Patient Safety Culture in South African Obstetric Theatres

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Submitted: Trinity Term, 2020

This thesis is submitted to the Department of Surgical Science, University of Oxford, in partial fulfilment of the requirements for the degree of Doctor of Philosophy

Declaration

I declare that this thesis is entirely my own work and, except where otherwise stated, describes my own research.

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2020

Word Count: 48 237

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Abstract

Introduction: Patient safety culture (PSC) in African surgical settings is not well described. This dissertation provides a foundational investigation into the origins and nature of PSC in South Africa and, building on that foundation, aims to propose a model for PSC suited to that context.

Methods: A multi-method approach comprising of a historical analysis of South African PSC, a literature review of PSC in sub-Saharan African obstetric surgery, qualitative interviews, semi-quantitative safety climate surveys and quantitative social network analysis was used to develop a model of PSC in three Cape Town obstetric theatres. As the thesis evolved, Schein's model of organisational culture was used as a theoretical basis. Building on the results of chapters 5, 6 and 7, a pilot patient safety training intervention based on an intraoperative surgical crisis simulation, intended to be suitable for low resource settings, was designed and piloted.

Results: The historical review, PSC in sub-Saharan Africa review and qualitative interviews demonstrate that contemporary barriers to South African patient safety can be linked to a history of discrimination in medicine coupled with resource constraint. These barriers necessitated the adaption of Schein's model to develop a conceptual framework of PSC in this context. The Safety Attitudes Questionnaire (SAQ) six-factor construct achieved face and content validity, but failed to achieve construct validity (RMSEA 0.09), potentially due to poor local fit. The social network analysis study demonstrated its utility as a means of measuring collaboration and power dynamics in surgical teams and its potential for measuring change following PSC interventions. An in-situ simulated crisis intervention proved acceptable and feasible as a small pilot.

Conclusion: Contemporary South African PSC continues to be shaped by a legacy of discrimination and resource constraint. For these reasons, safety climate surveys, training interventions and models of PSC require considerable adaption to South African PSC settings in order to achieve validity.

Acknowledgements

I would like to thank the following people for their contribution:

Professor Peter McCulloch for his unending supervision, academic mentorship and friendship.
Professor Chris Lavy for his co-supervision and support.
Dr Rowan Duys for co-facilitating the simulation exercises and research support.
Dr Nicole Louw for her assistance in handing out and collecting the SAQ surveys.
Dr Asha Khachane for assisting me with data collecting (interviews and social network analysis).

Dr Sheri-Leigh Franks for helping with SAQ data collection and logistics.
Dr Zime Shabalala for assisting me with social network analysis data collection.
Dr Mathabo Makhele for helping me with logistics associated with the simulation exercises.
Dr James van Vuuren for helping with investigating the use of social network analysis.
Dr George Hadjipouvlou for checking my statistics.
Dr Jade Esau for helping me with SAQ data collection.

Professor Kokila Lakhoo and Dr Lauren Morgan for their advice and support.
Ms Madeline Mitchell, Ms Janet Higham and Ms Valerie Parke for their administrative support.
Mr Jim Wilkinson for time off at work.
Professors Bruce Biccard, Sue Fawcus and Greg Petro for their mentorship.

The Rhodes Trust for providing me with a lifelong community and scholarship.
The Wellcome Trust and the John Fell fund for funding this research.

Mr Tim Bergling for his unending support through music.
Professor Delawir Kahn for supporting my desire to study at Oxford University
Professor Bongani Mayosi for his mentorship and enduring impact on my life. Rest in peace.
Ms Orenna Krut for proofreading my dissertation.

Thank you to Danielle for your love, patience and support.
Thank you to my sisters Sophia and Rumbidzai for their unending love and support.
A special thank you to my mother, Emily, this one is for you.

Abbreviations

AD Density	Average Directed Density
AU Density	Average Unredirected Density
BEMONC	Basic Emergency Obstetric and Neonatal care
CEMONC	Comprehensive Emergency Obstetric and Neonatal Care
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
HIC	High-Income Country
HIV	Human Immunodeficiency Virus
LIC	Low-Income Country
LMIC	Low- and Middle-Income Country
MMR	Maternal Mortality Rate
NCCEMD	National Committee for Confidential Enquiry into Maternal Deaths
PSC	Patient Safety Culture
RMSEA	Random Mean Square Error of Approximation
SAQ	Safety Attitudes Questionnaire
SNA	Social Network Analysis
SRMR	Standardised Root Mean Residual
WHO	World Health Organization

Chapter 1: Introduction

1.1 A preventable maternal death

My interest in safe obstetric surgery in South Africa began with the most humbling of events – a patient's death. As a medical student at the University of Cape Town, I took for granted that the world-class clinical medicine I was learning reflected how medicine functioned everywhere. I knew that severe resource constraints existed, but as a medical student I ultimately had no responsibility for the outcomes. I had no "skin in the game". However, my medical internship that followed in the Eastern Cape was a brutal introduction to medicine in a resource-limited environment marked by unpredictable deficiencies. Sometimes we had everything, then the next day we would run out of drip needles.

One summer morning, the obstetric surgery team in charge of the elective surgeries started the day with an emergency drill on post-partum haemorrhage. I remember it so well because I was sweating from resuscitating a doll so thoroughly that, for a moment, I swear the pulse oximeter could actually measure some oxygen in its inanimate fingers. The humidity made the air thick and heavy. Our team went through all the steps: calling for help, the ABCs of resuscitation, establishing IV access, attaching monitors for mother and child, taking blood, giving drugs, reviewing progress and moving to increasingly invasive interventions to stop the bleeding. We debriefed and retired to the doctors' room before the first case began. That's when the shouting started.

Two paramedics rushed an exhausted woman into the unit in a wheelchair. There was a commotion as they called out for help. Being veterans of the Eastern Cape, our obstetric team knew this could only mean a moribund patient was in urgent need of care. We took our places around her wheelchair, lifting her tired body onto a bed. I remember how she struggled to breathe and how cold and pale her hands were. This sort of thing stays with you, perhaps forever.

While several doctors and nurses put into practice what we had just learnt in the drill, I heard the senior obstetric registrar (chief resident equivalent) ask the paramedics for her notes and clinical handover. They shook their heads. “Sorry doc,” they said. “The midwives didn’t give us notes. They are bringing them soon. They asked us to just bring her here as soon as possible. We know she was there [the community delivery centre for uncomplicated births] the whole night. Apparently, she got worse all of a sudden and they called us.” We were all shocked that they had left her notes, but we had to proceed with the resuscitation. Within fifteen minutes our patient, Ms X, had IV access, blood ordered and was delivering her child in the labour ward. Ms X was so fatigued she could not apply any effort to push her baby, and we had to use forceps to assist her. She delivered a floppy child who was rushed to the neonatal ICU next door. But Ms X kept on bleeding.

The obstetric registrars and consultant battled to find the source of bleeding and resorted to using a balloon tamponade to stop the haemorrhage. Oxytocin simply would not work. A decision was made to operate and the team prepared Ms X for theatre. We gave her blood, took blood gases and kept resuscitating her. When she lost consciousness, we intubated her and took her to theatre. We knew we could still save her life by arresting the haemorrhage.

An anaesthetic registrar attempted to place an arterial line to measure blood pressure. Minutes turned into tens of minutes until her consultant was called. In the red mist of clinical combat, the trainee had become fixated on the arterial line. Once the consultant arrived, the trainee could focus on the rest of the induction. Unfortunately, Ms X developed cardiac arrest and despite an hour long on-table CPR, she died.

Our team was devastated and shocked.

As we reeled from the shock, a nurse from the community delivery facility that had referred her arrived with her notes. A diligent night shift student nurse had charted her prolonged labour and even marked with red ink on the partogram the points where Ms X crossed the alarm lines. It was not clear why no action was taken. Ms X was overweight, but other than that she had no underlying

condition. The loss of her life was acutely felt by the district service. The maternal morbidity and mortality audit concluded that her death was preventable, and that it was the result of several system and human factor errors lining up. I went to bed that night knowing that I wanted to use my doctoral degree at Oxford to investigate patient safety.

1.2 Contextual framing

As my own personal experience described above shows, a gulf still exists between quality of care, particularly obstetric and surgical care, observed in HIC and low and middle income settings (LMIC) (1–3). Rice et al. (4) remark that Patient Safety Culture (PSC) research "has led to lasting improvements in patient outcomes, healthcare quality, as well as organisational performance in a variety of high income countries" (p.1). Similarly, the publications by Carayon (5,6), Dixon-Woods (7,8), Gawande (9,10) and Catchpole (11) challenged the author to think of how human factors, surgical checklists and high performance culture approach could improve surgical care outcomes and quality of care in LMIC settings. Furthermore, the works of Leape (12,13), Vincent (14–16) and Amalberti (17,18) on PSC gave the author a foundational understanding of PSC. In addition, Sevdalis' (19–21) work on simulation in multi-disciplinary teams helped the author to appreciate the impact of stress on medical decision-making and performance.

Despite the abundance of research into PSC in HIC settings, African researchers Wami et al. (22) report that "little is known and information is limited in scope about patient safety culture" within their setting (p.1). In particular, PSC research could offer novel insights and strategies to reduce preventable maternal deaths in the South African public healthcare sector where maternal mortality is approximately 130/100 000 live births, well above the WHO target of 70/100 000 (23). However, there is scant existing research on PSC within South African healthcare settings.

Thus, the objective of this dissertation was to produce a foundational text examining PSC in an African setting, comprised of a set of studies using multiple research methodologies to triangulate the characteristics of PSC in this environment. Such a broad undertaking was difficult to execute in

an LMIC context, but the results provide a foundation for other African researchers to build a wider and more in-depth understanding of PSC within this context.

1.3 Overarching structure

This dissertation begins with two narrative literature review chapters which establish the background to the thesis and provide especially important historical contextual information (Chapters 3 and 4) (see Table 1). These are followed by investigational studies presented in four chapters, making use of in-depth interviews and a modified version of Edward Schein's organisation culture model to develop a South Africa-specific model of PSC (Chapter 5); the adaption and testing of a self-administered patient safety questionnaire (Chapter 6); an exploration of surgical teams using the methods of social network analysis (Chapter 7); and feasibility testing of a team-based simulation training that might be used to enhance non-technical skills that could promote patient safety (Chapter 8). In conclusion, the final chapter (Chapter 9) is a discussion of the findings of this investigation, its limitations and areas where further research is required.

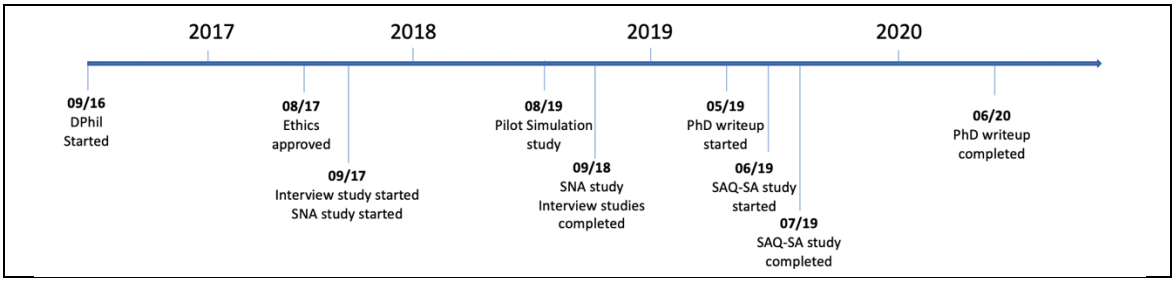
Table 1: Thematic structure of the dissertation and how each chapter contributes to each theme

Theme	**Chapter**
Understanding the current state of safety in South Africa	**Chapter 1:** Introduction
	Chapter 2: Objectives, theories and methods
	Chapter 3: A narrative historical review of healthcare in South Africa
	Chapter 4: A narrative review of safety in sub-Saharan African obstetric surgery
Investigating safety culture in a South African obstetric surgery setting	**Chapter 5:** Semi-structured interviews on safety in obstetric surgery
	Chapter 6: Validating a South African obstetric surgery safety attitudes questionnaire
	Chapter 7: Social network analysis of intraoperative communication patterns of Cape Town obstetric surgical teams
Application of findings	**Chapter 8:** A pilot of a low fidelity simulation training programme for post-partum haemorrhage in Cape Town secondary hospitals
Synthesis of investigation findings	**Chapter 9:** Reflection, strengths and limitations

1.4 Temporal sequence of studies

The set of studies described in this dissertation were conducted between September 2016 and July 2019 (see Figure 1). The in-depth interview study and theatre observations (SNA study) were the first to be initiated, thus insights gained from interviewing and observing staff informed the design of subsequent studies, particularly the pilot study of an in-situ surgical crisis simulation training intervention.

Figure 1: Timeline to show the start and completion of the interview, SNA, SAQ-SA and pilot simulation studies described in the dissertation



1.5 Levels of analysis

It is worth noting that the methods used range from expansive studies of PSC (interviews), to focused surveys (SAQ) and finally to very detailed analysis of non-technical skills in a South African setting (SNA study and Notechs II scoring), as shown in Table 2.

Table 2: Research methods chosen to examine different levels and attributes of PSC.

Research method	Level of analysis	Patient safety Attribute
PSC interviews (Chapter 5)	Expansive organisational	Patient safety culture
SAQ-SA survey (Chapter 6)	Focused organisational	Patient safety climate
SNA study (Chapter 7)	Detailed team level	Communication
Simulated crisis non-technical skills assessment (Chapter 8)	Detailed team level	Global non-technical skills assessment

Chapter 2: Objectives, theory and methods

2.1 Introduction to research chapters

African women who undergo caesarean sections have a fifty times greater risk of mortality in comparison to women in high income countries (HICs), according to Bishop et al. (24). In South Africa, the National Committee for Confidential Enquiries into Maternal Deaths (NCCEMD) has identified that bleeding during and after caesarean section is a major contributor to maternal mortality (25–27). This has generated an impetus to understand the role of quality of care—in particular, patient safety—in contributing to maternal mortality. The Lancet Commission for Global Surgery and the Lancet Global Health Commission on High Quality Health Systems have focused the international development community's attention on quality of care in African maternal surgical services (1,2,28). However, prior to implementing interventions developed and validated in high-income country (HIC) settings in South Africa, researchers must be sure that there are no substantial differences between patient safety culture (PSC) in South Africa and in HICs which would mitigate against the imposition of an intervention designed for an HIC environment. Thus, it is necessary to investigate if there are indeed differences and, where they exist, to explain why.

2.2 Research objectives

The primary objective of this dissertation is to produce a foundational text and South African model of PSC that lays the groundwork for other researchers to build an understanding of PSC in South African obstetric theatres. This will be done by addressing several sub-objectives:

i) To describe why South African PSC's unique historical roots continue to impact on contemporary PSC in South Africa (Chapter 3).

ii) To describe the current body of knowledge concerning PSC in sub-Saharan African obstetric theatres (Chapter 4).

iii) To describe how healthcare workers perceive PSC in South African obstetric theatres (Chapter 5).

iv) To investigate how researchers can accurately measure PSC in a South African setting (Chapter 6).

v) To describe with objectivity how PSC is practised in South African obstetric surgical teams (Chapter 7).

vi) To test the feasibility of a PSC intervention designed for South African settings (Chapter 8).

vii) To compare and contrast PSC in South African theatres with PSC in HIC theatres (Chapter 9).

2.3 The role of Schein's model of organisational culture in determining the author's choice of research methods

2.3.1 The value of adopting Schein's model of organisational culture

There are several theories of organisational culture and PSC. However, Edgar Schein's theory of organisational culture is simple and foundational to several PSC theories, and is widely applicable to many disciplines and contexts (29). This makes it a useful tool with which to unpack the complexities of organisational culture in a resource-constrained setting. Schein's theory will be referred to at various points, particularly in Chapters 5 and 9. Thus, it is useful to reflect on its strengths and limitations.

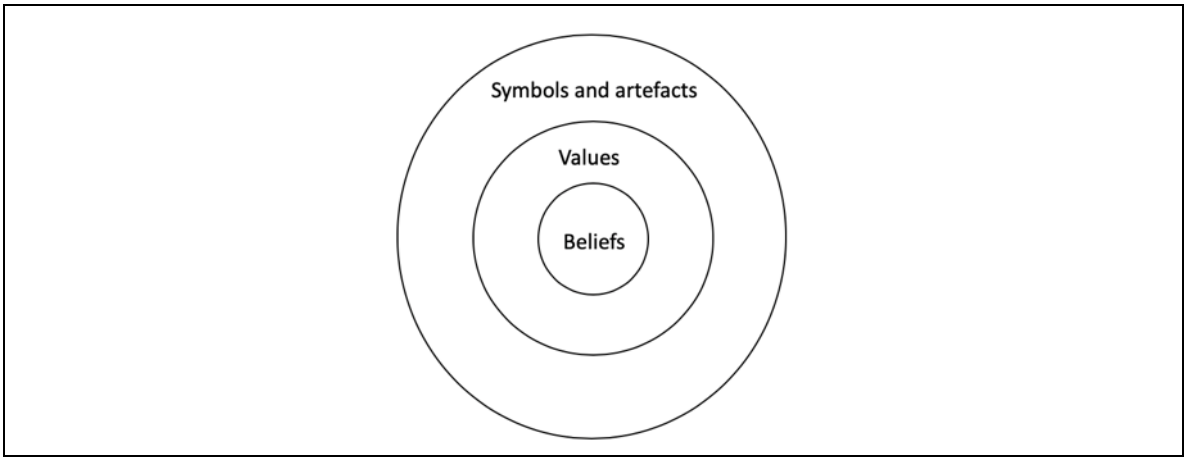
2.3.2 Definitions

Schein (30) defines organisational culture as a way of doing things "which a given group has invented, discovered, or developed in learning to cope with its problems of external adaptation and internal Integration, which have worked well enough to be considered valid, and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems" (p.1).

Schein (31) proposes that "culture is to a group what personality or character is to an individual" (p.14). Schein (32) proposes that as a group thrives and succeeds, the group goes through a process of learning and the initial values and beliefs of a group's founders gradually become taken for

granted as assumptions if the group succeeds. Schein (32) also argues that an organisation's culture is made up of three building blocks (see Figure 2): "basic assumptions, espoused values and artefacts" (p.25). Schein (32) defines basic assumptions are the "ultimate, non-debatable, taken-for-granted values" that are shared by a group, whereas espoused values are "what people say is the reason for their behaviour, what they ideally would like those reasons to be, and what are often their rationalisations for what they have done, where the 'true' reason or 'latent functions' of the behaviour remain unconscious" (p.3). Schein (32) defines artefacts as "the constructed environment of the organisation, its architecture, technology, office layout, manner of dress, visible or audible behaviour patterns and public documents such as employee orientation materials" (p.2). Artefacts are observable and make manifest the assumptions and values of an organisation.

Figure 2: Edward Schein's original model of organisational culture based on Schein (32)



2.3.3 Applying Schein's model to the choice of research methods

Schein's three-layer organisation culture model challenges researchers to use multiple methods in order to capture the totality of an organisation's culture. Schein (33) warns that "the assumption that a lot of individual responses [to a single survey] can be amalgamated into a picture of something that is organisational" is incorrect (p.11). Although quantitative approaches can analyse the structures and behaviours within an organisation, only qualitative studies can reveal the assumptions and values that underpin culture (33). In light of this, the author has adopted the use of qualitative interviews, psychometric surveys and observational data.

2.3.4 Strengths and limitations of Schein's model

The Schein model's strength lies in its simplicity and wide applicability, which make it easy to use as a starting point to explore PSC in South African obstetric theatres. However, it does have limitations. Firstly, it is easy to focus on "what here is attributable to culture?" rather than seeking to answer, "why is culture here the way it is?". Secondly, it does not adequately consider the role of environmental factors in shaping the culture of a team, something this study adapted for, as discussed in Chapter 5.

2.4 Research methods

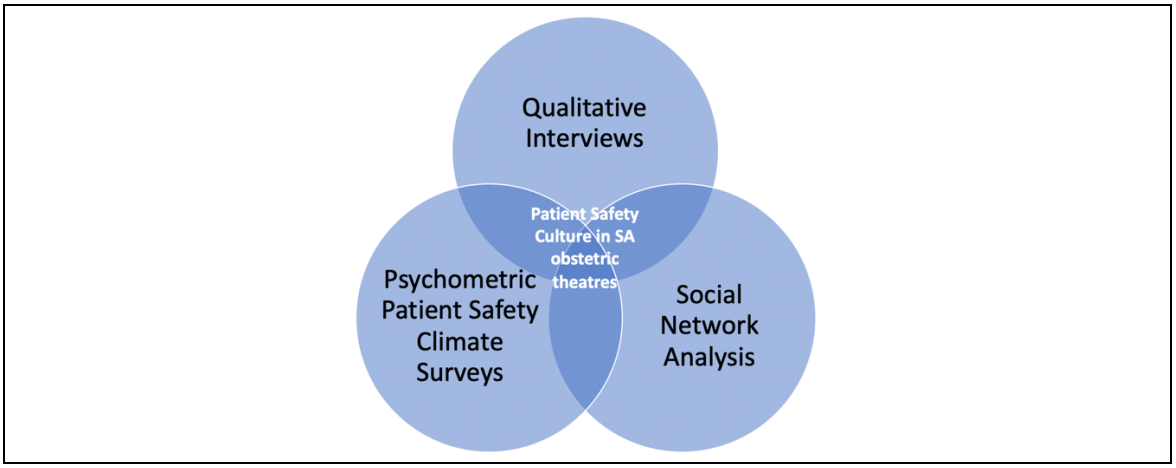
2.4.1 Narrative reviews

The task of describing PSC in South African obstetric surgical theatres is considerable, given the absence of foundational research. Multiple research methods are required to triangulate PSC in this context. To start off with, the author chose to conduct two narrative reviews that outline the historical development of South Africa's health system (Chapter 3) and describe the body of knowledge concerning PSC in sub-Saharan African obstetric surgical services (Chapter 4). Due to the limited amount of published literature addressing PSC in South African and African operating theatres, the author chose to complete a narrative review instead of a systematic review on the subject.

2.4.2 Analytical research

For the analytical research (Chapters 5-7), three research methods were chosen to triangulate the most accurate version of PSC in this setting (see Figure 3). These were qualitative, semi-quantitative and quantitative in nature. Each method has its strengths and limitations, but the simultaneous use of all three methods combines the strengths of all three to give a better perspective of PSC in South African obstetric surgical services. These will be described below.

Figure 3: Diagram of research methods: The overlapping strengths of each method lead to a more accurate picture of PSC and limit the impact of the downsides of each method.



2.4.2.1 Qualitative interviews (qualitative approach)

Qualitative interviews enabled the author to explore the underlying assumptions that shape individual team members' perceptions of patient safety. Qualitative interviews offer four advantages. Firstly, they offer study participants the opportunity to share their opinions and insights as to why things are the way they are. Secondly, the interview format allows participants to explain the context and meaning of artefacts (policies, symbols and behaviours) in their own words. Thirdly, interviews allow the interviewer to test hypotheses through questioning and to receive feedback which may illuminate new lines of thinking or link themes that may not be obviously connected. Finally, interviews allow for participants to share sensitive information they may not feel comfortable writing down. The major limitation of this method is that it is time-intensive, requiring months of interviews and weeks of analysis.

In Chapter 5, a constructivist grounded theory approach will enable the author to identify unique themes through thematic analysis (see section 5.3.5). Once identified, themes will be organized into Schein's existing model for organisational culture. Themes that do not fit into that structure will warrant the adaptation or creation of an entirely new culture model to explain the research findings in an LMIC setting. Thus, a novel understanding of PSC in a South African healthcare setting will be achieved.

2.4.2.2 Testing the validity of an international safety climate measuring tool (semi-quantitative approach)

Safety climate surveys will be used to assess contemporary knowledge, attitudes and practices toward safety. Whereas PSC takes a long-term view of the values and practices that guide a group, patient safety climate takes a more short-term view (34). Combining the data from the surveys with interview and observational data will help to build a complete view of safety in this setting. The advantage of using surveys is that they can be standardised, enabling wide and rapid distribution. Their findings can be used to compare safety climate at a facility, national and international level. However, surveys require validation in every new context in which they are used. Thus, an international safety climate survey's construct validity and internal reliability will be tested to determine the suitability of using international measuring instruments in a South African context.

The short form Safety Attitudes Questionnaire (SAQ) survey developed by Sexton et al. (35) will be used for this investigation because it is a widely researched and validated international instrument. The survey has utility in a number of LMIC settings such as Brazil and China (36,37). In the context of this dissertation, the process of validating an international patient safety climate survey in a South African setting will yield useful insights into the extent to which this tool is fit for purpose in an African context and, perhaps, why it is not (Chapter 6). This will be useful in defining the attributes that should define a validated African patient safety climate survey.

2.4.2.3 Social Network Analysis (quantitative approach)

Social network analysis (SNA) is a mathematical method based on graph theory (38). It describes the relation between actors in a network through the ties that bind them. Surgical teams are a type of small network and the communication patterns that link different individuals to one another during the course of a procedure can be described using sociograms (SNA graphs). The advantage of this method is that the author can insert himself into the world of the surgical team and record his observations through these sociograms. These observations can be analysed using computational software to illuminate unexpected relationships and communication hierarchies

between team members. Quantitative variables for centrality (i.e. influence in a network) and overall network statistics will be reported.

The disadvantage of this method is that it is research-intensive, requiring that the author observes tens of surgeries until no new patterns emerge (i.e. saturation). This process requires concurrent data collection and analysis. Furthermore, due to the novel nature of this work in a healthcare setting, there are few clinical studies with which to compare the results.

2.4.3 Piloting a human factors intervention

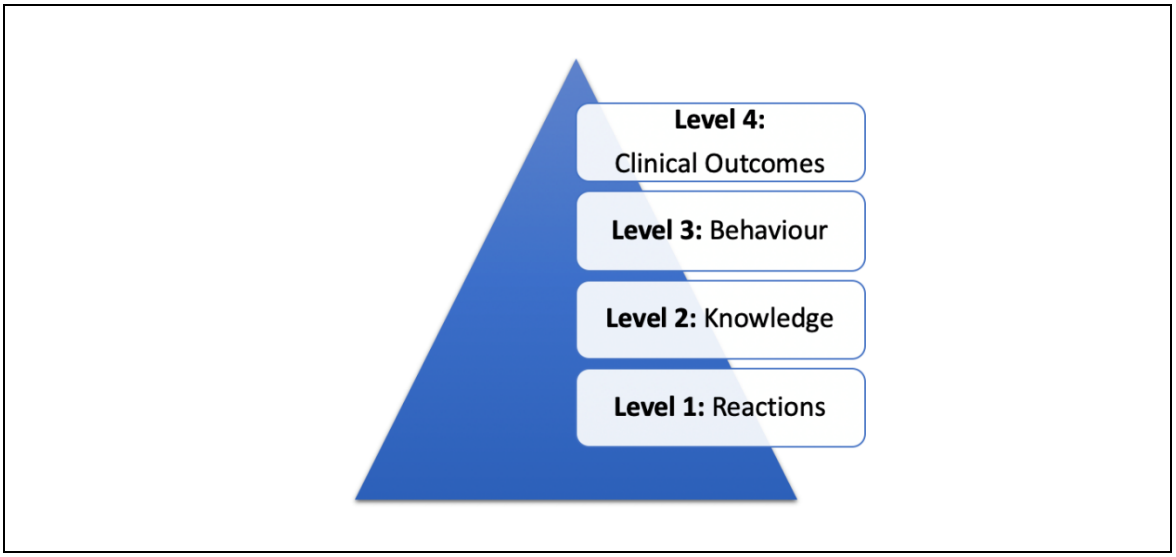
Finally, the feasibility and validity of an educational intervention based on the findings of this dissertation will be trialled in an obstetric surgical hospital. This intervention is comprised of two intra-operative surgical crisis drills and a debriefing session between the two drills. The objective is to equip obstetric surgical teams with non-technical skills they can use in cases of intraoperative obstetric haemorrhage. Feasibility assessment will be based on the logistical difficulty of implementing the intervention in a South African state hospital on a limited budget. Note, however, that due to the small sample size of the pilot, it will not be possible to validate the research tools, which include feedback surveys and knowledge tests.

The impact of the intervention will be evaluated using the Kirkpatrick assessment scale as shown in Figure 4 (39). Kirkpatrick level 1 (reactions) will be assessed using a feedback form and video-recorded feedback sessions with participants. Kirkpatrick level 2 (change in knowledge) will be assessed using a knowledge test. A comparison of the participants' pre-training test score against their post-training test score will test for statistically significant improvement. Kirkpatrick level 3 (change in behaviour) will be assessed by using the Notechs II scoring system to detect changes in non-technical skills competency due to training.

The surgical teams will complete a surgical crisis drill, after which they will be assigned a whole team Notechs II score (pre-debriefing score). The drill will be followed by a whole team debriefing session in which non-technical skills deficits and errors will be discussed and remedied. The debrief

will be followed by a second surgical crisis drill, after which the teams will be given another Notechs II score (post-debriefing score). Kirkpatrick level 4 (changes in clinical outcomes) changes such as blood transfusion use, near misses and maternal mortality rate will not be measured due to the short duration of this pilot.

Figure 4: Kirkpatrick's four levels of assessment



2.5 Summary

In brief, the primary objective is to produce a foundational text and South African model of PSC that lays the groundwork for other researchers to build an understanding of PSC in South African obstetric theatres. This will be done using a multiple method approach that includes narrative reviews (Chapters 3 and 4), qualitative interviews (Chapter 5), evaluation of a locally adapted safety climate survey (Chapter 6) and a social network analysis study (Chapter 7). A proof-of-concept study to evaluate the acceptability and feasibility of an in-situ obstetric crisis simulation programme will also be conducted to test if some of the safety culture issues identified in earlier chapters can be addressed through this type of intervention. The findings of Chapters 5, 6 and 7 will be used to triangulate and define what PSC is in this context. Schein's model of organizational culture will be adapted to form a model of PSC in South African obstetric operating theatres.

Chapter 3: A narrative review of the development of maternal healthcare in Cape Town and South Africa

3.1 Introduction

The contemporary structure, processes and outcomes of obstetric care in South Africa's Cape Town region reflect successive policies of past and present health administrations. The present cannot easily be understood on its own terms without situating it within historical context. Thus, it is necessary to offer a brief account of the history of South Africa's healthcare system in order to show how historical factors have contributed to an environment marked by resource constraint. This serves as an important context for scientific investigations into the knowledge, attitudes and practices of obstetric surgical practitioners in Cape Town hospitals. Furthermore, this chapter will explore the impact of South Africa's history of race-based separate development on health outcomes. Finally, the current challenges surrounding the delivery of safe obstetric care will be explored through an overview of the work of Professors Sue Fawcus[1], Bruce Biccard[2] and the South African National Committee of Confidential Enquiries into Maternal Deaths (NCCEMD)[3]. This background will provide a historical context to help the reader understand and interpret the findings of a narrative review, qualitative interviews, an adapted South African safety attitudes questionnaire, a social network analysis study of communication patterns between healthcare workers and a low-cost simulation intervention aimed at improving communication amongst healthcare workers.

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[1] Prof. Sue Fawcus FRCOG is a Senior Scholar and Emeritus Professor in the Department of Obstetrics and Gynaecology, University of Cape Town, and was previously Head of Obstetrics Services at Mowbray Maternity Hospital (1996-2018).

[2] Prof. Bruce Biccard is an anaesthesiologist, professor and Second Chair in the Department of Anaesthesia and Perioperative Medicine at Groote Schuur Hospital in Cape Town and the University of Cape Town, South Africa.

[3] The NCCEMD, formed in 1998, is modelled on the UK Confidential Enquiry into Maternal Deaths (CEMD). It is made up of professionals in the fields of obstetrics, gynaecology and midwifery across South Africa's nine provinces.

3.2 Objective

The objective of this chapter is to identify and describe how key historical themes of South Africa's development have influenced organisational culture and patient safety in contemporary Cape Town's obstetric surgical service.

3.3 Methods

This overview is based on the writings of several expert medical historians, public health practitioners and other health experts who have analysed the historical development of South Africa's health system. A narrative literature review of key publications on the subject was conducted by the author. A non-structured search was conducted for relevant academic publications describing the structure, processes and outcomes of obstetric healthcare in the Western Cape region of South Africa, of which Cape Town is a part, dating from the indigenous settlement of the Cape area to contemporary times. The search involved the use of Pubmed, Embase, SOLO[4] and Google Scholar as described in Table 3. Due to the limited number of publications covering the indigenous settlement of the Cape to the 1950s, this account relies on the writings of a small number of academic historians.

Table 3: Search strategy used to identify academic publications

Step 1: Initial search terms	**Step 2: Expanded search**	**Step 3: Review**
"Medical History" +: - "South Africa" - "Cape Town" - "Indigenous birth practices South Africa" - "Cape Colony" - "Dutch Cape Colony" - "British Cape Colony" - "Union of South Africa" - "Apartheid" - "Post-Apartheid South Africa" - "Obstetrics in South Africa" - "Birth in South Africa" - "Maternal mortality South Africa" - "Maternity hospitals in the Cape" - "Medical schools South Africa" - "Mining and disease South Africa"	Further articles were identified from references in articles selected in Step 1.	- 46 articles selected - Findings summarised

[4] SOLO: Search Oxford Libraries Online

3.4 Results

The author identified 46 articles. A summary of key relevant findings for each is provided below. The findings have been categorised in chronological order of governing administrations. Within each period, the articles have been arranged according to the sequence of historical events they describe. With regard to place names, Cape Town is a city in the Western Cape province, also confusingly referred to as the Cape, which today is one of nine provinces in the country called South Africa. From 1652 to 1910, the Cape was commonly referred to as the Cape Colony.

