papers from developing countries, as their national maternity service configuration was considered to be too different to the UK to merit research in this study. Non-English language papers were also excluded. Ovid Alert systems were then created in 2007 with monthly emailed alerts to update the literature search and any new and relevant data was obtained for the study.

Search strategy for data relevant to planned place of birth

The following electronic databases were searched from 1980 onwards or the start of the database if after 1980:

Medline

EMBASE

Cochrane Libarary

OVID: Maternity and Infant Care

Health Economic Evaluations Database (HEED)

Biomed Central

British Nursing Index (BNI)

RCN Journals Database

Health Management Information Consortium (HMIC)

Cumulative Index to Nursing and Allied Health Literature (CINAHL)

The search terms included:

1. maternity
2. cost$ maternity
3. cost-effectiveness maternity
4. efficiency maternity

5. models of care (citation + abstract)
6. care pathways maternity
7. data envelopment analysis maternity
8. service configuration maternity

Current OVID search terms for monthly alerts:

Maternity OVID

Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations and Ovid

Ovid MEDLINE(R) Corrections (updates since 2010-03-31)

Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations and Ovid

Ovid MEDLINE(R) <2006 to April Week 3 2010> (updates since 2010-03-31)

Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations and Ovid

Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <April 30, 2010> (updates since 2010-03-31)

MaternityEMB

EMBASE <1996 to 2010 Week 17>

EMBASE (updates since 2010-03-25)

MaternityGLO

Global Health <1973 to March 2010>

Global Health (updates since 2010-03-03)

Following the design of the decision-analytic model, literature searches were then conducted on Pubmed for each of the variables or probable events recorded in table 7. Detailed research on the references contained in the NICE Intrapartum Care Guidelines was also conducted. Birthplace has its

own Endnote database of relevant references which were also searched. The following table shows the studies reviewed by category.

Key words / topics addressed	Number of outlines / abstracts scanned	No of papers read
Duration of labour maternity, aspects of the clinical pathway	194	2
Midwife-led staffing – care during labour	488	4
Cost-effectiveness analysis birth	855	1
Home birth – safety, economics	23	4
Birth centres	156	2
Home versus hospital birth	110	3
NHS maternity statistics England	26	0
Reconfiguration of maternity units, models of maternity care	4	2
Augmentation	1428	2
Use of gas and air (entonox)	58	0
Fetal monitoring labour human	3966	1
Immersion water labour birth	31	1
Epidural analgesia	1927	2
Meconium staining	367	0
Perineal trauma	224	1
Postpartum haemorrhage human birth	636	2
Unplanned caesarean section human	31	8
Kernicterus newborn neonate	873	1
Saving mother's lives	7	1
Neonatal care – costs, staffing, resuscitation, near miss	20	5
Critical audit perinatal maternal morbidity	6	1
Brachial plexus injury obstetric newborn	282	3
Maternal morbidity postpartum obstetric	275	1
Neonatal morbidity term obstetric England	28	0
Life expectancy newborn england	36	0
Clinical negligence maternity litigation	9	1

The following literature search histories show the abstracts scanned and final number of papers read for longer terms cost-effectiveness data. Searches were undertaken for the following clinical outcomes in Pubmed, Embase and the Cochrane Collaboration.

Searches conducted for adverse maternal outcomes

Postpartum Haemorrhage

Search History

PUBMED

Search	Most Recent Queries	Time	Result
#23	Search #22 AND #9	09:33:49	4
#22	Search #20 AND #21	09:33:18	333
#21	Search hysterectomy[MeSH Terms]	09:32:39	22213
#20	Search postpartum haemorrhage[MeSH Terms]	09:31:09	4027
#18	Search longer term followup [MeSH Terms]	09:29:49	0
#17	Search economic evaluation[MeSH Terms]	09:29:07	0
#9	Search cost* OR cost-saving* OR cost-effect*[MeSH Terms]	07:02:33	315115
#8	Search outcome*[MeSH Terms]	07:01:49	0
#7	Search outcomes[MeSH Terms]	07:01:21	0
#3	Results: 4	06:47:29	1083747

COCHRANE LIBRARY

Cochrane Reviews [35]
Other Reviews [12]
Clinical Trials [351]
Methods Studies [0]
Technology Assessments [5]
Economic Evaluations [5]
Cochrane Groups [0]

EMBASE

Searches	Results	Search	Type
1	(cost* or cost-saving or cost-effect*).xs.	0	Advanced
2	limit 1 to english language [Limit not valid in Econlit; records were retained]	0	Advanced
3	limit 2 to humans [Limit not valid in Econlit; records were retained]	0	Advanced
4	(cost* or cost-saving or cost-effect*).kw.	15200	Advanced
5	(cost* or cost-saving or cost-effect*).ab.	624679	Advanced
6	((cost* or cost-saving or cost-effect*) and postpartum haemorrhage).kw.	2	Advanced

Vaginal birth after caesarean section

PUBMED

Search History

Search	Most Recent Queries	Time	Result
#10	Search #9 AND #7	10:45:28	7
#12	Search #10 AND #3	10:44:59	0
#11	Search #10 AND #2	10:44:29	0
#9	Search #1 AND #5 AND #4	10:42:31	17
#8	Search #1 AND #7	10:41:50	506
#7	Search cost* OR cost-saving* OR cost-effect*[MeSH Terms]	10:41:04	315115
#6	Search follow-up studies	10:40:24	567077
#5	Search outcomes	10:38:58	293585
#4	Search economic evaluation	10:38:43	70075
#3	Search vaginal birth after caesarean section	10:38:16	1636
#2	Search vaginal birth after caesarean section[MeSH Terms]	10:37:56	0
#1	Search caesarean section[MeSH Terms]	10:37:24	31441

COCHRANE COLLABORATION

Cochrane Reviews [10]
Other Reviews [0]
Clinical Trials [22]
Methods Studies [2]
Technology Assessments [0]
Economic Evaluations [1]
Cochrane Groups [0]

EMBASE

Searches	Results	Search	Type
1	(caesarean section and (cost* or cost-saving or cost-effect*)).kw.	4	Advanced
2	((cost* or cost-saving or cost-effect*) and vaginal birth after caesarean section).kw.	0	Advanced

Perineal Trauma

PUBMED

Search History

Search	Most Recent Queries	Time	Result
#19	Search #18 AND #6	09:28:15	3
#18	Search ("Vaginal Birth after Cesarean"[Mesh] AND "Cesarean Section"[Mesh]) AND ("Morbidity"[Mesh] OR "Epidemiology"[Mesh])	09:25:30	41
#13	Search #6 AND #11 AND #9	09:19:01	3
#6	Search cost*	09:18:24	314731
#11	Search birth injuries	09:17:58	6923
#10	Search birth	09:16:07	222265
#9	Search perineum	09:15:43	8143
#8	Search #6 AND #5	09:14:51	0

#7 Search #6 OR #5 09:14:39 314739
#5 Search (("Perineum"[Mesh]) AND ("Parturition"[Mesh] OR "Term Birth"[Mesh] OR "Birth Injuries"[Mesh])) AND "Outcome Assessment (Health Care)"[Mesh]

Searches conducted for adverse perinatal outcomes

Stillbirth

Search	Stillbirth	Time	Result
#11	Search #10 AND #9	07:04:03	8
#10	Search #3 AND #4	07:03:26	451
#9	Search cost* OR cost-saving* OR cost-effect*[MeSH Terms]	07:02:33	315115
#8	Search outcome*[MeSH Terms]	07:01:49	0
#7	Search outcomes[MeSH Terms]	07:01:21	0
#4	Search Stillbirth/economics OR Stillbirth/epidemiology[MeSH Terms]	06:48:34	580
#3	Search Search newborn OR neonat* OR infant OR birth OR childbirth[MeSH Terms]	06:47:29	1083747
#2	Search newborn OR neonate OR infant OR birth OR childbirth[MeSH Terms]	06:46:33	1110122
#1	Search newborn OR neonat OR infant OR birth OR childbirth[MeSH Terms]	06:46:32	1107562

Meconium Aspiration Syndrome

Search	Meconium Aspiration Syndrome	Time	Result
#17	Search #15 and #10	12:16:17	0
#16	Search #14 and #10	12:15:43	1
#15	Search #12 and #9	12:14:50	36
#14	Search #12 and #8	12:14:11	50
#13	Search #12 AND #7	12:13:37	2
#12	Search #11 AND #6	12:13:09	827
#11	Search #2 and #5	12:12:46	827
#10	Search cost* OR cost-saving OR cost-effect*[MeSH Terms]	12:12:13	315115
#9	Search follow up	12:11:31	764909
#8	Search outcomes	12:11:08	293585
#7	Search economic evaluation	12:10:53	70075
#6	Search newborn OR neonat* OR infant OR birth OR childbirth[MeSH Terms]	12:10:26	1147411
#5	Search Neonatal aspiration of meconium	12:09:22	1334
#2	Search "Meconium Aspiration Syndrome"[Mesh]	12:06:06	827

Neonatal Encephalopathy

Search	Neonatal Encephalopathy	Time	Result
#13	Search #8 AND #11 AND #12	11:03:36	36
#12	Search cost*	11:03:03	314907
#11	Search #9 OR #10	11:02:21	44441
#10	Search encephalopathy	11:01:56	33232

#9	Search hypoxia-ischemia, brain OR asphyxia neonatorum	11:01:21	12536
#8	Search hypoxia-ischemia, brain OR asphxia neonatorum	11:01:20	6382
#7	Search neonat* OR newborn* OR birth OR childbirth	10:59:55	742685
#6	Search infant	10:58:53	895440

Neonatal Encephalopathy cont..

Search	Neonatal Encephalopathy		Time	Result
#26	Search #16 AND #21 AND #25	07:09:09	593	
#25	Search #23 OR #24	07:08:43	53682	
#24	Search cooling OR hypothermia	07:08:18	53682	
#23	Search "Hypothermia, Induced"[Mesh]	07:07:57	15088	
#21	Search #19 OR #20	07:07:24	40938	
#20	Search encephalopathy	07:07:09	33113	
#19	Search ("Hypoxia-Ischemia, Brain"[Mesh]) OR "Asphyxia Neonatorum"[Mesh]	07:06:58	8964	
#16	Search #14 OR #15	07:06:00	1191888	
#15	Search neonat* OR newborn* OR infant* OR birth OR childbirth	07:05:46	1191888	
#14	Search "Infant"[Mesh]	07:05:16	854421	

Birth-related Injury

Search History

Search	Most Recent Queries	Time	Result
#16	Search fractured skull	17:15:16	17752
#14	Search #6 and #5 and #11	17:02:19	2
#13	Search "Birthplace in England Collaborative Group"[Corporate Author]	17:01:21	1
#11	Search fractured clavicle	17:00:59	1761
#10	Search #9 and #6 and #5	16:58:54	2
#9	Search fractured humerus	16:58:31	4641
#8	Search #7 AND #6 and #5	16:52:18	16
#7	Search brachial plexus injury	16:51:53	7893
#6	Search cost* OR cost-saving OR cost-effect*	16:49:20	315115
#5	Search newborn OR neonat* OR birth OR childbirth OR infant[MeSH Terms]	16:48:40	1126153

Sepsis

Search History

Search	Most Recent Queries	Time	Result
#20	Search #19 and #8	13:55:00	19
#21	Search #20 and #9	13:54:44	1
#19	Search #7 and #18	13:53:46	208
#18	Search #6 and #16	13:53:26	17529
#16	Search newborn OR neonat* OR infant OR childbirth OR birth	13:51:43	1151900
#9	Search economic evaluation	13:43:40	70075
#8	Search outcomes	13:40:18	293585
#7	Search sepsis[MeSH Terms]	13:30:10	80169