Healthcare in the pre-colonial Cape	
Author	Key findings
Viljoen et al. (40)	The Khoi-Khoi were semi-nomadic pastoralists who inhabited the southern cape of Africa prior to the arrival of European settlers in 1652. Their health and well-being were essential to their ability to hunt, gather and herd animals and so shaped important facets of their lives.
Kolb (41)	The Khoi-Khoi devised medicines ground from herbs and animal products. They believed rituals around the administration of medicines conferred healing power. Several herbs with uterotonic properties were ingested to cause abortion or speed up delivery. Respected elder women were elected by members of the kraal. Midwives kept their positions until death.
Wikar (42)	Khoi-Khoi women played an important role in medical practice, particularly midwifery. Men were not allowed to watch the birth process.
Healthcare in the Dutch- and British-administered Cape Colony	
Author	**Key findings**
Pretorius (43)	The Dutch East India Company (DEIC) governed the Cape in the 17th and 18th centuries. Cape Town was established as a victualling station in 1652. Barber surgeons were appointed by the DEIC as the first western medical practitioners in

	the region. DEIC surgeons who left its employ became the first private practitioners of the Cape. Medical practice was not formally regulated. Rural communities and allies had few western-trained midwives and physicians. Trek Boers (European settlers) learnt local herbal medicinal practices from the indigenous Khoi-Khoi. Trek Boers relied on local Khoi-Khoi midwives to deliver their pregnancies due a lack of western-trained practitioners in the frontier territories. Western-trained midwives were examined by two company physicians and sworn in by company officials. Despite this, high rates of maternal and neonatal mortality prevailed in the Cape due a lack of obstetric skills and hygiene practices. This was a global problem at that time.
Deacon (44)	The arrival of permanent British rule of the Cape in 1806 led to the regulation of midwifery, particularly in urban centres. Midwives had to be formally trained and registered on a professional roll. Only British- and European-trained physicians were permitted to practise medicine. Wealthier middle-class European families sought accoucheurs rather than midwives to deliver their children. These new regulations relegated traditional midwives to the less developed rural periphery of the Cape Colony. Registered physicians preferred to practise in urban centres.
Deacon et al. (45)	Deacon et al. explore how regulations and legislation were crafted by the British administration to professionalise medical practice in the Cape Colony. These regulations had the effect of excluding physicians trained outside Europe or Britain, as well as women and non-white people, from medical practice.
Deacon (46)	The key message is that legislation, institutional setting, gender, socio-economic status and stereotypes influenced the forms and severity of racism in medical practice in the Cape Colony. The author makes a distinction between racist medicine and medical racism: racist medicine is defined as the institutionalisation

	of discriminatory practices in medicine based on broader social discrimination, while medical racism is defined as the application of racially discriminatory practices in medicine justified on medical grounds. Though racism was commonplace in 19th-century Cape society, few medical practitioners in the Cape tried to ascribe differences in treatment to race. Deacon shows that the Cape medical community was largely composed of British-trained men, a composition which was the result of the regulations governing medical registration and rising British immigration. Race-based healthcare institutions emerged in the late 1800s and these "colonial institutions were conducive environments for the development of racist theory and practice, as their custodial overtone lent itself to discrimination" (p.199). Racial stereotypes were constructed around some illnesses such as leprosy. Black and mixed-race citizens were labelled as "idle, smelly, promiscuous, dirty" and their "nomadic lifestyle was translated into a popular aetiology of disease" (p.204).
Deacon (47)	An ordinance passed in 1807 gave a legal monopoly for the practice of medicine to British-and European-trained physicians, displacing practitioners who did not meet this criterion to less developed peripheral towns of the Cape Colony. The effect was that medical practice professionalised faster in Cape Town than in the rural periphery. A powerful Cape Town-based medical elite emerged that governed the regulation of medical practice across the Cape Colony.
Deacon (48)	Regularly trained medical practitioners had a broad medical market that included "white settlers, their slaves, servants, free blacks and indigenes, usually in decreasing order of frequency" (p.45). Alternative practitioners, i.e. those outside the formal medical market, were generally described as shopkeepers selling patent

	medicines, apothecaries, chemists, midwives, Muslim folk healers and indigenous Khoisan or African healers.
Van Heyningen (49)	Several public health laws were instituted between 1880 and 1910 in response to both epidemics and political objectives. These laws led to the regulation of hygiene and healthcare across the Cape Colony. Some members of society were identified as being less hygienic than others, leading to the curtailment of freedom of movement and of housing choice. Examples of such laws include those relating to prostitution and contagious diseases.
Van Heyningen (50)	Public health laws in the Cape were used as a pre-text for segregative powers in the late 19th century. For example, an outbreak of the bubonic plague in 1901 became the pretext used by the Colonial Medical Advisor, Dr J. Gregory, for the forced removal of Africans and their resettlement to the outskirts of the city on the "ground[s] that they were a danger to public health", an argument which rested on the powers of the Public Health Act of 1897 (p.470). For the first time, Africans lost the right to live on equal terms with their fellow citizens. Their removal clearly contradicted the spirit of the Cape constitution, with its franchise open to all races and its concept of equality before law. These interventions reduced the mortality rates of white populations, but not of African populations. Van Heyningen remarks that "by 1904, Whites had a life expectancy of fifteen years more than Blacks, while black infant mortality was double that of Whites. Towns had become graveyards for black people and would remain so for decades" (p.471).
Brock (51)	Missionaries played a crucial role in spreading the use of western medicine in South Africa, including in the Cape Colony. Dr James Stewart was a prominent Scottish medical missionary of the Free Church of Scotland. He was the Principal

	of Lovedale Mission in the Cape (now Eastern Cape) from 1870 to 1905. Lovedale Mission was a centre of medical and missionary teaching for the surrounding African population. The mission "urged Africans to value education, to adopt European standards of civilisation and to accept the equality of all men in the eyes of God" (p.4).
Herrle-Fanning (52)	In Britain, midwifery was predominantly the domain of female practitioners up until the 18th century. Midwifery was taught by more experienced women practitioners to younger women through an apprenticeship model of learning. Herrle-Fanning argues that an increase in scientific publication in obstetrics had the effect of promoting the status of physicians, mostly male, in the domain of childbirth. Physicians acquired the power to set best obstetric practices, such as professional registers, and therefore came to regulate who was deemed a competent midwife.
Sweet (53)	Early nursing care in the Cape Colony was dispensed by both western-trained midwives and traditional, non-white midwives. In contrast, 19th-century South African military hospitals employed mostly white nurses. Civilian hospitals employed black and mixed-race women as assistant nurses for more menial duties. Within this context, missionary and Overland Nursing Association (ONA) nurses from Britain had the responsibility of spreading the latest British nursing practices across colonial territories (late 19th to early 20th century). ONA nurses and missions played a significant role in training black nurses, particularly in the eastern region of the Cape Colony.
Levy (54)	Founded in 1835, Somerset Hospital is Cape Town's oldest medical hospital. The clinical teaching site for the University of Cape Town medical school, Somerset Hospital was the first academic teaching hospital in South Africa.

Gregory (55)	At the turn of the 20th century, registration data for births and deaths in the Cape Colony was deemed inaccurate due to a lack of recording systems. Without an accurate denominator for the population of the Cape Colony, disease prevalence could not be accurately reported. Powers over local public health were devolved to district surgeons. Outbreaks of smallpox, enteric fever and scarlet fever were common, and pulmonary tuberculosis was endemic.
Healthcare in the Cape Province and pre-apartheid Union of South Africa (1910 -1948)	
Author	**Key findings**
Walker (56)	The Natives Land Act of 1913 decreed the displacement of Africans from arable land to less fertile and crowded reserves. Some 87% of the arable land was entitled to the white population. Africans could not purchase land outside reserves. They were forced to show proof of employment when moving outside reserves. The Natives Land Act had a negative impact on the economic prospects, health and well-being of African people in South Africa. It created a source of cheap African labour.
Jeeves (57)	The South African syphilis epidemic during the first half of the 20th century highlighted growing inequality in health services in the 1920s to 1940s. Syphilis was endemic in South Africa and it spread to rural African communities through migrant labour. Public discourse attributed the disease to the poor and non-white population. Public health regulations were fashioned to control and treat the disease, but these health interventions, such as mercury, largely targeted African people rather than the broader population and were ineffective.
Rotberg (58)	Gold and diamond mining required the recruitment of hundreds of thousands of young men from rural areas. The growth of migrant labour fractured rural African

	society and created unhealthy conditions in high-density mining hostels where pulmonary disease and sexually transmitted disease were rife.
Phillips (59)	At the end of World War Two, the Beveridge plan outlined the creation of a welfare state and a National Health Service for the United Kingdom. The South African government of the day put forward a similar plan as a strategy for unifying the anti-war white population[5] with the pro-war white population.
Kark et al. (60)	The authors describe the Pholela community health centre, an example of the socialised community health centres envisioned in the National Health Service. The goal of community health centres was to improve rural African health through preventive health interventions, the use of community health workers and accessible curative care.
Louw (61)	The University of Cape Town's Medical School was the first in South Africa. The teaching staff were initially almost entirely British and Irish. Formal obstetric training began in 1920. The Academic Obstetric Department played a significant role in advancing the organisation of care in the Cape Town region.
Shapiro (62)	The structure, cost and distribution of public health services was a major issue of economic and political debate in South Africa between 1918 and 1948. The delivery of health services was fragmented and structured around the supply of labour. Mining corporations and the Chamber of Mines provided hospital services to their employees. Mining corporations lobbied the state to provide healthcare services in rural African reserves because the spread of disease impacted their

[5] South Africa had a significant white population that was not in support of joining World War Two on the side of the British due to atrocities carried out by the British against Afrikaners interred in British concentration camps. Prominent Afrikaner figures who went on to lead the National Party were jailed during the War.

	source of cheap African labour. The state launched the Loram Commission to investigate how to provide medical services to the rural African poor. Mr C.T. Loram, a veteran of the Native Affairs Commission, argued that the state should establish a government Native Medical Service staffed by African doctors, nurses and medical assistants. In sharp contrast, the Secretary of Public Health, Sir Edward Thornton, argued that African medical assistants without formal degree training would be sufficient. There was strong resistance to equipping Africans with higher education degrees. The medical community feared this would lead to black practitioners competing with white medical healthcare workers in the supply of medical services. In a letter penned by Dr D.F. Malan to the Loram Commission, the Federal Council of the Medical Association opposed the creation of differentiated and inferior medical degrees for Africans. The University of Cape Town declined to train non-whites due to a lack of "clinical material" (p.242). Provincial health boards denied non-white students access to "clinical material" but allowed white medical students to see non-white patients (p.242). In contrast, the University of the Witwatersrand agreed to train medical students if separate facilities were made available by the state for their training. These facilities never materialised, and the medical school continued to reject applicants of colour.
Digby (63)	The National Health Services Commission (NHSC) of 1942-1944, led by Dr Henry Gluckman, made recommendations for an integrated system of primary health care centres that would provide healthcare services at community level. The NHC recommendations mirrored plans being developed in the United Kingdom for a post-war nationalised health service. These would form the keystone of a centrally

	governed healthcare system. This initiative failed because i) it was opposed by influential provincial health authorities, ii) its egalitarian values were in opposition to the conservative values of the Nationalist government which ruled from 1948 and iii) medical practitioners saw it as a threat to private practice.
Healthcare in the Cape Province and apartheid South Africa (1948-1994)	
Author	**Key findings**
Fawcus et al. (64)	This audit shows a u-shaped fall and eventual rise in maternal mortality rates (MMR) in the Cape Peninsula over a 50-year period. MMR was initially 301/100,000 live births (1953). By the early 1980s MMR reached a nadir of 28/100,000 live births (1983). This is attributed to: - rapid response maternal and neonatal emergency transport services that expanded access to antenatal care - greater utilisation of midwife obstetric units instead of home births - increasing access to uterotonics, antibiotics, blood transfusions and treatment of hypertensive disorders. MMR rose to 78/100,000 by 2001. This is largely attributed to the spread of HIV, the lack of antivirals and an increase in the number of deliveries, straining the public sector emergency and maternity services which did not expand in step with the increase in demand.
Van Rensburg et al. (65)	Van Rensburg summarised the situation as follows in his article: "Health care in this country [South Africa] is deployed more often than not in a marked two-class system, providing the best of services to a privileged, self-paying and insured, mainly white (but also rapidly growing non-white) clientele, as against a poorly equipped and staffed, often second-class public service to a predominantly non-white clientele" (p.105).

	Apartheid was a policy of separate development instituted by the National Party from 1948 to 1994. However, legal segregation in South African healthcare predated apartheid. Successive colonial and union government administrations passed laws that placed the non-white population at a disadvantage in both supplying and accessing healthcare. From a health perspective, apartheid legalised and regulated the separation by race of healthcare delivery, authority and professional standards. State and private allocation of resources along racial lines led to substantially poorer health outcomes for non-white people. *Training* Legalised racism in the regulation of the medical profession resulted in undergraduate and postgraduate training in medicine being the exclusive reserve of white people until the late 1980s, when reforms began to take place. Under the Nursing Amendment Act of 1957, nurses registered on different professional registers and belonged to different nursing councils based on their race. The Act also prohibited black nurses from issuing orders to white nurses. *Clinical environment* Non-white healthcare workers were restricted from treating white patients. Their scope of practice was largely limited to non-white patients. Clinical wards and outpatient services were segregated by race. *Healthcare financing* Reserves, later called Bantustans or homelands, were neglected by district surgeons and government authorities. Service levels were in line with the low level of taxes collected from the area. At the height of apartheid, the state spent nearly

	four times per capita on healthcare for white people than for African people. The South African government claimed that the Bantustans were independent and underfunded them so that they were unable to provide adequate services to the poor rural African population. The South Africa economy benefited from the cheap labour supplied by the Bantustans, while government avoided the cost of providing social services. As a result, the health of African people lagged behind that of other race groups. *Healthcare outcomes* Significant discrepancies in health outcomes could be observed between different race groups during late apartheid. Apartheid regulations contributed to race-based inequalities in socio-economic status, living conditions and access to healthcare, and these in turn contributed to substantial differences in life expectancy, maternal mortality rates and infectious disease incidence.
Gunston et al. (66)	The Cape Town obstetric service developed a sophisticated emergency obstetric flying squad in 1953. This service connected specialist obstetric units with outlying obstetric units. Two-way radio communication allowed rapid and continuous communication between the base of operations and the outlying facilities. Specialised obstetric staff used converted Land Rovers and Jeeps to transport patients back to the hospital for definitive treatment. A well-run flying squad was an important part of MMR reduction between 1953 and 1975 in the Cape Peninsula. In 1975, the top three reasons for calls were: - post-partum complications related to haemorrhage and retained placenta (30%) - ante-partum haemorrhage (24%) - hypertensive complications (12%)

Brauns et al. (67)	At its zenith, the apartheid health system duplicated its race-based services through fourteen different health departments. *Lack of clear accountability* Whereas health outcomes in the white population were clearly the domain of the South African Department and Minister of Health, accountability for health outcomes for the non-white population was split among provincial, local and Bantustan authorities. Health interventions lacked central coordination and evaluation. *Poor health in Bantustans* Bantustans were made responsible for managing the healthcare of their resident African populations, but were inadequately resourced with funds, infrastructure and medical professionals. By 1962, their populations relied on mission hospitals for 77% of the available hospital beds. In the mid-1960s the apartheid government took over control of mission hospitals and placed them under the management of homeland authorities. *Inequity in hospital and maternity services* The authors point out that in 1976 the bed occupancy rate in the non-white wards of Cape Town's Groote Schuur hospital was 110%, in contrast to the occupancy rate in the white wards of 75%. As noted earlier in Van Rensburg et al. (1993), non-white nurses were forbidden from attending to white patients and issuing instructions to white nurses. They were also given fewer opportunities for promotion, received less pay, were required to staff overcrowded wards and were subjected to open racism during performance evaluations. The author cites

	accounts of two African patients occupying a single bed in segregated maternity wards while beds in white wards were unoccupied. *Impact on post-apartheid South Africa* Despite the deracialisation of health services in post-apartheid South Africa, a period which stretches from 1994 to the present day, coordination between government health services remains complex. The social determinants of health continue to disproportionately reflect racial inequality, with continuing impact on current health outcomes.
Baldwin-Ragaven (68)	South Africa's policy of separate development in health services ran against human rights and ethical healthcare provision. The most prominent example is segregation practices in emergency services. White ambulances—ambulances reserved for white patients—were not allowed to carry non-white patients; thus, injured patients had to wait for the arrival of non-white ambulances at an accident scene even if white ambulances were present and empty. This had a negative impact on maternal health outcomes.
Seedat (69)	Non-white people had poor access to safe and effective maternal and neonatal healthcare services during apartheid. Seedat supports earlier findings that African women often had to share beds while in labour due to bed shortages in non-white maternity wards.
Zwi et al. (70)	The initial state response to the HIV epidemic was slow, fragmented and ineffective. This is in part due to the prevalent prejudice of the National Party leadership. The health establishment and government held conservative cultural and religious views that mitigated against thoughtful discussion of issues related to sex, homosexuality and the spread of HIV among migrant labourers.

	Coercive regulations were enforced that infringed on the labour rights of HIV-positive people. An amendment to the Admissions of Persons to the Republic of South Africa Act of 1972 made it legal for migrants to be tested, and quarantined and deported to their country of origin if they proved HIV-positive. The state launched HIV prevention campaigns that encouraged the black populace to practice monogamy or else risk death, and these campaigns added considerably to HIV stigma and fear of testing. The article predicts a major HIV epidemic in South Africa worsened by tuberculosis co-infection.
Healthcare in the Western Cape and post-apartheid South Africa (1994-present)	
Author	**Key findings**
Faculty of Medicine, Truth and Reconciliation Committee, University of Cape Town (71)	As a result of the Truth and Reconciliation Commission Special Hearings into the Health Sector in 1997, the University of Cape Town launched a "Faculty Reconciliation Process" (1998 – 2005) to investigate the medical faculty's history of discriminatory practices, and to identify current obstacles for black staff and students as well as women. The purpose was to take the faculty through a process of transformation. The report documented a litany of discriminatory practices that created psychological trauma, and included accounts such as the following: "We were not allowed to examine white patients. When black ward rounds were finished the professor or consultant would just walk on to the white ward and we would just disappear" (p.154). Another black alumnus remarked, "We formed 'clans' and we became an amorphous group known as the 'Coloured students'. It pushed us into corners. I did not befriend a single white student" (p.155).
Meel et al. (72)	The Choice on Termination of Pregnancy Act of 1996 legalised safe and legal termination of pregnancy (TOP) within state health facilities. The authors found that 54% of women accused of illegal abortions had not used state services

	because they did not know their legal right to these services. Another 17% were afraid of rude medical staff, 6.5% were afraid of a breach of confidentiality and 6.5% had not been able to get a legal abortion early enough in their pregnancy to comply with the law. Many rural women were unaware of their rights to safe TOP services, which led to excess morbidity and mortality.
Fawcus et al. (26)	Post-partum haemorrhage (PPH) is a major cause of preventable maternal mortality in South Africa. Inexperienced community service doctors and medical officers carry out a substantial number of caesarean sections in district hospitals. Workforce shortages and poor supervision contribute to less experienced personnel carrying out caesarean sections. Bleeding associated with caesarean section (BLACS) was responsible for 180 (26.2%) of the 688 maternal deaths caused by obstetric haemorrhage, making it the number one cause of deaths due to obstetric haemorrhage between 2008-2010. The contributing factors to deaths linked to BLACS were: - poor haemostasis at the initial caesarean section - lack of skill to carry out surgical measures required to arrest haemorrhage - poor post-caesarean section monitoring
Marcus et al. (73)	Response times to calls made by midwife obstetric units (MOUs) in Cape Town were slow, which had deleterious effects on maternal and neonatal outcomes. Marcus' study showed that i) median response times across all priorities of calls and to all MOUs in the sample fell short of national guidelines, ii) no statistical differences were noted between various priorities of calls from MOUs and iii) emergency services did not respond within minimum prescribed response times to emergency transfer calls from MOUs in the Cape Town area.

Norris (74)	South Africa's post-apartheid government exacerbated inequality in health resources. It did this by allocating more funds to provincial authorities with greater absorptive capacity and ability to deliver care, thereby creating an "infrastructure-inequality" trap. Without a change in budget allocation formulas, less developed provinces will continue to receive less funding and so the cycle will continue.
Roussow et al. (75)	South African primary care doctors have a high prevalence of both burnout and depression. Respondents ascribe this to excessive workloads, poor organisational work culture, inappropriate training, inadequate equipment, management problems, long working hours, little vacation time and lack of support systems. Some 76% of medical practitioners had clinical burnout and 53% had high levels of exhaustion. Medical doctors completing their compulsory year of community service had the highest rates of clinical burnout. Systemic factors that create such a high risk for clinical burnout among primary care doctors need to be addressed. Primary care practitioners could benefit from resilience training.
Wabiri et al. (76)	HIV remains the most important contributor to maternal morbidity and mortality in South Africa. In addition, income and social disparities are described as a major cause of varied health outcomes among South African women using antenatal services. The wealthiest quartile of survey respondents live in the industrialised and urban provinces of Gauteng and the Western Cape. The poorest quartile of respondents are concentrated in provinces that previously had large Bantustans: the Eastern Cape, Kwa-Zulu Natal (KZN) and Limpopo provinces. Gauteng and the Western Cape have lower MMR rates than the Eastern Cape, Limpopo and KZN. *Access to antenatal care (ANC)* Of the women surveyed, 10% did not attend ANC prior to delivery. Women under the age of twenty are the least likely to attend four or more ANC visits. A higher

	proportion of women with tertiary education attended four or more antenatal visits compared to those with three years or less of schooling (94.7% vs 72.9%). Substantial decreases in overall ANC coverage and the percentage of planned pregnancies were noted in some provinces, particularly the Eastern Cape. *Recommendations* The study recommends earlier access to social grants for the poorest quartile of pregnant women so that their antenatal visit transport and general living costs can be covered. Evidence from other developing countries suggests that this might increase access to ANC programmes, especially in the poorest regions. State intervention to improve ANC services in the poorest provinces would also impact maternal outcomes.
Ross et al. (77)	South Africa has a two-year medical internship programme. The authors administered a questionnaire and analysed responses from medical interns at King Edward Hospital to study interns' perception of training at the hospital. *Working hours* Interns in obstetrics, medicine, family medicine, orthopaedics, paediatrics and surgery reported working in excess of eighty hours of commuted overtime per month, whereas interns in anaesthetics and psychiatry rarely worked outside of their contracted hours. Long hours of overtime resulted from staff shortages, high patient loads and limited support from nursing staff and medical officers. *Perceptions of suitability of infrastructure* Only 4.9% of the interns felt that the facilities and infrastructure at the hospital were completely suitable for internship training. Only 5% felt that their internship

	had adequately prepared them for community service. Of the interns surveyed, 20% planned to pursue their careers overseas in the future.
Kwinda (78)	The remunerated work outside public service (RWOPS) policy was instituted in the mid-1990s to regulate private practice work carried out by state-employed healthcare workers. Poor enforcement of the policy's strict regulations has resulted in negative health outcomes due to absenteeism. In 2004, 50% of public sector specialists in Gauteng, South Africa's most populous province, ran a private practice. The majority of these specialists spent less than four hours per day at public sector facilities and devoted the rest of their working hours to their private clinics. A major reason for this abuse was doctors wanting to supplement their low public sector wages with additional income.
Howarth (79)	Obstetricians are increasingly targeted by medical claim lawyers who specialise in obstetric claims. *Unique liability factors in the public sector* High caseloads, resource constraint and a young workforce with limited surgical skills experience places medical practitioners at risk of preventable maternal morbidity and mortality. *Unique liability factors in the private sector* Obstetricians work alone or in small groups. Thus, an obstetrician may not be on site after hours when patients are in the first stage of labour. Experienced mid-wives will call the obstetrician to the hospital in the late first stage, meaning that if anything happens prior to the arrival of the obstetrician on call, a physician may not be present. *Sequelae of increasing medical claims*

	The rising cost of medical indemnity is leading to fewer obstetricians practising in the private sector. A growing number of successful claims against the state obstetric sector threatens to divert already dwindling state funds toward medical litigation instead of patient care.
Mlambo et al. (80)	Mlambo et al. identified that the following factors are leading to increased emigration of South African health professionals: - low wages compared to international and private sector wages - poor working conditions - limited opportunities for career advancement - burnout due to long work hours and workforce shortages - uncertainty about South Africa's economic future
Bezuidenhout (81)	Survey results from this study show that medical professionals emigrated from South Africa for two main reasons, being the pursuit of better pay and fear of crime. Push factors appear to be the main reasons why South African healthcare workers emigrate overseas.
Twala et al. (82)	This study aimed to assess the preparedness of a South African health district to deliver emergency obstetric services (EmNOC) as prescribed by the United Nations standards for maternal care. Firstly, the authors found that community health centres did not perform emergency caesarean sections because district health policy centralised these services to higher-level facilities to improve outcomes. Secondly, health facilities performed poorly on the availability of emergency maternal care protocols, achieving a mean score of 41%. Finally, only 6.7% implemented emergency maternal resuscitation drills regularly.

Solanki et al. (83)	Solanki et al. found that caesarean section (CS) rates for the South African private sector are substantially higher than the 10-15% recommended by the WHO. The public sector had a CS rate of 26.2% (2015) in contrast to 73.6% (2015) in the private sector. Private obstetricians and anaesthetists earn approximately 40% and 50% more respectively for completing a caesarean section procedure compared to earnings for a vaginal delivery. The hospital earns approximately 45% more for caesarean section deliveries. Factors cited for high private sector CS rates are i) economic pressure on hospitals, ii) perverse financial incentives, iii) private health insurance, iv) rising medico-legal claims, v) rising professional indemnity costs and vi) the predictability of elective deliveries makes them less disruptive to private outpatient and after-hours work.
Moodley et al. (23)	This report is compiled by the National Committee of Confidential Enquiries into Maternal Deaths (NCCEMD). Moodley et al. report that institutional maternal mortality rate (iMMR) is falling in South Africa. This is attributed to improved HIV antenatal treatment and the improved health status of pregnant women. South Africa's iMMR in 2009 was 190/100,000 live births in comparison to an iMMR of 130/100,000 in 2016 (Figure 5). Bleeding during and after caesarean section (BDACS) is still the leading cause of mortality due to obstetric haemorrhage. *Figure 5: Institutional maternal mortality rates in South Africa between 2005 and 2016* 

3.5 Discussion

3.5.1 Structural inequality and maternal health

3.5.1.1 Unequal access to healthcare

The above literature on healthcare and medical practice in South Africa reveals a history of unequal and exclusionary legislation, the legacies of which continue to manifest today. Both historically and today, inequality stands out as a major feature of healthcare in South Africa. As early as the smallpox epidemics of 1713, 1755 and 1882, disease has exacted a greater toll on the poor and non-white populations of the Cape and of South Africa as a whole (49). Seedat (69) describes how African patients in state hospitals had to share beds during the first stage of labour even when the white wards had empty beds. Emergency services were also allocated by race (68). Thus, if a non-white patient required an ambulance and no non-white ambulances were available, they would be forced to wait even if those designated for whites were available (68). While the South African system produced the world's first heart transplant, that same system produced infant mortality rates for the under-fives of 30-50% of African children in some districts, and was characterised by rampant malnutrition and epidemics of preventable communicable disease (75). As late as the 1980s, outpatient clinics and clinical wards were separated by race at Groote Schuur Hospital, Cape Town's tertiary maternity hospital (65).

3.5.1.2 Healthcare and the politics of South Africa

Van Heyningen (84), Deacon (46–48), Price (85), Van Rensburg et al. (65), Stuckler et al. (86) and Coovadia et al. (87) offer strong evidence that successive political administrations, from the Dutch East India Company to the current ruling party, the African National Congress (ANC), have played significant roles in building and maintaining South Africa's unequal healthcare system. Successive governments of the early 20th century built state hospitals for non-white patients close to mines and industry in order to ensure they could keep their cheap labour force healthy (57). Apartheid planners neglected the health needs of non-whites in rural areas, locations and reserves as these populations were "surplus" to the economy (85). By 1985, the apartheid government spent nearly

three times per capita on the health of white South Africans than it did on Africans (65). Moreover, Zwi et al. (70) chronicle how racism and homophobia hobbled the effectiveness of early steps to prevent the spread of HIV in South Africa. Today, HIV is recognised as the largest contributing factor to maternal mortality (23).

More recently, the contemporary government has struggled to expand access to quality antenatal and caesarean delivery services in geographic regions neglected by previous governments. In the first fifteen years of South Africa's democracy, the ANC government's poor response to HIV led to regression in MMR and life expectancy (87), although that has since improved following the rollout of state-sponsored access to antiretrovirals (88).

3.5.1.3 Financing of healthcare

Price (85), Seedat (69) and Stuckler (86) explain how urban regions received higher levels of funding compared to rural African regions during colonial and apartheid rule. Furthermore, Stuckler et al. (86) detail how the post-apartheid ANC government used budget allocation formulae that widened inequality in health outcomes between provinces by awarding well-developed provinces with higher per capita funding than less developed provinces, creating an "infrastructure-inequality trap"(p.169). Without a new strategy of pooling funds and purchasing healthcare services centrally from an integrated care system, these inequalities will continue to the detriment of public sector obstetric patients in rural regions.

3.5.1.4 Inequality in the selection and training of healthcare workers

The arrival of permanent British rule in the Cape in 1806—and the accompanying marginalisation of Khoi-Khoi midwives used by the Trek Boers in the absence of other medical professionals—marked the start of centuries of inequality in the certification, selection and training of healthcare workers (43,44). Shapiro et al. (62), Tobias (89) and Sweet (53) detail how medical education institutionalised the exclusion of non-white medical applicants through legalised discrimination. As a consequence, South Africa's medical workforce was for a long time the preserve of white South Africans.

To understand South Africa's contemporary healthcare system requires understanding the enduring impact of the discriminatory social engineering of the medical community on today's medical workforce. Non-white practitioners trained at the zenith of apartheid still suffer from the trauma of the past (71). There is inadequate research to explore how past discrimination, and perhaps contemporary discrimination, continue to affect intra-team relations in today's obstetric surgical workforce. This will be addressed in Chapter 5.

3.5.1.5 Inequality and maternal mortality

This historical review of the development of healthcare services in South Africa, in particular Cape Town, reveals tiered healthcare structures and processes based on race (African, coloured or mixed race, Asian and white), economic means (insured vs non-insured) and geography (urban vs rural). Apartheid statistics were known to be inaccurate, particularly in their approximation of the health status of non-white populations (65). However, Van Rensburg et al. (65) show that significant differences in MMR existed between race groups, even with conservative estimations (see Table 4) Africans had an MMR of 24/100,000 live births in comparison to whites who had an MMR of 7/100,000 live births.

Table 4: Race-related disparities in health outcomes. Source: Van Rensburg et al. (65)

Indicator	Year	Whites	Asians/	Coloureds	Blacks
Life expectancy at birth (years)[a]					
■ Males	1980–85	66,8	63,1	55,4	55,1
■ Females	1980–85	74,3	69,8	63,5	62,5
Gross mortality rate (per 1000)[b]	1989	7,0	5,7	7,7	10,0
Mortinatal mortality (per 1000)[c]	1988	4,9	10,8	22,3	—
Infant mortality					
■ rate per 1000[d]	1980–85	13,0	18,9	56,0	82,0
■ Neonatal mortality (per 1000 live births)[e]	1988	9,5	13,7	27,9	—
■ Post-neonatal mortality (per 1000 live births)[e]	1988	3,7	3,7	29,5	—
■ Infant mortality as % of all deaths[f]	1988	2,3	6,2	16,5	15,6
Child mortality (1-4 years) (per 1000 at risk)[f]	1988	0,8	1,0	3,8	2,8
Maternal mortality rate[g]					
■ per 100 000 live births	1988	7,0	5,0	19,0	24,0
■ as % of total deaths in women (15–49 years)	1988	0,29	0,25	0,58	1,66
Teenage births (as % of all births)[h]	1987	6,6	8,4	13,9	11,4
Infectious/parasitic diseases[i]					
■ deaths per 100 000	1988	18,1	19,5	101,0	77,7
■ as % of all deaths	1988	2,2	3,3	11,7	12,9
Notifiable diseases (notifications per 100 000)[j]					
■ Tuberculosis	1990	16,5	59,2	599,7	183,4
■ Measles	1990	9,3	3,4	9,2	33,9
■ Typhoid	1990	0,4	1,1	0,2	7,1
Accidents/poisoning/violence (deaths per 100 000)[j]	1988	10,4	12,3	15,8	19,0
■ deaths per 100 000	1988	84,6	72,6	136,9	114,8
■ as % of all deaths	1988	10,4	12,3	15,8	19,0
Nutritional deficiencies (deaths per 100 000)[k]	1988	0,4	1,0	9,7	9,8

3.5.2 Contemporary challenges for healthcare workers

3.5.2.1 Poor infrastructure, inadequate equipment and shortage of staff

South Africa's long history of racially discriminatory care and neglect of non-urban areas continues to pose serious challenges for contemporary healthcare workers. Ross et al. (77) and Rossouw et al. (75) describe how junior doctors and primary care physicians are affected by working with inadequate infrastructure and equipment. These factors directly affect patient safety, particularly in maternal care. Similarly, Moodley et al. (23) describe how the National Committee for Confidential Enquiries into Maternal Deaths (NCCEMD) has enforced a "Safe Caesarean Delivery" accreditation programme to regularly check if district and secondary hospitals are adequately equipped to the highest standards of safe caesarean sections.

The public healthcare sector also suffers from a critical shortage of nurses, medical doctors and allied health professionals. This is a problem of both supply and retention. Many junior doctors feel despondent, burnt out and depressed after completing a gruelling community service practice year in a rural or otherwise neglected state hospital (75,77). Thereafter, many of them choose to work in the private healthcare sector or to emigrate (77). Reasons for emigration are linked to low salaries in comparison to other developed nations, burnout, resource constraint and insecurity about the overall future of the economy (80,81). Those remaining are faced with higher workloads.

3.6 Conclusion

Resource constraint and institutionalised discrimination are the two strongest themes in the history of South Africa's healthcare system and, while existing research is limited, it is important to explore the legacy effect of these factors on today's obstetric surgical team environment. Despite the end of apartheid in 1994, healthcare workers continue to be socialised in a society where discrimination and inequality are rife.

3.7 Relevance of these findings within the wider dissertation

This chapter demonstrated that South Africa's history of segregation and unequal development continues to shape its medical system, clinical outcomes and contemporary PSC. In the same vein, South Africa shares many historical parallels with other sub-Saharan African countries. For the purposes of describing unique attributes of South African PSC, it would be useful to investigate the barriers to PSC on the wider continent, thereby demonstrating areas of convergence and divergence with the findings of this chapter. Thus, the next chapter (Chapter 4) is a narrative literature review examining contemporary barriers to PSC in wider Africa.

Chapter 5's interview study will examine how a legacy of resource constraint and institutionalised discrimination impacts contemporary PSC in Cape Town operating theatres now that surgical teams from different racial, cultural and economic groups have been integrated. The findings of this chapter also informed how a safety climate survey for a South African setting was adapted (Chapter 6) and gave a rich context for the findings of a social network analysis study (Chapter 7).

Chapter 4: A narrative review of barriers that prevent the delivery of safe obstetric surgery in sub-Saharan Africa

4.1 Introduction

In the last chapter, a historical analysis demonstrated the impact of a legacy of resource constraint and institutional discrimination on the structure and outcomes of South African medical services, particularly in maternal health. In this chapter, barriers to patient safety in obstetric care in sub-Saharan Africa will be analysed through a narrative review. While much has been done to define PSC in HIC settings, research on safety in LMIC health systems, particularly in Africa, lags behind (22,90). Many LMIC health systems are recovering from decades of conflict, colonialism, poor governance and socio-economic upheaval, particularly in Africa (91). Complicating matters, the economic growth of LMIC states is threatened by climate change and widening economic inequality (92–94). With limited resources to provide and administer effective care, LMIC states are forced to prioritise the allocation of scarce resources to basic healthcare provision (90).

The consequence of this prioritisation is that fewer resources are available to train and retain local researchers to measure, monitor and evaluate the quality of local healthcare services. Thus, data required to monitor quality of care, in particular safety, is either sparse or non-existent (2). In the case of Africa, there is a paucity of research that builds on local paradigms of organisational culture to describe the complexity of patient safety and safety culture in a resource-constrained setting. The research agenda for PSC has been set in HICs where the interdisciplinary skills required to analyse PSC are more readily available than in LMIC settings (95).

Scott et al. (96) have identified that tools developed to measure non-technical skills in HIC may not be fit for purpose in African surgical settings characterized by resource variability and limitation. This could be due to underlying differences in PSC and health system structure that are not accounted for when instruments developed in HIC settings are imported for use in Africa.

The lack of fit-for-purpose African safety culture evaluation tools hampers the creation of evidence-based safety interventions. This is worrying in a context where Bishop et al. (24) have called for urgent quality of care interventions to address their finding that African women are at fifty times greater risk of operative maternal mortality compared to women in HIC settings. In the same vein, the Lancet Commission on Global Surgery has called for the establishment of national surgical plans as a key step towards improving surgical outcomes (1). However, given the lack of African evaluation tools, data collection and tracking systems, and the presence of social and cultural barriers particular to an African setting, it is not clear how policymakers will be able to determine the underlying drivers of improvement. Critical qualitative changes in the healthcare experiences of patients and healthcare workers may precede noticeable quantitative changes in surgical outcomes.

Thus, it is important to develop a body of research that brings us closer to understanding the nature of PSC in African contexts. This will pave the way for designing and evaluating sustainable healthcare quality interventions that take as their starting point a clear understanding of cultural issues and an ability to measure changes therein. This "ground up" approach will mitigate the risk of erroneous conclusions being drawn from "cut and paste" interventions developed for HIC settings but implemented in LMIC settings. The aim of this narrative review is to identify the barriers to safe obstetric surgery in sub-Saharan African healthcare settings and to identify research gaps for further exploration.

4.2 Methods

4.2.1 Geographic choice

The author acknowledges that the use of the phrase "sub-Saharan Africa" is contested (97). However, academic groups such as The Lancet Global Commission on Global Surgery examine this region as a collective because of the shared features that characterise unmet surgical need in the

region (1,28). Thus, for the purposes of investigating barriers to safe care in this region, the author chose to study this region and use this term.

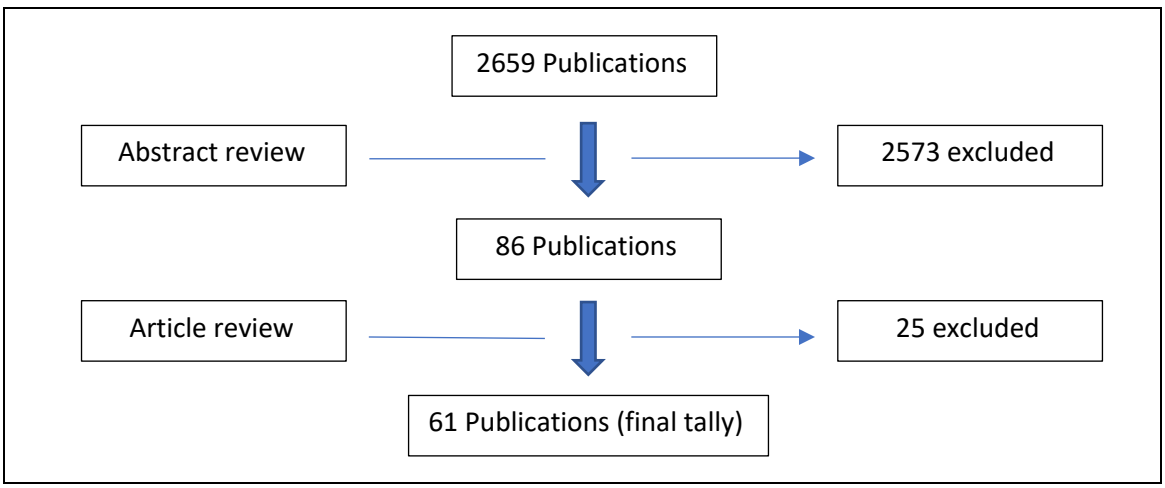
4.2.2 Search methodology

A preliminary survey revealed a paucity of literature concerning PSC in sub-Saharan African obstetric theatres. Thus, it proved preferable to conduct a discursive narrative review which was less specific in its focus, but accordingly more flexible and sensitive in identifying papers that were relevant to the overall theme. Several publication databases were searched for publications related to PSC in African obstetric theatres. Pubmed and Medline were used for the search. Only articles in English were screened and selected due to the language limitations of the author. The first stage of the review involved the collection of articles based on search terms shown in Table 5. In addition, relevant publications listed in the reference list of selected papers were included. A total of 61 articles were selected for full review (Table 6).

Table 5: Search terms and number of results found

"patient safety in Africa" (129)
"safety Africa caesarean section" (77)
"Africa caesarean section" (1 969)
"attitudes safe caesarean section" (95)
"attitudes safe surgery in Africa" (259)
"safety culture caesarean section Africa" (20)

Table 6: Article selection process and yield



4.2.3 Bate's taxonomy as a framework for organising the body of literature

For the purposes of presenting the search results in a systematic framework, Bate's taxonomy was used (98). Bate et al. (98) identified six core challenges facing high-performing healthcare systems: structural, cultural, educational , physical and technological, emotional and political. This taxonomy was not used to guide the search for articles, it was only used as a post-search organisational framework.

4.3 Results

Sixty-one academic publications were found in the literature search, and a breakdown of the studies by number of sites and geography is shown in Table 7. As described above, Bate's taxonomy was used to organise the search results after completion of the literature review. Each article was grouped to its corresponding category, and the articles in each category are presented in a summary table followed by a short summary of the results.

Table 7: A summary table of the literature search results

Number of single centre studies tallied by country	
Country	*Tally*
Botswana	1
Eritrea	1
Ethiopia	3
Ghana	2
Malawi	3
Nigeria	1
Kenya	1
Liberia	1
Rwanda	4
Sierra Leone	1
South Africa	8
South Sudan	1
Tanzania	10
Uganda	3
Zambia	1
Zimbabwe	1
Total	**42**

(Table continues on next page)

Multi-centre studies and number of countries		
Author	*Number of countries*	*Tally*
Aveling et al.(90)	2 (East Africa)	1
Biccard et al.(99)	25 (Predominantly sub-Saharan Africa)	1
Bishop et al.(24)	25 (Predominantly sub-Saharan Africa)	1
Boatin et al.(100)	7 (Central Africa)	1
Epiu et al.(101)	5 (East Africa)	1
Epiu et al.(102)	5 (East Africa)	1
Kinfu et al.(103)	12 (West, Central and East Africa)	1
McCord et al.(104)	3 (Southern Africa)	1
Spiegel et al.(105)	8 (West, East and Southern Africa)	1
Total		**9**
Editorials, protocols and reviews		
Author		*Tally*
Hutch et al.(106)		1
Meara et al.(1)		1
Merry et al.(107)		1
Ginsburg et al.(95)		1
Graham et al. (108)		1
Kruk et al.(2)		1
Say et al.(109)		1
Steffner et al.(110)		1
Stones et al.(111)		1
Weiser et al.(112)		1
Total		**10**

4.3.1 Structural barriers

Theme 1: Structural barriers	
Author	**Key points**
Atuheire et al. (113)	The authors conducted a descriptive study and modelling exercise to evaluate current utilisation of caesarean section (CS) facilities in Uganda, using the Ugandan National Health Management Information System. Of the 112 districts, "80 (72%) had a population CS rate below 5%, while 38 (34%) had a CS rate below 1% over the study period" (p.1). The authors infer that the Ugandan population is underserved with CS services. CS rates fall well below the recommended WHO guideline of 10-15%. Meeting this guideline will

	require a workforce. The authors conclude that "the government may need to implement differential levels of interventions across districts, to ensure equitable access to the service by those who need it" in order to meet 2030 sustainable development goals (p.6).
Aveling et al. (90)	This cross-sectional study used 57 semi-structured interviews to ascertain "why patient safety is so difficult in low income countries" (p.1). The authors found that "these accounts suggest that the origins and solutions to patient safety problems are likely to be similar everywhere and are rooted in human factors, resources, culture and behaviour" (p.3), but that "what distinguishes these findings in African countries from high-income countries is not the nature of the hazards that threaten patient safety, but the scale and impact of the material deprivation and the relative weakness of structures of governance and accountability" (p.6).
Biccard et al. (114)	South Africa, the African continent's most industrialised economy, has a well-developed perioperative research group. The authors list the following obstetric research objectives as part of the broader research strategy: (i) establishment of a national database of critical care outcomes and critical care resources; (ii) a national observational study of maternal and foetal outcomes following operative delivery in South Africa; (iii) a stepped-wedge trial of an enhanced recovery after surgery programme for obstetrics; (iv) a stepped-wedge trial of a surgical safety checklist on patient outcomes in South Africa; (v) a prospective observational study of perioperative outcomes after surgery in district general hospitals in South Africa; (vi) short-course interventions to improve the anaesthetic skills of rural doctors; (vii) studies of the efficacy of simulation training to improve (a) patient outcomes, (b) team

	dynamics, and (c) leadership; and (viii) development and validation of a risk stratification tool for South African surgery based on the South African Surgical Outcomes Study (SASOS) data.
Biccard et al. (99)	This seven-day international, prospective, observational cohort study of patients aged eighteen years and older undergoing any in-patient surgery in hospitals across 25 countries in Africa recruited 11,423 patients. Each hospital served a median of 810 000 people. The specialist[6] to population ratio was 0·7 (0·2–1·9) per 100 000 population. The average age of patients was 38.5. The HIV prevalence was 11%. Of the cases, 57% were emergent and 33% were caesarean sections. The overall perioperative mortality rate (POMR) was 2.1%. 95% of deaths occurred in the postoperative period, with 94% in the first 24 hours after surgery. Post-operative complications occurred in 18% of cases (n=1977), of which infection was the greatest contributor (58.4%, n=1156). Worryingly, "surgical patients in Africa are younger, with a lower risk profile and low complication rates, but twice as likely to die when compared with the global average" (p.1597). Surgical systems strengthening across Africa, particularly post-operative care, are urgently required.
Bishop et al. (24)	This study is an offshoot of Biccard et al. (99) and its authors conclude that African women having caesarean sections in this cohort were at fifty times greater risk of maternal mortality compared to women in HIC settings. The authors conclude that peripartum haemorrhage and anaesthesia complications are the main drivers of preventable maternal mortality.

[6] Specialists refers to surgeons, obstetricians, and anaesthetists.

Boatin et al. **(100)**	This study evaluated the relationship between income status and caesarean section rates (CSR) in several central African states. It found that "CSR were lowest in the poorest fifth of the population (median 3.7%) and highest in the richest fifth (median 18.4%)" (p.1). The authors conclude that inequality in caesarean section rates can be attributed to the wealthiest income groups having too many caesarean sections, the majority of which are not medically indicated (CSR greater than 15%), and the poorest groups having inadequate access to emergency caesarean sections (CSR under 10%).
Brouillette et al. **(115)**	The authors conducted a clinical audit and observational study in order to ascertain perioperative anaesthesia services and resources at a Ghanaian hospital. They found that there "were not enough physicians to consistently supervise care, especially in postanaesthetic care units (PACUs) and the critical care unit (CCU)" (p.2063). Although clean water and electricity are available in operating theatres, "patient safety was hindered by hospital-wide oxygen supply failures and shortage of vital signs monitors and working ventilators in PACUs and the CCU" (p.2063). Worryingly, "at the national level, 70 anaesthesia attending physicians and 565 NAs [nursing assistants] cared for Ghana's population of 27 million" (p.2063). This study highlights the structural difficulties of providing safe perioperative care even in a politically stable LMIC setting like Ghana.
Dekker et al. **(116)**	This retrospective audit of caesarean sections at a Tanzanian district hospital shows that a significant proportion of caesarean sections are not medically indicated (34-75%, based on the findings of two different auditors). The implementation of audit findings in the facility led to a drop in non-medically justifiable caesarean sections, but this was not significant (p=0.29). Sustained

	auditing and buy-in from obstetric providers could lead to a significant drop in unnecessary operations.
Ellard et al. (117)	Ellard et al. conducted a two-year training programme to give non-physician clinicians (NPCs) a broad range of clinical, emergency and non-technical skills. This qualitative interview study shows that participants in the programme demonstrated an increase in knowledge which they showed signs of incorporating into their clinical practice. Barriers to implementation included lack of support from seniors and lack of equipment at their facilities.
Ellard et al. (118)	A follow-up study to the one above was conducted to determine if clinical outcomes had changed in facilities staffed by trainees who had been on a surgical, obstetric and anaesthesia skills improvement programme. A survey of the operating theatres staffed by trainees found that none of the theatres had soap, 75% had gloves (n=12), and only 63% had antiseptics (n=10). Under these trying conditions, a non-significant downward trend in MMR was observed. The authors conclude that system deficits must be resolved in order for skills training to yield positive clinical outcomes.
Epiu et al. (101)	This survey of WHO safe surgery checklist use in five major central and east African hospitals showed poor adoption of the tool: "Of the 85 anaesthetists interviewed, only 25% regularly used the WHO surgical checklist" (p.1). Low rates of usage are attributed to lack of buy-in and a shortage of printed checklists in theatre. Solutions could include gaining stakeholder buy-in from key leaders, finding the resource to print sufficient checklists and assigning responsibility to a specific person to ensure use of the checklist is monitored and evaluated.

Epiu et al. (119)	Epiu et al. distributed a cross-sectional survey to 64 Ugandan hospitals to ascertain whether these hospitals met World Federation of Societies of Anaesthesiology guidelines. They found that "only three of the 64 (5%) hospitals had all requirements available to meet the WFSA International guidelines for safe anaesthesia" and "(84%) did not have a trained physician anaesthetist" (p.1). Hospitals lacked essential anaesthesia drugs and even the most basic equipment, for example "continuous ECG was only available in 3/64 (5%) of hospitals" (p.1).
Epiu et al. (102)	This survey of five major east African teaching hospitals found that personnel and equipment shortages hamper the ability to deliver safe and effective caesarean sections. It also found that "no hospital had all the requirements to meet the international standards for safe anaesthesia. When the criteria were reduced to eight variables, only 4% (3 of 85) of the anaesthetists had access to good-quality facilities" (p.296). Severe resource constraint limits the ability to provide safe obstetric anaesthesia and surgery in these facilities. Safety interventions must be tailored to provide the best quality care within this context.
Epiu et al. (120)	This is a follow-up study to Epiu et al. (101) . The authors "set out to further assess 64 government and private hospitals in Uganda for the availability and usage of the WHO Checklists, and investigate the post-operative care of patients; to advocate for implementation of caesarean emergency services in similarly burdened low income countries" (p.1). Only 22 of 64 (34.38%) Ugandan hospitals used the WHO safe surgical checklist. On further analysis, 71% of private hospitals used the safe surgical checklist, implying that the checklist was poorly adopted in state and not-for-profit hospitals. Only 6% of

	government hospitals had an ICU, in contrast with 57% of private hospitals. This paper highlights the unequal provision of safe perioperative care between state and fee-for-service healthcare systems in African settings.
Esquivel et al. (121)	The authors conducted a geospatial study to investigate access to surgical care in Zambia, surveying 103 hospitals. They found that "only 17 hospitals (16.5%) met the WHO minimum standards of surgical safety" (p.1064). Furthermore, data acquired from the surveys showed that "80.7% of the population (11 704 700 people) lived in an area that was more than two hours [travel]" from functional obstetrical and surgical facilities (p.1064).
Evjen-Olsen et al. (122)	This study shows the benefits of co-ordination between non-governmental organisations (NGOs) and government to create a comprehensive caesarean section emergency service. Maternal mortality ratios in the Tanzanian facility studied in this paper are lower than those in the surrounding district.
Fawcus et al. (64)	This audit shows a "u-shaped" fall and eventual rise in maternal mortality rates (MMR) in South Africa's Cape Peninsula over a fifty-year period. MMR was 301/100 000 live births in 1953. By the early 1980s, MMR reached a nadir of 28/100 000 live births (1983). This is attributed to: - rapid-response maternal and neonatal emergency transport services that expanded access to antenatal care - greater utilisation of midwife obstetric units instead of home births - increasing access to uterotonics, antibiotics, blood transfusions and treatment of hypertensive disorders MMR rose to 78/100 000 by 2001. This is largely attributed to the spread of HIV, the lack of antivirals and an increase in the number of deliveries, straining

	the public sector emergency and maternity services which did not expand at the same pace.
Glenshaw et al. (123)	The authors conducted a retrospective descriptive study of anaesthesia-associated mortality over an eight-year period in a Zimbabwean district hospital. They found that the district hospital had MMR of 360/100 000 live births and that most fatalities were due to preventable anaesthesia-related errors. 70% of deaths were linked to prior complications in labour. A national confidential maternal enquiry is recommended to audit and support district hospitals.
Graham et al. (108)	This study of divergence in maternal deaths between HICs and LMICs shows that "maternal deaths are strongly clustered in LMICs, with the highest levels of maternal mortality found in the sub-Saharan African region" (p.8). The authors found that in the 72 LMICs surveyed, "rich-poor gaps in women's uptake of maternity services persist across rural and urban areas within countries, and across very different national levels of maternal mortality" (p.9). They also found that "women with the least education were found to be twice as likely to have a severe maternal outcome and nearly six times as likely to die compared with those with the highest education" (p.9). The authors note that there is an "increasing diversity in the levels and causes of maternal health problems between and within populations [which] presents a major challenge to policies and programmes aiming to match diverse needs with diverse care across diverse settings. This diversity, in turn, contributes to divergence in the magnitude of maternal mortality, seen most acutely in vulnerable populations and predominantly in sub-Saharan Africa" (p.10). New

	systems must be created that track and monitor equity gaps as these are related to maternal outcomes.
Haftu et al. **(124)**	The authors observe that missed nursing care during the perioperative period presents a major challenge to achieving safe obstetric care in Ethiopia. The Missed Nursing Care (MISSCARE) cross-sectional survey was used in eight hospitals in the Tigray region and showed that "299 (74.6%) participants commonly missed at least one nursing care in the perinatal setting" (p.1). Participants reported that "Labour resources (96.3%), teamwork (91%), material resources (90%) and communication (85.3%) were the reasons identified for commonly missing care" (p.1). This study shows that resource constraint and PSC issues lead to poor quality nursing care.
Kinfu et al. **(103)**	Kinfu et al. attempted to model how long it would take for twelve African countries to meet the WHO target of 2.28 health workers per 1000 population. The selected countries included the Central African Republic (CAR), Côte d'Ivoire, Democratic Republic of the Congo (DRC), Ethiopia, Kenya, Liberia, Madagascar, Rwanda, Sierra Leone, Uganda, the United Republic of Tanzania and Zambia. The study considered the in-flow and out-flow of physicians from each country, but this was difficult due to a lack of data in some countries. They found that Kenya, the DRC, the CAR, Rwanda and Zambia had negative growth rates for the physician and nurse communities. Countries would have to expand their rate of healthcare worker supply by 5-20% to meet the WHO 2015 development goals targets in a five-year period.
Knowlton et al.	The authors studied the workforce capability and outcomes of the Liberian surgical services in order "to identify unmet needs in regard to trained

(125)	personnel, equipment, infrastructure, and outcomes measurement" (p.721). They found that the ratio of postgraduate-trained surgical and anaesthesia personnel to population was 0.1 per 100,000 population and that the "30-day postoperative mortality at hospitals providing data was 1,359 per 100,000 operative cases" (p.721). Liberia has considerable unmet surgical need, with considerable implications for operative MMR. Broad systems improvement to infrastructure, workforce and planning is required.
Kruk et al. (2)	This article calls for quality to become a central pillar in health systems improvement in LMIC settings. The authors argue that high-quality health systems could prevent half of all maternal deaths globally. They argue that in order to reduce the impact of chronic infectious disease (e.g. HIV), skilled attendants must be empowered to work in high-quality health systems that have a longitudinal approach. They present a new framework based on the Donabedian framework, which they term the high-quality health system framework, for evaluating high-quality healthcare systems for LMIC settings. The three components of the framework are foundations, processes of care and quality impacts.
Litorp et al. (126)	The authors conducted 22 semi-structured interviews with medical practitioners and additional focus groups to identify why a hospital had a particularly high CS rate. Participants reported that they conducted unnecessary caesarean sections to avoid being judged by colleagues at morbidity and mortality audits if something went wrong. Some felt pressured by nurses. Delivering private sector patients via caesarean section provided significant financial incentives because, as one participant put it, "I minimise my time and I earn more!" (p.235).

Madzimbamuto et al. (127)	The authors carried out a root-cause analysis of maternal death in 56 cases of maternal death in Botswana. They found that "of the 82 deaths reported in 2010, 56 case notes were provided by health facilities for review and 26 case notes were missing or irrelevant" (p.3). The analysis showed that the majority of maternal deaths had a high number of contributory factors, "with 0–4 contributory factors in 19 deaths, 5–9 in 27 deaths and 9–14 in nine" (p.1). "Highest ranking categories were failure to recognise seriousness of patients' condition (71% of cases); lack of knowledge (67%); failure to follow recommended practice (53%); lack of or failure to implement policies, protocols and guidelines (44%); and poor organisational arrangements (35%)" (p.1). Worryingly, "half the deaths had some barrier to accessing health services" (p.1). The authors show that maternal deaths are the result of several factors lining up, a frequent occurrence in resource-constrained settings. Systems strengthening will reduce the likelihood of these factors converging.
Mazimpaka et al. (128)	The authors conducted a study "to describe demographic characteristics, clinical management, and maternal and neonatal outcomes among women receiving c-sections at Kirehe District Hospital (KDH) in rural Rwanda" (p.390). They found that 75% of women were subsistence farmers and 13.7% came from a nearby Burundian refugee camp. Only 5% of women experienced post-operative complications. This study highlights the plight of a neglected demographic, rural and displaced women. These women require safe, local obstetric surgical services to avoid traversing huge distances and borders to receive care.

McCord et al. **(104)**	This study highlights the effective role that non-physician assistants (NPAs) play in providing care in Tanzania, Malawi and Mozambique. NPAs operating in mission hospitals have better outcomes than those working in state hospitals. Mission hospitals are better equipped, have access to emergency blood and receive patients with a lesser prevalence of chronic disease.
Meara et al. **(1)**	The Lancet Global Commission has identified that of the "313 million procedures undertaken worldwide each year, only 6% occur in the poorest countries" (p.569). The Commission goes on to conclude that "high case-fatality rates from common, treatable surgical conditions… occur in areas where unmet need is greatest in eastern, western, and central sub-Saharan Africa, and south Asia" (p.569). The Commission calls for the adoption of national surgical, obstetric and anaesthesia plans to close the gap of unmet need.
Merry et al. **(107)**	The World Federation of Societies of Anaesthesiologists has developed international guidelines for use in LMIC settings which lack guidelines.
Moodley et al. **(23)**	This report is compiled by the National Committee of Confidential Enquiries into Maternal Deaths (NCCEMD). Moodley et al. report that institutional MMR is falling in South Africa, attributing this decline to improved HIV antenatal treatment and health status of pregnant women. South Africa's iMMR in 2009 was 190/100,000 live births in comparison to an iMMR of 130/100,000 in 2016. Bleeding during and after caesarean section (BDACS) is still the leading cause of mortality due to obstetric haemorrhage.
Mugo et al. (129)	South Sudan has a midwife to population ratio of 1:40,000, and as a consequence, midwives work under testing conditions. War, low pay and lack

	of equipment, drugs and infrastructure present further barriers to providing quality healthcare.
Nyamtema et al. (130)	The authors conducted a clinical audit after a training programme was instituted in rural Tanzanian community and district hospitals to increase the quality of CS. "During the audit period (2012–2014), 5,868 of 58,751 deliveries were by CS (10%). The proportion of CS considered to be unjustified decreased from 30 to 17% in health centres (P = 0.02) and from 37 to 20% in hospitals (P < 0.001). Practice of spinal anaesthesia for CS increased from 10% to 64% in hospitals (P < 0.001). Of 110 maternal deaths, 18 (16.4%) were associated with complications of CS, giving a risk of 3.1 per 1000 CS; three (2.7%) were judged to be anaesthetic-associated deaths with a risk of 0.5 per 1000 caesarean deliveries" (p.1676). This study shows that basic rural anaesthetic and surgical training can lead to improvement in clinical care.
Nyberger et al. (131)	The Tanzanian health system struggles to cope with severe resource constraint and inequality. The authors found that "41% of practicing doctors are located in urban regions" and there are 0.31 surgical specialists[7] per 100,000 population, compared to the recommended 20–40 per 100,000 population" (p.28). Up to 82% of all blood ordered is discarded.
Okafor et al. (132)	A retrospective descriptive study at a Nigerian delivery unit shows it has a high anaesthetic maternal mortality rate of 56/10,000 caesarean deliveries. The authors attribute this mainly to a lack of skilled anaesthetic providers, poor endotracheal intubation, lack of pulse oximeters and poor access to blood transfusions.

[7] Surgical specialists include specialist surgeons, obstetricians and anaesthesiologists.

Say et al. **(109)**	This analysis of multiple maternal mortality publications from around the globe published between 2003 and 2009 shows that haemorrhage, hypertensive disorders and sepsis were responsible for more than half of maternal deaths worldwide. These are all preventable causes of death that could be addressed through improved quality of care.
Scott et al. **(96)**	In this Rwanda-based study, preparedness for resource variability is highlighted as being just as important as preparedness for resource scarcity. The authors conclude that as more and more African countries acquire new resources and expand access to healthcare, surgical providers will have to adapt to resource variability.
Smiley et al. **(133)**	Ghana's Volta River Authority Hospital is considered a high-quality health facility in its region. It is wholly owned by the Volta River Authority, a state electricity parastatal. A safety attitudes questionnaire (SAQ) study and process map analysis found that its staff were efficient, 83% of workers reported a positive perception of teamwork and 77.4% reported a positive perception of safety culture. The institution's leadership considers safety a priority. This facility is an example of a high-quality facility in an LMIC setting.
Skelton et al. **(134)**	This pilot study in Rwanda showed promising results, suggesting that a low-cost simulation model, with good psychological fidelity, can be used to effectively teach anaesthesia non-technical skills (ANTS) for use during caesarean delivery.
Spiegel et al. **(105)**	This study assessed surgical availability and readiness in eight African countries using the WHO's Service Availability and Readiness Assessment (SARA) tool. The authors found substantial variation in the number of facilities

	per 100,000 population, in blood transfusion services and in surgical services. The substantial deficiencies found will require multiple stakeholders to finance and implement solutions.
Steffner et al. **(110).**	The authors highlight that the "lack of well-trained anaesthesia providers, inadequate infrastructure, equipment, monitors, medicines, oxygen, and blood products, and absence of meaningful data" hinder patient safety in LMIC settings (p.625).
Solanki et al. **(83)**	Solanki et al. found that CS rates for the South African private sector are substantially higher than the rates recommended by the WHO (10-15%). The public sector had a CS rate of 26.2% (2015) in contrast to 73.6% (2015) in the private sector. Despite the oversupply of caesarean sections in the private sector, most intraoperative maternal deaths occur in the state sector. This points to a potentially inferior quality of perioperative care in the public sector.
Stones et al. **(111)**	The International Federation of Gynaecology and Obstetrics has developed staffing standards to match the case mix that might be observed in LMIC settings.
Tiruneh **(135)**	Systems strengthening through the implementation of basic emergency obstetric and new-born care can result in measurable improvement to the number and quality of institutional deliveries.
Thwala et al. **(82)**	This study aimed to assess the preparedness of a South African health district to deliver emergency obstetric services (EmNOC) as prescribed by the United Nations standards for maternal care. Firstly, the authors found that community health centres (CHCs) did not perform certain surgical procedures

	because district health officials limited these services to higher-level facilities. Secondly, CHCs performed poorly on the availability of emergency maternal care protocols – they produced a mean score of 41% out of a possible 100. Finally, only 6.7% did emergency maternal resuscitation drills regularly.
Vaughan et al. (136)	A survey distributed to 23 health sites showed that Sierra Leonne lacks sufficient numbers of postgraduate and undergraduate trained surgical, anaesthetic and nursing providers. Specialists (n=10) are concentrated in urban areas, and medical officers carry the bulk of surgical services. Urban and rural hospitals lack infrastructure, equipment, drugs and stable power supply.
Van Hamersveld et al. (137)	In this Tanzanian participatory observational study, morbidity and mortality audits of adverse events do not have the full buy-in of the team due to time scarcity, lack of supporting resources and inadequate implementation of findings.
Weiser et al. (112)	The authors attempted to estimate the global volume of surgery and found that approximately 312 million procedures were conducted in 2012, an increase from the estimated 234 million procedures conducted in 2004. They found that caesarean sections account for 29% of all procedures in LMICs and only 5% of procedures in HICs.

The literature summarised above suggests that structural barriers appear to be the dominant barriers to safe surgical care. A small number of publications dealt with PSC directly, but those that did so were of varying quality. Few articles make the explicit link between resource constraint and PSC. However, Epiu et al. (119) report that “no [major east African] hospital had all the requirements to meet the international standards for safe anaesthesia” and that “a continuous ECG

was only available in 3/64 (5%) of hospitals" (p.1). Such extreme scarcity of basic perioperative equipment is not reported as widely in HIC settings. This adds considerable doubt to the validity of PSC models, instruments and interventions in African obstetric surgical theatres. These publications point to the conclusion that without co-ordinated planning between all stakeholders, matched by adequate resourcing and outcomes monitoring, intraoperative maternal mortality will not reduce.

4.3.2 Cultural barriers

Theme 2: Cultural barriers	
Author	**Key points**
Wami et al. **(22)**	The aim of this cross-sectional study was to assess the level of PSC and associated factors in four hospitals in the Jimma Zone of south-west Ethiopia. The Hospital Survey on Patient Safety Culture (HSOPSC) was administered to 637 participants. The combined safety climate score for the region was 46% (95% CI: 43.0, 51.2). Qualitative interview participants made the following comments: - "In maternity department water supply is very necessary but there is shortage" (p.7); - "Sometimes gloves and syringes, which seems simple, were not found" (p.7); - "I had been working in surgical department, one patient dead due to health care professional mistakes but they kept silent about the case" (p.7); and - "There is no personnel responsible for patient safety in this hospital, in developed countries I know there is risk management department" (p.7).

	Lack of resources are a consistent issue, but this study highlights how cultural issues, particularly negative attitudes and practices related to addressing safety, adversely affect safety culture in a resource-constrained environment.

Cultural barriers to PSC were prominent in the publication by Wami et al. (138). Qualitative interviews were superior to surveys in their ability to explain why medical providers adopted values and behaviours that seemed contrary to ideal PSC. Issues such as professional hierarchy, secrecy and resource constraint are mentioned as contributors to inadequate PSC, but the authors fall short of describing the underlying assumptions and value system shaping PSC in this environment. In addition, it is not clear if the HSOPSC survey was adequately validated in this Ethiopian setting, despite being translated to Amharic.

4.3.3 Educational barriers

Theme 3: Educational barriers	
Author	**Key points**
Alexander et al. (139)	In this Kenyan study, the authors conducted a series of simulated obstetric crises to test whether the implementation of a safe caesarean delivery checklist would improve the number of completed tasks in an obstetric emergency. They found that "the use of the caesarean delivery checklist during simulations of peripartum haemorrhage and preeclampsia showed significant improvement in the percentage of completed actions (pre-training 23% ± 6% for preeclampsia and 22% ± 13% for peripartum haemorrhage; post-training 75% ± 9% for preeclampsia, and 69% ± 9% for peripartum haemorrhage ($P < .0001$, both scenarios)" (p.993). The authors showed that the low fidelity simulation, together with a locally developed safe caesarean section checklist, could improve the performance of essential tasks in obstetric emergencies.

Bergh et al. (140)	A South African group of researchers conducted a systematic review of studies evaluating the efficacy of implementing simulated obstetric and neonatal emergency drills in LMIC settings. They concluded that "every maternity unit should provide EmONC [emergency obstetric and neonatal care] teamwork training, mandatory for all health-care providers" (p.1028). Barriers to implementation include "integrating training into institutional and health-system patient safety initiatives and 'thinking out of the box' in evaluation research" (p.1029).
Chang et al. (141)	Malawi's Alliance for Innovation on Maternal Health (AIM) programme ran an obstetric emergency skills programme that "included classroom didactics on obstetric haemorrhage, teamwork protocols, skills laboratory activities, and simulation training" (p.507). The authors found that "[t]here was a significant increase in the use of B-lynch sutures for the management of uterine atony in the postintervention compared with preintervention period (P=.014). In the postintervention period, the rate of maternal mortality from obstetric haemorrhage decreased significantly from 1.2% to 0.2% (P=.02), a relative decrease of 82.1% from the preintervention rate. Hospital safety culture scores improved significantly from baseline in four out of five domains after the AIM Malawi training" (p.507). This programme demonstrates that intensive and sustained patient safety interventions can improve perioperative outcomes in resource-limited settings.
Egenberg et al. (142)	The authors report on a training programme which targeted nurses, midwives, doctors and medical attendants at a district hospital in rural Tanzania. "Compared to pre-training, post-training patients had a 47% drop in whole blood transfusion rates and significant increases in caesarean section rates,

	birth weights, and vacuum deliveries. The logistic regression analysis showed that transfusion rates were significantly associated with the time period (pre- vs. post-training), caesarean section, patients transferred from other hospitals, maternal age, and female genital mutilation and cutting" (p.1). This study demonstrates that a low-cost, high psychological fidelity simulation programme with debriefing can improve clinical outcomes.
Fawcus et al. (143)	The authors investigated the direct causes of maternal mortality in South Africa. They found that obstetric haemorrhage was the third highest direct cause of maternal mortality (n=491 or 12% of all deaths). Of that, bleeding during and after CS, uterine atony and uterine rupture were responsible for 50% of all deaths in this category. This raises concern about technical skills during emergencies, particularly at level 1 hospitals.
Ginsburg et al. (95)	This cross-sectional survey took place in 62 LMICs. Survey findings indicate that patient safety curricula have not been implemented by faculty due to a lack of buy-in by decision-makers, insufficient faculty training, poor fit between curriculum and the broader economic context, and a lack of resources.
Hutch et al. (106)	The College of Surgeons of East, Central and Southern Africa (COSECSA) is made up of ten countries. This study investigates the retention rate of specialist surgical graduates who have graduated from COSECSA's training programmes. "Ninety-three per cent (93.4%) were retained within Africa. Of the eight countries, Malawi had the highest retention rate with 100% of surgical graduates remaining in country, while Zimbabwe had the lowest rate with 65.5% remaining" (p.3046). This study shows that local regional specialist programmes can have high retention rates.