#6	Search cost* OR cost-saving OR cost-effect*[MeSH Terms]	13:27:32	315115

Cerebral palsy

Search History

Search	Most Recent Queries	Time	Result
#26	Search #22 AND #19	18:44:20	1
#25	Search "Costs and Cost Analysis"[Mesh] AND "Health Care Costs"[Mesh] AND "Cost of Illness"[Mesh] AND "Cost-Benefit Analysis"[Mesh] AND "Cost Allocation"[Mesh] AND "Hospital Costs"[Mesh] AND "Employer Health Costs"[Mesh] AND "Cost Savings"[Mesh] 18:43:58 0		
#23	Search #22 OR #19	18:42:57	331
#22	Search cost*	18:42:00	137
#19	Search #17	18:40:25	195
#17	Search #16 OR #15	18:39:40	195
#16	Search #11 18:38:20 4		
#15	Search #14 OR #12	18:37:43	191
#14	Search infant	18:36:47	34
#12	Search neonat* OR newborn OR infant OR birth OR childbirth	18:34:42	191
#11	Search cerebral palsy		

Appendix 19 Weighted probabilities and distributions for the model's care pathways

Nulliparous women			Multiparous women		
Probability	**Weighted estimate nulliparous women**	**Distribution**	**Weighted estimate multiparous women**	**Distribution**	**Source**
Planned birth at home					
Actual birth at home	0.650	Point estimate	0.938	Point estimate	Birthplace (Hollowell et al., 2010)
Actual birth in OU	0.349	Point estimate	0.061	Point estimate	Birthplace (Hollowell et al., 2010)
SVB	0.395	Point estimate	0.734	Point estimate	Birthplace (Hollowell et al., 2010)
Ventouse	0.172	Point estimate	0.077	Point estimate	Birthplace (Hollowell et al., 2010)
Forceps	0.191	Point estimate	0.067	Point estimate	Birthplace (Hollowell et al., 2010)
Unplanned CS	0.235	Point estimate	0.100	Point estimate	Birthplace (Hollowell et al., 2010)
Planned birth in an FMU					
Actual birth in FMU	0.727	Point estimate	0.950	Point estimate	Birthplace (Hollowell et al., 2010)
Actual birth in OU	0.272	Point estimate	0.049	Point estimate	Birthplace (Hollowell et al., 2010)
SVB	0.391	Point estimate	0.624	Point estimate	Birthplace (Hollowell et al., 2010)
Ventouse	0.174	Point estimate	0.069	Point estimate	Birthplace (Hollowell et al., 2010)
Forceps	0.200	Point estimate	0.143	Point estimate	Birthplace (Hollowell et al., 2010)
Unplanned CS	0.228	Point estimate	0.129	Point estimate	Birthplace (Hollowell et al., 2010)
Planned birth in an AMU					
Actual birth at home	0.662	Point estimate	0.904	Point estimate	Birthplace (Hollowell et al., 2010)
Actual birth in OU	0.337	Point estimate	0.095	Point estimate	Birthplace (Hollowell et al., 2010)
SVB	0.346	Point estimate	0.946	Point estimate	Birthplace (Hollowell et al., 2010)
Ventouse	0.202	Point estimate	0.117	Point estimate	Birthplace (Hollowell et al., 2010)
Forceps	0.220	Point estimate	0.113	Point estimate	Birthplace (Hollowell et

					al., 2010)
Unplanned CS	0.221	Point estimate	0.110	Point estimate	Birthplace (Hollowell et al., 2010)
Planned birth in an OU					
Actual birth in OU	1.0	Point estimate	1.0	Point estimate	Birthplace (Hollowell et al., 2010)
SVB	0.612	Point estimate	0.886	Point estimate	Birthplace (Hollowell et al., 2010)
Ventouse	0.117	Point estimate	0.036	Point estimate	Birthplace (Hollowell et al., 2010)
Forceps	0.107	Point estimate	0.020	Point estimate	Birthplace (Hollowell et al., 2010)
Unplanned CS	0.159	Point estimate	0.053	Point estimate	Birthplace (Hollowell et al., 2010)

Appendix 19 continued: Weighted probabilities and distributions for the model's care pathways repeated for women without complicating conditions at the start of care in labour

Nulliparous women			Multiparous women		
Probability	**Weighted estimate nulliparous women**	**Distribution**	**Weighted estimate multiparous women**	**Distribution**	**Source**
Planned birth at home					
Actual birth at home	0.681	Point estimate	0.947	Point estimate	Birthplace (Hollowell et al., 2010)
Actual birth in OU	0.318	Point estimate	0.052	Point estimate	Birthplace (Hollowell et al., 2010)
SVB	0.389	Point estimate	0.729	Point estimate	Birthplace (Hollowell et al., 2010)
Ventouse	0.179	Point estimate	0.082	Point estimate	Birthplace (Hollowell et al., 2010)
Forceps	0.193	Point estimate	0.088	Point estimate	Birthplace (Hollowell et al., 2010)
Unplanned CS	0.237	Point estimate	0.099	Point estimate	Birthplace (Hollowell et al., 2010)
Planned birth in an FMU					
Actual birth in FMU	0.745	Point estimate	0.956	Point estimate	Birthplace (Hollowell et al., 2010)
Actual birth in OU	0.254	Point estimate	0.043	Point estimate	Birthplace (Hollowell et al., 2010)
SVB	0.377	Point estimate	0.605	Point estimate	Birthplace (Hollowell et al., 2010)
Ventouse	0.185	Point estimate	0.112	Point estimate	Birthplace (Hollowell et al., 2010)
Forceps	0.204	Point estimate	0.156	Point estimate	Birthplace (Hollowell et al., 2010)
Unplanned CS	0.229	Point estimate	0.125	Point estimate	Birthplace (Hollowell et al., 2010)
Planned birth in an AMU					
Actual birth at home	0.681	Point estimate	0.919	Point estimate	Birthplace (Hollowell et al., 2010)
Actual birth in OU	0.318	Point estimate	0.080	Point estimate	Birthplace (Hollowell et al., 2010)
SVB	0.336	Point estimate	0.636	Point estimate	Birthplace (Hollowell et al., 2010)
Ventouse	0.211	Point estimate	0.128	Point estimate	Birthplace (Hollowell et al., 2010)
Forceps	0.237	Point estimate	0.118	Point estimate	Birthplace (Hollowell et al., 2010)
Unplanned CS	0.215	Point estimate	0.117	Point estimate	Birthplace (Hollowell et al., 2010)
Planned birth in					

an OU					
Actual birth in OU	1.0	Point estimate	1.0	Point estimate	Birthplace (Hollowell et al., 2010)
SVB	0.656	Point estimate	0.905	Point estimate	Birthplace (Hollowell et al., 2010)
Ventouse	0.115	Point estimate	0.034	Point estimate	Birthplace (Hollowell et al., 2010)
Forceps	0.098	Point estimate	0.021	Point estimate	Birthplace (Hollowell et al., 2010)
Unplanned CS	0.129	Point estimate	0.039	Point estimate	Birthplace (Hollowell et al., 2010)

Appendix 20 Unit costs per resource item (£ sterling, 2009/10 prices)

Resource item (unit)	Unit cost or range	Source of unit cost
COSTS INCURRED FOR A PLANNED BIRTH AT HOME		
Homebirth packs	34.3	Primary cost data collection
Staff travel to homebirth – distance 23 miles return trip	23.2	Primary cost data collection
COSTS INCURRED FOR PLANNED 'NON-OU BIRTHS' IF TRANSFERRED TO AN OU		
Mode of transfer (per hour)		
Ambulance	402.0	PSSRU Unit Costs of Health and Social care 2010 DH reference costs
Private car	0.0	Cost not attributed to NHS
Wheelchair or trolley	0.01	PSSRU Unit Costs of Health and Social care 2010
Bed	0.01	PSSRU Unit Costs of Health and Social care 2010
Rapid response ambulance car	214	PSSRU Unit Costs of Health and Social care 2010 DH reference costs
Helicopter	144.5	Primary data collection (NHS staff costs only)
Taxi	0.0	Cost not attributed to NHS
No physical transfer	0.0	Cost not attributed to NHS

Resource item (unit)	Unit cost or range	Source of unit cost
Procedures related to intrapartum care		
Augmentation	159.1	Primary cost data collection
Epidural/Spinal	311.1	Primary cost data collection
General Anaesthetic	846.5	Primary cost data collection
Active Management of the third stage of labour	4.1	Primary cost data collection
Episiotomy	24.6	Primary cost data collection
Perineal trauma	595.3	Primary cost data collection
ECMO	1651.0	Primary cost data collection
Total body cooling	2110.0	Primary cost data collection
Care following a stillbirth	644	Primary cost data collection
Care following a neonatal death	644	Primary cost data collection

COSTS INCURRED FOR CARE DURING LABOUR AND BIRTH		
Mode of birth		
Spontaneous vertex birth		
OU	26.3	Primary cost data collection
Home	28.5	Primary cost data collection
FMU	29.3	Primary cost data collection
AMU	29.3	Primary cost data collection
Vaginal breech birth	99.1	Primary cost data collection
Ventouse	429.2	Primary cost data collection
Forceps	569.9	Primary cost data collection
Caesarean section	1052.6	Primary cost data collection

Resource item (unit)	Unit cost or range	Source of unit cost
POST NATAL AND HIGHER LEVEL CARE FOR THE MOTHER		
Postnatal care (days)	95	DH reference costs
High dependency care following birth provided within the labour ward (per 4 hours)	80	DH reference costs
Admission to intensive care unit (days)	560	DH reference costs
Admission to high dependency unit (days)	1525	DH reference costs
Admission to specialist care (days)	400	DH reference costs
HIGHER LEVEL OF CARE FOR THE BABY		
Admission to neonatal intensive care unit (days)	1081	DH reference costs
Admission to neonatal high dependency unit (days)	759	DH reference costs
Admission to neonatal specialist care (days)	429	DH reference costs

Appendix 21 Model Payoffs: combined unit cost and resource use data

Planned birth at home and actual birth at home 'Low risk' nulliparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**unit cost (£)**	**sum (£)**
average duration of labour (hrs)*	7.30		
Midwifery care	1	674.8	674.8
Overheads	0		0
Entonox	1	111.6	111.6
Homebirth pack	1	34.3	34.3
Midwifery travel	1	23.2	23.2
Birth	1	28.5	28.5
Syntometrine	0.579	4.1	2.3
Episiotomy	0.034	24.6	0.8
Transfer	0.131	201.6	26.5
Assessment by Consultant in OU by those transferred in	0.967	194.7	188.4
Epidural	0.04	311.1	12.4
General Anaesthetic	0.004	846.5	3.7
Perineal repair	0.037	595.3	22.2
Blood transfusion	0.008	720.71	6.3
Stillbirth	0	644	0
Higher level postnatal observation on labour ward	0.009	80	0.7
Postnatal care	0.131	95	12.5
ITU mother	0.0008	1525	1.2
Special care mother	0.0008	400	0.3
NICU baby	0.022	1081	24.5
HDU baby	0.0022	759	1.6
SCBU baby	0.068	429	29.4
ECMO	0	0	0
Cooling	0.0003	2110	0.7
Baby died	0.0007	644	0.4
Effectiveness and Cost payoffs			
mother well baby well	**0.949**		**925.8**
mother well baby not well	**0.006**		**6709.3**
mother not well baby well	**0.044**		**2113.2**
mother not well baby not well	**0**		**0.0**

*Estimated from the start of care in labour until the end of the third stage of labour

Planned birth at home Actual birth in obstetric unit with spontaneous vertex birth 'Low risk' nulliparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**unit cost (£)**	**sum (£)**
average duration of labour (hrs)	14.81		
Midwifery care	1	499.9	499.9
Overheads			0
entonox	1	94.0	94.0
homebirth pack	1	34.3	34.3
midwifery travel	1	23.2	23.2
Transfer	1	192.7	192.7
OU overheads	1	537.1	537.1
OU midwifery costs	1	445.6	445.6
OU consultant assessment	0.585	194.7	113.9
Augmentation	0.382	159.1	60.8
Epidural	0.279	311.1	86.7
General Anaesthetic	0.008	846.5	7.02
Birth	1	26.3	26.3
Syntometrine	0.876	4.1	3.59
Episiotomy	0.223	24.6	5.50
Perineal repair	0.048	595.3	28.8
Blood transfusion	0.013	910	12.1
Stillbirth	0.001	644	1.2
Higher level postnatal observation on labour ward	0.013	80	1.0
Postnatal care	0.938	100.7	94.5
ITU mother	0.003	1525	4.8
HDU mother	0.009	560	5.2
Special care mother	0.003	400	1.2
NICU baby	0.038	1081	41.4
HDU baby	0.015	759	12.0
SCBU baby	0.145	429	62.5
ECMO	0	0	0
Cooling	0.002	2110	5.4
Baby died	0	644	0
Effectiveness and Cost payoffs			
mother well baby well	**0.922**		**2256.4**
mother well baby not well	**0.017**		**7741.8**
mother not well baby well	**0.060**		**3636.4**
mother not well baby not well	**0**		**0.0**