Kihaile et al. **(144)**	Non-physician clinicians (NPCs) play a crucial role in treating labour complications in rural Tanzania. This programme highlights the significant deficits in knowledge and the scarcity of training resources for NPCs. Many NPCs did not know how to use a vacuum, when destructive procedures were indicated, what the indications are for prophylactic rectal misoprostol in the third stage of labour or how to conduct safe caesarean sections. After an average of only 27 procedures under supervision, NPCs return to their own hospitals and are expected to conduct these procedures safely.
Lin et al. **(145)**	This article is a follow-up to Scott et al. (96) . Scott et al. concluded that patient safety in Rwanda was hampered by resource variability and resource scarcity. Lin et al. adapted the Non-Technical Skills for Surgeons (NOTSS) taxonomy for an LMIC African setting and implemented "a 1-day training course for surgical and anaesthesia postgraduate trainees. The curriculum comprises lectures, videos and group discussions. A pre-training and post-training questionnaire was administered to compare knowledge and attitudes regarding non-technical skills, and their potential to improve surgical safety" (p.1014). The authors found that "understanding of NOTSS improved significantly (55.6% pre-course, 80.9% post-course, $p<0.01$). All residents reported that the course would improve their ability to provide safer patient care, and 97.4% believed developing non-technical skills would improve patient outcomes" (p.1014). Lin et al. show that non-technical skills training can be feasibly adapted to African settings and lead to improvement in safety-related knowledge.
Marzolf et al. **(146).**	This Eritrean study assessed the impact of a resident-led patient safety education programme on MMR, blood transfusion and neonatal outcomes. Maternal and "neonatal quality indicators did not change significantly. Utilising

	residents to teach staff-developed training within a hospital setting was feasible and may improve the work environment. Impact on maternal/neonatal outcomes is not evident but continued follow-up is important" (p.980).
Nyamtema et al. (147)	A comprehensive training programme for assistant medical officers (AMOs), clinical officers providing anaesthesia and nurse midwives based in rural Tanzanian health facilities resulted in a 300% increase in institutional deliveries, decreased fresh stillbirth rate (OR: 0.4; 95% CI: 0.1-1.7) and reduced obstetric referrals (OR: 0.2; 95% CI: 0.1-0.4) at three health centres. Systems support education programmes for assistant physicians could improve maternal outcomes in rural Africa.

Educational barriers emerge as the second most significant barrier in this study. Kinfu et al. (103), summarised under "structural barriers" (see 4.1.1 above), demonstrate that African countries in their study did not have the capacity to train highly skilled healthcare workers at a rate sufficient to meet demand. Thus, many countries train professionals known as non-physician assistants with intermediate skills. Nyamtema et al. (130) and Kihaile et al. (144) show that cadre often lack surgical, vacuum extraction and blood transfusion skills. Training is shown to lead to increased CS rates, reduced still birth rates and increased blood transfusion (130,144). It is not clear if these cadre are regulated in a similar fashion to medical and nursing professionals, but it is evident that they are a key pillar in rural obstetric services in less well-resourced African countries.

4.3.4 Physical and technological barriers

Theme 4: Physical and technological barriers	
Author	**Key points**
Nyamtema et al. (148)	An e-learning/distance learning intervention was launched at a rural Tanzanian hospital. The project was hampered by inadequate internet and mobile phone

	connectivity, low baseline computer literacy among healthcare users and a lack of information technology (IT) support. However, "60% of the health centres participated in more than one third of the teleconferences" (p.7). There is potential for e-learning and distance learning to be scaled up if rural infrastructure is upgraded.

Nyamtema et al. (148) demonstrate the feasibility of implementing digital interventions in rural district hospitals. Participation could be improved, but low computer literacy and inadequate IT support present major hurdles to widespread and sustainable adoption.

4.4 Discussion

The aim of this narrative review was to describe the current body of knowledge concerning the impact of resource constraint on safety practices in African obstetric theatres. Using Bate et al.'s (98) framework of six core barriers to high performance healthcare systems, four category barriers stand out in this review. In order of importance, the categories that stand out are structural barriers, educational barriers, cultural barriers and physical/technological barriers. Political barriers and emotional barriers have great importance in impacting maternal care, but these are not addressed in the literature evaluated. A discussion of how findings related to each barrier follows.

4.4.1 Structural barriers

Structural barriers, which are primarily related to deficits in resource planning, provision and availability, represent the most important barriers to the provision of safe obstetric surgical care in African settings. Aveling et al. (90) found that "although some aspects of patient safety problems are likely to be similar everywhere and are rooted in human factors, resources, culture and behaviour… what distinguishes these findings in African countries from high-income countries is not the nature of the hazards that threaten patient safety, but the scale and impact of the material deprivation and the relative weakness of structures of governance and accountability" (p.6).

4.4.1.1 Resource availability

Resources are not uniformly scarce in all African health systems. Availability varies over time, for example, a given resource may be available in abundance today but in short supply tomorrow, and varies in setting, for example, private sector versus state wards in the same region. In support of this, Scott et al. (96) found that "although scarcity of resources is commonly considered the reason for the disparity in performance between HICs and LMICs, the variability described in this study, as opposed to fixed scarcity, may present different challenges" (p.466). It also appears that the availability of a given resource is unpredictable. For example, Epiu et al. (101) note that variable supply of WHO safe surgery checklists to theatres resulted in inconsistent checklist completion.

4.4.1.2 Social determinants as structural barriers

The body of literature shows strong evidence that social determinants of health impact the ability of African women to access high-quality care. Boatin et al. (100) show that "caesarean section rates (CSR) were lowest in the poorest fifth income group (median CSR 3.7%) and highest in the richest fifth income group (median CSR 18.4%)" (p.1). Solanki et al. (83) report that in South Africa, the public sector CSR is 26.2% in contrast to 73.6% in the private sector. Furthermore, Epiu et al. (120) report that only 6% of Ugandan state hospitals have ICUs, whereas 57% of Ugandan private hospitals have ICUs. These findings demonstrate a considerable disparity in quality of care based on income.

4.4.1.3 Lack of infrastructure and equipment affects safety

Poor infrastructure presents a major structural barrier to the provision of safe care. For example, Scott et al (96) say that the success of blood transfusion depends on whether ''the ambulance is ok [and] the traffic is ok… because sometimes blood must be sent from across town" (p.464). In the same vein, the lack of equipment presents a major barrier to safe care as evidenced by Epiu et al. (102) finding that "only 3 of the 64 (5%) 3/64=5% hospitals had all the requirements available to meet the WFSA international guidelines for safe anaesthesia" in their survey of Ugandan hospitals (p.1). Ellard et al. (117,118) found that despite training 43 trainees to deliver improved obstetric

surgical care, the trainees were unable to produce a statistically significant drop in MMR because their operating theatres remained poorly resourced; none of the operating theatres had soap, only 63% had antiseptics, and 25% of did not have gloves. This shows that without simultaneous improvement in infrastructure and equipment, the positive effect of other interventions may be nullified.

4.4.1.4 Shortage and unequal distribution of skilled healthcare providers

The combined shortage and unequal distribution of skilled surgical and anaesthesia providers presents an additional structural barrier to the provision of safe obstetric surgery. Kinfu et al. (103) showed that twelve central and east African countries would have to increase their registered medical providers by 5-20% annually in order to meet the UN millennium development goal of 2.28 health workers per 1000 of the population. Nyberger et al. (131) highlight that non-physician assistants can help fill the gap: "At the time of the review, the specialist surgical workforce density of Tanzania was 0.31 per 100,000 population, a majority of SOA care is provided by non-physician clinicians (NPCs)" (p.30). It is evident that further research is needed to understand the actual roles for which NPCs take responsibility in day-to-day practice. It appears as though their level of training, though well intentioned, falls short of preparing them to carry out safe caesarean sections. Furthermore, a model of PSC which incorporates NPCs has not been described in an African setting.

4.4.1.5 Deficits in monitoring of quality of care

The lack of strong monitoring systems appears to limit the maternal death and near-miss audit capability of some African health systems (123,137). The Lancet Global Commission on High Quality Health Systems in the sustainable development goals (SDG)-era report by Kruk et al. (2) mentions "evaluation" 22 times as a critical requirement. Kruk et al. (2) argue that sustained "monitoring and evaluation of the impact of all improvement efforts at national and subnational level is needed to drive learning and improvement" and that "new initiatives should embed measurement, evaluation, and plans for how the results could be disseminated effectively to the people responsible" (p.36,39). This finding is pivotal, but difficult to implement in resource-constrained

settings where clinicians barely have time to meet for constructive engagement. Finding creative ways to integrate feedback into African obstetric surgical practice appears as a research gap.

4.4.1.6 Deficits in auditing maternal morbidity and mortality

There is an unmet need for confidential maternal death enquiries in African health services. Fawcus et al. (149) describe that South Africa, a comparatively wealthy African country, has the only "sustained and functional National Confidential Enquiry into Maternal Deaths Committee (NCCEMD) on the continent" (p.S4). Glenshaw et al. (123) argue that a system of national audit data collection comparable to the NCCEMD is overdue in Zimbabwe. Such audits improve the provision, skills and support for anaesthesia providers and reduce perioperative mortality as shown by the drop of MMR from 190/100,000 live births to 130/100,000 live births in South Africa between 2009 and 2017 (149). However, further research is needed to understand how each African country's national culture and level of resourcing could affect the design of a national audit system. For example, what may work in South Africa may not work in Zimbabwe due to differences in cultural norms and the politicisation of healthcare.

4.4.2 Educational barriers

The body of literature shows that caesarean section basic emergency obstetric and newborn care (CEmONC) training can reduce obstetric surgical morbidity and mortality in resource-constrained settings provided adequate infrastructure, equipment and buy-in from clinical leadership is present. Tiruneh et al. (135) show that a statistically significant reduction in infection rates, an increase in utilisation of tests (VDRL), the use of life-saving drugs (antibiotics, $MgSO^4$ and hydralazine), and handwashing occurred after training in an Ethiopian setting. Tiruneh et al. (135) conclude that "the implementation strength of BEmONC is strongly associated with the improved availability and utilisation of obstetric services in the intervention facilities, which ultimately will enhance the uptake of life-saving interventions to tackle the major causes of maternal and neonatal mortality in Ethiopia" (p.8).

Ellard et al. (118) found that, despite investing heavily in training non-physician assistants to conduct safe caesarean sections, “A number of facilities where trainees were returned to post-training were not upgraded, as planned, thus preventing them from putting into practice their new skills and knowledge” (p.1) To be effective, training must happen in tandem with system improvement.

4.4.3 Cultural barriers

Cultural change is not easy to achieve, but it is essential for the adoption of patient safety interventions. In an Ethiopian safety attitudes study, Wami et al. (138) found that adverse outcomes are sometimes hidden; a nurse in the study remarked, “I remember one case when I had been working in surgical department, one patient dead [sic] due to health care professional mistakes but they kept silent about the case, you see it was forgotten now without learning from that mistakes and not sure the same mistakes will not occur in the future” (p.7).

Van Hamersveld et al. (137) conducted an audit of obstetric morbidity and mortality meetings in a Tanzanian district hospital and found that “during 9 weeks of observation, four audit sessions were held. When the head of department was absent or there was no case prepared, there was no meeting”, inadequate staff commitment to audit was manifested by low attendance” and “despite efforts to maintain anonymity, blaming and using harsh language were also mentioned, as inhibiting participation, attendance and staff commitment” (p.654-5). These findings highlight that obtaining support from key clinical leaders and providing them with resources and skills to run safety culture interventions is critical. Not doing so leads to interventions failing or causing psychological harm to healthcare workers.

The study by Smiley et al. (133) of Ghana’s Volta River Authority Hospital (VRAH) found that “over 80% of employees across a variety of perioperative roles held a positive view of teamwork and safety climate within the institution” and that “the institution’s safety and quality-focused culture to be reflected in its perioperative processes and institutional practices” (p.19). In addition, Smiley

et al. (133) found that “a number of positive processes and behaviours known to be associated with patient safety were observed, including 100% adherence to the WHO checklist, closed loop communication and flat hierarchies allowing all employees to raise issues related to patient safety without fear of reprisal” (p.19). This facility demonstrates what is possible even in a resource-constrained setting. This could be because the VRAH is owned and funded by the Volta River Authority (a Ghanaian parastatal) as a limited liability company. This enables it to hire, retain and incentivise high quality medical staff (150).

4.4.4 Physical and technological barriers

Rural obstetric health facilities are far from large urban teaching hospitals. Nyamtema et al. (148) demonstrate the feasibility of using e-learning strategies to improve teaching, learning and outreach between urban centres and rural district hospitals: “38 emergency calls (teleconsultations) were made and attended by consultant obstetricians in 2015” and there were “no reports of any negative consequences associated with presenting real event case studies with bad outcomes, suggesting acceptability of this learning method” (p.4,8). Despite these positive results, further research is needed to understand whether digital health tools can be applied widely in rural African obstetric surgical services. Low computer literacy, inadequate IT support and the high cost of data are possible obstacles, but these could be overcome through multisectoral collaboration. Connecting generalist rural practitioners with experienced urban specialist practitioners via digital platforms could improve quality of care and positively impact PSC.

4.4.5 Political and emotional barriers

Political and emotional barriers were not noted in the literature found. It is likely that this reflects both the limitations of this review and the need for more literature on these topics.

4.5 Conclusion

In conclusion, this review collates and summarises the available literature relevant to PSC in LMIC settings and identifies important gaps that require further research. While bearing in mind the

limitations of this review, it appears as though structural barriers are a considerable obstacle to providing safe obstetric surgical services in African healthcare settings. Resource scarcity occurs in tandem with resource variability. In addition, educational, cultural and physical/technological barriers also present further obstacles to the provision of safe care. Finally, while the historical review in Chapter 3 highlighted the significant role played by race-based separate development and HIV in shaping healthcare in South Africa, this review shows that lack of structural capacity is the overwhelming obstacle to safe care in the rest of Africa.

However, the existing literature also leaves several "unknowns". Firstly, the role of national cultures and the impact this could have on the implementation of PSC interventions is not mentioned. Hypothetically, a confidential maternal death enquiry process developed in South Africa may not be implementable in the same format in another country due to differences in perceptions of confidentiality and truth-telling. Failing to take this into account could lead to the enquiry process being weaponised and losing the trust of clinicians.

Secondly, the status and exact role of NPCs is poorly described. Their role in obstetric surgical services must be better defined, especially considering that they appear to fill the role of conventional medical doctors in rural central Africa. Their scope of practice is poorly delineated and, similarly, their position in an African model of PSC is not clear. This is true for many other African medical professionals. Is it reasonable to assume that the scope of practice of medical doctors in a level 1 Tanzanian hospital equates to that of medical doctors in a level 1 hospital in France, the United Kingdom or even South Africa? These questions necessitate detailed studies of PSC in African settings to develop valid models, instruments and interventions to achieve safe obstetric care.

4.6 Limitations

This narrative review has several limitations. Firstly, a systematic review approach could have yielded a more focused set of publications, thereby reducing the risk of selection bias. However, a

preliminary search revealed only a limited number of high-quality publications on patient safety in African settings. A systematic review is unlikely to have yielded a significantly better set of publications. Nonetheless, this could be a source of selection bias. In addition, a systematic review would have focused on a very specific question, but at this stage of the overall thesis, the focus was on understanding what was broadly described about PSC in sub-Saharan Africa, which required a less specific approach.

Secondly, most of the publications dealt only in passing with safety culture – their focus was elsewhere. They mostly described the environment in which surgery is conducted rather than safety culture. Combining this with the poor methodological quality of many studies, the literature only provides general impressions without certainty or precision in many areas.

Thirdly, the author selected only publications in English. This could have led to additional selection bias as publications from former French and Portuguese colonies could have been missed. In addition, the selected publications show a geographic bias toward countries with medical research capacity; thus, there is a geographic bias mainly towards Burundi, the DRC, Ethiopia, Uganda, Ghana, Kenya, Nigeria, Rwanda, South Africa, Tanzania, Uganda, Zambia and Zimbabwe.

Furthermore, there could be articles published in databases smaller than the ones consulted in this analysis. Finally, there is also a risk of subjective bias in the selection of articles and themes. The inclusion of substantial studies like the Africa Surgical Outcomes Study (ASOS), WHO surveys and two Lancet Global Commission reports should mitigate against this.

4.7 Relevance of these findings within the wider dissertation

In this chapter, structural, educational, cultural and physical/technological barriers emerge as the main barriers to achieving high performance health systems in sub-Saharan Africa. In contrast, race-based institutional discrimination emerged as a major historical theme in Chapter 3. Resource scarcity was a common theme in both contexts, but markedly so in wider sub-Saharan Africa. The lack of literature directly addressing PSC resulted in the absence of a description of PSC in any

specific setting. Only broad conclusions about the common theme of resource constraint could be drawn. Therefore, the next step of investigation is to examine this directly in one country through an in-depth interview study of PSC in three hospitals in Cape Town, South Africa.

Chapter 5: A constructivist-grounded theory approach to understanding patient safety culture in South African obstetric surgical teams

5.1 Introduction

As proposed in Chapter 1, applying a PSC lens to understanding high MMR in South Africa could lead to further improvements in outcomes. MMR rose to a high of 190/100 000 live births in 2009 and by 2017 had declined to 130/100 000 live births (149). Improved MMR figures have been linked to improved data collection and widespread availability of HIV anti-retrovirals (149). However, the contributory role of PSC to MMR trends has not been researched sufficiently. PSC research in HICs has demonstrated a link between safety culture and high performance. However, these models fail to fully capture safety culture in resource-constrained and resource-variable environments in African LMIC settings (96). An African PSC model is therefore required.

Schein (31) proposes that "organisational culture is the pattern of basic assumptions which a given group has invented, discovered, or developed in learning to cope with its problems of external adaptation and internal integration, which have worked well enough to be considered valid, and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems"(p.18). Using Schein's approach and qualitative interviews, the author aims to construct a South African model of PSC by bringing to the fore basic assumptions, values and symbols that healthcare workers in this setting have used to construct their PSC. This will help us to understand how new members are taught the "correct way to perceive, think, and feel in relation to those problems" (p.1). The objective of this chapter is therefore to propose a new South African model of PSC founded on qualitative insights and, where appropriate, aspects of Schein's model of organisational culture.

5.2 Objectives

The aim of this study is to clearly define the nature of PSC in obstetric surgical teams in a South African setting by exploring the assumptions, values and artefacts that underpin their PSC. The following objectives will be addressed:

i) Define patient safety in this setting;

ii) Evaluate the suitability of Schein's models of organisational culture in this context;

iii) Describe the PSC values and beliefs of healthcare workers in this setting;

iv) Describe safety practices/behaviours linked to a healthy PSC in this context;

v) Describe practices that maintain PSC over time;

vi) Describe the barriers to safe care; and

vii) Identify barriers to organisational change.

5.3 Methodology

5.3.1 Study design and ethics

This is a cross-sectional qualitative study which has used one-on-one semi-structured interviews to explore assumptions, values and artefacts that shaped PSC in three Cape Town hospitals. A constructivist-grounded theory approach was used to understand the social processes observed (see section 5.3.5). Interviews were conducted over the period of one year, from September 2017 to September 2018. Ethics approval was obtained from the University of Oxford Tropical Research Ethics committee (OxTREC), the University of Cape Town (UCT), individual hospitals and the Western Cape Department of Health.

5.3.2 Study sites

The study sites included three maternity hospitals with obstetric surgical theatres of caesarean emergency maternal and newborn care (CEMONC) services. Two of the three facilities are Level 2 referral centres and one is a Level 1 district hospital. The major difference between Level 2 facilities and Level 1 facilities is that Level 2 facilities have specialist obstetricians continually cover for all

day and night cases throughout the week, whereas Level 1 facilities are staffed by medical officers who may not have specialist cover during night cases. Complex cases are referred from Level 1 to Level 2 facilities that have high care facilities. Community health centres were excluded because they do not provide CEMONC services in South Africa. Level 1 and Level 2 facilities were chosen because the highest incidence of maternal deaths due to caesarean-associated obstetric haemorrhage occur at this level of care.

5.3.3 Participant selection criteria

Selected participants were full-time employees of the Western Cape Health Department, had worked in one of the study sites' obstetric surgical theatres for longer than a month and had given informed consent to participate. Participants were recruited via convenience sampling through announcements at department meetings and one-on-one requests.

Table 8: Topic guide for semi-structured interviews

Semi-structured interview questions: These questions will be used to guide a discussion with all participants to ensure there is some consistency across all interviews.
1. Patient Safety Culture/Attitudes: a. Can you describe the culture toward patient safety in surgery in your institution and team? b. Do you think patient safety in surgery is a major priority in your i) institution and ii) team? c. How do leaders in your hospital/department/team talk about patient safety? **2. Patient Safety Practices:** a. Are there any barriers to achieving patient safety in surgery in your theatre environment? b. Can you describe protective measures to improve patient safety in surgery in your workplace? **3. Organizational Learning and Training:** a. Are there opportunities for medical staff to get patient safety training? b. Are there opportunities to learn from adverse incidents? How frequent are these? c. Are they confidential and structured? Are these useful for you? **4. Counter-culture:** a. How do people in your institution respond to change? b. What are barriers to introducing new patient safety practices? c. What would be the best approach to introducing new patient safety practices?

5.3.4 Topic guide

The semi-structured interviews followed the topic guide shown in Table 8 to ensure a level of consistency across interviews. These topics were chosen to investigate knowledge, attitudes and practices related to patient safety. In addition, the author wanted to explore PSC training and counterculture (resistance) towards PSC initiatives. Feedback from local clinicians helped to edit the final guide.

5.3.5 Constructivist grounded theory approach

The emergence of unexpected themes of interest meant that data collection and data analysis had to be conducted simultaneously to adequately explore emergent themes. Early data collection informed the collection of subsequent data. Data also needed to be represented in a way that attended to the participants' South African social context. This made it necessary to adopt a constructivist grounded theory approach. According to Charmaz (p.2), "grounded theory methods consist of a systematic inductive, comparative, and interactive approach *to* inquiry with several key strategies *for* conducting inquiry" and that the "logic of grounded theory requires comparisons and checks that enable us to shape our emerging theoretical ideas about the data while keeping these ideas grounded in data"(151).

Furthermore, Charmaz (p.299) proposes that *constructivist* grounded theory adopts grounded theory strategies, but also involves "(1) assuming a relativist epistemology, (2) acknowledging your and your research participants, multiple standpoints, roles, and realities, (3) adopting a reflexive stance toward your background, values, actions, situations, relationships with research participants, and representations of them, and (4) situating your research in the historical, social, and situational conditions of its production"(152).

A constructivist grounded theory approach is employed in this chapter through the retention, as far as possible, of words, phrases and descriptions used by research participants in the process of analysis, production of categories and discussion of results. The intention was to ensure that the

categories and PSC model employed in analysis reflected the epistemological context of South African state healthcare and South African healthcare professionals. The identified categories were placed within Schein's existing model of organizational culture where possible but, where placement was inappropriate, Schein's organizational model was expanded. The purpose of using Schein's model was to show the usefulness and weakness of existing PSC paradigms in the context of a South African healthcare setting.

5.3.6 Data collection

Interviews took place during breaks or after hours to minimise the impact on clinical services. Due to the unpredictable availability of staff across multiple hospitals, the author recruited Dr Asha Khachane (AK)[8] to assist him with conducting interviews at the study sites. Dr AK had conducted her own qualitative interview study on patient safety in an Oxford hospital prior to this study (153). To ensure quality control, the author and Dr AK conducted four interviews together before she carried out three interviews on her own. These were then reviewed with the author. The author carried out nineteen interviews (roughly 13 hours of interviewing), while Dr AK carried out three interviews (1.5 hours), making a total of 22 interviews. Fourteen and a half hours of audio were recorded for the 22 interviews. Interviews were analysed during the data collection process to assess new themes as they were developing. This enabled the author to determine if qualitative saturation had taken place, meaning no new themes were being raised by participants, and to identify specific participants who were able to give deeper insight into social processes that were emerging as important themes – for example, exploring conflict between surgeons and nurses required more interviews with nurses at a particular facility. Recruitment was halted when qualitative saturation was achieved. Collected interviews were transcribed using a GDPR-compliant transcription service, called "Ways with Words".

[8] Dr Asha Khachane was a Research Fellow in the Nuffield Department of Surgery at the time of study.

5.3.7 Thematic analysis

Data was analysed using methodological processes described by Attride-Stirling (154). Transcriptions were read and coded by the author using Nvivo version 12. The author did not construct a set of codes prior to reading the data; instead, emergent themes were organised into basic themes as described by Attride-Stirling (154). These basic themes were discussed with Dr Laura Pickup[9] (LP), a qualitative researcher, and Professor Peter McCulloch[10] (PM).

The author took the additional step of discussing the themes with participants he had interviewed. Based on the feedback of researchers and participants, the author congregated basic themes into a smaller set of organising themes as described by Attride-Stirling (154). The author discussed these organisational themes with LP and PM. All three agreed on basic themes, organising themes and areas where Schein's organisational model would potentially need to be adapted in order to accommodate the findings of the interviews. This adapted model could be useful in identifying the different aspects of organisational culture and their impact on safety in this context.

5.3.8 Positionality

The author is a black African male born in Zimbabwe and raised in South Africa. The author trained to become a medical doctor at local study sites before pursuing doctoral studies abroad. Thus, he is considered both an insider and outsider. Dr AK is a mixed race American female surgical trainee. This was her first contact with African clinical environments. She was regarded as an outsider and she relied on the author's local credibility to initially gain access to the participants. Due to the complex legacy of discrimination in South African healthcare, both the author and Dr AK were sensitive about their positionality when conducting interviews and interpreting data. This is further explored in Chapter 7, under heading 7.3.5.

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[9] Dr Laura Pickup is Independent Consultant and Chartered Human Factors specialist

[10] Prof. Peter McCulloch is a Professor of Surgical Science and Practice, Nuffield Department of Surgical Sciences, University of Oxford

5.4 Results

5.4.1 Descriptive statistics

The study cohort was made up 27 participants who took part in 22 interviews conducted at two secondary hospitals (Level 2 referral centres) and a district-level hospital (Level 1). Fourteen and a half hours of interview audio were collected. Descriptive characteristics of the population are shown in Table 9. Of the study population, 77% was female, in line with the Safety Attitude Questionnaire (SAQ) study described in Chapter 6. Only 30% of the study population were nursing staff.

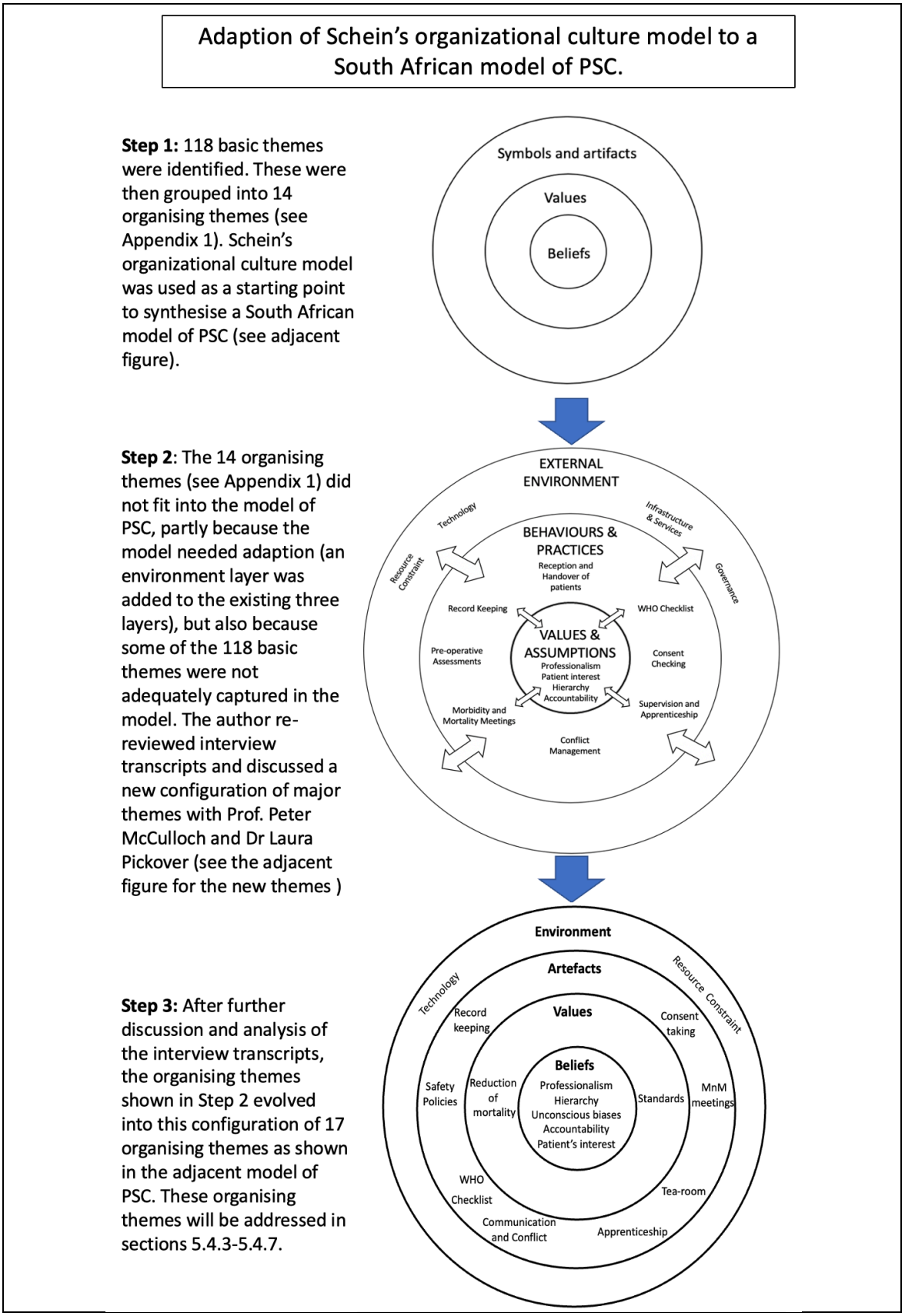
Table 9: Characteristics of the sample population

	Male % (n)	**Female % (n)**	**Absolute totals**
Participants	22% (6)	77% (21)	27
By site			
Site 1 (Level 2)	11% (3)	30% (8)	11
Site 2 (Level 2)	0	19% (5)	5
Site 3 (Level 1)	7% (2)	33% (9)	11
By level of care			
Level 2	11% (3)	49% (13)	16
Level 1	7% (2)	33% (9)	11
By profession			
Obstetrician	11% (3)	37% (10)	13
Anaesthetic	7% (2)	15% (4)	6
Nursing	4% (1)	26% (7)	8
By physician rank			
Consultant	4% (1)	15% (4)	5
Registrar	4% (1)	4% (1)	2
Medical Officer	4% (1)	11% (3)	4
Community Service	4% (1)	7% (2)	3
Intern	4% (1)	15% (4)	5

5.4.2 Thematic analysis findings

Data analysis was conducted as described in 5.3.7, using the methodology described by Attride-Stirling (154). A total of 118 basic themes were coded from the interviews (see Appendix 1) and grouped together in various configurations of organising themes to produce a model of South African PSC (see Figure 6).

Figure 6: Schein's original organisational theory model was adapted to a model of South African obstetric PSC in three iterative steps as shown below.



5.4.3 Underlying assumptions and beliefs

In this section, underlying assumptions about PSC expressed by participants will be explored. The concept of "patient safety" as described in western healthcare settings was new to the majority of participants interviewed for this study. Participants struggled to use their own words to describe patient safety, saying, for example, that "it's such a broad term, so it's difficult to say what it means" (155). Participants felt more comfortable defining patient safety through examples of professional values, teamwork, medicolegal case prevention and safety policies:

> Example 1: In theatre, you also need to check your theatre, like your daily check is, 'Is your bed working, is your suction working?' The sick nurse will do their part where they check the anaesthetic equipment. [They will check] whether it's working, your tubes if that is all the different sizes and stuff like that… and obviously we do a normal dusting, just to prevent cross-infection… and then when you go to the person that's doing the case, the scrub person. She [nurse] will then check vitals, you go according to your check list, what patients are being done today, do we have all the relevant [consent] sheets (156).

Belief 1: Healthcare workers are professional and competent

During the process of exploring the beliefs around safe obstetric practice within their environment, participants drew a link between professionalism and safety. Professionalism was not just linked to one's profession group, for example, being a medical doctor. Rather, it was linked to the way in which a professional conducted themselves and treated others during the perioperative period, even when under pressure. The following quotes appear to focus on negative elements, but this is because participants found it easier to illustrate how the absence of professionalism in some instances only serves to magnify its importance to their belief system:

> Example 1: One day, I had a patient and you could see his social background, he's coming from a farm and all of that. So, I asked him who's taking care of him. This patient came for a hip replacement. I said, 'who's coming in, does anybody watch you', and so on. And he said no. And I asked the doctor, I made a notice of it in his nursing process. I took the patient away, I went and asked the [ward] nurse, 'can you please give this patient a bath? Because he's just received a prosthesis of how many thousands of rand'. And she was like [ward nurse], 'I'm not his relative'. It's as if there's no insight [in junior nurses]. Why are we doing this thing? What is the outcome of this thing? What will happen if I don't do it? (157).

One nurse went further, linking unprofessional behaviour and hierarchy with increased risk of patient harm:

> Example 1: I had an incident one day where two doctors were fighting at the table. I was a scrub sister. And they were mean to each other, plain unprofessional mean. They were swearing at each other. And I thought: I can jump in and then I will become them. They will then team up against me and then fight me. I didn't talk. That is how we were taught: you don't talk, you just listen, you just anticipate, you follow the conversation, you don't socialise at the table. Because that is a time where you become less vigilant (157).

Belief 2: Healthcare workers are accountable for their actions

Several participants drew links between enforcing accountability and improved clinical practices and clinical outcomes:

> Example 1: I found in the different provinces, the accountability is not that hectic. And that drives patient safety. If I know I'm not going to have to answer for this and everyone's going to think, oh, it's just sepsis, then why am I going to be stressed out about being pedantic about keeping the sterile field sterile? But if I know even the smallest wound sepsis must be discussed, you would best believe I'm going to make sure that I keep my field sterile, because I don't want to be discussed, because I'm accountable (158).

Belief 3: Hierarchy is a necessary part of healthcare culture

As noted in one of the earlier quotations under Belief 1, participants described how hierarchy can lead to increased risk of patient harm. In addition, participants also described how they work as "flat" teams to get through challenging cases. They described how and why power structures vary in elective versus emergency obstetric surgery cases:

> Example 1: Hierarchy is very strong from speciality to speciality in terms of the surgeons and I think there's a lot more power-sharing per se, for example, in emergencies. So, the anaesthetist there sort of plays the chief role in conjunction with the nurse in charge of the emergencies and then together they will run the board, they'll tell the surgeon when they're going to do what. Whereas [in elective surgery], what the "boss" says goes and that would be the surgeon. And they will sort of be… they'll be in charge (159).

> Example 2: They [obstetric departments] have a hierarchy of people who we can speak to. So if there had been any issues with patient safety or any complications, it's always taken up at a higher level (160).

There are negative aspects to hierarchy within any organisational context, but, as highlighted in Chapter 3's narrative review of the development of healthcare in South Africa, power structures linked to socio-economic status and past policies of race-based separate development continue to echo through obstetric surgical teams today. Healthcare workers describe it as a 'normal' facet of South African culture:

> Example 1: [Race and hierarchy is a] South African unique issue, because I've worked elsewhere, the issue of class and race which sometimes comes up and causes issues. So linguistics, culture, people saying things. And it's largely from medical doctor personnel who then, to talk down from that bit on the medical hierarchy and then it's imbued with race and class and socio-economics which I think is probably the ugliest factor (155).

> Example 2: People would talk seriously to a male student of mine… if I had a white male student, they would always assume that that was the doctor and I was either a nurse or a student (161).

> Example 3: We used to have those Cuban [trained] students or Muslim students. People who have any accents, who sound like they're a little bit less fluent in English. They may be involved in theatre performance or surgery performance. There'd be like the anaesthetist teaching the student or the surgeon teaching the student. They'd maybe adjust the way they talk to them or what they expect from them. [The adjustment would be] negative, yes. But I don't think that its related to what happens in the actual surgery and surgery outcome. It's more just the vibe (161).

In the same vein, some nurses felt that medical doctors were in a stronger position to gain the ear of management in comparison to nurses:

> Example 1: There's a hierarchy, and the doctors are on top, and the nurses are at the bottom… If the doctor needs something, whatever the need might be, I feel sometimes that those needs are being heard. And then when nurses speak up, then it's 'no, we can address it, you know, don't worry we're going to, we'll try and sort out something', but nothing happens (156).

Belief 4: Healthcare workers must work in the best interest of patients

On several occasions, healthcare workers highlighted that deciding what was in the patient's best interests was useful to find motivation, resolve conflict or make a difficult clinical decision:

> Example 1: I just have to manage whatever medical problems that patient has. The patient needs surgery now, so I need to just get on with it and do the anaesthetic to the best of my abilities (159).

> Example 2: If the designated person is not available, for instance, if there's no porter, what deters you from not getting the patient? Why must it be a porter? At the end of the day, we are all here to render patient service or patient care (162).

> Example 3: If the surgeon shouts, it's not personal. I've seen some of my junior colleagues, scrub sisters are like, 'now I'm going to strip my gloves'. And I said, 'it's not about stripping your gloves'. That's patient abuse, that's neglecting your patient… our main focus, as much as you want to do your things, everybody's in a tight spot because we want to save this patient (157).

5.4.4 Espoused values

Schein (31) states that identifying values allows researchers "to begin to deal with the question of why members behave the way they do". Similarly, Hogan et al. (29) state that "although not directly observable, values have a powerful force on norms and resultant observable behaviours". Two

values were prominent in the interviews, one centring on reducing maternal mortality and the other on maintaining high standards of an academic training service.

Value 1: Maternal mortality must be reduced to 70/100 000 to meet the 2030 SDG goal

Interviews with senior obstetric and anaesthetic consultants showed that the leadership were advocates for reducing maternal mortality:

> Example 1: Someone must take charge of safety, when I arrived the theatre didn't have a red line and you had to walk across the recovery area to get the change rooms… I used to check the air ducts to make sure they were clean (163).
>
> Example 2: When I worked in X hospital, it was very much 'see one, do one, teach one' [learning how to do caesareans] and 'can you do one in seven minutes'… patient safety is something that became really important to me after twenty years in practice. I became a senior leader with access to data [on maternal deaths] and it changed my view on how risky caesarean sections actually were (163).
>
> Example 3: The [Saving Mothers] report for 2011-2013 highlighted the increasing caesarean section deaths… we had [national] meetings with rural doctors and agreed on minimum standards… we saw big drops in maternal mortality when district hospitals centralised their caesarean section service, we think it was due to the adoption of these standards (163).

Value 2: All three sites are academic training facilities that must offer a safe 24-hour service

The senior obstetric surgeons, anaesthetists and nurses felt proud about their facilities being academic training sites. They felt they had to raise standards by evaluating their practice and doing whatever it took to ensure continuity of care, even at personal risk:

> Example 1: Senior doctors here [Level 2 facility] do outreach to the district hospitals [Level 1]. Once a week they will go to and join perinatal meetings, do emergency drills and help. It keeps up the standards (163).
>
> Example 2: Site 3 hospital is a new district hospital in our region, it's supposed to be staffed by medical officers, but a consultant has been assigned there because it's so busy. Night cover is a problem because you can't have one person covering all the nights… I used to drive there at night, but others don't want to go because the X road is a dangerous road to drive at night (163).
>
> Example 3: So, where we have flaws, where we slump a bit, that's where we get our training for, to improve… how to resus, all these types of illnesses these patients have, like how to treat a GPH, PPH, cardiac arrest, everything about the baby (164).

5.4.5 Artefacts and processes

Schein (32) describes "visible artefacts as the constructed environment of the organisation, its architecture, technology, office layout, manner of dress, visible or audible behaviour patterns,

public documents such as charters, employee orientation materials" (p.2). In this study, several artefacts stood out: the WHO safe surgery checklist, M&M meetings, informed consent-taking, safety policies, learning by apprenticeship, record-keeping and tearoom layouts. These will be described below.

Artefact 1: The WHO checklist

The WHO safe surgery checklist featured as the most prominent artefact of patient safety in this study. It was mentioned in every interview as an example of an intervention that breaks down hierarchy and improves patient safety. The most striking example of its usefulness was:

> Example 1: …a really good example of that today. I assisted in an emergency caesar this morning and so I was called up at the very last minute and I kind of ran to theatre, quickly got changed, ran into theatre, just scrubbed, and immediately was at the patient's bedside. So, I had walked in as they were check listing and I missed the reason why she was having the caesar, which I then asked afterwards and then my senior said okay, it's for foetal distress. And then he was under the impression that we were doing tubal ligation and it actually wasn't the case. And our midwife, who was behind the scene, she picked up that the patient wasn't for tubal ligation and she actually spoke up. She was comfortable enough in her position to say no, the patient didn't consent to this. And then the other nursing staff checked the consent form and then it was actually picked up that she wasn't for tubal ligation, which, if the midwife hadn't spoken up, we would've done a tubal ligation on some poor woman who has only had one child and who is still very young (165).

Artefact 2: Morbidity and mortality meetings

Weekly morbidity and mortality meetings create useful forums for the group to reflect on the causes of near-misses or fatalities. One senior doctor is in charge of chairing the discussion, while a junior doctor is in charge of presenting the cases. The names of the patients and staff are kept anonymous. Neonatology staff and nurses join these meetings. These meetings provide platforms for staff to point out problems to their leadership in a non-judgemental environment. Some participants felt that these meetings could be stressful, while others felt the meetings were positive learning environments

> Example 1: [In] Obstetrics, in general, there's an attitude of what were you doing? When did you do that? Why did you do that? And that's got a lot to do with people getting sued, with the pressures of the job, with people's outside perceptions of everything needs to go perfect. So, it's a difficult one to actually say how to change it, because it's cultural thing of you can do wrong, but if you did, it's intentional. Which is not true. And unfortunately, no one wants to

> hear, I was under pressure. It is a pressure cooker environment; you can't now say you are under pressure. That's every day (158).

Artefact 3: Informed consent-taking

Gaining informed consent and checking for written records of such consent prior to obstetric surgery was seen as an important part of ensuring patient safety. Participants mentioned that consent records are checked before all cases, but language issues present a major barrier to ensuring patient understanding:

> Example 1: There are some patients that are obviously not South African nationals or that don't speak English, and the language barrier is a massive thing. So, sometimes a consent obviously is not 100% conveyed because of that language barrier (159).

Artefact 4: Safety policies

Policies and protocols were clearly displayed in all the operating theatres. A distinct practice that emerged was that of gaining caesarean section licences. Junior medical doctors in some of the facilities were required to pass a caesarean section licence exam before being allowed to operate. Similarly, any new medical officers had to complete the same exercise:

> Example 1: It's important for a senior to watch how every new person [medical officer] does a caesarean before allowing them to operate alone, even if they say they did 200 before (163).

Artefact 5: Learning by apprenticeship

Participants said that they gain competence through observing other colleagues' clinical practice and through repeated supervised practice of accepted practices and skills:

> Example 1: You learn it as you go along (165).
>
> Example 2: On call [night shifts], you have one MO with you and that's your go-to person, but during the week it's kind of anyone (165).
>
> Example 3 (junior doctor): You kind of figure out along the way… then you, like, kind of watch and see, okay, that's the anaesthetic nurse, that's what she does (165).

Artefact 6: Record-keeping

The possibility of litigation means that record-keeping is seen as an important part of obstetric practice:

> Example 1 (anaesthesia nurse): As long as you've written it down that you did inform the doctor. So then if anything goes wrong inside, then that doctor will have to answer in those meetings [morbidity and mortality meetings] …Write your notes, mark it down… just a little short saying just to cover yourself (157).

Artefact 7: Tearooms

Participants talked about how tearoom dynamics can foster unison or discord. In one facility, nurses and doctors shared lunch together and got to know one another very well. They displayed a strong bond. In another facility, the doctors and nurses started off by sharing a tearoom, but the doctors started using a different room. The operative teams at this facility were not as well bonded:

> Tearoom 1: You have nurses calling doctors by first name, doctors calling nurses by first name. Yes, it's a very friendly atmosphere. I think because the staff are the same staff all the time. There's, like, very few people who come in and out, who they take in and out, so we've gotten to know each other quite well, I think this hospital is a lot less hierarchical than a lot of the other hospitals (165).

> Tearoom 2: That [doctors' tearoom] was initially an open area and we called it our time-out area… then they [doctors] had it enclosed, okay. After it was enclosed, they still had the tables there, so we could still like… If you don't feel you want to sit in the tearoom, you can go and sit there. Then we noticed it was being locked, and then after it's been locked, equipment was being put into the lounge area, into that area. But it wasn't a discussion, it was just like, everything just happened so, almost like undercover. Until it became a doctors' tea-room, and now at the moment a lot of the nurses are unhappy about it, but unfortunately there's nothing, we feel there's nothing we can do (156).

5.4.6 Environmental factors

Schein (31) describes three layers of organisational culture: basic assumptions, espoused values and artefacts and behaviours. In the process of interviewing participants, it became evident that another layer of organisational culture was emerging: the obstetric healthcare team's response to resource constraint and variability, and to fast-changing technology (mobile, digital and equipment). This necessitated the author adding a further descriptive cultural layer: "environment". Two environmental factors are examined here: resource constraint and technology.

Environmental factor 1: Resource constraint

Staff were able to vividly link lack of resources, workforce shortages and high clinical loads to poorer patient safety practices by identifying that resource constraint leads to an increased tolerance of shortcuts and lower quality of care standards:

> Example 1: Unfortunately, I think patient safety is definitely compromised when it's busy. Multiple reasons that I have seen but including that the surgeons feel stressed about what's on the board. So, everyone tries to be faster, clean faster, cut faster, the nurses are forced to recover patients faster, possibly sending patients out of recovery before they are ready (166).
>
> Example 2 (a healthcare worker links high caseloads to near-misses): A caesar was cancelled three days in a row, an elective caesar, but because she was always booked on the list, she was never seen by a doctor in the ward on any of those days, and every day she was just waiting for her caesar. On the third day when she was about to get an elective caesar, it turned out she had HELLP syndrome, and no one had checked her platelets and she had an eclamptic fit while waiting for her day. So, that kind of thing, if it hadn't been so busy, she would have got her caesar on the first day. Also if it hadn't been so busy the obstetric doctors would have hopefully seen her and looked at her results and bumped her up on the list because she is actually an emergency (166).
>
> Example 3 (a healthcare worker links high clinical loads to shortcuts in preparing the patient for theatre): Not giving the pre-meds, not making sure the drip is running before the patient comes to theatre. Not putting the catheter in before the patient goes to theatre. Not taking an adequate history from the patient sometimes before the patient gets the certain drug. It can slow us down if you need to then get to theatre. Put the drip up, put the catheter in, make sure the patient doesn't have any other illnesses! (165)
>
> Example 4 (a nurse complains about working conditions): There is not enough staff, and there is too much work, which is putting us at risk, because you might make the mistakes that will put the patient in danger, or that you might be in trouble at the end of the day… people are more inclined to sue nowadays. You must be so, walk on eggshells the whole time, you understand? (164)

Environmental factor 2: Technology

The advent of instant messaging platforms is making clinical communication easier, but the high price of devices and data seems to widen communication gulfs between nurse and doctors:

> Example 1: And I think what's important is that, like, from what I understand, our seniors in the department have communication with anaesthetics and sometimes the message doesn't filter through… to the nursing staff, then it's kind of, like, they get a surprise thrown on them that there's a caesar now, whereas they could've planned their time a bit better, which happens occasionally, but not every day (156).
>
> Example 2: [They have] the latest devices. We aren't all on WhatsApp with them. (157)

5.4.7 Communication and conflict

Communication and conflict were the themes most often mentioned by participants. Nurses in particular felt that they were kept out of communication loops concerning the decision to operate. They expressed frustration that anaesthetists and surgeons communicated among themselves and did not loop them in:

> Example 1: When communication fails then the nurses become a bit agitated and in turn, the doctors then also become slightly more agitated towards each other, but then we always seem to kind of talk it out and resolve whatever issue has come up (163).

In addition, tempers flared between night duty obstetric surgical residents and anaesthesia locum doctors or anaesthesia residents. Anaesthetists describe frustration at being forced to safeguard patients:

> Example 2: [Obstetric surgeons] may get annoyed with the anaesthetist who won't want to anaesthetise someone until they've got the results of all the bloods and ECG… the anaesthetist is going ahead and doing a job that they technically would rather have more information before going into, particularly in emergency cases (167).

> Example 3: People who are visiting, like registrars who just do the occasional call here, who get into big fights in theatre. Like, I know that there have been showdowns and throw-downs in theatre and not everyone is diplomatic in dealing with kind of disagreements on how things need to move forward… it's difficult to work with people you don't know at all (165).

Conflict is resolved by senior staff the following day, but some participants suggested proactive solutions:

> Example 4: We're dealing with individuals that are stressed out on whatever level… you don't really know where people are coming from or what they're fighting, what they're dealing with at home… make sure that everyone's expectations are on the same page to communicate well. So what [some facilities] do very well is they have a huddle at the beginning of the day to talk about what's going on. So it immediately puts everybody on the same page (168).

5.5 Discussion

5.5.1 Adapting Schein's model to an African healthcare system

It is evident that for participants in this study, PSC is not just an outcome of assumptions, values and artefacts. It is a careful balance of resource rationing, resilience and constant adaptation to resource constraint. One hundred and eighteen themes emerged through the interviews, and while many of them could fit into the organisational model described by Schein, some themes could not.

Though Schein describes the impact of external factors on organisational culture, the model fell short of capturing how obstetric surgical teams adapt their PSC to resource constraint (e.g. workforce shortage) and changing technology (instant messaging). For this reason it was necessary to make explicit the impact of external factors on safety culture through tolerance of shortcuts and lower quality care by adding an additional sphere referred to as "environment" (see Figure 6).

5.5.2 What are the beliefs and values of healthcare workers pertaining to PSC?

Several beliefs and values were identified, as described in **Error! Reference source not found.**. Before proceeding, it is worth referring back to the definitions offered by Schein in Chapter 2 under heading 2.3.2. Assumptions are the "ultimate, non-debatable, taken-for-granted values" that are shared by a group, whereas espoused values are "what people say is the reason for their behaviour, what they ideally would like those reasons to be" and these are espoused at an individual level (32). The interplay between beliefs and values held by individuals could give rise to group norms that govern PSC within a team.

It is worth highlighting three sets of beliefs that were described: these are beliefs about professionalism, competency and hierarchy. In relation to professionalism, professional practitioners are expected to focus on tasks, one at a time, despite the heavy clinical loads. They are expected to work well with other professionals, avoid overt conflict and act in the interests of patients. In a resource-constrained environment, these ideals are difficult to achieve unless teams have strong, resilient leaders and access to additional resources. Healthcare workers can only compensate for system challenges up to a certain threshold; thereafter, many become demotivated and burnt out. These stresses can lead to conflict, loss of vigilance and increasing risk of adverse events:

> I had an incident one day where two doctors were fighting at the table. I was a scrub sister. And they were mean to each other, plain unprofessional mean… we were taught you don't talk, you just listen, you just anticipate, you follow the conversation, you don't socialise at the table. Because that is a time where you become less vigilant... (157).

The second set of beliefs relates to competency. Safe practitioners are expected to have achieved competence through completing formal (regulated) and informal (apprenticeship) training that other health professionals deem to be satisfactory and sufficient. Competency in this environment includes dealing with fatigue and being able to complete tasks/procedures quickly and safely. Speed appears to be valued over quality in settings with high workloads. Leaders have to actively monitor quality standards to ensure that quality is not sacrificed for speed:

> So, everyone tries to be faster, clean faster, cut faster, the nurses are forced to recover patients faster, possibly sending patients out of recovery before they are ready (158).

As happens in many other healthcare systems, the participants held strong beliefs about rank and hierarchy. There is evidence that hierarchy remains steep, especially between nurses and doctors. Hierarchy is also impacted by a national culture shaped by centuries of legalised discrimination. Healthcare workers at the lower end of these power spectra describe disempowerment and discrimination. Nurses perceive that they have fewer resources and less of a voice in institutional life than more senior personnel. Junior female healthcare workers feel they are not recognised as being on par with male counterparts due to gender stereotypes. Healthcare workers and trainees who do not speak fluent English or come from other low-income countries may be perceived as being less competent than their more fluent or South African-trained counterparts:

> We used to have those Cuban [trained] students or Muslim students. People who have any accents, who sound like they're a little bit less fluent in English. They may be involved in theatre performance or surgery performance. There'd be like the anaesthetist teaching the student or the surgeon teaching the student. They'd maybe adjust the way they talk to them or what they expect from them… negatively, yes. But I don't think that… That's not related to what happens in the actual surgery and surgery outcome. It's more just the vibe (161).

Finally, healthcare workers expect one another to be stoic and persistent. Taking breaks and raising concerns can be seen as weakness, or as not wanting to pull one's weight in a team. Many of the healthcare workers displayed features of burnout and found it hard to debrief about their experiences. Instead of voicing their concerns about staff shortages and inefficiency, some have opted to take early retirement, emigrate or work in the private sector. This exodus of staff makes

it difficult to build and retain experienced, high-functioning teams that can deliver safe caesarean sections.

5.5.3 What behaviours were linked to PSC?

The WHO surgical checklist was the most commonly described group practice to ensure patient safety. It was closely followed by morbidity and mortality meetings, good record-keeping and procedural accuracy. The WHO checklist has been embraced as an important safeguard at all three facilities in this study, but there is room for improvement. Nurses wanted doctors to point out when they can participate in the WHO checklist and to give them adequate time to check that their suction and diathermy were functioning before starting a procedure. It was clear that the evidence basis of the safe surgical checklist is not well understood. It has become a "tick box exercise" for some practitioners:

> …definitely great, but it sometimes becomes routine in the fact that people just sort of might read it out and don't really take full note of what they are actually saying or what the other person said (169).

Morbidity and mortality meetings are multidisciplinary in nature. It is evident that the effectiveness of these meetings depends on the skill and experience of the chair. Participants highlight that some meetings turn into a negative learning environment. The impact of increasing medical litigation has led some healthcare workers to adopt a culture of accurate note-keeping "to cover oneself" from malpractice and blame. Good record-keeping is to be welcomed, but there is a risk that if it is driven by self-interest, it may not result in accurate, faithful recording of events. This risk diminishes trust, and trust deficit diminishes team performance:

> So then if anything goes wrong inside, then that doctor will have to answer in those meetings [morbidity and mortality meetings] …Write your notes, mark it down… just a little short saying just to cover yourself (165).

5.5.4 What practices maintain PSC over time?

Values, strongly held beliefs and external environmental factors, particularly resource constraint, shape healthcare workers' patient safety practices and the subsequent outcomes. For instance,

one healthcare practitioner describes how she practises safe surgery, despite high clinical loads, because she is aware her outcomes will be evaluated:

> But if I know even the smallest wound sepsis must be discussed, you would best believe I'm going to make sure that I keep my field sterile, because I don't want to be discussed, because I'm accountable (158).

5.5.5 What are the barriers to safe care?

The major barriers to safe care, as described by participants, appear to be resource constraint—particularly shortages of personnel and operating theatres—along with communication and conflict. Doctors and nurses highlighted a need for improved interdisciplinary communication around the booking of emergency patients for theatre. This was a major source of conflict between nurses and obstetric surgeons. Nurses feel that they could be better prepared for these cases with more advanced warning. Conflict is at its zenith during night shifts when gap cover trainee specialists and locums work in these teams. The lack of trust leads to doubts about team members' clinical judgment. Without senior staff to diffuse the situation, tension escalates. This is complicated by the fact that all night-time cases are emergency caesarean cases which are by definition higher risk.

5.5.6 What is preventing change today?

Participants cite resource constraint as the biggest barrier to change. Participants are opposed to any interventions that may increase their workloads as they feel they are already under too much pressure. Careful assessment of readiness for change and the impact of change on clinical workloads must be conducted before designing and implementing new interventions.

5.5.7 Unexpected findings

The first unexpected finding was the use of instant messenger services to book operating room cases (elective and emergency) and to disseminate information about error avoidance. These were not top-down initiatives, but innovations driven by the healthcare workers themselves. These digital groups excluded theatre nurses, partly because some of the nurses could not afford

smartphones, but potentially because the creators of the groups preferred to curate a "doctors only" digital environment. As a result, nurses were excluded from aspects of theatre decision-making, particularly in relation to emergency cases. This contributed to a power gulf between doctors and nurses.

The second unexpected finding was the important role that social interactions in tearooms play in bonding operating teams. Site 1 had a shared facility for nurses and medical doctors, so they knew one another's names, children's names, wedding or celebration dates and recent car acquisitions. This informal bonding builds empathy and connection that fosters teamwork and diffuses conflict that may arise due to heavy clinical loads:

> I think that another helpful thing in this theatre, about helping prevent barriers, is the fact that we all have a tearoom together, and people don't take that lightly… anaesthetists, surgeons, nursing and cleaning staff – everyone has tea together (170).

Site 2 and Site 3 staff lacked this level of bonding between nurses and doctors.

5.6 Conclusion

Many aspects of safety culture in government-funded South African obstetric operating theatres resemble many of those described in the wider body of PSC research. Basic assumptions about professionalism, acting in the patient's best interests and the need for organisational hierarchy appear to be universal aspects of medical culture across the globe.

5.6.1 The legacy impact of discriminative practices on PSC in South African theatres

As outlined in Chapter 3, South Africa has a legacy of institutionalised discrimination. In view of the findings of this chapter, this adds a negative dimension to assumptions about who is a professional and where health professionals fit within organisational hierarchy. In the past, South African medical professionals were predominantly white and male. As the obstetric workforce becomes more diverse, cultural assumptions of "who is a professional" have to adapt in order to reflect a new reality. As a consequence of this process of change, some professionals, particularly female, foreign and non-white professionals, may feel inadequately supported by colleagues. Some may

feel poorly integrated into surgical teams. These professionals are at risk of feeling unable to speak up and challenge unsafe practices, in a manner that is reminiscent of the way steep hierarchy prevents junior pilots from challenging senior pilots in cockpits (171). It is difficult to say how severe or distinct the impact of discrimination is on PSC in this context versus other healthcare settings, but the degree to which this was mentioned in interviews suggests a need for further research.

5.6.2 The legacy impact of resource constraint on PSC in South African theatres

Resource scarcity was continually cited as an underlying theme that shaped the daily experience of professionals. While resources are finite in every healthcare system, South African obstetric theatre professionals are under significant stress from considerable surgical caseloads, lack of bed space and inadequate infrastructure. The professionals interviewed in this case series displayed resilience, but in some cases they showed features of chronic stress and high risk for burnout. Whereas HIC health systems take a system view of patient safety, a senior consultant confirmed that in the South African setting, it was up to senior staff to ensure that facilities had positive PSC. However, reports of maternal mortality audits, monitoring of WHO checklist use and sepsis rates showed that these Cape Town hospitals are transitioning toward a system view of PSC as seen in HIC settings. This may not be generalisable to the rest of South Africa, or Africa. Further research is required to identify how different African regions adapt their PSC to their level of resourcing.

The proposed model of South African PSC (Figure 6) combines the universal aspects of medical culture with the uniquely South African aspects of basic assumptions, values, artefacts and environment. It captures the local surgical professional's struggle to adapt to and integrate into a workplace undergoing radical social transformation while under considerable resource constraint. Despite the adaption of Schein's model, the model's lack of fit does raise the question of whether perhaps an entirely new model or an adaption of another better model is required.

5.7 Limitations

The first limitation of this study is that it is not entirely generalisable as participants could only speak about their local experiences within the three facilities that were studied. However, there are similarities between the study sites and other facilities in the same provincial health system. These findings could be used to advocate for further research, improved staffing, funding and culture change at the study sites. In addition, the significant number (14.5) of hours spent interviewing a broad range of participants to achieve qualitative saturation will have resulted in the broadest possible set of themes which can be used to describe PSC within this context.

The second limitation is that the author must acknowledge his own positionality. As a black male naturalised South African, the author has experienced various aspects of the country's national culture, in particular, overt and covert forms of racism and xenophobia. Bias caused by this has been countered by enlisting several researchers from the United Kingdom and South Africa to audit this work.

Finally, in the process of organising the numerous smaller themes into fewer, larger general themes, some of the smaller themes may have been watered down in the analysis. To counter this, the author has repeatedly referred back to the list of all 118 themes to make sure that, as far as possible, all major themes are represented.

5.8 How this chapter fits in the wider context of this dissertation

The consequences of institutional discrimination and resource constraint observed in Chapter 3 contribute to low morale, burnout, conflict, tolerance for shortcuts leading to patient harm (sepsis, anaesthetic and surgical errors) and near-miss events described in this chapter. Although interviews give a rich picture of PSC, they do not describe PSC in a standardised way which allows comparisons with healthcare settings in other countries. A validated South African safety climate survey would fill this gap. In the next chapter, the strengths and limitations of using the Safety Attitudes Questionnaire (SAQ) in an LMIC setting will be explored through a validation study.

Chapter 6: Insights from adapting an international patient safety climate survey to a South African obstetric setting

6.1 Introduction

In Chapter 5, a qualitative study using semi-structured interviews demonstrated the impact of resource constraint on PSC in South African state-funded obstetric surgical settings. Epiu (101), Smiley et al. (133) and Scott et al. (96) demonstrated the feasibility of using patient safety climate surveys developed in high income contexts in African settings. Scott et al.'s (96) study is particularly noteworthy because it identifies that "despite knowledge that context influences both provider behaviour and clinical outcomes, neither the contextual challenges faced by surgeons in low-to-middle income countries (LMICs) nor the strategies used to overcome them have ever been described", and it uses this as the premise to adapt a non-technical skills taxonomy to an African setting (p.461).

Similarly, patient safety researchers working in LMIC settings prevalent in Africa lack validated patient safety climate tools. Existing tools do not adequately anticipate and account for the type of healthcare workers (clinical officers), the standard of English used, resource constraint (including power and water supply interruptions) and lack of equipment (such as sterilisation equipment) that may be found in LMIC environments. Patient safety climate scores designed in HIC settings may therefore fail to give an accurate global assessment of the safety climate in LMIC settings. A validated patient safety climate tool would enable South African safety researchers to i) accurately compare patient safety climate across facilities at a district, provincial or national level; ii) collect qualitative data that can provide additional explanations for mortality trends in a way that pure quantitative data cannot; and iii) develop a patient safety climate surveillance network that uses annual surveys to evaluate improvement or decline in patient safety in between the release of

maternal mortality statistics every three years.[11] For this reason, the objective of this chapter's study was to adapt and validate an international psychometric safety climate questionnaire for a South African context.

6.2 Methods

6.2.1 Study design

The core objective of this study was to adapt and validate the Safety Attitudes Questionnaire (SAQ), a widely used international safety climate questionnaire, for a South African context. A cross-sectional study design was utilised to determine face validity, construct validity, content validity and internal reliability. The safety climate questionnaire was distributed and collected between 3 June 2019 and 8 July 2019.

6.2.2 Geographic location and population

The study took place in the Cape Town Metropolitan West region (Metro-West). It included all three public sector hospitals that offer Level 1 and Level 2 obstetric surgical services in the region (Table 10). A fourth facility that provides obstetric surgical services to another district was included because it refers complex emergency cases and receives outreach from a Level 2 facility located in the Metro-West. Two and a half million people live in the area under study.

Table 10: Level of care, adult bed capacity and number of theatres at each obstetric facility

	Level of care	**Adult bed capacity**	**Number of obstetric theatres**
Site 1	Level 2 (secondary hospital)	106	2
Site 2	Level 2 (secondary hospital)	330	1
Site 3	Level 1 (district hospital)	60	1
Site 4	Level 1 (district hospital)	56	1

[11] The National Committee for Confidential Enquiries into Maternal Deaths releases a triennial report on maternal mortality statistics.

6.2.3 Choice of psychometric tool

The Safety Attitudes Questionnaire (SAQ) short form developed by Sexton et al. (35) was chosen for adaption to a South African context because of its relative simplicity and the comparative advantage that it had been adapted for use in other LMIC settings such as Brazil and China (35–37). Thus, the future results of the South African study could be compared to those from a spectrum of HICs and middle-income countries (MICs). Several well-known safety climate questionnaires were considered but not selected for the converse reasons that the SAQ was chosen. These are:

i) Agency for Healthcare Research and Quality hospital survey by Nieva et al. (172)

ii) Patient Safety Culture in Healthcare Organizations survey by Singer et al. (173)

iii) Modified Stanford Patient Safety Culture survey instrument by Ginsburg et al. (174)

6.2.4 Evolution of the SAQ tool

The SAQ short form is an adaption of a much longer SAQ questionnaire (35). The SAQ was originally based on the Intensive Care Unit Management Attitudes Questionnaire (ICU MAQ) (10, 11). Looking further back, the ICU MAQ was based on the widely used commercial aviation safety climate survey, the Flight Management Attitudes Questionnaire (FMAQ), because 25% of the FMAQ questions demonstrated utility in a medical setting (35). According to Sexton et al. (35), the FMAQ was derived from a series of studies that showed that “most airline accidents were due to breakdowns in interpersonal aspects of crew performance such as teamwork, speaking up, leadership, communication, and collaborative decision-making” (p.2). Sexton et al. (35) used “Vincent's framework for analysing risk and safety and Donabedian's conceptual model for assessing quality (15,35,177). This generated a pool of over one hundred new items covering four themes: safety climate, teamwork climate, stress recognition, and organisational climate (177)” (p.2).

6.2.5 Ethics, copyright permissions and advice

Ethical approval for this study was granted by the University of Cape Town Human Research Ethics Committee (HREC 534/2017), the Western Cape Health Department, the University of Oxford Tropical Research Ethics Committee (530-17) and local hospital Chief Executive Officers at the study sites. The author received permission from the University of Texas to adapt the language and structure of the SAQ to a South African context. A University of Texas representative was kind enough to explain the evolution of the SAQ and potential areas requiring additional investigation. The author took the additional step of discussing the practical challenges of adapting the SAQ with the principal investigator of a Brazilian SAQ adaptation study.

6.2.6 Calculation of SAQ scores

The SAQ score is made up of six domains and 30 items (Table 11). The SAQ score is calculated by assigning a value to Likert responses for each question in a domain as follows: disagree strongly=1, disagree slightly=2, neutral=3, agree slightly=4 and agree strongly=5. The total sum for the domain is calculated, followed by a calculation of the mean score for the domain. The average value is then subtracted by 1. This value is then multiplied by 25 to generate a score of between 0 and 100. Thus, a mean SAQ domain (e.g. teamwork) value of 4 would translate into an SAQ domain score of 75 [75 = (4-1) *25].

Table 11: The SAQ's six domains and an additional seventh domain

Domains of the SAQ	Items included in the domain
Teamwork	Q1, Q2, Q3, Q4, Q5 and Q6
Safety climate	Q7, Q8, Q9, Q10, Q11, Q12 and Q13
Job satisfaction	Q15, Q16, Q17, Q18 and Q19
Stress recognition	Q20, Q21, Q22 and Q23
Perception of management	Q24, Q25, Q28 and Q29
Working conditions	Q27, Q30, Q31 and Q32
Resource constraint[12]	Q37, Q38, Q39, Q40, Q41 and Q42

[12] The original SAQ is made up of six domains. A seventh domain, "resource constraint", was tested here.

6.2.7 Presentation of responses to individual items in the SAQ

The SAQ has five possible Likert responses for each item; disagree strongly=1, disagree slightly =2, neutral=3, agree=4 and agree strongly=5. In 6.3.3, responses to disagree strongly and disagree slightly were aggregated to produce single category called “disagree”. Neutral responses were treated as neutral, whereas agree and agree strongly were aggregated into “agree”.

6.2.8 SAQ-SA - face validation and addition of the resource constraint domain

A multidisciplinary focus group was established (see Table 12), consisting of two senior obstetric specialists (University of Cape Town), a perioperative anaesthesia researcher (University of Cape Town), a specialist general surgeon and patient safety expert (University of Oxford), the author and two medical officers (South Africa). Six of the seven group members had worked extensively in the region as researchers or healthcare workers. The author played a considerable role in the design, organisation of logistics and collection of suggestions from all members of the group, but final decisions were made through group consensus to ensure the highest degree of face validity. Figure 7 illustrates the alterations made to the SAQ-SA to make the SAQ fit-for-context in a South African setting. Table 13 offers a written description of these changes.

The changes did not alter the original factor structure of the SAQ short form. There was no change to the number of domains, the essence of the questions in those domains and the number of questions. A principle of the adaptation process was to maintain the spirit of the questions as far as possible to allow for comparison with international sites. The adapted SAQ-SA retained all six original domains of the SAQ designed by Sexton et al. (35): teamwork, safety climate, perceptions of management, working conditions, job satisfaction and stress recognition.

An experimental seventh domain was added, which comprised of six questions assessing the impact of resource constraints on patient safety climate (see questions 37-42 in Figure 7). These additional questions were generated by the SAQ-SA modification working group mentioned above. All committee members participated in generating and editing the questions. Questions were only

included after full consensus was achieved. Six questions were agreed upon and included in the SAQ-SA pilot. No negative feedback related to the readability or understanding of these questions was noted by pilot participants.