Planned birth at home Actual birth in obstetric unit with ventouse 'Low risk' nulliparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**unit cost (£)**	**sum (£)**
average duration of labour (hrs)	15.34		
Midwifery care	1	554.2	554.2
Overheads			0
entonox	1	104.3	104.3
homebirth pack	1	34.3	34.3
midwifery travel	1	23.2	23.2
Transfer	1	185.8	185.8
OU overheads	1	512.7	512.7
OU midwifery costs	1	425.3	425.3
OU consultant assessment	0.93	194.7	181.3
Augmentation	0.46	159.1	74.3
Epidural	0.488	311.1	151.8
General Anaesthetic	0.006	846.5	5.4
Birth	1	429.2	429.2
Syntometrine	0.947	4.1	3.8
Episiotomy	0.70	24.6	17.2
Perineal repair	0.041	595.3	27.4
Blood transfusion	0.009	535.5	4.8
Stillbirth	0	0	0
Higher level postnatal observation on labour ward	0.009	80	0.7
Postnatal care	0.97	132.3	128.5
ITU mother	0	1525	0
HDU mother	0.003	560	2.0
Special care mother	0	400	0
NICU baby	0.063	1081	68.8
HDU baby	0.015	759	11.5
SCBU baby	0.168	429	72.3
ECMO	0	0	0
Cooling	0	2110	0
Baby died	0.003	644	2.2
Effectiveness and Cost payoffs			
mother well baby well	**0.922**		**2993.9**
mother well baby not well	**0.019**		**5654.5**
mother not well baby well	**0.058**		**3567.0**
mother not well baby not well	**0**		**0.0**

Planned birth at home Actual birth in obstetric unit with forceps 'Low risk' nulliparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**unit cost (£)**	**sum (£)**
average duration of labour (hrs)	16.81		
Midwifery care	1	589.2	589.2
Overheads			0
entonox	1	104.3	104.3
homebirth pack	1	34.3	34.3
midwifery travel	1	23.2	23.2
Transfer	1	193.1	193.1
OU overheads	1	590.1	590.1
OU midwifery costs	1	489.5	489.5
OU consultant assessment	0.913	194.7	177.8
Augmentation	0.562	159.1	89.4
Epidural	0.784	311.1	244.0
General Anaesthetic	0	0	0
Birth	1	569.9	569.9
Syntometrine	0.966	4.1	3.9
Episiotomy	0.948	24.6	23.3
Perineal repair	0.114	595.3	68.3
Blood transfusion	0.005	479.8	2.6
Stillbirth	0.005	644	3.2
Higher level postnatal observation on labour ward	1	80	80
Postnatal care	0.948	152.09	144.2
ITU mother	0	1525	0
HDU mother	0.003	560	1.9
Special care mother	0	400	0
NICU baby	0.012	1081	13.6
HDU baby	0.006	759	5.2
SCBU baby	0.18	429	80.5
ECMO	0	0	0
Cooling	0.001	2110	3.7
Baby died	0	644	0
Effectiveness and Cost payoffs			
mother well baby well	**0.866**		**3498.6**
mother well baby not well	**0.012**		**7752.2**
mother not well baby well	**0.120**		**4122.0**
mother not well baby not well	**0**		**0.0**

Planned birth at home Actual birth in obstetric unit with an unplanned caesarean section 'Low risk' nulliparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**unit cost (£)**	**sum (£)**
average duration of labour (hrs)	17.76		
Midwifery care	1	574.7	574.7
Overheads			0
entonox	1	108.1	108.1
homebirth pack	1	34.3	34.3
midwifery travel	1	23.2	23.2
Transfer	1	208.9	208.9
OU overheads	1	660.5	660.5
OU midwifery costs	1	547.9	547.9
OU consultant assessment	0.98	194.7	192.3
Augmentation	0.57	159.1	91.2
Epidural	0.93	311.1	291.9
General Anaesthetic	0.071	846.5	60.6
Birth	1	1052.6	1052.6
Syntometrine	0.904	4.1	3.7
Episiotomy	0	24.6	0
Perineal repair	0	595.3	0
Blood transfusion	0.015	647.1	10.0
Stillbirth	0.003	644	2.3
Higher level postnatal observation on labour ward	1	80	80
Postnatal care	0.95	239.38	228.1
ITU mother	0.013	1525	20.2
HDU mother	0.011	560	6.3
Special care mother	0.013	400	5.3
NICU baby	0.067	1081	73.0
HDU baby	0.073	759	55.5
SCBU baby	0.234	429	100.5
ECMO	0	0	0
Cooling	0.002	2110	5.0
Baby died	0.007	644	4.7
Effectiveness and Cost payoffs			
mother well baby well	**0**		**0.0**
mother well baby not well	**0**		**0.0**
mother not well baby well	**0.986**		**4350.3**
mother not well baby not well	**0.011**		**14693.8**

Planned birth in an Freestanding Midwifery Unit Actual birth in Freestanding Midwifery Unit with transfer after birth 'Low risk' nulliparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
average duration of labour (hrs)	7.39		
Midwifery care	1	600.9	600.9
Overheads	1	409.4	409.4
Birth	1	29.3	29.3
Syntometrine	0.730	4.1	3.0
Episiotomy	0.059	24.6	1.5
Postnatal stay in FMU	0.961	143.1	137.6
Transfer	0.083	249.5	20.9
Assessment by consultant	0.013	194.7	2.5
Epidural	0.045	311.1	14.1
General anaesthetic	0.002	846.5	2.0
Perineal repair	0.034	595.3	20.7
Blood transfusion	0.004	663.8	3.3
Stillbirth	0.000	0.0	0.0
Higher level care postnatal observation in labour ward	0.004	80.0	0.4
Postnatal care	0.080	190.9	15.3
ITU mother	0.0004	1525.0	0.7
HDU mother	0.001	560.0	0.8
Special care mother	0.0004	400.0	0.2
NICU baby	0.004	1081.0	5.2
HDU baby	0.007	759.0	5.5
SCBU baby	0.048	429.0	20.8
ECMO	0.000	1651.0	0.0
Cooling	0.000	2110.0	1.2
Baby died	0.0009	644.0	0.5
Effectiveness and Cost payoffs			
mother well baby well	**0.957**		**1272.1**
mother well baby not well	**0.002**		**5921.2**
mother not well baby well	**0.039**		**2500.9**
mother not well baby not well	**0.0005**		**4489.1**

Planned birth in an Freestanding Midwifery Unit Actual birth in Obstetric Unit with a spontaneous vertex birth 'Low risk' nulliparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
average duration of labour (hrs)	6.64		
Midwifery care	1	540.1	540.1
Overheads	1	368.7	368.7
Transfer	1	235.5	235.5
Obstetric Unit overheads	1	428.9	428.9
Obstetric Unit midwifery care	1	355.8	355.8
Consultant assessment in the Obstetric Unit	0.719	194.7	140.2
Augmentation	0.403	159.1	64.2
Epidural	0.310	311.1	96.7
General anaesthetic	0.002	846.5	2.4
Birth	1	26.3	26.3
Syntometrine	0.937	4.1	3.8
Episiotomy	0.244	24.6	6.0
Perineal repair	0.068	595.3	41.0
Blood transfusion	0.009	605.3	5.7
Stillbirth	0.002	644.0	1.7
Higher level care postnatal observation in labour ward	0.009	80.0	0.8
Postnatal care	0.968	171.8	166.5
ITU mother	0.0009	1,525.0	1.4
HDU mother	0.0009	560.0	0.5
Special care mother	0.0009	400.0	0.4
NICU baby	0.020	1,081.0	22.5
HDU baby	0.043	759.0	32.8
SCBU baby	0.070	429.0	30.4
ECMO	0	0.0	0.0
Cooling	0	2,110.0	0.0
Baby died	0	644.0	0.0
Effectiveness and Cost payoffs			
mother well baby well	**0.919**		**2509.8**
mother well baby not well	**0.007**		**9451.5**
mother not well baby well	**0.072**		**3464.4**
mother not well baby not well	**0**		**0.0**

Planned birth in an Freestanding Midwifery Unit Actual birth in Obstetric Unit with a ventouse birth 'Low risk' nulliparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
average duration of labour (hrs)	7.06	574.2	574.2
Midwifery care	1	574.2	574.2
Overheads	1	392.0	392.0
Transfer	1	247.9	247.9
Obstetric Unit overheads	1	434.5	434.5
Obstetric Unit midwifery care	1	360.5	360.5
Consultant assessment in the Obstetric Unit	0.945	194.7	184.0
Augmentation	0.498	159.1	79.2
Epidural	0.440	311.1	137.0
General anaesthetic	0.007	846.5	6.0
Birth	1	429.2	429.2
Syntometrine	0.969	4.1	4.0
Episiotomy	0.793	24.6	19.5
Perineal repair	0.033	595.3	20.1
Blood transfusion	0.009	479.8	4.4
Stillbirth	0	0.0	0.0
Higher level care postnatal observation in labour ward	0.009	80.0	0.7
Postnatal care	0.939	185.2	174.1
ITU mother	0	1,525.0	0.0
HDU mother	0	560.0	0.0
Special care mother	0	400.0	0.0
NICU baby	0.039	1,081.0	42.2
HDU baby	0.031	759.0	23.5
SCBU baby	0.122	429.0	52.6
ECMO	0.007	1,651.0	12.5
Cooling	0	2,110.0	0.0
Baby died	0	644.0	0.0
Effectiveness and Cost payoffs			
mother well baby well	**0.957**		**3364.2**
mother well baby not well	**0**		**0.0**
mother not well baby well	**0.042**		**4078.1**
mother not well baby not well	**0**		**0.0**

Planned birth in an Freestanding Midwifery Unit Actual birth in Obstetric Unit with a forceps birth 'Low risk' nulliparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
average duration of labour (hrs)	7.79		
Midwifery care	1	634.0	634.0
Overheads	1	432.8	432.8
Transfer	1	237.6	237.6
Obstetric Unit overheads	1	532.3	532.3
Obstetric Unit midwifery care	1	441.6	441.6
Consultant assessment in the Obstetric Unit	0.964	194.7	187.7
Augmentation	0.5586	159.1	88.9
Epidural	0.7662	311.1	238.4
General anaesthetic	0.0038	846.5	3.2
Birth	1	569.9	569.9
Syntometrine	0.9812	4.1	4.0
Episiotomy	0.8961	24.6	22.0
Perineal repair	0.1081	595.3	64.4
Blood transfusion	0.022	500.7	11.3
Stillbirth	0	0.0	0.0
Higher level care postnatal observation in labour ward	1	80.0	80.0
Postnatal care	0.93	202.7	189.3
ITU mother	0.002	1,525.0	4.5
HDU mother	0.012	560.0	6.9
Special care mother	0.002	400.0	1.2
NICU baby	0	1,081.0	0.0
HDU baby	0.0174	759.0	13.2
SCBU baby	0.06	429.0	27.2
ECMO	0	0.0	0.0
Cooling	0	2,110.0	0.0
Baby died	0	644.0	0.0
Effectiveness and Cost payoffs			
mother well baby well	**0.8704**		**3,690.5**
mother well baby not well	**0.0035**		**6,163.6**
mother not well baby well	**0.1261**		**4,881.7**
mother not well baby not well	**0**		**0.0**

Planned birth in an Freestanding Midwifery Unit Actual birth in Obstetric Unit with a unplanned caesarean section 'Low risk' nulliparous women Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
average duration of labour (hrs)	7.28		
Midwifery care	1	591.7	591.7
Overheads	1	403.9	403.9
Transfer	1	232.7	232.7
Obstetric Unit overheads	1	567.0	567.0
Obstetric Unit midwifery care	1	470.4	470.4
Consultant assessment in the Obstetric Unit	0.94	194.7	183.7
Augmentation	0.57	159.1	91.5
Epidural	0.926	311.1	288.1
General anaesthetic	0.09	846.5	80.9
Birth	1	1,052.6	1,052.6
Syntometrine	0.95	4.1	3.9
Episiotomy	0.0071	24.6	0.2
Perineal repair	0	595.3	0.0
Blood transfusion	0.0109	702.9	7.7
Stillbirth	0	0.0	0.0
Higher level care postnatal observation in labour ward	1	80.0	80.0
Postnatal care	0.96	261.3	251.1
ITU mother	0	1,525.0	0.0
HDU mother	0.009	560.0	5.0
Special care mother	0	400.0	0.0
NICU baby	0.03	1,081.0	38.5
HDU baby	0.27	759.0	207.1
SCBU baby	0.29	429.0	128.7
ECMO	0	0.0	0.0
Cooling	0.0029	2,110.0	6.1
Baby died	0	644.0	0.0
Effectiveness and Cost payoffs			
mother well baby well	**0**		**0.0**
mother well baby not well	**0**		**0.0**
mother not well baby well	**0.9768**		**4432.0**
mother not well baby not well	**0.0232**		**9722.5**

Planned birth in an Alongside Midwifery Unit Actual birth in Alongside Midwifery Unit with transfer after birth 'Low risk' nulliparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
average duration of labour (hrs)	7.77		
Midwifery care	1	632.4	632.4
Overheads	1	423.1	423.1
Birth	1	29.3	29.3
Syntometrine	0.816	4.1	3.3
Episiotomy	0.07	24.6	1.8
Postnatal stay in AMU	0.95	102.4	97.5
Transfer	0.07	80.3	6.2
Consultant assessment	0.005	194.7	0.9
Epidural	0.05	311.1	17.8
General Anaesthetic	0.0017	846.5	1.4
Perineal repair	0.04	595.3	26.7
Blood transfusion	0.0062	582.3	3.6
Stillbirth	0	644	0
Higher level postnatal observation in labour ward	0.0062	80	0.4
Postnatal care	0.0798	3.39	0.2
ITU mother	0.00155	1525	2.3
HDU mother	0.004	560	2.2
Special care mother	0.0015	400	0.6
NICU baby	0.011	1081	12.3
HDU baby	0.004	759	3.5
SCBU baby	0.075	429	32.1
ECMO	0.0003	1651	0.6
Cooling	0	2110	0
Baby died	0	644	0
Effectiveness and Cost payoffs			
mother well baby well	**0.946**		**1215.8**
mother well baby not well	**0.003**		**12496.8**
mother not well baby well	**0.051**		**2310.9**
mother not well baby not well	**0.00019**		**13385.2**

Planned birth in an Alongside Midwifery Unit Actual birth in Obstetric Unit with a spontaneous vertex birth 'Low risk' nulliparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
average duration of labour (hrs)	13.08		
Midwifery care	1	492.9	492.9
Overheads	1	330.4	330.4
Transfer	1	71.2	71.2
Overheads OU	1	449.3	449.3
Midwifery care OU	1	372.7	372.7
Consultant assessment OU	0.6596	194.7	128.4
Augmentation	0.3854	159.1	61.3
Epidural	0.3092	311.1	96.1
General Anaesthetic	0.002	846.5	1.69
Birth	1	26.3	26.3
Syntometrine	0.9635	4.1	3.9
Episiotomy	0.2432	24.6	5.9
Perineal repair	0.0582	595.3	34.6
Blood transfusion	0.0042	521.6	2.1
Stillbirth	0.0013	644	0.8
Higher level postnatal observation in labour ward	0.0042	80	0.336
Postnatal care	0.966	129.4	125.1
ITU mother	0.0005	1525	0.78
HDU mother	0.0025	560	1.44
Special care mother	0.0005	400	0.20
NICU baby	0.007	1081	7.5
HDU baby	0.0075	759	5.6
SCBU baby	0.0706	429	30.3
ECMO	0	0	0
Cooling	0.0010	2110	2.17
Baby died	0	644	0
Effectiveness and Cost payoffs			
mother well baby well	**0.934**		**2161.4**
mother well baby not well	**0.003**		**10518.0**
mother not well baby well	**0.063**		**3050.1**
mother not well baby not well	**0**		**0.0**

Planned birth in an Alongside Midwifery Unit Actual birth in Obstetric Unit with a ventouse birth 'Low risk' nulliparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
average duration of labour (hrs)	14.29	574.2	574.2
Midwifery care	1	559.4	559.4
Overheads	1	375.0	375.0
Transfer	1	64.31	64.3
Overheads OU	1	462.4	462.4
Midwifery care OU	1	383.6	383.6
Consultant assessment OU	0.9365	194.7	182.3
Augmentation	0.5193	159.1	82.6
Epidural	0.5076	311.1	157.9
General Anaesthetic	0.0022	846.5	1.8
Birth	1	429.2	429.2
Syntometrine	0.9733	4.1	3.9
Episiotomy	0.7946	24.6	19.5
Perineal repair	0.0431	595.3	25.6
Blood transfusion	0.0182	601.47	10.9
Stillbirth	0	0	0
Higher level postnatal observation in labour ward	0.0182	80	1.4
Postnatal care	0.970	150.94	146.5
ITU mother	0.0027	1525	4.17
HDU mother	0.005	560	3.3
Special care mother	0.0019	400	0.78
NICU baby	0.0253	1081	27.3
HDU baby	0.011	759	8.34
SCBU baby	0.05	429	23.08
ECMO	0	1651	0
Cooling	0	2110	0
Baby died	0	644	0
Effectiveness and Cost payoffs			
mother well baby well	**0.9353**		**2873.8**
mother well baby not well	**0.002**		**8503.3**
mother not well baby well	**0.063**		**3898.5**
mother not well baby not well	**0**		**0.0**

Planned birth in an Alongside Midwifery Unit Actual birth in Obstetric Unit with a forceps birth 'Low risk' nulliparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
average duration of labour (hrs)	15.64		
Midwifery care	1	626.1	626.1
Overheads	1	419.7	419.7
Transfer	1	68.01	68.01
Overheads OU	1	505.6	505.6
Midwifery care OU	1	419.5	419.5
Consultant assessment OU	0.90	194.7	177.0
Augmentation	0.62	159.1	99.8
Epidural	0.76	311.1	238.3
General Anaesthetic	0.0034	846.5	2.8
Birth	1	569.9	569.9
Syntometrine	0.9725	4.1	3.9
Episiotomy	0.9552	24.6	23.4
Perineal repair	0.1299	595.3	77.3
Blood transfusion	0.0194	549.5	10.6
Stillbirth	0	644	0
Higher level postnatal observation in labour ward	1	80	80
Postnatal care	0.96	173.2	167.5
ITU mother	0	1525	0
HDU mother	0.0007	560	0.43
Special care mother	0	400	0
NICU baby	0.008	1081	9.2
HDU baby	0.0091	759	6.9
SCBU baby	0.16	429	71.5
ECMO	0	0	0
Cooling	0	2110	0
Baby died	0.001	644	1.06
Effectiveness and Cost payoffs			
mother well baby well	**0.831**		**3414.2**
mother well baby not well	**0.011**		**4812.9**
mother not well baby well	**0.155**		**4217.5**
mother not well baby not well	**0.003**		**5116.4**

Planned birth in an Alongside Midwifery Unit Actual birth in Obstetric Unit with a unplanned caesarean section 'Low risk' nulliparous women Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
average duration of labour (hrs)	17.14		
Midwifery care	1	605.9	605.9
Overheads	1	406.2	406.2
Transfer	1	67.9	67.9
Overheads OU	1	606.2	606.2
Midwifery care OU	1	502.9	502.9
Consultant assessment OU	0.9362	194.7	182.2
Augmentation	0.6042	159.1	96.1
Epidural	0.9583	311.1	298.1
General Anaesthetic	0.0896	846.5	75.8
Birth	1	1052.6	1052.6
Syntometrine	0.967	4.1	3.9647
Episiotomy	0.005	24.6	0.123
Perineal repair	0	595.3	0
Blood transfusion	0.0218	591.3	12.8
Stillbirth	0	644	0
Higher level postnatal observation in labour ward	1	80	80
Postnatal care	0.96	249.0	239.8
ITU mother	0.004	1525	6.36
HDU mother	0.017	560	9.7
Special care mother	0.0046	400	1.84
NICU baby	0.012	1081	13.1
HDU baby	0.006	759	4.554
SCBU baby	0.15	429	68.1
ECMO	0	0	0
Cooling	0.0016	2110	3.5
Baby died	0.0016	644	1.07
Effectiveness and Cost payoffs			
mother well baby well	**0**		**0.0**
mother well baby not well	**0**		**0.0**
mother not well baby well	**0.991**		**4315.4**
mother not well baby not well	**0.01**		**6873.2**

Planned birth in an Obstetric Unit with a spontaneous vertex birth 'Low risk' nulliparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
Average duration of labour (hrs)	9.19		
Midwifery care	1	485.8	485.8
Overheads	1	585.6	585.6
Augmentation	0.2091	159.1	33.3
Epidural	0.205	311.1	63.8
General anaesthetic	0.002	846.5	1.7
Birth	1	26.3	26.3
Syntometrine	0.9307	4.1	3.8
Episiotomy	0.1602	24.6	3.9
Perineal repair	0.0446	595.3	26.6
Blood transfusion	0.0079	606.2	4.8
Stillbirth	0	644.0	0.0
Higher level postnatal observation	0.0079	80.0	0.6
Postnatal care	0.971	120.4	116.9
ITU mother	0.0015	1525.0	2.3
HDU mother	0.004	560.0	2.6
Special care mother	0.001	400.0	0.6
NICU baby	0.00782	1081.0	8.5
HDU baby	0.012	759.0	9.3
SCBU baby	0.071	429.0	30.5
ECMO	0	1651.0	0.0
Cooling	0.0003	2110.0	0.7
Baby died	0.0007	644.0	0.2
Effectiveness and Cost payoffs			
mother well baby well	**0.9448**		**1334.3**
mother well baby not well	**0.0023**		**4954.5**
mother not well baby well	**0.0526**		**2345.3**
mother not well baby not well	**0.003**		**4133.9**

Planned birth in an Obstetric Unit with a ventouse birth 'Low risk' nulliparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
average duration of labour (hrs)	12.49		
Midwifery care	1	660.2	660.2
Overheads	1	795.9	795.9
Augmentation	0.47	159.1	75.3
Epidural	0.54	311.1	168.7
General anaesthetic	0.0044	846.5	3.7
Birth	1	429.2	429.2
Syntometrine	0.9856	4.1	4.0
Episiotomy	0.7776	24.6	19.1
Perineal repair	0.0474	595.3	28.2
Blood transfusion	0.0197	532.6	10.5
Stillbirth	0.0008	644.0	0.6
Higher level postnatal observation	0.0197	80.0	1.6
Postnatal care	0.9679	151.0	146.1
ITU mother	0.00445	1525.0	6.8
HDU mother	0.012	560.0	6.9
Special care mother	0.00445	400.0	1.8
NICU baby	0.011	1081.0	12.6
HDU baby	0.026	759.0	20.3
SCBU baby	0.167	429.0	71.8
ECMO	0	1651.0	0.0
Cooling	0	2110.0	0.0
Baby died	0.0008	644.0	0.6
Effectiveness and Cost payoffs			
mother well baby well	**0.9315**		**2351.3**
mother well baby not well	**0.0051**		**5261.0**
mother not well baby well	**0.0624**		**3334.2**
mother not well baby not well	**0.0009**		**3713.1**