A key objective was restricting the survey to a maximum length of one page because, as the focus group pointed out, obstetric surgical staff do not often have more than ten minutes to fill in research forms during their busy work schedules. Thus, a short one-page questionnaire design was agreed on.

6.2.9 Illustration

The Oxford Medical Illustration group produced a professional layout for the SAQ-SA questionnaire based on the specifications of the focus group (see Figure 7). A footnote at the bottom of the SAQ-SA was added to note that the copyright for the SAQ belongs to the University of Texas and that this version had been produced with their permission.

Table 12: A brief description of the professional background of each member of the SAQ-SA working group

Member	Experience
Dr S.F.	Experienced obstetrician with over 40 years of medical practice, an African maternal mortality expert and member of the National Committee on Confidential Enquiries into Maternal Deaths.
Dr G.P.	Experienced obstetrician with over 30 years of medical practice, chief regional specialist in obstetrics and gynaecology.
Dr R.D.	Anaesthetist and perioperative crisis simulation expert (15 years of perioperative practice). Has practised medicine in HIC and LMIC settings.
Dr P.M.	Upper gastrointestinal surgeon and patient safety researcher. Over 40 years of clinical and academic experience in HIC settings.
Dr T.C.	Doctoral student with two years of perioperative practice and six years of medical training in the local environment (author).
Dr N.L.	Obstetric medical officer with four years of perioperative practice and six years of medical training in the local environment.
Dr. J.L.	Obstetric medical officer with five years of perioperative practice and six years of medical training in the local environment. Conducts caesarean sections in a rural hospital.

Figure 7: Visual illustration of the changes made to produce the SAQ-SA

SAFETY ATTITUDES QUESTIONNAIRE SOUTH AFRICA (OPERATING THEATRES)

Please answer the following items with respect to your specific unit or operating theatre. Choose your responses using the scale below:

Safety Attitudes: Your opinions on care in this Patient Care Area | Today's Date (month/year):

I work at least once a week operating theatre time: ☐ Yes ☐ No

This is in the Department of:

INSTRUCTIONS (Please complete this survey with respect to your experiences in this operating theatre)

Use number 2 pencil only. USE A NO.2 PENCIL ONLY ■ Correct Mark ■ Incorrect Marks ☐ ✉ ☑

QUESTIONS ON WORKPLACE SAFETY CLIMATE	Disagree Strongly	Disagree Slightly	Neutral	Agree Slightly	Agree Strongly	Not Applicable
1. Nurse input is well received by other professionals in this operating theatre.	A	B	C	D	E	X
2. In this operating theatre, it is difficult to speak up if I perceive a problem with patient care.	A	B	C	D	E	X
3. Disagreements in this operating theatre are resolved appropriately (i.e, with a focus on what is right for the patient, not who is to blame)	A	B	C	D	E	X
4. I have the support I need from other staff to care for patients.	A	B	C	D	E	X
5. It is easy for staff here to ask questions when there is something that they do not understand.	A	B	C	D	E	X
6. The doctors and nurses here work together as a well-coordinated team.	A	B	C	D	E	X
7. I would feel safe being treated here as a patient.	A	B	C	D	E	X
8. Medical errors are handled appropriately in this operating theatre.	A	B	C	D	E	X
9. I know the proper channels to direct questions regarding patient safety in this operating theatre.	A	B	C	D	E	X
10. I receive appropriate feedback about my performance.	A	B	C	D	E	X
11. In this operating theatre, it is difficult to discuss errors.	A	B	C	D	E	X
12. I am encouraged by my colleagues to report any patient safety concerns I may have.	A	B	C	D	E	X
13. The culture in this operating theatre makes it easy to learn from the errors of others.	A	B	C	D	E	X
14. My suggestions about safety would be acted upon if I expressed them to management.	A	B	C	D	E	X
15. I like my job.	A	B	C	D	E	X
16. Working here is like being part of a large family.	A	B	C	D	E	X
17. This is a good place to work.	A	B	C	D	E	X
18. I am proud to work in this operating theatre.	A	B	C	D	E	X
19. Morale in this operating theatre is high.	A	B	C	D	E	X
20. When my workload becomes too heavy, the quality of my performance is reduced.	A	B	C	D	E	X
21. I am less effective at work when I am tired.	A	B	C	D	E	X
22. I am more likely to make errors when there are tensions or conflict situations in the theatre.	A	B	C	D	E	X
23. Being t[illegible] reduces my performance during emergency situations (e.g. emergency resuscitation, seizures, heavy bleeding)	A	B	C	D	E	X
24. Management supports my daily work	A	B	C	D	E	X
25. Management doesn't knowingly worsen patient safety	A	B	C	D	E	X
26. Management is doing a good job.	A	B	C	D	E	X
27. Problem staff are dealt with constructively by our management	A	B	C	D	E	X
28. I get adequate, timely information about events that might affect my work from management	A	B	C	D	E	X
29. The levels of staffing in this operating theatre are enough to handle the number of patients.	A	B	C	D	E	X
30. This hospital does a good job of training new staff.	A	B	C	D	E	X
31. All the necessary information is often available for me to make good decisions regarding patient care.	A	B	C	D	E	X
32. Trainees in my discipline are adequately supervised.	A	B	C	D	E	X
33. I experience good teamwork with nurses in this operating theatre.	A	B	C	D	E	X
34. I experience good teamwork with doctors in this operating theatre.	A	B	C	D	E	X
35. I experience good teamwork with pharmacy, stores and procurement pharmacists in this operating theatre.	A	B	C	D	E	X
36. Communication breakdowns that lead to delays in delivery of care are common.	A	B	C	D	E	X
37. Sterility and correct draping principles are adhered to.	A	B	C	D	E	X
38. We have a working recovery area.	A	B	C	D	E	X
39. The temperature in our operating theatres is maintained to allow us to focus and maintain sterility.	A	B	C	D	E	X
40. We have regular meetings to discuss problems affecting our theatre e.g. broken autoclave.	A	B	C	D	E	X
41. Shortage of water and electricity supply do not impact theatre operations at our hospital.	A	B	C	D	E	X
42. Bed shortages that result in a backlog of elective theatre cases frequently occur here.	A	B	C	D	E	X

BACKGROUND INFORMATION

Have you completed this survey before? ☐ Yes ☐ No | Age: | Mark your gender: ☐ Male ☐ Female ☐ Other:

Profession:

- ☐ Consultant Anaesthetist
- ☐ Consultant Obstetrician
- ☐ Consultant Surgeon Consultant
- ☐ Paediatrics
- ☐ Registrar Anaesthesia
- ☐ Registrar Obstetrician
- ☐ Registrar Surgery
- ☐ Registrar Paediatrics
- ☐ Medical Officer Obstetrics
- ☐ Medical Officer Surgeon
- ☐ Medical Officer Anaesthesia
- ☐ Medical Officer Paediatrics
- ☐ Community Service Officer – Anaesthesia
- ☐ Community Service Officer – Obstetrics
- ☐ Community Service Officer – Surgery
- ☐ Community Service Officer – Paediatrics
- ☐ Intern – Anaesthesia
- ☐ Intern – Obstetrics
- ☐ Intern – Surgery
- ☐ Intern – Paediatrics
- ☐ Theatre Nurse – Floor Nurse
- ☐ Theatre Nurse – Scrub Nurse
- ☐ Theatre Nurse – Anaesthesia
- ☐ Porter
- ☐ Cleaning Assistant
- ☐ Technologist/Technician
- ☐ Admin Support (Clerk/Secretary/Receptionist)
- ☐ Mid-wife

Years in specialty: ☐ Less than 6 months ☐ 6 to 11 months ☐ 1 to 2 yrs ☐ 3 to 4 yrs ☐ 5 to 10 yrs ☐ 11 to 20 yrs ☐ 21 or more

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Table 13: Description of the alterations shown in Figure 7

Edit	Description of alteration
1	The title has been changed to "Safety Attitudes Questionnaire South Africa (Operating Theatres)"
2	Text has been altered from "Frontline perspectives from this patient area" to "Your opinions on care in this Patient Care Area". "I work in the (clinical area or patient care area where you typically spend your time)" altered to "I work at least once a week operating theatre time: yes (tick box) or no (tick box)". "Department of" altered to "This in the Department of".
3	HB pencil enlarged. "Use number 2 pencil only" positioned more prominently.
4	Correct marks and incorrect marks made more prominent. One of the examples of incorrect marks has been removed for simplicity and space.
5	The multiple-choice headings for the scoring system have been simplified and placed on the far right as a continual column. These changes were in response to feedback from the pilot.
6	New section 2 heading added: "Questions on workplace safety climate."
7	"Nurse input is well received in this clinical area" was changed to "Nurse input is well received by other professionals in this operating theatre".
8	"i.e. not who is right, but what is best for the patient" changed to "i.e. with a focus on what is right for the patient, not who is to blame". Feedback from the qualitative interviews suggests that the threat of litigation leads to decisions designed to avoid litigation, which may not always be the same as decisions made in the best interests of the patient.
9	In Q20, "excessive" changed to "too heavy".
10	In Q20, "impaired" changed to "reduced".
11	In Q21, "fatigued" changed to "tired".
12	In Q22, "intense or hostile situations" changed to "when there are tensions or conflict situations in the theatre".
13	In Q23, "Being fatigued" changed to "Being tired".
14	In Q23, "heavy bleeding" added to list of examples.
15	In Q24, "efforts" changed to "work".
16	In Q25, "compromise" changed to "worsen".
17	In Q31, "necessary information for diagnostic and therapeutic decisions is routinely available to me" changed to "necessary information is often available for me to make good decisions regarding patient care".
18	In Q35, "good collaboration with pharmacists in this clinical area" was changed to "good teamwork with pharmacy, stores and procurement pharmacists in this operating theatre".
19	Additional questions added: 37. Sterility and correct draping principles are adhered to.

	38. We have a working recovery area. 39. The temperature in our operating theatres is maintained to allow us to focus and maintain sterility. 40. We have regular meetings to discuss problems affecting our theatre e.g. broken autoclave. 41. Shortage of water and electricity supply do not impact theatre operations at our hospital. 42. Bed shortages that result in a backlog of elective theatre cases frequently occur here.
20	Professions altered to represent disciplines that form obstetric surgical teams: consultants, registrars, medical officers, community service doctors, medical interns, theatre nurses, mid-wives, porters and cleaning assistants.

6.2.10 Pilot feedback

Ten obstetric surgical staff completed a draft version of the survey to test their feedback before the survey was handed out widely. The font size of the SAQ-SA was increased because of their feedback.

6.2.11 Inclusion and exclusion criteria

Inclusion criteria	**Exclusion criteria**
- Fulltime employees of the Western Cape Health Department - Healthcare workers and allied professionals must have worked in obstetric theatres for at least one month in the last twelve months - Must be over eighteen years of age - Must have given voluntary informed consent to filling in the SAQ-SA questionnaire and the use of their data for research purposes	- Non-full-time employees of the Western Cape Health Department - Staff who did not work in operating theatres for the required period - Below the minimum age of eighteen years - Not giving voluntary informed consent to participate in the study

6.2.12 Participant recruitment

Recruitment took place between 3 June and 8 July 2019. Due to the unpredictable availability and the constant rotation of the staff across hospitals, staff were recruited through convenience sampling methods. A South African research associate from the University of Oxford arranged meetings with all obstetric, anaesthetic and nursing department heads at the four hospitals in order to explain the study to them. The research associate explained the SAQ-SA at prescheduled theatre

staff meetings and handed out and collected the questionnaires at the study sites after the meetings. She also left surveys in hospital theatres for night staff and collected them from staff at a predetermined time in theatre the following morning. This approach was adopted due to safety concerns about night travel in certain parts of Cape Town.

6.2.13 Bias

The use of convenience sampling posed a risk of sampling biases such as self-selection bias and exclusion bias. To mitigate against both, significant effort was made to achieve the highest possible response rate, with a target of over 70%. Randomisation of distribution proved impractical due to the rotation of staff between facilities and the need to physically hand out the sheets. Blinding was not relevant as the study design did not have an experimental group and an intervention group and was not measuring an effect or outcome from survey completion.

6.2.14 Calculating internal reliability

One hundred and ninety staff met the inclusion criteria to participate in the study. Internal reliability of SAQ-SA was calculated using the cronbach alpha score of each of the six domains and the cronbach alpha score for the overall SAQ survey. Cronbach alpha tests for inter-item consistency between questions in a domain (i.e. do similar questions get similar responses) and produces cronbach alpha scores in a range from zero to one. The closer a value is to one, the greater the internal consistency between responses to different questions in a domain (see Table 14 for ranges of internal consistency for a given cronbach alpha score). STATA 14.1 was used to calculate the cronbach alpha score in this study (178).

Table 14: Ranges of internal consistency for cronbach alpha values

Cronbach alpha score range	**Internal consistency**
1 - 0.80	High
0.79 - 0.70	Good
0.69 - 0.60	Acceptable
0.59 – 0.50	Poor
<0.50	Not consistent

6.2.15 Determining construct validity

Construct validity was calculated using STATA 14 and associated graphics were made with IBM SPSS AMOS (178,179). Goodness of fit measures were calculated using a confirmatory analysis: chi square test of absolute fit, Standardised Root Mean Residual (SRMR), Comparative Fit Index (CFI) and Random Mean Square Error of Approximation (RMSEA). According to the original authors of the SAQ, the chi square test is extremely sensitive to "trivial misspecifications in the model's structure", requiring the use of other models of fit such as SRMR, RMSEA and CFI. The recommended cut-offs shown in Table 15 are based on Browne et al. (180), Hu et al. (181), Marsh et al. (182) and Schweizer et al. (183).

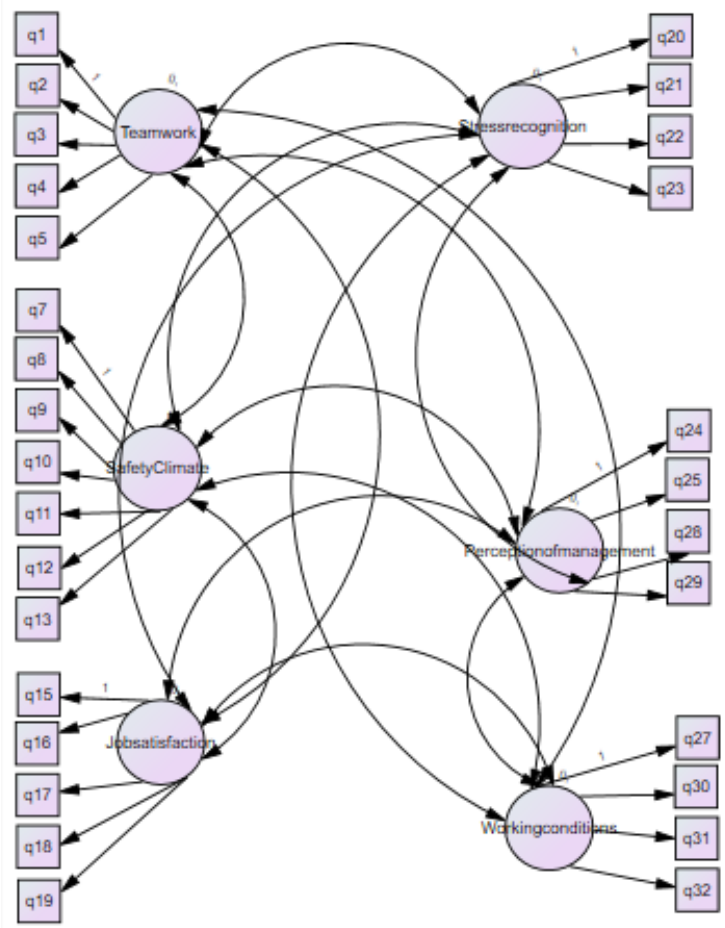
Table 15: Cut-off ranges for goodness of fit measures

	Poor	**Acceptable**	**Good**
CFI	<0.90	0.90 – 0.949	0.95-1.00
RMSEA	<0.08	0.08 – 0.06	<0.06
Chi x^2	<0.11	0.08 - 0.11	<0.08
SRMR	>3.00	2.01-3.00	>3.00

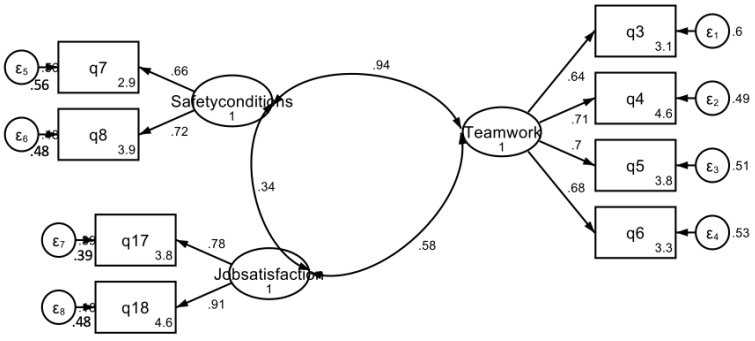
6.2.16 Testing of various constructs

As mentioned earlier in 6.2.15, an initial confirmatory factor analysis was carried out to test construct validity of the original 30-item, six-factor construct of the SAQ. SPSS STATA 14 and IBM SPSS AMOS (178,179) were used to generate measures of goodness of fit as described in 6.2.15 (see Figure 8 and Table 18). Items that resulted in weak factor-item associations were then deleted sequentially until satisfactory model fit was attained as described by Sexton et al. (35). The implications of this are that whole domains could be discarded if all items within the factor construct resulted in poor association with other factors in the original six-factor construct. By implication, the resultant model of fit could be a small factor construct made of fewer items as has been observed in other SAQ studies (36,37).

Figure 8: (A) The original SAQ-SA six-factor construct and (B) the revised three-factor construct



(A) An image of the original six-factor construct taken from IBM SPSS AMOS: Labelled circular shapes represent factors (domains). Each box represents a numbered item within the survey (q1=question 1). The arrows represent inter-factor and intra-factor correlational relationships. Goodness-of-fit results are shown in Table 18.



(B) An image of the revised three-factor construct discussed under heading 6.3.6. The circular shapes represent the domains (factors). Each box represents an item within the SAQ survey. The arrows represent inter-factor and item-factor correlational relationships. A factor loading co-effecient, which is similar to a correlation co-efficient, is adjacent to each arrow. The numbers to the immediate right of each epsilon represent the variance in each item's factor loading co-efficient that is unexplained by its relationship with the factor.[13]

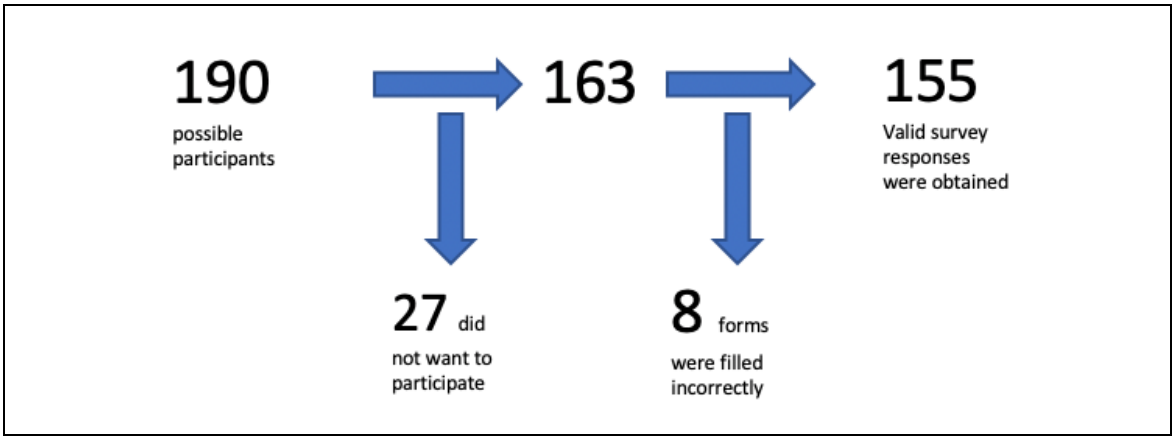
[13] A useful description of confirmatory factor analysis diagrams by Grace-Martin can be found at https://www.theanalysisfactor.com/the-fundamental-difference-between-principal-component-analysis-and-factor-analysis/ (222)

6.3 Results

6.3.1 Descriptive statistics

A total of 163 responses were obtained out of the possible 190 (Figure 9). Out of the total responses, 155 were valid, making the final response rate 81.5%. Of these respondents, 39 % (n=61) were male, 52% were medical doctors, 47% were nurses and 1% were cleaning assistants.

Figure 9: Distribution and yield of SAQ-SA survey responses



6.3.2 Internal reliability

The SAQ-SA had an overall cronbach alpha of 0.89, indicating a high degree of internal reliability. The detailed breakdown of cronbach alpha scores for each of the six domains is shown in Table 16.

6.3.3 Responses to specific items

The raw dataset containing all 155 participants' responses to all 42 items is shown in Appendix 2: Raw responses to all SAQ-SA items. A selection of survey responses illuminates the sample population's level of job satisfaction, communication, quality of working environment and the impact of resource constraint on patient safety climate (Table 17). With regard to job satisfaction, 85% (133/155) of participants agreed that they liked their jobs. 59% (90/153) of participants agreed that communication breakdowns leading to delays in delivery of care are common. In addition, only 41% (63/152) of participants agreed that they had regular opportunities to discuss problems in theatre. 53% (80/152) of participants agreed that shortage of water and electricity supply impacted

theatre operations.[14] 65% (99/153) of participants agreed that bed shortages frequently lead to a backlog in elective theatre cases, potentially leading to harm.[15] The negatively phrased questions (2 and 11) behaved as expected and had to be reverse weighted when testing the internal reliability of the SAQ-SA.

Table 16: Cronbach alpha scores for all domains and the overall SAQ-SA scores with and without the resource constraint domain (r.c.). Although the SAQ-SA has 42 questions, the original SAQ only uses 30 questions to generate a score (see Table 11). When calculating SAQ-SA score with the addition of the resource constraint domain, 6 additional items were added to make a total of 36 items.

Teamwork	**Cronbach alpha coefficient:**	**0.7070**
	Number of items in the scale:	6
Working conditions	**Cronbach alpha coefficient:**	**0.6608**
	Number of items in the scale:	4
Safety climate	**Cronbach alpha coefficient:**	**0.7463**
	Number of items in the scale:	7
Job satisfaction	**Cronbach alpha coefficient:**	**0.7975**
	Number of items in the scale:	5
Stress recognition	**Cronbach alpha coefficient:**	**0.8791**
	Number of items in the scale:	4
Perceptions of management	**Cronbach alpha coefficient:**	**0.5479**
	Number of items in the scale:	5
Resource constraint (r.c.)	**Cronbach alpha coefficient:**	**0.5796**
	Number of items in the scale:	6
SAQ-SA overall (– r.c.)	**Cronbach alpha coefficient:**	**0.8890**
	Number of items in the scale:	30
SAQ-SA overall (+ r.c.)	**Cronbach alpha coefficient:**	**0.8942**
	Number of items in the scale:	36

[14] Cape Town experienced a record drought from 2015 to 2017 and rolling electricity blackouts between 2016 and 2020 due to failures in the national grid.

[15] The author interviewed a medical doctor who pointed out that backlogs in elective cases lead to some of the elective cases becoming emergency cases. She gave the example of an elective caesarean patient who developed HELLP syndrome while waiting for delayed elective caesarean section.

Table 17: Selection of specific SAQ item responses

Question	Disagree % (n)	Neutral % (n)	Agree % (n)
Q.15 I like my job.	5 (8)	10 (16)	85 (131)
Q.36 Communication breakdowns that lead to delays in delivery of care are common.	23 (35)	18 (28)	58 (90)
Q.37 Sterility and correct draping principles are adhered to.	8 (13)	9 (14)	82 (125)
Q.38 We have a working recovery area.	4 (6)	8 (12)	88 (136)
Q.39 The temperature in our operating theatres is maintained to allow us to focus and maintain sterility.	29 (45)	11 (17)	60 (92)
Q.40 We have regular meetings to discuss problems in theatre.	33 (51)	25 (38)	41 (63)
Q.41 Shortage of water and electricity supply do not impact theatre e.g. broken autoclave.	37 (57)	10 (15)	53 (80)
Q.42 Bed shortages that result in a backlog of elective theatre cases frequently occur here.	23 (35)	12 (19)	65 (99)

6.3.4 Construct validity of the SAQ-SA: Confirmatory factor analysis

Construct validity was calculated as described under heading 6.2.15. The objective was to determine if the SAQ-SA's construct truly measured the concepts it was intended to measure. The six-factor (domains) construct described by Sexton et al. (35) was retained as shown in Figure 8 (i.e. the domains were comprised of the exact same questions as described in the original SAQ). The proposed seventh domain, comprising of six new questions described earlier, was excluded from this initial analysis so that the results could be compared to international findings. A chi square pearson correlation of 0.00 was calculated. This suggests that the six-factor structure had a poor goodness of fit. Underlining this, an SRMR of 0.099, RMSEA of 0.092 and CFI of 0.748 were calculated (Table 18). All the above values fell out of the range of acceptability, further indicating that the six-factor structure described by the original SAQ's authors has a poor goodness of fit. This implies that the six-factor structure does not have construct validity in this population of healthcare workers.

Table 18: Comparison of the original SAQ-SA construct with the revised SAQ-SA construct

	SAQ-SA	SAQ-SA revised
RMSEA	0.092	0.042
CFI	0.748	0.989
SRMR	0.099	0.042
Items in the survey	30	9

6.3.5 Why does the original six-factor structure not have construct validity?

From a macro-perspective, an analysis of the six-factor structure model (Figure 8) shows that only three factors/domains had high correlation with one another: teamwork, safety climate and job satisfaction. Further analysis shows that stress recognition is poorly correlated with five of the six domains: teamwork (0.06), safety climate (-0.24), job satisfaction (0.07), perception of management (-0.09) and working conditions (-0.23). In addition, the perception of management domain is poorly correlated (negatively) to the job satisfaction domain (-0.55). Similar observations have been made in other studies (184). Poor correlation between the stress recognition domain and other domains is a strong contributing factor to why the original construct fails to be valid. The small sample size is a further contributing factor. This is because the significance of correlations is variance-dependent, and the small sample size therefore reduced the power of correlation analysis to demonstrate significance.

6.3.6 Finding a valid SAQ-SA construct

A valid construct was sought through an iterative exercise of eliminating individual items and retesting goodness of fit until a valid construct emerged, as described in 6.2.16. A valid construct with only three domains was produced after the SAQ-SA was reduced to eight items (Figure 8): Questions 3, 4, 5 and 6 (teamwork domain), Questions 7 and 8 (safety climate domain) and Questions 17 and 18 (job satisfaction domain). This revised model achieved a non-significant chi square p value of 0.208, RMSEA of 0.042, CFI of 0.989 and an SRMR of 0.042. Its construct validity is compared to the original SAQ as shown in Table 18.

6.3.7 How does the SAQ-SA compare to SAQ results in other HIC and LMIC settings?

For reasons described under heading 6.3.5, the SAQ-SA fails to display construct validity, a major reason being small sample size. Thus, the following comparisons must be viewed cautiously. Results for safety climate, teamwork and job satisfaction domains have a valid construct. All six domains had good internal reliability and face validity. SAQ-United Kingdom (UK) results, taken from Sexton et al. (35), are compared to the SAQ-SA results in Table 19. The comparison is only valuable in noting general differences between the two populations because several domains of the SAQ-SA failed to achieve construct validity.

Table 19: Comparison of safety climate scores for the SAQ- SA and SAQ-UK for operating theatres. Scores for teamwork, safety climate and job satisfaction domains are shaded as these had a valid construct.

Tool	Teamwork	Safety climate	Perception of management	Job satisfaction	Working conditions	Stress recognition	Sample size
SAQ-SA	70.3	69.0	56.4	70.3	69.4	65.0	155
SAQ-UK	71.7	69.6	47.6	70.1	57.5	54.7	385

Similarities include almost identical safety climate scores for three domains: teamwork, safety climate and job satisfaction. The perception of management domain scores poorly for both tools (SAQ-SA, 56.4 and SAQ-UK, 47.6). Differences between the two tools include considerably higher stress recognition scores for the South African sample population (SAQ-SA, 65.0 vs SAQ-UK, 54.7) and surprisingly higher scores for the South African cohort's working conditions domain. There is a ten-point difference between the South African cohort's average perception of management score in comparison to the UK sample population's score.

The similarities are surprising as one might assume that staff in less resourced settings would have lower scores for teamwork, safety climate and job satisfaction in comparison to staff in a well-resourced healthcare system. The Cape Town cohort perceived that they have relatively good

working conditions, but this may be because they belong to a high-performing and well-resourced provincial health department in comparison to those in the rest of South Africa.

6.4 Discussion

The objectives of this study were to adapt and validate a psychometric safety climate questionnaire for a South African context, demonstrate the feasibility of measuring safety climate in the Cape Town area and describe the knowledge, attitudes and practices of theatre staff working in obstetric theatres in the Cape Town region. The findings of this study will be discussed in relation to these aims.

6.4.1 Internally reliable but not valid in construct

Despite a rigorous process of achieving face and content validity, including a pilot and inclusion of experienced local researchers in the modification of the tool, the six-factor SAQ-SA failed to demonstrate construct validity using the original six-factor model. However, the SAQ-SA demonstrated excellent internal reliability by scoring a cronbach alpha of 0.89. Attention will now be turned to the possible reasons for the SAQA-SA failing to achieve construct validity in its original structure.

6.4.1.1 Sample size

Firstly, the sample size of this study was considerably smaller than the original validation study by Sexton et al. (35) (n=10 803), de Carvalho et al. (36) in Brazil (n=1 301) and Li et al. (37) in China (n=1 689). Kenny et al. (185) suggest that goodness of fit indices are skewed toward predicting poor goodness of fit in small sample sizes. Thus, a larger sample size of n>500 could result in changes in the RMSEA, CFI and SRMR values that could lead to the six-factor SAQ-SA having an acceptable goodness of fit. One way to address the problems resulting from a small sample size might be to compare the results of the SAQ-SA to those of other South African safety climate surveys, should other research groups attempt to validate instruments in South African operating theatres. This might validate the findings of the SAQ-SA despite poor goodness of fit due to a small sample size.

6.4.1.2 Problems with the original six-factor construct of the SAQ

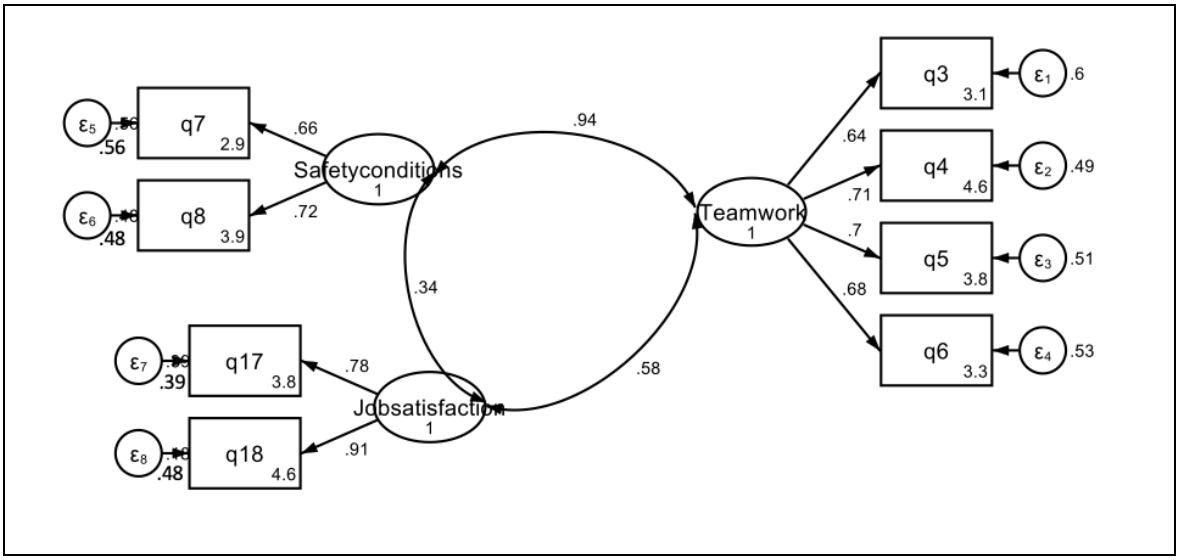
Secondly, the stress recognition domain has poor correlation to the other five domains. Bondevik et al. (186), de Carvalho et al. (36), Sperrof et al. (187) and Lee et al. (188) all had similar findings. Lee et al. (188) removed this dimension from their final model for this reason. In their paper "A dissonant scale: Stress recognition in the SAQ", Taylor et al. (184) ascribe this to a problem in the design of the stress recognition questions: "the intent of the subscale was to capture attitudes that reflected an increased understanding of the role stress plays in the ability to do one's job safely … however, it appears responses are indicative of the level of stress experienced at the time" (p.5). A possible solution could be for researchers to investigate the impact of inverting stress recognition domain scores to balance the score or to agree to leave out this domain completely. This recurring finding concerning the stress recognition domain in different healthcare settings shows that this is not a unique finding limited to a South African setting, but a globally observed phenomenon.

6.4.1.3 Application in an African setting

Finally, it is possible that the SAQ's six-factor structure may not be fit for purpose in a resource-scarce African health setting. Resource constraint is not accounted for in the original design of the SAQ, even though lack of equipment, clean water and beds can have an enormous impact on patient safety climate. This unfactored aspect could influence the responses to several domains: perceptions of management, stress recognition and working conditions, all domains that had to be eliminated from the valid construct composed of only teamwork, safety climate and job satisfaction. This final construct (Figure 10) had only nine items, but had an RMSEA of 0.042, an SRMR of 0.042 and a non-significant chi square pearson correlation. Though considerably smaller, this construct shows the core domains of what could be the genesis of an Afrocentric safety climate survey. The next logical step would be the addition of two domains with questions addressing resource constraint and working conditions. Further research is required to investigate the design, implementation and validation of such a survey. Further research is required to determine if this

new survey would correlate with direct indicators of safety (e.g. sepsis rates and maternal mortality rates)

Figure 10: A revised SAQ factor structure that achieves valid construct



6.4.2 A feasible exercise

The SAQ-SA tool was redesigned, piloted and analysed within a period of three months by a team of largely African clinicians. The tool was administered over five weeks at four hospitals by one full-time research associate. Data capture was conducted by a single researcher in three working days; if a digital scanner were used, this could be achieved in half a day. Based on these findings, a valid safety climate tool could be distributed on an annual basis if it were adopted by the Western Cape Department of Health as one of its standard measures of performance. The initial adaptation cost of £5,000 is substantial for an African context (John Fell Fund Grant, Oxford University). However, we believe that these costs could be reduced by running all activities in Cape Town. The process of validating an English-language safety climate tool for Africa has shown that there is need for validated safety climate tools to be administered in other South African languages.