Planned birth in an Obstetric Unit with a forceps birth 'Low risk' nulliparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
average duration of labour (hrs)	14.42		
Midwifery care	1	762.3	762.3
Overheads	1	918.8	918.8
Augmentation	0.5906	159.1	94.0
Epidural	0.7983	311.1	248.4
General anaesthetic	0.0043	846.5	3.6
Birth	1	569.9	569.9
Syntometrine	0.9837	4.1	4.0
Episiotomy	0.9398	24.6	23.1
Perineal repair	0.1075	595.3	64.0
Blood transfusion	0.0435	618.5	26.9
Stillbirth	0	644.0	0.0
Higher level postnatal observation	1	80.0	80.0
Postnatal care	0.964	165.6	159.8
ITU mother	0.008	1525.0	13.5
HDU mother	0.019	560.0	10.8
Special care mother	0.008	400.0	3.5
NICU baby	0.023	1081.0	24.9
HDU baby	0.008	759.0	6.1
SCBU baby	0.099741176	429.0	42.8
ECMO	0	1651.0	0.0
Cooling	0.0028	2110.0	5.9
Baby died	0.0009	644.0	0.6
Effectiveness and Cost payoffs			
mother well baby well	**0.8478**		**2850.3**
mother well baby not well	**0.0048**		**5705.7**
mother not well baby well	**0.1434**		**3981.6**
mother not well baby not well	**0.0039**		**7145.1**

Planned birth in an Obstetric Unit with an unplanned caesarean section 'Low risk' nulliparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
average duration of labour (hrs)	14.31		
Midwifery care	1	756.4	756.4
Overheads	1	911.8	911.8
Augmentation	0.6073	159.1	96.6
Epidural	0.9167	311.1	285.2
General anaesthetic	0.1009	846.5	85.4
Birth	1	1052.6	1052.6
Syntometrine	0.9132	4.1	3.7
Episiotomy	0.0058	24.6	0.1
Perineal repair	0.0006	595.3	0.4
Blood transfusion	0.0182	535.6	9.7
Stillbirth	0	644.0	0.0
Higher level postnatal observation	1	80.0	80.0
Postnatal care	1	95.0	236.1
ITU mother	0.003	1525.0	5.6
HDU mother	0.012	560.0	7.0
Special care mother	0.003	400.0	1.5
NICU baby	0.401	1081.0	434.3
HDU baby	0.029	759.0	22.5
SCBU baby	0.261	429.0	114.3
ECMO	0.0006	1651.0	1.0
Cooling	0.0014	2110.0	3.0
Baby died	0	644.0	0.0
Effectiveness and Cost payoffs			
mother well baby well	**0**		**0.0**
mother well baby not well	**0**		**0.0**
mother not well baby well	**0.9869**		**3633.2**
mother not well baby not well	**0.0131**		**8656.0**

Planned birth at home Actual birth at home 'Low risk' multiparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
average duration of labour (hrs)	4.81		
Midwifery care	0.932	473.1	442.9
Overheads			0
entonox	0.93	73.7	69.0
homebirth pack	1	34.32	34.3
midwifery travel	1	23.2	23.2
Birth	1	28.5	28.5
Syntometrine	0.6553	4.1	2.6
Episiotomy	0.0074	24.6	0.18
Transfer	0.0543	205.3	11.1
Consultant assessment	0.0206	194.7	4.0
Epidural	0.0134	311.1	4.1
General anaesthetic	0.0015	846.5	1.2
Perineal repair	0.0094	595.3	5.5
Blood transfusion	0.0023	581.3	1.3
Stillbirth	0.00008	644	0.05
Higher level postnatal observation on labour ward	0.0023	80	0.184
Postnatal care	0.0025	52.2	0.1
ITU mother	0.0005	1525	0.76
HDU mother	0.003	560	1.8
Special care	0.0005	400	0.2
NICU baby	0.003	1081	3.7
HDU baby	0.002	759	2.2
SCBU baby	0.02898	429	12.4
ECMO	0.0002	1651	0.4
Cooling	9.18189E-05	2110	0.19
Baby died	0.0004	644	0.29
Effectiveness and Cost payoffs			
mother well baby well	**0.985**		**676.0**
mother well baby not well	**0.002**		**5542.8**
mother not well baby well	**0.013**		**1795.0**
mother not well baby not well	**0.000091**		**4931.6**

Planned birth at home Actual birth in obstetric unit with spontaneous vertex birth 'Low risk' multiparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
average duration of labour (hrs)	10.03		
Midwifery care home	1	361.8	361.8
Overheads			0
entonox	1	68.1	68.1
homebirth pack	1	34.3	34.32
midwifery travel	1	24.2	24.2
Birth	1	28.5	28.5
Transfer	1	196.3	196.3
OU overheads	1	339.8	339.8
OU midwifery staffing	1	281.9	
Consultant assessment	0.4	194.7	88.5
Augmentation	0.12	159.1	20.6
Epidural	0.13	311.1	41.8
General anaesthetic	0.001	846.5	1.1
Syntometrine	0.9089	4.1	3.7
Episiotomy	0.0464	24.6	1.1
Perineal repair	0.0119	595.3	7.08
Blood transfusion	0.0051	580.1	2.9
Stillbirth	0.0014	644	0.9016
Higher level postnatal observation on labour ward	0.005	80	0.4
Postnatal care	0.9261	67.06	62.1
ITU mother	0.00085	1525	1.2
HDU mother	0.0054	560	3.024
Special care	0.0054	400	2.16
NICU baby	0	1081	0
HDU baby	0	759	0
SCBU baby	0.08	429	38.5
ECMO	0	1651	0
Cooling	0	2110	0
Baby died	0	644	0
Effectiveness and Cost payoffs			
mother well baby well	**0.9758**		**1593.5**
mother well baby not well	**0.0053**		**3797.2**
mother not well baby well	**0.0189**		**3091.7**
mother not well baby not well	**0**		**0.0**

Planned birth at home Actual birth in obstetric unit with ventouse 'Low risk' multiparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
average duration of labour (hrs)	11.68		
Midwifery care home	1	433.2	433.2
Overheads			0
entonox	1	81.5	81.5
homebirth pack	1	34.32	34.32
midwifery travel	1	24.2	24.2
Birth	1	429.2	429.2
Transfer	1	159.3	159.3
OU overheads	1	339.8	339.8
OU midwifery staffing	1	281.9	
Consultant assessment	0.4546	194.7	88.5
Augmentation	0.1298	159.1	20.6
Epidural	0.1345	311.1	41.8
General anaesthetic	0.0014	846.5	1.1
Syntometrine	0.9089	4.1	3.7
Episiotomy	0.0464	24.6	1.1
Perineal repair	0.0449	595.3	26.7
Blood transfusion	0	0	0
Stillbirth	0	644	0
Higher level postnatal observation on labour ward	0	0	0
Postnatal care	0.9057	89.7	81.2
ITU mother	0.0008	1525	1.2
HDU mother	0.0054	560	3.02
Special care	0.0054	400	2.16
NICU baby	0.0744	1081	80.4
HDU baby	0	759	0
SCBU baby	0.1336	429	57.3
ECMO	0	1651	0
Cooling	0	2110	0
Baby died	0	644	0
Effectiveness and Cost payoffs			
mother well baby well	**0.9217**		**2397.0**
mother well baby not well	**0.0334**		**6211.8**
mother not well baby well	**0.0449**		**4054.9**
mother not well baby not well	**0**		**0.0**

Planned birth at home Actual birth in obstetric unit with forceps 'Low risk' multiparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
average duration of labour (hrs)	12.33		
Midwifery care home	1	463.8	463.8
Overheads			0
entonox	1	87.2	87.2
homebirth pack	1	34.3	34.32
midwifery travel	1	24.2	24.2
Birth	1	569.9	569.9
Transfer	1	203.0	203.0
OU overheads	1	397.9	397.9
OU midwifery staffing	1	330.1	330.1
Consultant assessment	0.9826	194.7	191.3
Augmentation	0.3876	159.1	61.6
Epidural	0.7394	311.1	230.0
General anaesthetic	0.0471	846.5	39.8
Syntometrine	0.9802	4.1	4.0
Episiotomy	0.8811	24.6	21.6
Perineal repair	0.138	595.3	82.1
Blood transfusion	0.0315	647.1	20.3
Stillbirth	0	644	0
Higher level postnatal observation on labour ward	1	80	80
Postnatal care	0.9207	134.0	123.3
ITU mother	0	1525	0
HDU mother	0	560	0
Special care	0	400	0
NICU baby	0	1081	0
HDU baby	0	759	0
SCBU baby	0.3843	429	164.8
ECMO	0	1651	0
Cooling	0	2110	0
Baby died	0	644	0
Effectiveness and Cost payoffs			
mother well baby well	**0.8081**		**3089.1**
mother well baby not well	**0.0225**		**1860.9**
mother not well baby well	**0.1695**		**3702.0**
mother not well baby not well	**0**		**0.0**

Planned birth at home Actual birth in obstetric unit with an unplanned caesarean section 'Low risk' multiparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
average duration of labour (hrs)	13.51		
Midwifery care home	1	403.1	403.1
Overheads			0
entonox	1	75.8	75.8
homebirth pack	1	34.3	34.32
midwifery travel	1	24.2	24.2
Birth	1	1052.6	1052.6
Transfer	1	178.6	178.6
OU overheads	1	500.6	500.6
OU midwifery staffing	1	415.3	415.3
Consultant assessment	0.9638	194.7	187.6
Augmentation	0.3385	159.1	53.8
Epidural	0.8914	311.1	277.3
General anaesthetic	0.1184	846.5	100.2
Syntometrine	0.8633	4.1	3.5
Episiotomy	0.0099	24.6	0.2
Perineal repair	0	0	0
Blood transfusion	0.0666	613.6	40.8
Stillbirth	0	644	0
Higher level postnatal observation on labour ward	1	80	80
Postnatal care	0.9663	230.6	222.8
ITU mother	0.00955	1525	14.5
HDU mother	0.0382	560	21.3
Special care	0.00955	400	3.8
NICU baby	0.0435	1081	47.0
HDU baby	0.161	759	122.9
SCBU baby	0.423	429	181.6
ECMO	0	1651	0
Cooling	0	2110	0
Baby died	0	644	0
Effectiveness and Cost payoffs			
mother well baby well	**0**		**0.0**
mother well baby not well	**0**		**0.0**
mother not well baby well	**0.9855**		**3869.5**
mother not well baby not well	**0.0145**		**11878.9**

Planned birth in an Freestanding Midwifery Unit Actual birth in Freestanding Midwifery Unit 'Low risk' multiparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
average duration of labour (hrs)	5.01		
Midwifery care	1	407.4	407.4
Overheads	1	277.6	277.6
Birth	1	29.3	29.3
Syntometrine	75.06	4.1	307.7
Episiotomy	0.01	24.6	0.2
Postnatal stay FMU	0.96	98.3	94.7
Transfer	0.04	236.8	9.6
Assessment by Consultant in OU	0.006	194.7	1.1
Epidural	0.01	311.1	5.1
General Anaesthetic	0.001	846.5	1.4
Perineal repair	0.008	595.3	5.1
Blood transfusion	0.0027	702.8	1.8
Stillbirth	0.0001	644	0.1
Higher level postnatal observation in labour ward	0.0027	80	0.2
Postnatal care	0.0409	168.5	6.8
ITU mother	0.0006	1525	0.9
HDU mother	0.002	560	1.2
Special care mother	0.0006	400	0.25
NICU baby	0.004	1081	4.7
HDU baby	0.003	759	2.8
SCBU baby	0.03	429	13.3
ECMO	0	1651	0
Cooling	0	2110	0
Baby died	0.0004	644	0.2
Effectiveness and Cost payoffs			
mother well baby well	**0.9866**		**848.9**
mother well baby not well	**0.0019**		**6968.6**
mother not well baby well	**0.0114**		**2499.5**
mother not well baby not well	**0**		**0.0**

Planned birth in a Freestanding Midwifery Unit Actual birth in Obstetric Unit with a sponteneous vertex birth 'Low risk' multiparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
average duration of labour (hrs)	9.62		
Midwifery care	1	343.3	343.3
Overheads	1	233.9	233.9
Transfer	1	250.9	250.9
OU running costs	1	315.7	315.7
OU midwifery costs	1	261.9	261.9
OU consul asst	0.6222	194.7	121.1
Augmentation	0.1814	159.1	28.8
Epidural	0.1816	311.1	56.4
General Anaesthetic	0	846.5	0
Birth	1	26.3	26.3
Syntometrine	0.9329	4.1	3.8
Episiotomy	0.0527	24.6	1.2
Perineal repair	0.0137	595.3	8.1
Blood transfusion	0.0089	647.1	5.7
Stillbirth	0.0059	644	3.7
Higher level postnatal observation in labour ward	0.0059	80	0.472
Postnatal care	0.9793	115.6	113.2
ITU mother	0	1525	0
HDU mother	0.005	560	2.8
Special care mother	0	400	0
NICU baby	0.04	1081	44.5
HDU baby	0.015	759	11.7
SCBU baby	0.02	429	9.7
ECMO	0	0	0
Cooling	0	2110	0
Baby died	0	644	0
Effectiveness and Cost payoffs			
mother well baby well	**0.9746**		**1845.8**
mother well baby not well	**0.0029**		**1573.6**
mother not well baby well	**0.0226**		**2349.1**
mother not well baby not well	**0**		**0.0**

Planned birth in an Freestanding Midwifery Unit Actual birth in an Obstetric Unit with a ventouse 'Low risk' multiparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
average duration of labour (hrs)	13.05		
Midwifery care	1	518.1	518.1
Overheads	1	353.0	353.0
Transfer	1	234.5	234.5
OU running costs	1	405.6	405.6
OU midwifery costs	1	336.5	336.5
OU consul asst	1	194.7	194.7
Augmentation	0.5395	159.1	85.8
Epidural	0.2963	311.1	92.1
General Anaesthetic	0	846.5	0
Birth	1	429.2	429.2
Syntometrine	1	4.1	4.1
Episiotomy	0.7974	24.6	19.6
Perineal repair	0.0273	595.3	16.2
Blood transfusion	0	0.03	0
Stillbirth	0	0	0
Higher level postnatal observation in labour ward	0	80	0
Postnatal care	1	164.2	164.2
ITU mother	0	1525	0
HDU mother	0	560	0
Special care mother	0	400	0
NICU baby	0	1081	0
HDU baby	0	759	0
SCBU baby	0.1164	429	49.9
ECMO	0	1651	0
Cooling	0	2110	0
Baby died	0	644	0
Effectiveness and Cost payoffs			
mother well baby well	**0.9727**		**2955.8**
mother well baby not well	**0**		**0.0**
mother not well baby well	**0.0273**		**2826.9**
mother not well baby not well	**0**		**0.0**

Planned birth in a Freestanding Midwifery Unit Actual birth in an Obstetric Unit with forceps 'Low risk' multiparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
average duration of labour (hrs)	13.58		
Midwifery care	1	512.0	512.0
Overheads	1	348.9	348.9
Transfer	1	232.2	232.2
OU running costs	1	479.5	479.5
OU midwifery costs	1	397.8	397.8
OU consul asst	0.9527	194.7	185.4
Augmentation	0.5641	159.1	89.7
Epidural	0.7545	311.1	234.7
General Anaesthetic	0	846.5	0
Birth	1	569.9	569.9
Syntometrine	0.9473	4.1	3.8
Episiotomy	0.9401	24.6	23.1
Perineal repair	0.0254	595.3	15.1
Blood transfusion	0	0	0
Stillbirth	0	0	0
Higher level postnatal observation in labour ward	1	80	80
Postnatal care	0.9566	180.0	172.2
ITU mother	0	1525	0
HDU mother	0.0726	560	40.6
Special care mother	0	400	0
NICU baby	0	1081	0
HDU baby	0	759	0
SCBU baby	0.0322	429	13.8
ECMO	0	0	0
Cooling	0	2110	0
Baby died	0	644	0
Effectiveness and Cost payoffs			
mother well baby well	**0.9746**		**3521.9**
mother well baby not well	**0**		**0.0**
mother not well baby well	**0.0254**		**2410.3**
mother not well baby not well	**0**		**0.0**

Planned birth in an Freestanding Midwifery Unit Actual birth in an Obstetric Unit with an unplanned caesarean section 'Low risk' multiparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
average duration of labour (hrs)	13.57		
Midwifery care	1	445.0	445.0
Overheads	1	303.2	303.2
Transfer	1	215.9	215.9
OU running costs	1	522.3	522.3
OU midwifery costs	1	433.3	433.3
OU consul asst	0.9823	194.7	191.2
Augmentation	0.3107	159.1	49.4
Epidural	0.9392	311.1	292.1
General Anaesthetic	0.1313	846.5	111.1
Birth	1	1052.6	1052.6
Syntometrine	0.9075	4.1	3.7
Episiotomy	0	24.6	0
Perineal repair	0	595.3	0
Blood transfusion	0.0177	312.5	5.5
Stillbirth	0	0	0
Higher level postnatal observation in labour ward	1	80	80
Postnatal care	0.9121	278.9	254.3
ITU mother	0.008	1525	13.4
HDU mother	0.0177	560	9.9
Special care mother	0.008	400	3.54
NICU baby	0.136	1081	147.0
HDU baby	0.136	759	103.2
SCBU baby	0.3	429	141.8
ECMO	0	0	0
Cooling	0	2110	0
Baby died	0	644	0
Effectiveness and Cost payoffs			
mother well baby well	**0**		**0.0**
mother well baby not well	**0**		**0.0**
mother not well baby well	**0.9456**		**4199.8**
mother not well baby not well	**0.0544**		**7559.7**

Planned birth in an Alongside Midwifery Unit Actual birth in Alongside Midwifery Unit with transfer after birth 'Low risk' multiparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
average duration of labour (hrs)	5.11		
Midwifery care	1	415.5	415.5
Overheads	1	278.08	278.0
Birth	1	29.3	29.3
Syntometrine	0.8335	4.1	3.4
Episiotomy	0.0181	24.6	0.4
Postnatal stay AMU	0.9518	71.0	67.5
Transfer	0.0389	77.7	3.0
Consultant assessment	0.0048	194.7	0.9
Epidural	0.0218	311.1	6.7
General Anaesthetic	0.0016	846.5	1.3
Perineal repair	0.0146	595.3	8.6
Blood transfusion	0.0044	554.7	2.4
Stillbirth	0	644	0
Higher level postnatal observation on labour ward	0.0044	80	0.3
Postnatal care	0.0482	146.6	7.0
ITU mother	0.0006	1525	1.0
HDU mother	0.00285	560	1.5
Special care mother	0.0006	400	0.2
NICU baby	0.009	1081	10.5
HDU baby	0.006	759	5.2
SCBU baby	0.025	429	10.7
ECMO	0.0008	1651	1.3
Cooling	0.0005	2110	1.1
Baby died	0.0002	644	0.1
Effectiveness and Cost payoffs			
mother well baby well	**0.978**		**823.6**
mother well baby not well	**0.002**		**5307.7**
mother not well baby well	**0.02**		**1997.9**
mother not well baby not well	**0.00014**		**1578.9**

Planned birth in an Alongside Midwifery Unit Actual birth in Obstetric Unit with a spontaneous vertex birth 'Low risk' multiparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
average duration of labour (hrs)	9.58		
Midwifery care	1	369.5	369.5
Overheads	1	247.7	247.7
Transfer	1	64.9	64.9
OU running costs	1	332.9	332.9
OU midwifery costs	1	276.1	276.1
Assessemnt by consultant	0.5505	194.7	107.1
Augmentation	3.1902	159.1	507.5
Epidural	0.2954	311.1	91.8
General Anaesthetic	0.0026	846.5	2.2
Birth	1	26.3	26.3
Syntometrine	0.9676	4.1	3.9
Episiotomy	0.0787	24.6	1.9
Perineal repair	0.0099	595.3	5.8
Blood transfusion	0.0052	898.0	4.6
Stillbirth	0	644	0
Higher level postnatal observation on labour ward	0.0052	80	0.4
Postnatal care	0.9743	100.1	97.5
ITU mother	0	1525	0
HDU mother	0.0046	560	2.5
Special care mother	0	400	0
NICU baby	0	1081	0
HDU baby	0	759	0
SCBU baby	0.076	429	32.9
ECMO	0	0	0
Cooling	0	2110	0
Baby died	0	644	0
Effectiveness and Cost payoffs			
mother well baby well	**0.9792**		**1646.3**
mother well baby not well	**0.0011**		**2095.3**
mother not well baby well	**0.0196**		**3119.6**
mother not well baby not well	**0**		**0.0**

Planned birth in an Alongside Midwifery Unit Actual birth in Obstetric Unit with a ventouse birth 'Low risk' multiparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
average duration of labour (hrs)	11.59		
Midwifery care	1	412.6	412.6
Overheads	1	276.5	276.5
Transfer	1	78.8	78.8
OU running costs	1	393.5	393.5
OU midwifery costs	1	326.5	326.5
Assessemnt by consultant	0.98	194.7	190.8
Augmentation	0.28	159.1	45.1
Epidural	0.34	311.1	108.0
General Anaesthetic	0	846.5	0
Birth	1	429.2	429.2
Syntometrine	1	4.1	4.1
Episiotomy	0.4703	24.6	11.5
Perineal repair	0.0145	595.3	8.6
Blood transfusion	0	0	0
Stillbirth	0	0	0
Higher level postnatal observation on labour ward	0	80	0
Postnatal care	0.9709	133.4	129.5
ITU mother	0	1525	0
HDU mother	0.0147	560	8.2
Special care mother	0	400	0
NICU baby	0	1081	0
HDU baby	0	759	0
SCBU baby	0.023	429	9.8
ECMO	0	1651	0
Cooling	0	2110	0
Baby died	0	644	0
Effectiveness and Cost payoffs			
mother well baby well	**0.9647**		**2398.6**
mother well baby not well	**0.0062**		**2158.3**
mother not well baby well	**0.0291**		**3139.5**
mother not well baby not well	**0**		**0.0**

Planned birth in an Alongside Midwifery Unit Actual birth in Obstetric Unit with a forceps birth 'Low risk' multiparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
average duration of labour (hrs)	14.59		
Midwifery care	1	582.0	582.0
Overheads	1	390.1	390.1
Transfer	1	72.1	72.1
OU running costs	1	472.0	472.0
OU midwifery costs	1	391.5	391.5
Assessemnt by consultant	0.9846	194.7	191.7
Augmentation	0.4724	159.1	75.1
Epidural	0.7933	311.1	246.7
General Anaesthetic	0.0227	846.5	19.2
Birth	1	569.9	569.9
Syntometrine	0.9687	4.1	3.9
Episiotomy	0.8701	24.6	21.4
Perineal repair	0.0898	595.3	53.4
Blood transfusion	0.0457	479.8	21.9
Stillbirth	0	0	0
Higher level postnatal observation on labour ward	1	80	80
Postnatal care	0.9128	141.9	129.6
ITU mother	0.0076	1525	11.5
HDU mother	0.0198	560	11.1
Special care mother	0.0076	400	3.04
NICU baby	0.0152	1081	16.4
HDU baby	0	759	0
SCBU baby	0.08	429	37.2
ECMO	0	0	0
Cooling	0	2110	0
Baby died	0	644	0
Effectiveness and Cost payoffs			
mother well baby well	**0.8617**		**3132.3**
mother well baby not well	**0.0067**		**3209.6**
mother not well baby well	**0.1315**		**4768.4**
mother not well baby not well	**0**		**0.0**

Planned birth in an Alongside Midwifery Unit Actual birth in Obstetric Unit with a unplanned caesarean section 'Low risk' multiparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
average duration of labour (hrs)	13.04		
Midwifery care	1	448.6	448.6
Overheads	1	300.7	300.7
Transfer	1	73.6	73.6
OU running costs	1	495.9	495.9
OU midwifery costs	1	411.4	411.4
Assessment by consultant	0.95	194.7	185.6
Augmentation	0.38	159.1	61.3
Epidural	0.93	311.1	290.7
General Anaesthetic	0.12	846.5	107.7
Birth	1	1052.6	1052.6
Syntometrine	0.95	4.1	3.9
Episiotomy	0	24.6	0
Perineal repair	0	595.3	0
Blood transfusion	0.015	312.5	4.8
Stillbirth	0	0	0
Higher level postnatal observation on labour ward	1	80	80
Postnatal care	0.97	240.8	233.9
ITU mother	0	1525	0
HDU mother	0.01	560	8.68
Special care mother	0	400	0
NICU baby	0	1081	0
HDU baby	0	759	0
SCBU baby	0.18	429	78.5
ECMO	0	0	0
Cooling	0	2110	0
Baby died	0	644	0
Effectiveness and Cost payoffs			
mother well baby well	**0**		**0.0**
mother well baby not well	**0**		**0.0**
mother not well baby well	**0.9845**		**3782.4**
mother not well baby not well	**0.0155**		**6373.1**