6.4.3 What does the SAQ-SA tell us about Patient Safety Climate in Cape Town obstetric theatres?

The SAQ-SA findings demonstrate that the unmodified structure of the SAQ does not have construct validity in South Africa and cannot be relied on as a measure of safety culture. The possible reasons for this are several but include the influence of resource constraints, which should therefore be considered as a domain in future attempts to develop a valid tool for the context. Further development is required before the SAQ-SA can fully address these problems.

In comparison to the SAQ-UK operating theatre participants, the SAQ-SA participants score higher safety climate scores for job satisfaction, teamwork, safety climate, perception of management and working conditions. It is gratifying to note that staff in a less well-resourced setting can rate their working conditions, job satisfaction and safety climate highly. While this thesis makes a general argument that resource scarcity is an important issue when considering PSC in SA, this does not appear to lead to very different scores between the SAQ-SA and SAQ-UK. This could be due to the original design of the SAQ; it was not designed to measure how differences in resource constraint affect patient safety climate. Further validation and adaption of the tool in African settings is required.

6.4.4 Further research

This study has generated a snapshot of patient safety climate in this period. Further value could be derived by administering the survey on an annual basis to detect whether facilities are experiencing improved or decreased safety climate scores. If SAQ-SA scores were compared to clinical outcomes over time, it would be possible to analyse whether the SAQ-SA could be a lead indicator of maternal mortality.

The SAQ-UK and SAQ-SA were contrasted in Table 19 and the scores across many of the domains are quite similar. It is not clear if this is the case in all settings. Understanding this similarity would

allow us to have insight into the discriminant ability of the tool. Further research is needed to clarify this.

6.5 Limitations

This study has several limitations. The study was at risk of being affected by selection bias, but the high response rate of 82% could have mitigated against this. In addition, the use of an English tool where many healthcare workers speak English as second or third language could affect the way participants interpreted the questions. Also, the SAQ domains for perception of management domain and stress recognition domains are not structured for South African settings, which negatively impacted the performance of the instrument. Finally, this study had a small sample size which could have negatively impacted measures of construct validity. Further research with a larger sample size is required to validate safety climate surveys in African settings.

6.6 Relevance of these findings within the wider dissertation

The findings of Chapters 3 and 4 demonstrated that institutional discrimination, resource constraint and structural barriers are major barriers toward the achievement of PSC in South African surgical theatres. The original SAQ construct does not account for these factors fully. Thus, it is not entirely surprising that an adapted SAQ could not achieve construct validity in this study. This experience highlighted the need for an additional independent strategy for approaching the measurement of PSC in a team. One way is to develop a model of its communications structure in surgical teams through social network analysis. In Chapter 7, an observational study will be used to explore the possibility of using social network analysis as means of measuring and analysing intra-operative communication patterns of obstetric surgical teams. The findings of this study will be used to further explore interview themes described in Chapter 5 and contextual differences that may have led to failure to achieve SAQ construct validity in this setting.

Chapter 7: A social network analysis study of communication patterns between surgical staff in three Cape Town maternity hospitals

7.1 Introduction

7.1.1 Social Network Analysis

The added difficulty of measuring PSC in an LMIC was demonstrated through the SAQ-SA's failure to achieve construct validity, as described in Chapter 6. Interviews and surveys are useful methodologies to assess PSC, but could there be alternative methods, particularly measures to assess communication in healthcare teams? Social Network Analysis (SNA) is a powerful mathematical tool for understanding the relationships (edges, links or ties) between individual actors (nodes) by applying graph theory (189). It has the potential to offer measurable insights into teamwork interactions in healthcare settings. However, it has not previously been applied to the performance of surgical teams and clinical outcomes. Mathematicians and sociologists have used SNA to understand world-wide challenges such as the flow of pedestrian traffic in cities (190), trust between social groups (191,192), financial flows (193,194) and ties between members of drug and terrorism rings (195,196). In recent times, SNA has been used by modern technology firms such as Google (optimal search engines), Facebook (virtual social networks) and Netflix (recommendations of digital shows) to generate increased business. Given its wide application in an array of industries, it is surprising that the use of SNA in healthcare has been largely superficial. This reveals a lack of cross-pollination of ideas between sociologists, mathematicians and healthcare professionals.

This chapter describes a preliminary investigation into what insights SNA might yield into the relationships between members of obstetric surgical teams in an African setting. The underlying hypothesis was that SNA could identify novel communication patterns and hierarchies within surgical teams, leading to new insights of PSC within this setting. In addition, these insights could be used to identify important role players who could be targeted with non-technical skills training.

7.1.2 Prior use of SNA in healthcare settings

SNA has been applied to understanding process flow in surgical facilities and operating room processes (197). It has been used to understand the diffusion of new technologies in primary health care practices, where it showed the importance of peer influence in the adoption and spread of new practices (198). SNA investigations have demonstrated how the structure of a team may act to reproduce or perpetuate the division of labour within a healthcare team (199). SNA research has also shown how a lack of close ties between team members in a professional network can negatively affect the dissemination of information within that network (199).

SNA has shown that workplace schedules are a factor affecting the extent to which healthcare workers forge social bonds within teams. For example, SNA has demonstrated that nurses with flexible schedules do not form social attachments that are as strong as those made by nurses with fixed schedules within their teams (200). In an SNA study, Kravitz et al. (201) noted that simply identifying influential leaders in a healthcare network is of little value; rather, identified opinion-leaders must be targeted to adopt best medical practice. Finally, SNA has been used to show how interventions are better adopted when interdisciplinary teams share organisational values and work side by side (202).

7.1.3 Potential applications of SNA in the study of surgical safety practices

SNA could yield important information in the study of surgical safety practices, such as centrality scores that measure an individual's influence, which could be used to compare aspects of one team's performance to that of another. SNA might be used to directly compare the performance of operating teams in resource-rich settings to those in resource-limited settings. It could also be used to understand quantitative differences in process flow between elective operating teams and emergency operating teams.

Furthermore, SNA could be used to understand patient safety behaviours in teams by showing whether aspects of team member interactions have any correlation with clinical outcomes. This

would be useful in understanding the link between the social structure of operating teams, particularly in relation to communication, and safety attitude climate scores and clinical outcomes.

The objective of this investigation is to use SNA to explore the social structure and communication networks of obstetric surgical teams.

7.2 Objectives

As expressed above, the main objective of this investigation is to explore the social structure and communication networks of obstetric surgical teams by using SNA. In the process of achieving this objective, several sub-objectives will be addressed, including:

i) Describing communication flows in obstetric surgical teams;

ii) Identifying dominant communication figures in obstetric surgical teams;

iii) Describing important relationships between dominant figures and how these affect team function; and

iv) Describing the overall network characteristics and structure of obstetric surgical teams.

7.3 Methods

7.3.1 Study design

This is a quantitative study that applies graph theory to the observation of communication patterns between members of obstetric surgical teams. The basic unit being measured is verbal and non-verbal communication which is directly linked to the process of completing a caesarean section. For example, an obstetric surgeon (surgeon) asking her assistant for a scalpel would be counted as a communication event. By contrast, an obstetric surgeon talking about her favourite soccer club's acquisition of a new player would be noted, but not counted as a communication event for the purpose of this investigation.

7.3.2 Boundary definition

Physical and temporal boundaries were defined in order to delineate where, when and who would be studied. This study was limited to events taking place in an operating theatre between the arrival of a patient for a caesarean section and the patient leaving the operating theatre after completion of the procedure. Thus, events in the obstetric outpatient's clinic, triage area, ward, pre-operative area, recovery area and ICU were outside the purview of this investigation.

7.3.3 Sites

This study focuses on teamwork in Level 1 and Level 2 facilities, where most obstetric surgery and preventable mortality associated with caesarean sections takes place. Within Cape Town's western metropolitan health sub-districts (formerly known as the Peninsula Maternal and Neonatal Service), three facilities run Level 1 and Level 2 obstetric surgery services. For the purpose of reporting, the hospital sites will not be referred to by their real names. Site 1 and Site 2 are busy Level 2 facilities located within the urban centre of Cape Town. Site 3 is a busy Level 1 facility that serves a population of 800,000 people with obstetric surgical services. The combined service area of all three facilities caters for approximately 2.5 million residents of Cape Town.

7.3.4 Ethics

Permission was granted by the University of Oxford Tropical Research Committee (study number 530-17), the University of Cape Town Human Research Ethics Committee (study number 534/2017) and the Western Cape Provincial Health Department Ethics Review Board (study number WC_201708_016). Prior to starting data collection, the author met all the Heads of Department for Anaesthesia, Obstetrics and Nursing at the three facilities. The author also met the theatre managers, medical doctors, nurses and allied professionals at all sites to explain the study. All patients were asked for informed consent to allow an observer to study the communication between theatre staff conducting the caesarean section operation. Where this was not possible,

such as during emergency operations, a next of kin was asked for permission. All surgical staff were asked at the start of each shift or procedure for their consent to being observed.

7.3.5 Positionality of researchers

Three researchers collected data over the course of the study. Two researchers were South African-trained medical doctors, including the author and Dr ZS, and one researcher was a medical practitioner trained in the United States (Dr AK). The author was the principal investigator and was responsible for most data collection (75% of all observations). Dr AK was responsible for 20% of the observations and Dr ZS was responsible for 5% of observations. The author trained Dr AK and Dr ZS to collect SNA data within the operating theatres for one week prior to them collecting data without his supervision.

Due to the history of power relations based on race, gender and language in shaping South African medical culture, the positionality of the researchers will be described. Their positionality may have influenced how the researchers were perceived by the operating teams, which could in turn have impacted the conduct and behaviour of the surgery staff during the period of observation. The author is a South African-trained medical doctor who trained at two of the three study site facilities during his medical studies. The author is black, speaks three local languages and understands the national cultures of South Africa through lived experience and academic study. However, he could be considered both an “insider” and “outsider” because, although he trained in South Africa, he undertook his doctoral studies in the UK prior to this study. Dr AK and Dr ZS were introduced as associates of the author. Dr AK is an American mixed-race medical doctor who was seconded from Oxford University to help the author with data collection. Dr ZS is a black female medical doctor who has lived, trained and practised medicine entirely in South Africa.

7.3.6 Sampling

Cases were recorded based on convenience sampling, because the number of observable caesarean sections that could occur on any given day was not entirely predictable and permission to observe depended on the consent of both the patient and staff.

7.3.7 Bias

Sampling bias and the Hawthorne effect were the two biggest concerns in the design of the study.

The researchers could not sleep overnight at the hospitals due to a lack of facilities, and security issues made it unsafe to travel at night, so as a result of these factors the researchers could not be on site after dark. We therefore expected to observe fewer emergency cases, in comparison to elective cases, because a substantial number of emergency cases occur at night.

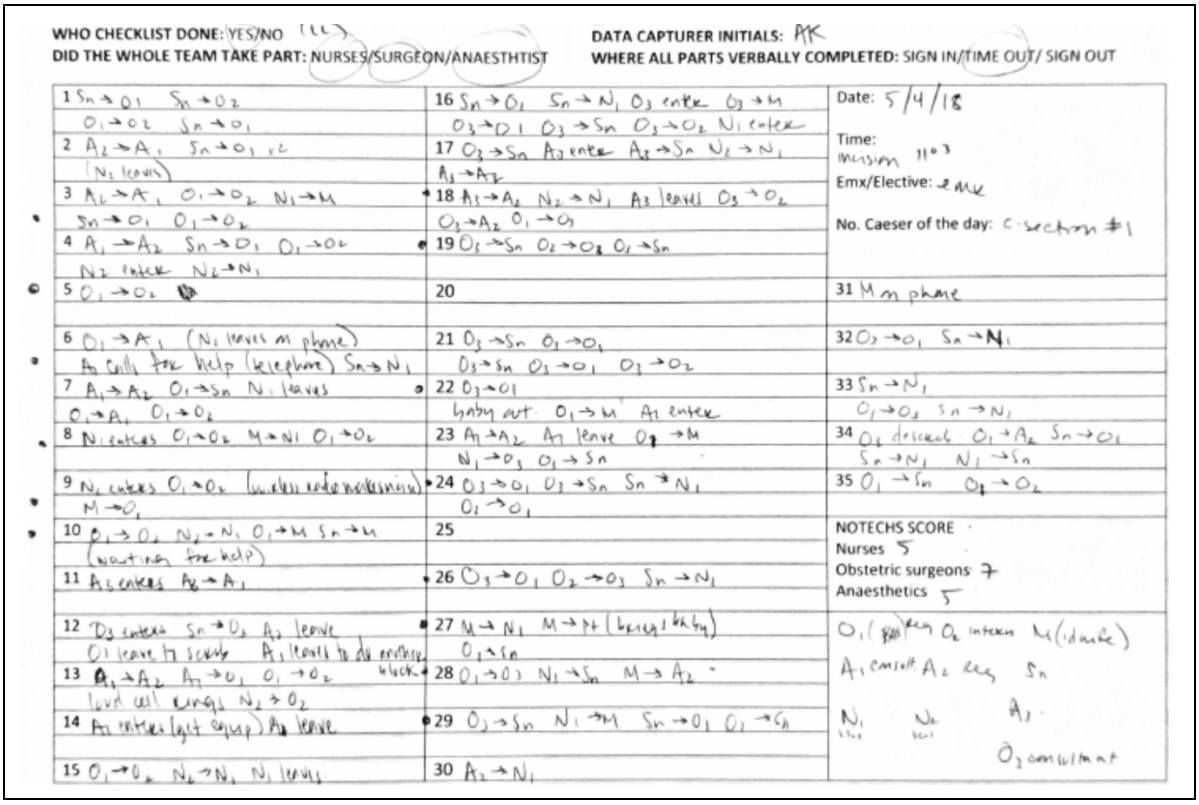
The Hawthorne effect was considered as another source of bias, as it is well known that individuals modify their behaviour when they know that they are under observation. The researchers spent a one-week immersion period observing case facilities before data collection started. To avoid the Hawthorne effect, the researchers only started recording data after operating staff began to display signs of trust and appeared to feel comfortable in the presence of the researchers. We regarded joking with one another, sharing gossip and inviting the author to social events after hours as evidence that trust and comfort levels were high. In the operating theatres, the researchers wore the same sterile theatre clothing and masks worn by the operating teams. They sat at the periphery of the operating theatres, being careful not impact the flow of activity, but with a good view of the operating site.

7.3.8 Data collection

Communication events were recorded on a data collection form (Figure 11). Each member of the team (actor) was assigned a code. Communication events were labelled as an arrow in the direction of communication between the different “actors”. For instance, an obstetric surgeon requesting the anaesthetist to start the WHO checklist would be coded as “O1 --> A1”. These codes were

recorded in time intervals, with notes detailing distractions and content of conversations added next to the codes where relevant. The following additional information was also recorded: whether the WHO safe surgery checklist had been completed, whether all members of the team had taken part in the checklist and whether the operation was an elective or emergency procedure. The researchers stopped recording communication events when the patient was wheeled out of the operating room.

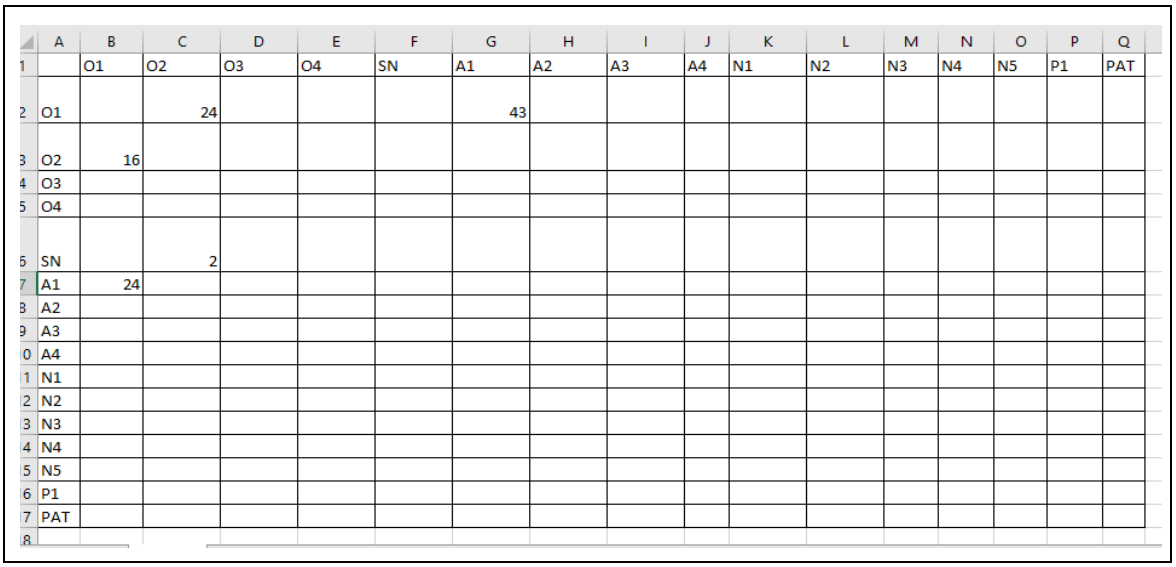
Figure 11: Example of an actual data collection form



7.3.9 Data capture and analysis

After data capture, an adjacent matrix was created using Microsoft Excel (Microsoft Office 10) (203). The adjacent matrices (Figure 12) could then be uploaded on to social network analysis software for further analysis. Gephi (version 0.9.2) was used to analyse centrality (a measure of the individual influence of actors in a group) and overall network analysis statistics (204). Sociograms were generated using Gephi and Socnet V (205). Sociograms allow the ties between actors to be expressed as graphs (spider network diagrams).

Figure 12: Adjacent matrix used for data capture of communication events recorded in theatre



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1		O1	O2	O3	O4	SN	A1	A2	A3	A4	N1	N2	N3	N4	N5	P1	PAT
2	O1		24				43										
3	O2	16															
4	O3																
5	O4																
6	SN		2														
7	A1	24															
8	A2																
9	A3																
10	A4																
11	N1																
12	N2																
13	N3																
14	N4																
15	N5																
16	P1																
17	PAT																
18																	

7.3.10 Social Network Analysis terminology and concepts

Definitions of SNA variables are provided in Table 20 and the equations for centrality variables are shown in Table 21.

Table 20: Definitions of SNA variables measured in this study as described by Wassermann and Faust (38)

Concept	Definition
Actor	"Actors are discrete individual, corporate or collective social units". Examples of actors include an individual obstetric surgeon, anaesthetist, scrub nurse and nurse (p.17).
Relational tie	"A relational tie establishes a linkage between a pair of actors" (p.4). In this study, relational ties represent communication events between operating theatre staff, for example, transfer of information between an obstetric surgeon and nurse.
Social network	A "set of actors and the ties among them" (p.9).
Triad	"A triad is a subgraph (group) consisting of three actors and the possible lines among them" (p.19).
Actor level measures	
Degree	"The degree of a node is the number of lines that are incident with it" (i.e. the number of ties that a node has) (p.100). Degree can have direction (in or out) and weight. In this study, degree was given weight and direction. Every communication event between two staff members was counted as a separate event, meaning each event was given a weight of 1. The direction of a communication event was assigned away from the actor who initiated the event, such that a message from person x to person y would have a direction of x--> y.
Betweenness	The betweenness centrality of a node is the proportion of all paths between pairs of other nodes which include this node (p.189). Individuals with high betweenness lie at the nexus of multiple actors. They can exert control on

	the passage of information between nodes by acting as gatekeepers or broadcasters.
Closeness	Closeness is the "inverse of the sum of the distances from the node to all other actors" (p.184). Actors with high closeness values have close proximity to other actors, high network visibility in a network and easier access to information flowing through a network.
Eigenvector	Eigenvector centrality is a measure of the influence of a node in a network based on its proximity to nodes of high degree. Thus, a node can have low betweenness, degree and closeness, but have a high eigenvector if it is connected to a few highly connected nodes.
Overall network measures	
Density	"The proportion of ties in a network relative to the total number possible" (p.102).
Directed and undirected density	Network density is the proportion of ties in a network relative to the total number possible (p.102). Density tells us how well "saturated" the ties in a network are, that is, what proportion of all possible communication pathways in a team are actually used. It is a group level measure. Density can also have direction. For example, if two actors form a network, and only one of them speaks to the other, that network has density of 1. This is an example of undirected density because we are only considering the number of ties between actors and not the origin of the communication. However, if we measure both the origin of an interaction and the act of interacting, we are measuring directed density. Thus, the network in this example would have a directed density of 0.5 because only of the two actors initiated an interaction. Thus, directed density could be a group level measure of reciprocal ties in a network.
Path length	The distances between pairs of nodes in the network. Average path length is the average of these distances between all pairs of nodes. It is also known as geodesic distance (p.144).

Table 21: Equations for degree, eigenvector, closeness and betweenness variables from Wasserman et al. (38)

Degree	Closeness
$C'_D(n_i) = \frac{d(n_i)}{g-1}$	$C_C(n_i) = \left[\sum_{j=1}^{g} d(n_i, n_j)\right]^{-1}$
Eigenvector	**Betweenness**
$C_D(G) = \frac{\sum_{i=1}^{\lvert V\rvert}[C_D(v*) - C_D(v_i)]}{H}$	$C'_B(n_i) = C_B(n_i)/[(g-1)(g-2)/2].$
Key: C_d= actor level degree centrality index C_c= actor level closeness centrality index C_b= actor level betweenness centrality index $d(n_i)$= degree of the node g= total nodes in the network n_i= v_i = number of nodes 'i'	

7.4 Results

7.4.1 General observations

Surgical teams at Level 2 facilities (large rota of specialist staff and a high care facility) had specialist anaesthetists and obstetric surgeons available on the theatre floor during day shifts, whereas day cases at Level 1 facilities were conducted by medical officers with between one and five years of experience (anaesthesia and surgery). Night cases were almost exclusively conducted by trainee surgeons, trainee anaesthetists and medical officers and consultants were called to drive in from home in major emergencies.

The nursing complement of the staff tended to be extremely stable in comparison to the medical staff. Nurses were generally highly experienced, and some had worked at the facilities for 20 years or more. Members of night surgical teams were stable once a shift started, whereas day cases were characterised by changes in medical anaesthesia staff depending on case complexity, the number of staff taking breaks and how busy the obstetric outpatient clinic was. It was very difficult to keep track of names and identify if surgeons were consistent between cases because they would often come into theatre already fully scrubbed, making visual identification potentially unreliable.

The smallest surgical teams were made up of five staff (two surgeons, one anaesthetist, one scrub nurse and two floor nurses). The teams were rarely larger than 10 people, unless in the case of major emergencies.

7.4.2 Descriptive statistics

This case series is composed of 57 caesarean sections: 30 from Site 1, 16 from Site 2 and 11 from Site 3, as shown in Table 22. A total of 46 hours and 37 minutes of operating time were recorded and analysed. The average duration of the operation was 48 minutes (std dev 13.5 mins; min 25, max 82). The WHO safe surgery checklist was used in 99% of cases (56 out of 57). However, the whole team participated in only 82% of WHO checklist processes observed (50 out of 57), because the surgeon would often start the operation before the scrub nurse could participate.

Table 22: Descriptive statistics of the case series

	Cases observed	***Total observation time***	***Avg. case length (mins)***	***Emergency Cases***	***Elective Cases***	***WHO checklist completion***	***% of WHO checklist cases with full participation***
Site 1	30	1562	52.1	20% (6/30)	80% (24/30)	97%	97% (29/30)
Site 2	16	714	44.6	19% (3/16)	81% (13/16)	100%	94% (15/16)
Site 3	11	521	47.4	18% (2/11)	82% (9/11)	100%	55% (6/11)
Overall	57	2797	48.0	19% (11/57)	81% (46/57)	99%	88% (50/57)

7.4.3 Centrality

The network properties analysed were degree, closeness, betweenness, eigenvector and density. Statistical comparisons were made between the three sites, and between the different team roles.

Degree, betweenness, closeness and eigenvector centrality were measured in this case series to identify important individual actors and describe their influence on communication pathways. Table 23 shows the overall network.

Table 23: Results for several social network variables

Variable	**Value**	**Standard deviation**	**Min**	**Max**
average degree centrality	4.8	1.10	2.8	7.8
average closeness centrality	0.5	0.10	0.30	0.72
average betweenness centrality	6.1	3.12	1.3	14.4
average undirected density	0.35	0.09	0.21	0.58
average directed density	0.24	0.07	0.14	0.40

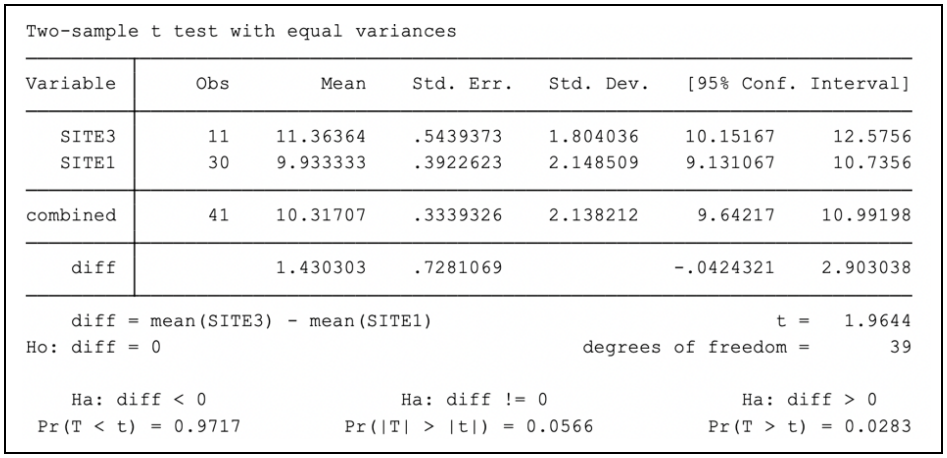
7.4.3.1 Degree centrality

The *average degree centrality* for the entire case series was 4.8 (see Table 23). Site 3's operating teams had a significantly greater average degree centrality than those of Site 1 (P= 0.03; CI 95%, Figure 13) and Site 2 (P= 0.02; CI 95%, Figure 14). This implies that Site 3's operating team staff had more direct communication with other team members during the operations than the operating teams at Site 1 and Site 2.

In the 57 cases observed, anaesthetists scored the highest degree in 17 cases, followed by obstetric surgeons and scrub nurses (16 cases each) and floor nurses (8 cases) as shown in Table 24. Thus, we can see that in the course of the operations observed, anaesthetists and obstetric surgeons

tended to occupy the position of greatest degree in the operating teams more frequently than the floor nurses did.

Figure 13: A t-test comparison of average degree centrality of operating teams at Site 1 vs Site 3

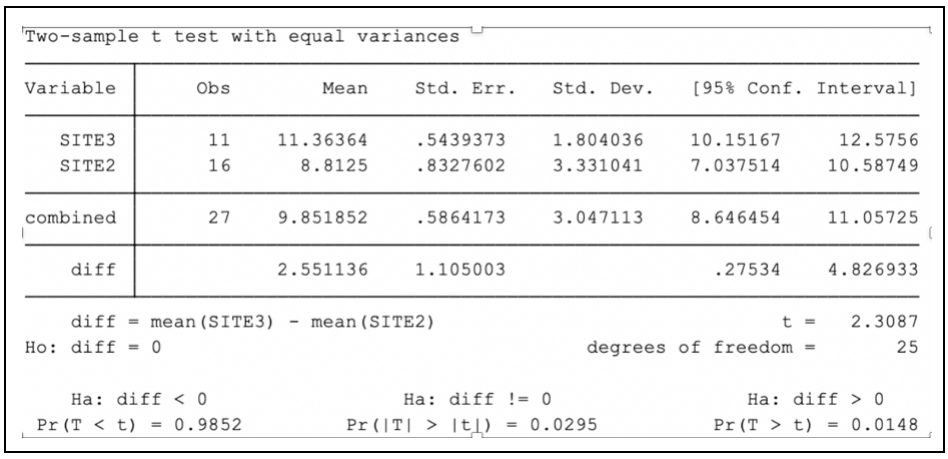


```
Two-sample t test with equal variances

Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
   SITE3 |      11    11.36364    .5439373    1.804036    10.15167    12.5756
   SITE1 |      30    9.933333    .3922623    2.148509    9.131067    10.7356
---------+--------------------------------------------------------------------
combined |      41    10.31707    .3339326    2.138212     9.64217    10.99198
---------+--------------------------------------------------------------------
    diff |            1.430303    .7281069               -.0424321    2.903038
------------------------------------------------------------------------------
    diff = mean(SITE3) - mean(SITE1)                              t =   1.9644
Ho: diff = 0                                     degrees of freedom =       39

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9717         Pr(|T| > |t|) = 0.0566          Pr(T > t) = 0.0283
```

Figure 14: A t-test comparison of average degree centrality of operating teams at Site 2 vs Site 3



```
Two-sample t test with equal variances

Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
   SITE3 |      11    11.36364    .5439373    1.804036    10.15167    12.5756
   SITE2 |      16      8.8125    .8327602    3.331041    7.037514    10.58749
---------+--------------------------------------------------------------------
combined |      27    9.851852    .5864173    3.047113    8.646454    11.05725
---------+--------------------------------------------------------------------
    diff |            2.551136    1.105003                .27534    4.826933
------------------------------------------------------------------------------
    diff = mean(SITE3) - mean(SITE2)                              t =   2.3087
Ho: diff = 0                                     degrees of freedom =       25

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9852         Pr(|T| > |t|) = 0.0295          Pr(T > t) = 0.0148
```

Table 24: Frequency of each professional category scoring the highest degree, closeness and betweenness centrality in operative cases (57 cases)

	Highest degree	Highest betweenness	Highest closeness
Anaesthetist	17	20	22
Obstetric surgeon	16	15	16
Scrub nurse	16	10	14
Floor nurse	8	12	5

7.4.3.2 Closeness centrality

Closeness centrality is a measure of the average proximity of a node to other nodes in a network.

The *average closeness centrality* for the entire case series was 0.5 (Table 23). The t-test showed no

significant difference between the average closeness centrality of the operating teams at Site 1, Site 2 and Site 3.

In the 57 cases observed, anaesthetists had the highest frequency of occupying the position of greatest closeness in a network (22 cases), followed by obstetric surgeons (16 cases), then scrub nurses (14 cases) and finally floor nurses (5 cases), as shown in Table 24.

This implies that anaesthetists exhibit the closest network proximity to other actors in operating teams the most frequently. This places them in a central position in the flow of communication in these operating teams.

7.4.3.3 Betweenness centrality

Betweenness is a measure of how many times an actor appears along the shortest distance between one actor and another in a network. It can be considered a measure of the brokering ability of an actor. The *average betweenness centrality* in this case series is 6.1 (Table 23). Site 1 operating teams have a significantly greater average betweenness score than those of Site 2 (P= 0.01; CI 95%, Figure 15) and Site 3 (P= 0.00; CI 95%, Figure 16). The average betweenness scores of Site 2 and Site 3 are not significantly different from each other. Anaesthetists most frequently display the highest betweenness value (20 cases), followed by obstetric surgeons (15 cases), floor nurses (12 cases) and finally scrub nurses (10 cases).

Figure 15: A t-test comparison of average betweenness centrality of operating teams at Site 1 vs Site 2

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
SITE1	30	32.87333	3.041169	16.65717	26.65344	39.09322
SITE2	16	20.09062	2.921145	11.68458	13.86435	26.3169
combined	46	28.42717	2.387502	16.19282	23.6185	33.23585
diff		12.78271	4.688895		3.332862	22.23255

diff = mean(SITE1) - mean(SITE2) t = 2.7262
Ho: diff = 0 degrees of freedom = 44

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 0.9954 Pr(|T| > |t|) = 0.0092 Pr(T > t) = 0.0046

Figure 16: A t-test comparison of average betweenness centrality of operating teams at Site 1 vs Site 3

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
SITE1	30	32.87333	3.041169	16.65717	26.65344	39.09322
SITE3	11	17.66636	3.557898	11.80021	9.738872	25.59386
combined	41	28.79341	2.624942	16.80783	23.48821	34.09862
diff		15.20697	5.483549		4.115445	26.29849

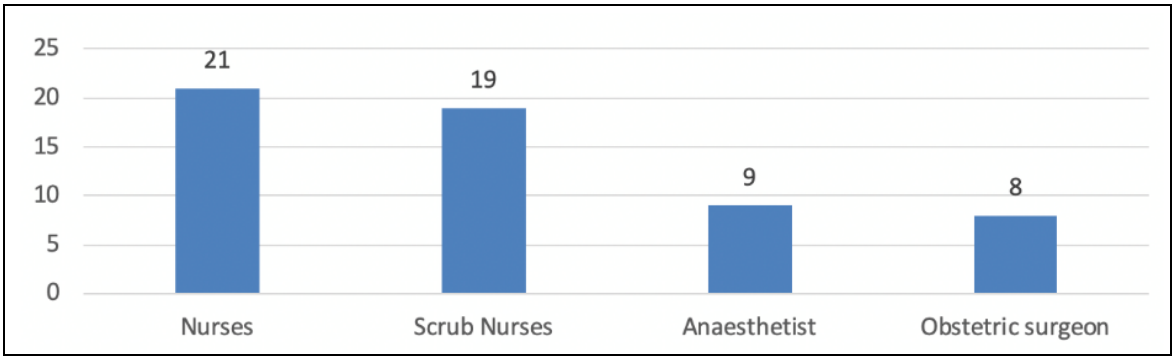
diff = mean(SITE1) - mean(SITE3) t = 2.7732
Ho: diff = 0 degrees of freedom = 39

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 0.9958 Pr(|T| > |t|) = 0.0085 Pr(T > t) = 0.0042

7.4.3.4 Eigenvector centrality

Eigenvector centrality is a measure of an actor's importance based on the connectivity (degree) of the actors adjacent to it. Eigenvalues can be a minimum of 0 and a maximum of 1. In this case series, the nurses demonstrated the greatest frequency of measuring the highest eigenvalue (21 cases), followed by scrub nurses (19 cases), anaesthetists (9 cases) and obstetric surgeons (8 cases) as shown in Bar Chart 1. Thus, the position occupied by nurses and scrub nurses places them in close proximity to the most central figures in the operative team's communication networks, being the obstetric surgeons and anaesthetists.

Bar Chart 1 Frequency of professional groups having the highest eigenvector values in the 57 cases observed



7.4.4 Density findings and correlation comparison of network variables

7.4.4.1 Density

For an explanation of density, directed density, undirected density and the usefulness of directed density as a measure of group level reciprocity, please refer to Table 20. In this case series, the

average *undirected* density (AU density) was 0.35 and the average *directed* density (AD density) was 0.24 (Table 23). Site 3 has a significantly larger average *undirected* density than Site 1 (P=0.00; CI 95%) and Site 2 (P=0.04; CI 95%), see Figure 17 and Figure 18. This shows that operating teams at Site 3 utilise a greater proportion of possible connections within their teams than those at Site 1 and Site 2.