Planned birth in an Obstetric Unit Actual spontaneous vertex birth 'Low risk' multiparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
average duration of labour (hrs)	6.24		
Midwifery care	1	330.2	330.2
Overheads	1	420.5	420.5
Augmentation	0.07	159.1	11.3
Epidural	0.09	311.1	30.9
General anaesthetic	0.001	846.5	1.0
Birth	1	26.3	26.3
Syntometrine	0.9	4.1	3.8
Episiotomy	0.04	24.6	1.0
Perineal repair	0.01	595.3	9.2
Blood transfusion	0.004	622.4	2.6
Stillbirth	0	644	0
Higher level postnatal observation after birth	0.004	80	0.3
Postnatal care	0.9	95	86.2
ITU mother	0.0006	1525	0.9
HDU mother	0.001	560	0.8
Special care mother	0.0006	400	0.2
NICU baby	0.006	1081	6.7
HDU baby	0.006	759	4.8
SCBU baby	0.05	429	24.0
ECMO	0	1651	0
Cooling	0.0003	2110	0.8
Baby died	0.0001	644	0.08
Effectiveness and Cost payoffs			
mother well baby well	**0.97**		**901.5**
mother well baby not well	**0.002**		**7835.7**
mother not well baby well	**0.02**		**1956.3**
mother not well baby not well	**0**		**0.0**

Planned birth in an Obstetric Unit Actual ventouse birth 'Low risk' multiparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
average duration of labour (hrs)	9.79		
Midwifery care	1	517.4	517.4
Overheads	1	658.9	658.9
Augmentation	0.25	159.1	40.8
Epidural	0.52	311.1	162.7
General anaesthetic	0	846.5	0
Birth	1	429.2	429.2
Syntometrine	0.96	4.1	3.9
Episiotomy	0.48	24.6	11.8
Perineal repair	0.01	595.3	6.4
Blood transfusion	0.005	479.8	2.6
Stillbirth	0.003	644	1.9
Higher level postnatal observation after birth	0.005	80	0.4
Postnatal care	1.23	95	117.1
ITU mother	0	1525	0
HDU mother	0	560	0
Special care mother	0	400	0
NICU baby	0.02	1081	27.2
HDU baby	0.01	759	8.9
SCBU baby	0.14	429	64.3
ECMO	0	1651	0
Cooling	0	2110	0
Baby died	0	644	0
Effectiveness and Cost payoffs			
mother well baby well	**0.9776**		**1961.5**
mother well baby not well	**0.006**		**8332.0**
mother not well baby well	**0.0139**		**2904.1**
mother not well baby not well	**0.0025**		**7856.5**

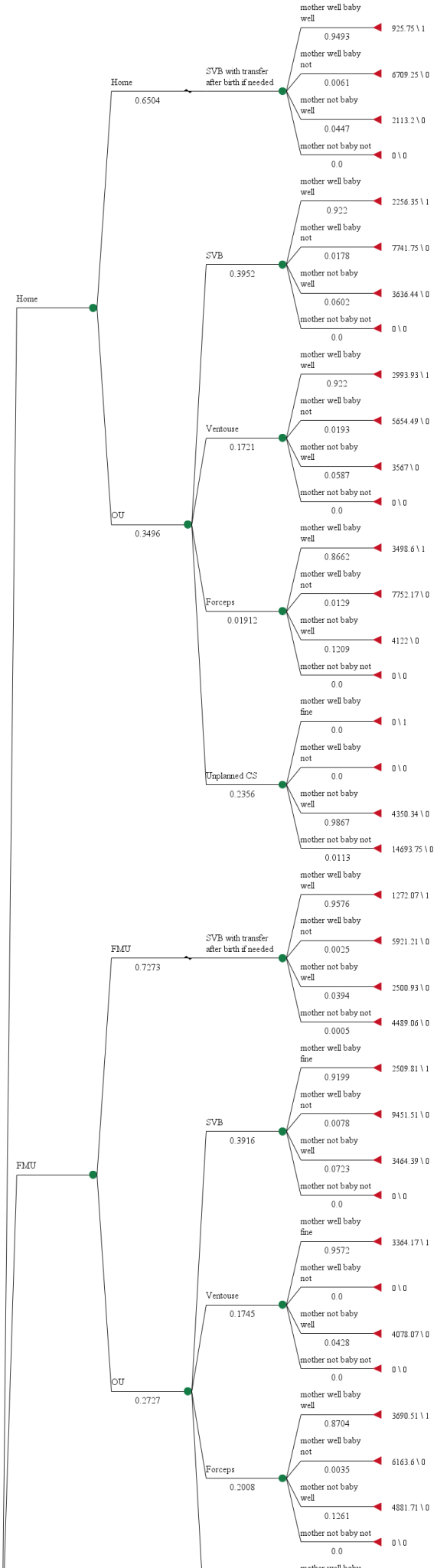
Planned birth in an Obstetric Unit Actual forceps birth 'Low risk' multiparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
average duration of labour (hrs)	11.14		
Midwifery care	1	589.1	589.1
Overheads	1	750.2	750.2
Augmentation	0.41	159.1	65.1
Epidural	0.71	311.1	222.1
General anaesthetic	0.006	846.5	5.4
Birth	1	569.9	569.9
Syntometrine	0.9	4.1	3.9
Episiotomy	0.8	24.6	21.8
Perineal repair	0.06	595.3	41.4
Blood transfusion	0.03	513.26	15.5
Stillbirth	0	644	0
Higher level postnatal observation after birth	1	80	80
Postnatal care	1.5	95	145.3
ITU mother	0.006	1525	9.9
HDU mother	0.009	560	5.4
Special care mother	0.006	400	2.6
NICU baby	0	1081	0
HDU baby	0	759	0
SCBU baby	0.1	429	79.1
ECMO	0	1651	0
Cooling	0	2110	0
Baby died	0	644	0
Effectiveness and Cost payoffs			
mother well baby well	**0.8995**		**2403.2**
mother well baby not well	**0.0067**		**9472.1**
mother not well baby well	**0.0938**		**3456.6**
mother not well baby not well	**0**		**0.0**

Planned birth in an Obstetric Unit Actual unplanned caesarean section 'Low risk' multiparous women			
Detailed breakdown of cost variables			
key resource episodes or procedures	**weighted average probability**	**average unit cost (£)**	**sum (£)**
average duration of labour (hrs)	11.83		
Midwifery care	1	625.3	625.3
Overheads	1	796.3	796.3
Augmentation	0.31	159.1	50.6
Epidural	0.8	311.1	265.2
General anaesthetic	0.1	846.5	127.8
Birth	1	1052.6	1052.6
Syntometrine	0.9	4.1	3.7
Episiotomy	0.008	24.6	0.2
Perineal repair	0	595.3	0
Blood transfusion	0.04	680.5	28.4
Stillbirth	0.002	644	1.3
Higher level postnatal observation after birth	1	80	80
Postnatal care	0.96	240.2	230.8
ITU mother	0.0005	1525	0.8
HDU mother	0.04	560	22.5
Special care mother	0.012	400	5.0
NICU baby	0.0213	1081	23.0
HDU baby	0.027	759	20.8
SCBU baby	0.22	429	96.9
ECMO	0	1651	0
Cooling	0.0029	2110	6.119
Baby died	6.34573E-06	644	0.004
Effectiveness and Cost payoffs			
mother well baby well	**0**		**0.0**
mother well baby not well	**0**		**0.0**
mother not well baby well	**0.9816**		**3330.8**
mother not well baby not well	**0.0184**		**7120.5**

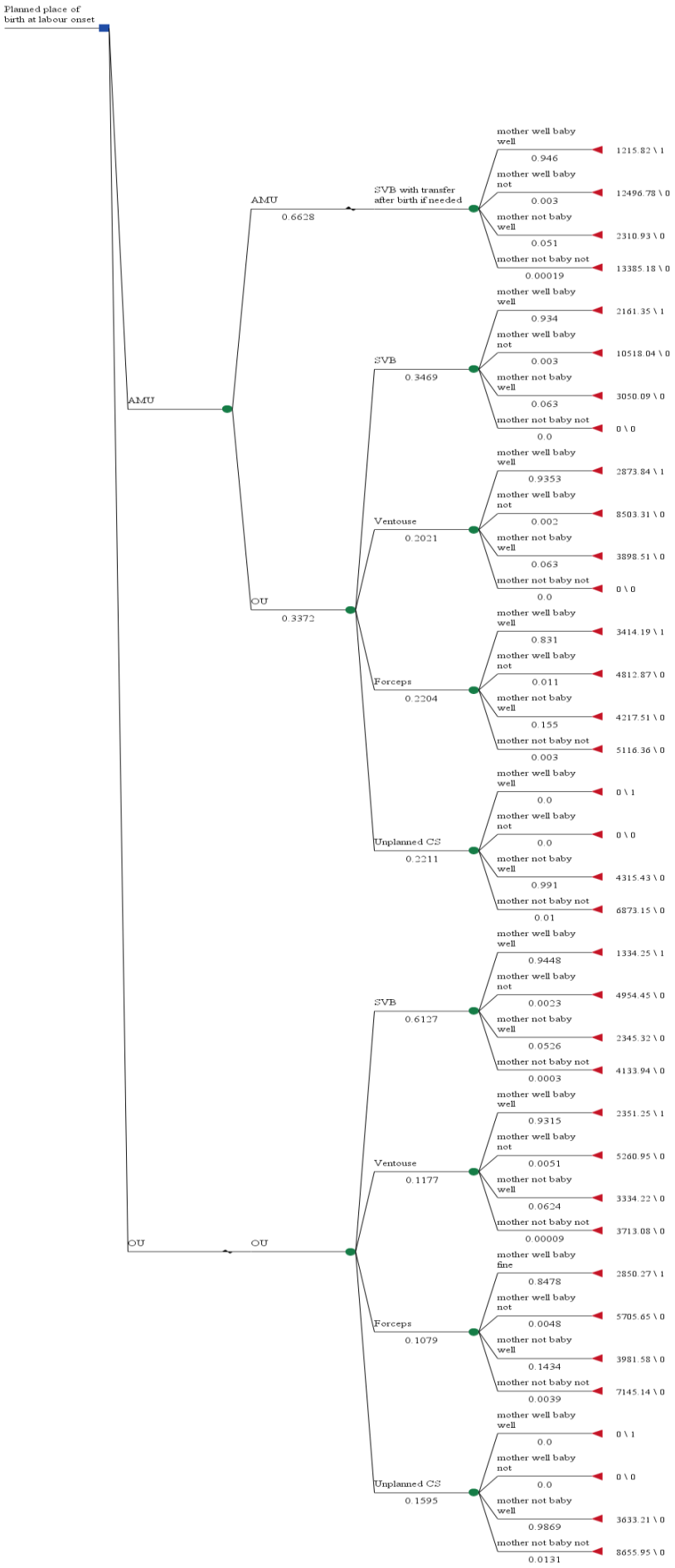
Appendix 22 Populated decision trees

See overleaf..

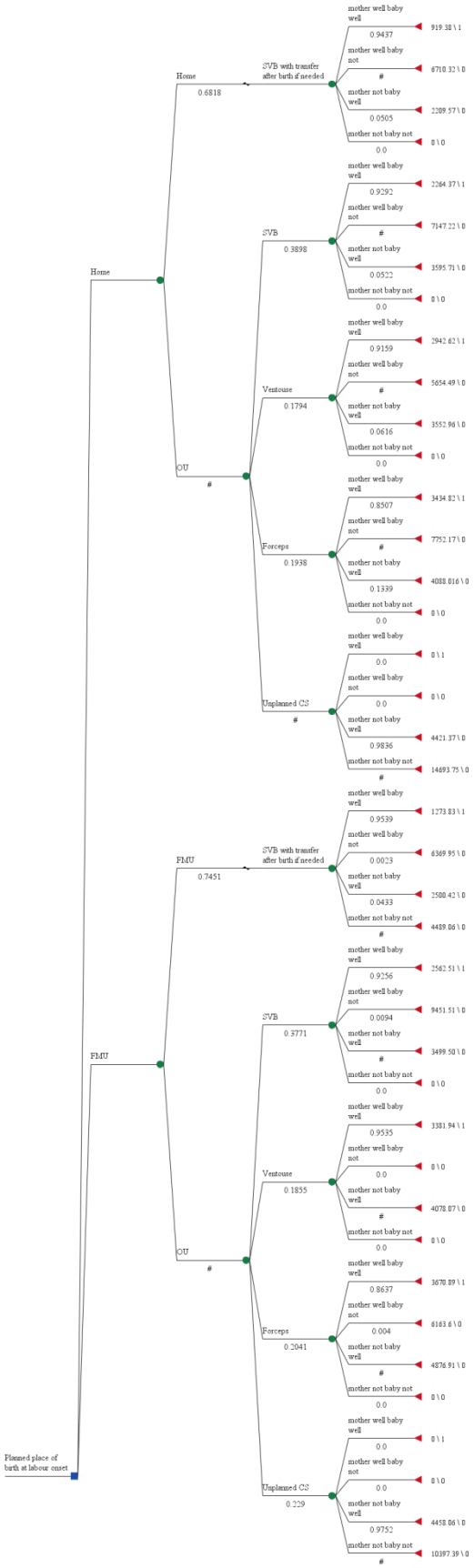
Appendix 22: Decision analytic model for 'low risk' nulliparous women



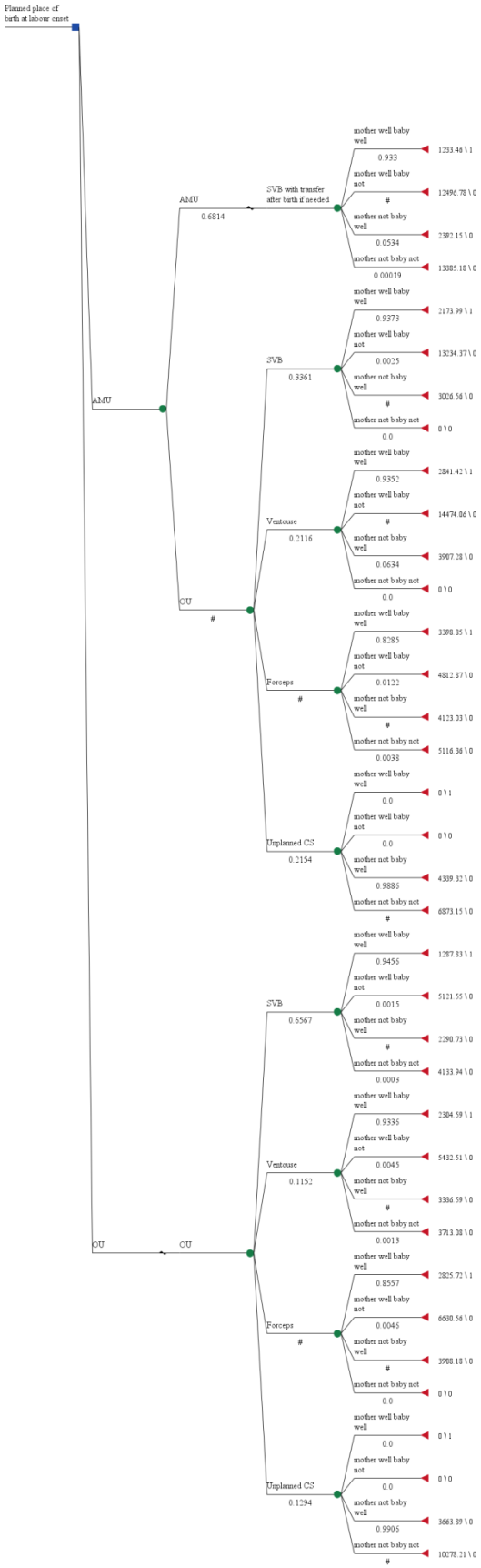
Appendix 22: Decision analytic model for 'low risk' nulliparous women continued



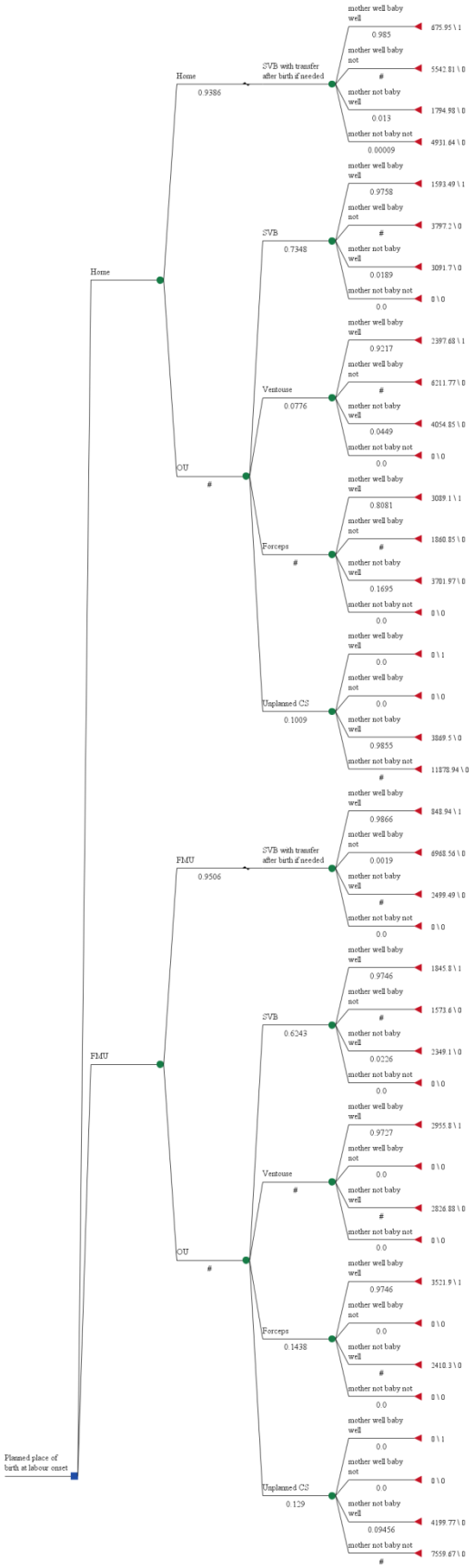
Appendix 22: Decision analytic model for 'low risk' nulliparous women without complicating conditions at the start of care in labour



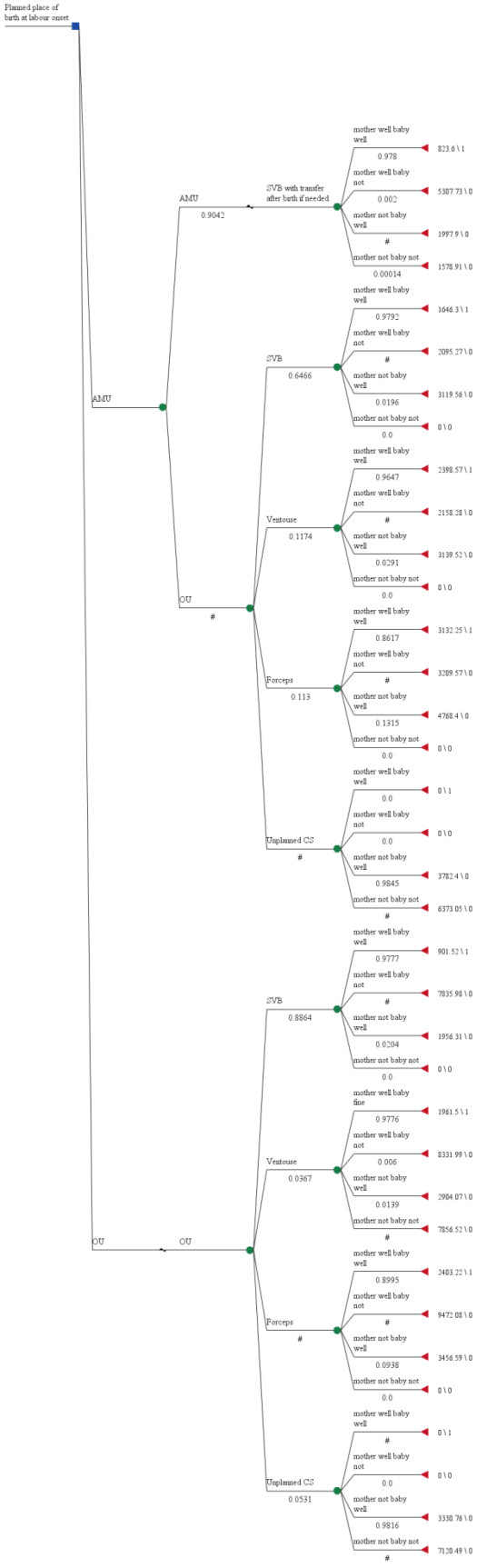
Appendix 22: Decision analytic model for 'low risk' nulliparous women without complicating conditions at the start of care in labour continued



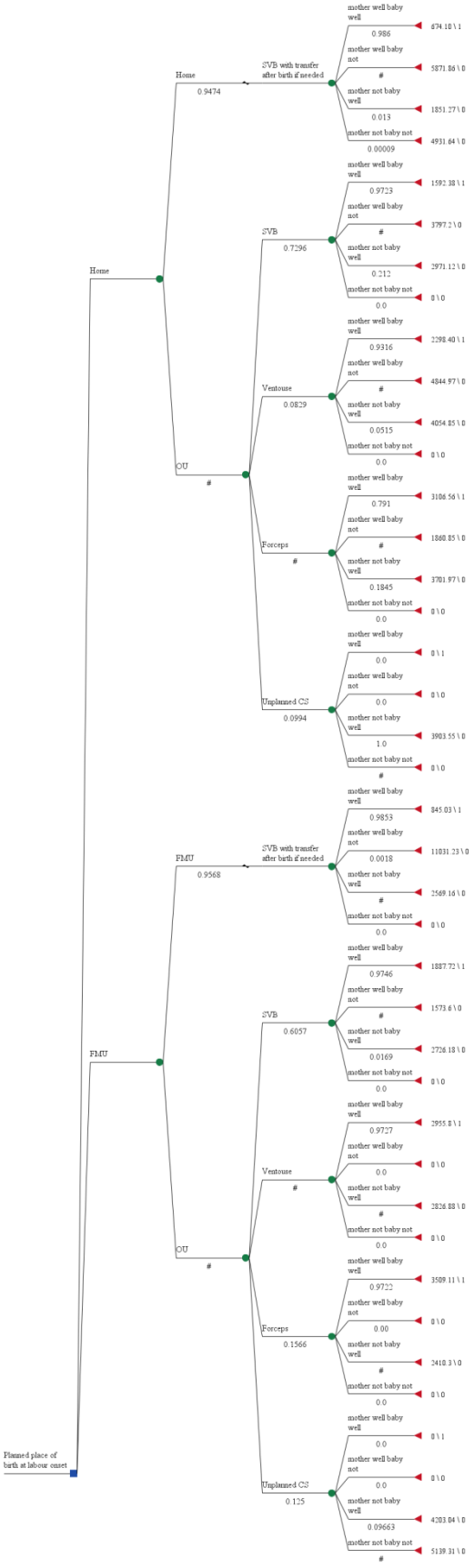
Appendix 22: Decision analytic model for 'low risk' multiparous women



Appendix 22: Decision analytic model for 'low risk' multiparous women continued



Appendix 22: Decision analytic model for 'low risk' multiparous women without complicating conditions at the start of care in labour



Appendix 22: Decision analytic model for 'low risk' multiparous women without complicating conditions at the start of care in labour