With regard to average directed density, Site 3 has a significantly greater average directed density in comparison to Site 1 (P=0.00; CI 95%) and Site 2 (P=0.03; CI 95%), see Figure 19 and Figure 20. This shows that the operating teams at Site 3 have greater proportions of reciprocal ties within their communication networks than do teams at Site 1 and Site 2. There is no significant difference between the average directed densities of Site 1 and Site 2.

Figure 17: A t-test comparison of mean average undirected density of operating teams at Site 1 vs Site 3

```
Two-sample t test with equal variances

   Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
------------+--------------------------------------------------------------------
      Site3 |      11    .4141818    .0354518    .1175805    .3351902    .4931734
      Site1 |      30      .3297    .0147034    .0805341    .2996281    .3597719
------------+--------------------------------------------------------------------
   combined |      41    .3523659    .0152975     .097952    .3214484    .3832833
------------+--------------------------------------------------------------------
       diff |            .0844818    .0322431                .019264    .1496996
------------------------------------------------------------------------------
    diff = mean(Site3) - mean(Site1)                              t =   2.6202
Ho: diff = 0                                     degrees of freedom =       39

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9938         Pr(|T| > |t|) = 0.0125          Pr(T > t) = 0.0062
```

Figure 18: A t-test comparison of the mean average undirected density of operating teams at Site 2 vs Site 3

```
Two-sample t test with equal variances

   Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
------------+--------------------------------------------------------------------
      Site3 |      11    .4141818    .0354518    .1175805    .3351902    .4931734
      Site2 |      16    .3434375    .0197543    .0790173    .3013322    .3855428
------------+--------------------------------------------------------------------
   combined |      27    .3722593     .019412    .1008676    .3323574    .4121612
------------+--------------------------------------------------------------------
       diff |            .0707443    .0377236               -.0069489    .1484375
------------------------------------------------------------------------------
    diff = mean(Site3) - mean(Site2)                              t =   1.8753
Ho: diff = 0                                     degrees of freedom =       25

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9638         Pr(|T| > |t|) = 0.0725          Pr(T > t) = 0.0362
```

Figure 19: A t-test comparison of the mean average directed density of operating teams at Site 1 vs Site 3

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
Site3	11	.2860909	.0244854	.0812089	.231534	.3406478
Site1	30	.2197	.0103563	.0567239	.198519	.240881
combined	41	.2375122	.0108969	.069774	.2154888	.2595356
diff		.0663909	.0225245		.0208308	.111951

diff = mean(Site3) - mean(Site1) t = 2.9475
Ho: diff = 0 degrees of freedom = 39

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 0.9973 Pr(|T| > |t|) = 0.0054 Pr(T > t) = 0.0027

Figure 20: A t-test comparison of the mean average directed density of operating teams at Site 2 vs Site 3

Two-sample t test with equal variances

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
Site3	11	.2860909	.0244854	.0812089	.231534	.3406478
Site2	16	.2335	.0141927	.0567709	.2032489	.2637511
combined	27	.2549259	.0137293	.0713393	.226705	.2831468
diff		.0525909	.0264829		-.0019516	.1071334

diff = mean(Site3) - mean(Site2) t = 1.9858
Ho: diff = 0 degrees of freedom = 25

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 0.9709 Pr(|T| > |t|) = 0.0581 Pr(T > t) = 0.0291

7.4.4.2 Visual patterns emerging from sociograms

Three triads emerge as the dominant nexus where most communication events occur and are generated from. Examples of triads and a sociogram are shown inFigure 21 and Figure 22. The first pattern of triads is comprised of the obstetric surgeon, the assistant obstetric surgeon and the anaesthetist. It is apparent visually that the obstetric surgeon generates the most communication events with the assistant obstetric surgeon. Visually speaking, the anaesthetist appears to be the net recipient of information from the surgeon in particular. The assistant obstetric surgeon also appears to be the net receiver of information, especially when he or she is less experienced. The hierarchical relationship between obstetric surgeon and assistant surgeon is reversed or reduced when an inexperienced trainee surgeon is assisted by an experienced surgeon who guides the trainee through the operation.

The second pattern of triads is composed of the obstetric surgeon, the assistant obstetric surgeon and the scrub nurse. Scrub nurses appear to have far more interaction with the obstetric surgeon than they have with the assistant surgeon. The last triad is made up of the anaesthetist, the obstetric surgeon and the scrub nurse.

Figure 21: Examples of triads taken from sociograms generated from this case series. SN = scrub nurse, O1 = obstetric surgeon and 02 = assistant obstetric surgeon. The arrows show the direction of a tie and the size of the ties reflects the volume of interaction between two ties in comparison to other ties between network members. These images were generated using a social network analysis package named Gephi (206).

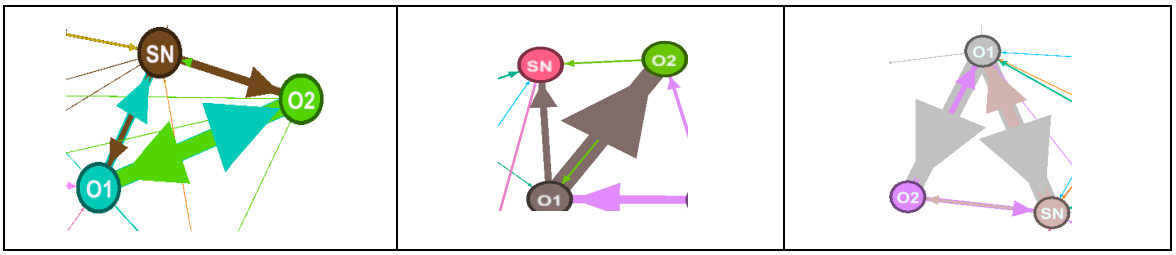
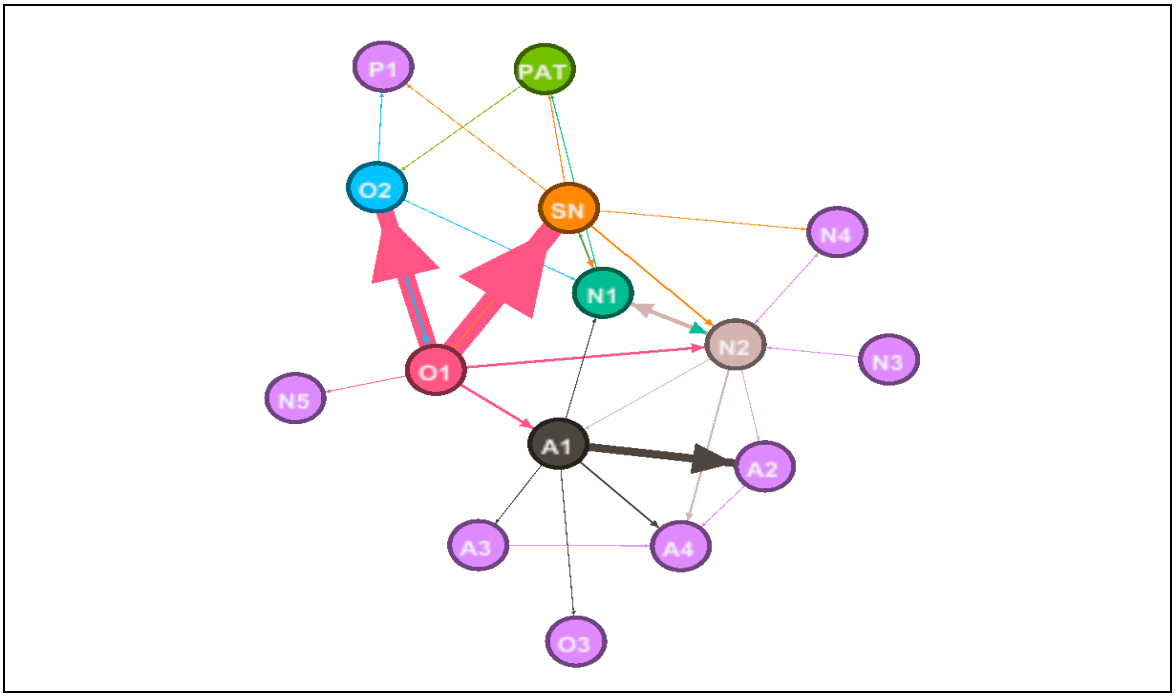


Figure 22: A complete sociogram that illustrates communication ties between several operating team members during a caesarean section. O = obstetric surgeons, A = anaesthetists, N = nurses, SN = scrub nurse, P = paediatrician, PAT = patient. The thickness of the arrows reflects the volume of interaction between ties. From a visual perspective, the most central members of the network are O1, O2, SN, N1, N2, A1. These images were generated using Gephi (206).



7.5 Discussion

The objective of this chapter was to use SNA to investigate relationships between members of obstetric surgical teams in an African setting. The underlying hypothesis was that the mathematical nature of SNA might allow us to identify hidden aspects of the networks, thereby giving novel insights into South African obstetric PSC. Key findings regarding the hierarchy of communication, roles of team members and the potential of SNA as a measuring tool are discussed below.

7.5.1 General observations

Obstetric surgical teams appeared to have a flatter hierarchy than the author would have expected prior to conducting this study. As mentioned in Chapter 5, some of the sites had a shared tearoom for surgeons, anaesthetists and nurses; this engendered a spirit of collaboration and softened the hierarchy between doctors and nurses. In this regard Site 1 stood out. Staff at this site capitalised on interdisciplinary relationships built in tearooms to diffuse potential conflict in theatre. Scrub nurses "adopted" trainee surgeons by offering them technical advice during difficult procedures and counselling them after difficult cases. Site 1 was well staffed and took the most visible steps toward adopting a positive patient safety culture (sepsis audits, caesarean surgery licence exams and highly professional morbidity and mortality meetings).

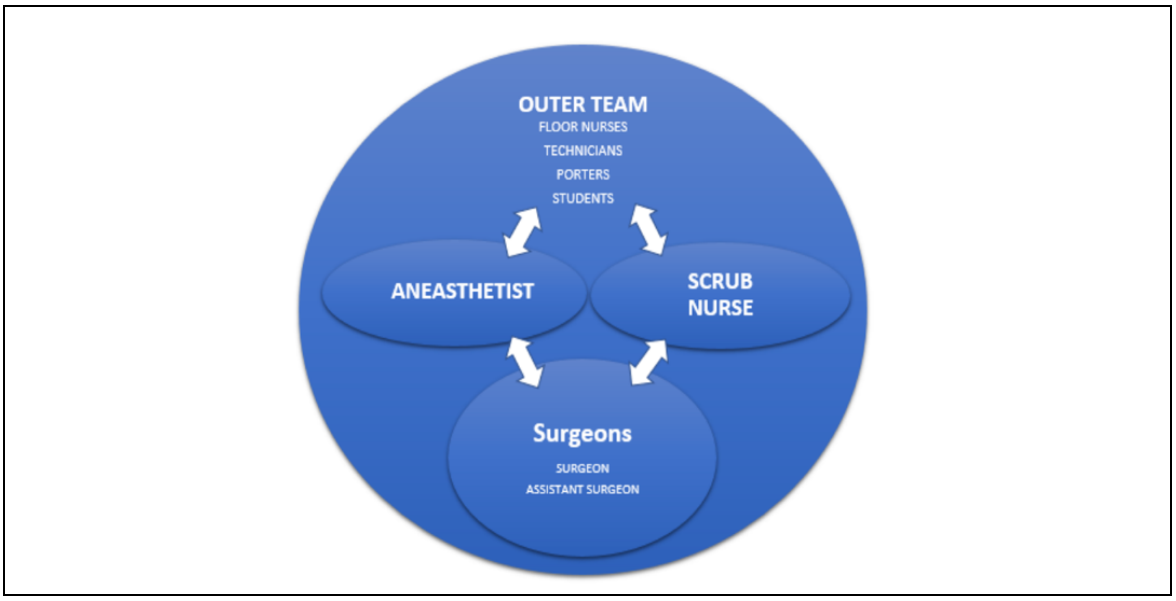
Similarly, senior obstetric surgeons from Site 1 mentored staff at Site 3. The collaborative culture of Site 1 could be observed to be taking hold here, but understaffing and low morale appeared to be a barrier to success. Site 2 staff, in particular the nurses, felt under enormous pressure to keep up with high caseloads. Trainees described feeling as though they had to compromise patient safety to complete surgeries quickly enough to keep up with the caseloads. This corroborates the findings of Chapter 5.

7.5.2 The hierarchy of intraoperative communication

Visual analysis of the sociograms showed that the South African obstetric surgical teams in the study demonstrate a hierarchical communication structure that is centred on a triad of

professionals: the obstetric surgeon, anaesthetist and scrub nurse. Together they form an "inner team", while the floor nurses and allied professionals (midwives and paediatricians) form a broader "outer team". The bulk of communication occurs within the inner team. However, anaesthetists and scrub nurses play a key role in disseminating information from the inner team to the outer team (Figure 23).

Figure 23: Flow of information during a caesarean section



7.5.3 Differentiated roles of team members

Members of South African obstetric operating teams have differentiated communication roles within a surgical network. Obstetric surgeons initiate a considerable volume of communication (weighted degree), whereas anaesthetists and scrub nurses play an influential role by connecting the inner team to the outer team – as is visible in sociograms and demonstrated by their high unweighted degree, betweenness and closeness values. Some floor nurses have high eigenvector centrality, indicating that they work closely with highly connected members of the "inner team". These figures suggest that nurses can influence the team.

7.5.3.1 Obstetric surgeons exert influence through generation of communication

From a quantitative perspective, the obstetric surgeons were directly responsible for initiating and receiving the greatest number of communication events within the inner team. The sheer volume

of instructions and information they share demonstrates the significant role obstetric surgeons play in these social networks. Visual analysis of the sociograms shows that most of their communication is directed toward the scrub nurse, assistant obstetric surgeon and anaesthetist. The obstetric surgeon relies heavily on these three actors to act as brokers and to relay instructions, information and concerns to the rest of the team.

Thus, a communication improvement intervention would as its first objective seek to strengthen the communication between the obstetric surgeon and the three "brokers". The second objective would be to improve the brokering ability of the anaesthetist, assistant obstetric surgeon and the scrub nurse. Concepts like closed feedback loops and SBAR (situation, background, assessment and recommendation) could help enhance the relevant skills of the obstetric surgeons and the brokers. The obstetric surgeon's limited field of focus (the operating field) and narrowed circle of communication (mainly the three brokers) creates a risk that the obstetric surgeon could lose situational awareness. The three brokers could play a significant role in raising the alarm when required and re-orientating the obstetric surgeon to changes in the operating environment. Human factors training to achieve this would be valuable for teams in this series, and for the broader South African environment where teams are structured in this way.

7.5.3.2 Anaesthetists exert influence through occupying central positions in surgical networks

The results show that anaesthetists have the highest betweenness in the greatest number of cases (22/57) in this series. Obstetric surgeons (15) and floor nurses (12) follow in second and third place. Anaesthetists are well positioned to act as strong brokers of communication in these networks, because in real life they are the most physically mobile of the four most central members of the communication network. They have the dual privilege of sharing information with the obstetric surgeon, assistant obstetric surgeon and scrub nurse, and of being able to physically move around the theatre to interact with additional team members. The other three central figures must maintain sterility and occupy their position by the bedside, lest they de-scrub.

Thus, anaesthetists occupy a central role in disseminating information from the core of the social network. This role is especially important when the obstetric surgeon is not vocal, is focused on damage control at the site of surgery, or if they are new and do not know other team members' names. Human factors interventions on how to make best use of this brokering ability could improve communication skills, raising the alarm when required and recruiting resource (e.g. calling for consultant support, extra blood and emergency drugs). Visual analysis shows that scrub nurses could perform a similar function because they occupy a similar network position to that of anaesthetists in that they connect the surgeons to a wider nursing team.

7.5.3.3 Floor nurses and scrub nurses exert influence through proximity to highly connected figures

The eigenvalue analysis shows that scrub nurses and nurses have the highest eigenvalue in the greatest number of cases (40/57), i.e. the highest centrality score based on proximity to the figures with the highest degree, closeness and betweenness. This is because the scrub nurses and nurses interact closely with the obstetric surgeons and anaesthetists.

This finding is useful because it quantitively demonstrates the influential role that nurses can play in intraoperative communication. In interviews reflected in Chapter 5, nurses report that they are often overlooked by medical doctors. Presenting the findings of this SNA back to nurses would allow them to see the influential role they can play in improving patient safety. By virtue of working in close proximity to obstetric surgeons and anaesthetists, experienced scrub nurses can restore the situational analysis of the inner team during an emergency by speaking up or challenging a potentially harmful decision. In a South African setting, experienced nurses and scrub nurses can guide inexperienced community service doctors and medical officers through a difficult caesarean section. Human factors communication interventions could focus on empowering nurses to speak up when they consider it advisable or to recruit the support of other nurses in raising the alarm when necessary. The value of empowering nurses was confirmed by an interviewed staff member (see Chapter 5):

> So, I had walked in as they were checklisting and I missed the reason why she was having the caesar, which I then asked afterwards and then my senior said okay, it's for foetal distress. And then he was under the impression that we were doing tubal ligation and it actually wasn't the case. And our midwife, who was behind the scene, she picked up that the patient wasn't for tubal ligation and she actually spoke up. She was comfortable enough in her position to say no, the patient didn't consent to this. And then the other nursing staff checked the consent form and then it was actually picked up that she wasn't for tubal ligation, which, if the midwife hadn't spoken up, we would've done a tubal ligation on some poor woman who has only had one child and who is still very young (165).

7.5.4 SNA as a tool for quantitively measuring improvement in collaboration

SNA can be used to measure the influence of different surgical team members through measures of centrality (betweenness, closeness, degree and eigenvector) as discussed previously. In addition, this study demonstrated that SNA can helpfully measure collaboration and hierachy through measures of average density within a team. Average density measures can also be utilized to measure significant change in the communication patterns of surgical teams after exposure to an intervention.

Average undirected density measures the proportion of actual ties that exist in a network over the total number of potential ties that could exist in a network. Thus, it is a potential measure of collaboration and hierarchy within teams. Networks with high undirected density utilise almost all the possible ties that can exist between members, suggesting that they have flat communication hierarchy. In contrast, teams with low undirected density display the use of fewer ties, potentially indicating poor levels of communication and centralised communication hierarchy.

Average directed density offers us deeper insight into hierarchy. Surgical teams with simultaneously low average directed density and high average undirected density scores may have hierarchical network structures where information flows from dominant figures without feedback or input from team members who occupy lower status. This could increase the probability of poor patient outcomes in operating theatres.

Thus, researchers could quantitatively demonstrate improved collaboration and reduced hierarchy by comparing average directed density and undirected density before and after an intervention.

7.5.5 What SNA tells us about PSC in South African obstetric surgery teams

Firstly, the SNA findings show that the South African obstetric surgery teams observed in this case series are collaborative in nature. Communication revolves around an inner triad, whose scrub nurses and anaesthetists play a key role in disseminating information from the inner triad to the wider team and vice versa. Due to a lack of comparative data from international studies, it is not possible to determine whether these South African teams are more collaborative than other teams.

Secondly, when the findings of this study are added to findings from previous chapters in this thesis, several differences start to emerge between the sites (Table 25). During the qualitative interviews, it emerged that staff at Site 1 believed that they had collaborative intraoperative culture because all theatre professionals shared a tearoom. They knew one another's names and shared stories about their families in an unthreatening environment. In addition, their leader was an experienced obstetric surgeon who monitored sepsis rates at her facility and conducted outreach visits at Site 3.

From the analysis in Table 25, we can see that Site 1 has comparatively higher SAQ scores and WHO safe surgery checklist participation rates. In addition, Site 1 teams trend towards spending more time per patient in theatre than do teams at other sites - on average, five to eight minutes longer as shown in Table 22. These findings indicate that Site 1 obstetric staff may be considered the model high performance PSC. The additional findings of this study are confirmed by the following quote from Chapter 5:

> [At Site 1] you have nurses calling doctors by first name, doctors calling nurses by first name. Yes, it's a very friendly atmosphere. I think because the staff are the same staff all the time. There's, like, very few people who come in and out, who they take in and out, so we've gotten to know each other quite well, I think this hospital is a lot less hierarchical than a lot of the other hospitals (165).

SNA findings described in the results section show that teams at Site 3 have significantly higher degree and average density scores than both Site 1 and Site 2. This implies that teams at Site 3 use proportionally more ties between their operating team members than teams at other sites. This could be due to the teams working collaboratively or alternatively working inefficiently. From

observation, the former was true. Worryingly, Site 3 had a low WHO safe surgery checklist full-participation rate because the surgeons would often start the procedures before the nurses could take part in the checklist at time out.

Table 25: Comparison of sites by findings from Chapters 5, 6 and 7

Site	SAQ score	Mixed tearoom	% cases with WHO checklist completed	% of WHO checklists with full participation
Site 1	69.64	Yes	97%	97% (29/30)
Site 2	63.12	No	100%	94% (15/16)
Site 3	68.23	No	100%	55% (6/11)

The SNA findings show that Site 1 teams have significantly more joining ties (betweenness) than Site 2 teams and that Site 3 teams have significantly more ties and reciprocation between team members than teams at Site 2 (degree and average directed density). One reason for this could be that Site 2 teams trend towards operating for shorter durations than all other sites (an average of 44 minutes, Table 22) so there is less time for their team members to interact. An obstetric surgeon from Site 2 described that she felt under pressure to operate quickly in order to appease the nurses, while the nurses at Site 2 complained that heavy caseloads meant they often had to skip lunch. This suggests that factors related to resource constraint may lead to reduced collaboration between team members. This is also reflected in the significantly lower SAQ scores for Site 2 because of low scores for working conditions, job satisfaction and perception of management (Table 25).

7.5.6 Application of these research findings

There are several opportunities for these research findings to be usefully applied.

Firstly, the SNA findings could be used to target specific aspects of South African obstetric surgical PSC. This study has shown that although use of the WHO safe surgery checklist is extremely high, the participation of all team members in the time out should be improved.

Secondly, this study highlighted the different intraoperative communication roles played by South African surgical team members. A non-technical skills programme for South African obstetric

surgical teams could enhance the skills of team members in relation to the roles they play as described in this study. For example, nurses could be empowered to speak up through a scrub nurse or anaesthetist, based on the evidence that their high eigenvector centrality scores show their close ties to these actors.

Thirdly, SNA can be used to measure quantitative changes in communication patterns after a non-technical skills training intervention. Measures of centrality and density can be taken before an intervention and compared to measures taken after an intervention. Statistical comparison of means can then be used to test for significant change.

Finally, SNA could be used to quantitively compare the intraoperative communication styles of teams from different settings. It would be possible, for example, to compare obstetric surgical teams in Oxford to those in Cape Town. However, surgical teams in extremely resource-restricted environments will present a special challenge because the surgeon and the anaesthetist may be the same person.

7.6 Further research

Further research is needed to understand the impact on patient safety of surgical team members using multiple languages during caesarean sections. In this study, isiXhosa, Afrikaans and English were often spoken in the process of carrying out a single task. Due to the multicultural nature of the South African healthcare workforce, unilingual or bilingual staff may not be able to follow instructions or information relayed in a language they do not speak.

An SNA comparison study of daytime operating teams versus night-time operating teams, and/or elective versus emergency cases, would yield new insights. In addition, there is an issue of whether observations could be dependent on the behaviour of selected actors or by the hospital/site or both. Further investigation is required to explore this topic.

Further research could be conducted to demonstrate the utility of using density as an accurate and useful measurement of communication network change. Comparing density to other teamwork measures would be the next step of this investigation.

In addition, researchers could study set combinations of surgical teams and compare their communication pattern outcomes. This would enable researchers to identify SNA communication patterns that are more likely to be associated with optimal surgical outcomes within a South African setting.

7.7 Limitations

Several limitations potentially introduced bias into this study.

Convenience sampling could have introduced selection bias. A higher proportion of daytime rather than night-time cases were observed in this study due to the lack of safe transport at night. This could have introduced selection bias to the findings. In addition, the Hawthorne effect could have led to participants changing behaviour while under observation. Further, the process of recording communication events during a live operation requires intense focus. It is possible that some communication events could have been missed during the process of data collection. This was mitigated by observing multiple cases.

7.8 Relevance of these findings within the wider dissertation

This study illustrated how patterns of communication in the theatre team, together with the previous findings of historical analysis (Chapter 3) and in-depth interviews (Chapter 5), paint a picture of PSC. This observational study showed that scrub nurses and anaesthetists play a hidden but central role in intraoperative communication within surgical teams. In addition, it was noted that Site 1 staff used inter-professional relationships built through a shared tearoom to diffuse conflict and operate as a more cohesive unit. This corroborates findings from the interviews in Chapter 5.

The findings of our study also suggest that improving aspects of teamwork and communication might be a useful tool to improve PSC in this environment. Simulation studies have played an important role in delivering team training in other contexts, but many of the resources described in other settings are absent here. The next chapter describes a pilot study to investigate the feasibility of a low-cost in-situ simulation-based teamwork training exercise aimed at improving PSC in a South African context.

Chapter 8: A pilot study to investigate the feasibility of a South African non-technical skills intervention for obstetric surgical teams

8.1 Introduction

Previous chapters have shown an unmet need for non-technical skills human factors training. In Chapter 5, surgical staff described the difficulty of operating under stressful conditions within a resource-constrained environment, managing conflict and the difficulties of cultural integration in a post-Apartheid medical system. The interviews also highlighted that patient safety is not yet viewed as a distinct concept in this environment. In Chapter 7, the social network analysis study identified that most communication in an obstetric surgical team is initiated by surgeons and disseminated to the wider team primarily through the anaesthetist and scrub nurse. The social network study identified that a low-cost patient safety intervention could target surgeons, anaesthetists and scrub nurses with non-technical skills training for maximal effect. These findings are similar to those of Scott et al. (96) who found that non-technical skills training could be effective and feasible in an LMIC setting like Rwanda.

Thus, the author, with the support of obstetric surgical staff at Site 2, designed a low-cost and low-fidelity non-technical skills training intervention for surgical staff operating in South African obstetric theatres. The primary objective of this intervention was to explore the acceptability and feasibility of a non-technical skills intervention for obstetric surgical teams within this context. The secondary objective was to document any evidence of benefits to PSC arising from the intervention.

8.2 Simulation design

8.2.1 Local factors and differentiation from ESMOE

According to staff interviewed, as reported in Chapter 5, resource constraint and high caseloads present major barriers to implementing a surgical skills intervention. Staff find it difficult to travel

to offsite training programmes due to personnel shortage, so training must be on site. Operating theatres are nearly always in use, limiting training facilities to mothballed operating theatres. Due to austerity, state hospitals have negligible budgets to purchase expensive medical simulation equipment or hire consultants to train staff.

Nevertheless, the availability of an existing labour ward simulation training programme known as ESMOE (Essential Steps in Managing Obstetric Emergencies) provided evidence that Cape Town obstetric hospitals viewed simulation as an acceptable learning tool (207). However, ESMOE does not have an in-situ surgical crisis simulation component. Thus, there is scope for an additional complementary surgical simulation component.

Based on the above factors, a low-fidelity and low-cost simulation exercise for improving non-technical skills during intraoperative haemorrhage could only be feasible if it were held in operating theatres not in use, took no more than an hour to run and could be run by local staff. We delivered several simulation exercises and afterwards sought to determine whether they had improved staff attitudes, knowledge and behaviours.

8.2.2 The proposed solution

The proposed solution was a simulation education intervention: an hour-long exercise made up of two simulation exercises (before and after) in an operating theatre the staff are familiar with. A facilitated debrief and discussion on non-technical skills was sandwiched between the simulated exercises. A second debrief discussion was conducted after the second simulation exercise. Before participating in the exercise, participants were requested to fill in a patient safety knowledge survey and a safety attitudes questionnaire. After participating in the exercise, participants were requested to fill in a patient safety knowledge survey.

8.3 Methods

8.3.1 Study design

This pilot was designed as an experimental study with no separate control arm. Instead, the participants' performance before the intervention was compared to their performance after the intervention. A control arm should be added in the full-scale trial. No randomisation or blinding took place for the pilot study. Two sessions were run over two days in August 2018 (one session per day with separate teams) at a major secondary hospital in Cape Town.

8.3.2 Ethics

Permission was granted by the University of Cape Town Human Research Ethics Committee (study number 534/2017), the Western Cape Provincial Health Department Ethics Review Board (study number WC_201708_016) and the University of Oxford Tropical Research Committee (study number 530-17). Prior to beginning data collection, the author met all the Heads of Department for Anaesthesia, Obstetrics and Nursing at the three facilities, as well as the theatre managers, medical doctors, nurses and allied professionals at all sites, in order to explain the benefits and risks of the study.

8.3.3 Assessment of non-technical skills score change

Assessment of this educational intervention is based on the Kirkpatrick framework for evaluation (39). The assessment evaluated performance in four domains: i) reactions to content, ii) knowledge enhancement, iii) behaviour change and iv) change in outcomes. The initial reactions to the intervention (Kirkpatrick level 1) were assessed from a feedback survey and video-recorded group feedback sessions. Change in knowledge (Kirkpatrick level 2) was measured through comparing scores from a knowledge test before and after the session (see Figure 39).[16] Change in behaviour

[16] For ease of reading, longer figures and tables in this chapter are reproduced in Appendix 3: Supporting materials for a pilot study to investigate the feasibility of a South African non-technical skills intervention for obstetric surgical teams (Chapter 8).

(Kirkpatrick level 3) was assessed at a group level by analysing video-recorded analysis to assign a Notechs II and SNA density scores to the teams.

Notechs II is a scale developed to evaluate the non-technical skills performance of operative teams. It gives a score of 0-8 (Figure 24) for four domains of performance (208). The four domains are leadership, teamwork and cooperation, problem-solving and decision-making and situational awareness (see Figure 25). Each sub-team of the surgical team is given a score for each non-technical skills domain. Thus, the maximum score for each sub-team is 32 because there are four domains and each domain has a maximum score of eight. There are three sub-teams in a surgical team (nurses, anaesthetists and surgeons), so the Notechs II score for a whole surgical team is the sum of the score for its sub-teams. Thus, the maximum score is 96.

The author and a research associate reviewed the footage and scored the teams separately using Notechs II. The average of both reviewers' Notechs II scores was then calculated and used to generate the final score. Due to the short duration of the pilot and small number of participants recruited, clinical outcomes (blood transfusion, sepsis and morbidity and mortality rates) were not measured because no change was expected within the time period.

Figure 24: Scoring system for the Notechs II framework developed by Robertson et al. (208)

Behaviour	**Frequency**	**Oxford NOTECHS II score**
Compromises patient safety and effective teamwork	Consistently	1
	Inconsistently	2
Could directly compromise patient safety and effective teamwork	Consistently	3
	Inconsistently	4
Maintains an effective level of patient safety and teamwork	Consistently	5
	Inconsistently	6
Enhances patient safety and effective teamwork	Consistently	7
	Inconsistently	8

Figure 25: Definitions of each domain of Notechs II (208)

Leadership and management	
Leadership	Involves/reflects on suggestions/visible/accessible/inspires/motivates/coaches
Maintenance of standards	Subscribes to standards/monitors compliance to standards/intervenes if deviation/deviates with team approval/demonstrates desire to achieve high standards
Planning and preparation	Team participation in planning/plan is shared/understanding confirmed/projects/changes in consultation
Workload management	Distributes tasks/monitors/reviews/tasks are prioritised/allots adequate time/responds to stress
Authority and assertiveness	Advocates position/values team input/takes control/persistent/appropriate assertiveness
Teamwork and co-operation	
Team building/maintaining	Relaxed/supportive/open/inclusive/polite/friendly/use of humour/does not compete
Support of others	Helps others/offers assistance/gives feedback
Understanding team needs	Listens to others/recognises ability of team/condition of others considered/gives personal feedback
Conflict solving	Keeps calm in conflicts/suggests conflict solutions/concentrates on what is right
Problem-solving and decision-making	
Definition and diagnosis	Uses all resources/analytical decision making/reviews factors with team
Option generation	Suggests alternative options/asks for options/reviews outcomes/confirms options
Risk assessment	Estimates risks/considers risk in terms of team capabilities/estimates patient outcome
Outcome review	Reviews outcomes/reviews new options/objective, constructive and timely reviews/makes time for review/seeks feedback from others/conducts post treatment review
Situation awareness	
Notice	Considers all team elements/asks for or shares information/aware of available of resources/encourages vigilance/checks and reports changes in team/requests reports/updates
Understand	Knows capabilities/cross checks above/shares mental models/speaks up when unsure/updates other team members/discusses team constraints
Think ahead	Identifies future problems/discusses contingencies/anticipates requirements

8.3.4 The simulation exercise

Table 26: Learning objectives and skills development for the simulated exercise

Learning objectives for technical skills	Learning objectives for non-technical skills

1. Recognising features of severe bleeding during caesarean section:
- Estimating blood loss correctly
- Falling/low haemoglobin
- Haemodynamic instability
  o Dropping blood pressure
  o Rising heart rate
2. Initial clinical management of severe bleeding during caesarean section:
- Resuscitation
- Surgical haemostasis strategies
- Medical haemostasis strategies
- Blood transfusion
	WHO Checklist Use Yes/No
	1. Situational Awareness:
	- Identify the risk of severe haemorrhage
	- Maintain vigilance
	- Restore the team's focus and vigilance when distractions occur
	2. Problem-solving:
	- Sharing mental models
	- Sharing problem-solving
	- Solutions from junior/less influential team members are considered
	3. Leadership:
	- A coordinated team response
	- Definition of roles and responsibilities
	- Feedback on progress given by the anaesthetist, surgeon or scrub nurse
	4. Communication:
	- Positive communication between the anaesthetist, scrub nurse and surgeons
	- Anaesthetist to give feedback on clinical vitals and progress of resuscitation and medical haemostasis strategies
	- Surgeon to indicate progress of surgical haemostasis strategies
	- Wider team resuscitation is coordinated by the anaesthetist to allow the surgical team to focus on the operation

The simulated drills address the problem of catastrophic intraoperative haemorrhage during a caesarean section by targeting technical and non-technical surgical skills (Table 26). The facilitators (the author and Dr Duys) use a standard equipment checklist before every session (see Appendix 3, Figure 36). Prior to the start of each session, the facilitator explains the structure of each session as illustrated in Figure 26 and Figure 27. All the participants agree to adopt a set of five guiding principles to ensure the simulation is a positive learning environment (see Appendix 3, Figure 37). After agreeing to these principles, the participants change into theatre garments and enter the operating theatre to begin the task as a surgical team. The facilitators brief the group about the scenario they were will face (Figure 28). In the scenario, a young woman is referred for an

emergency caesarean section by a local midwife obstetric unit (MOU) because of failure to progress to the second stage of labour. The scenario begins at the point where the patient is already on the theatre bed, anaesthetised, draped and ready for surgery.

At this point, the surgical team read out the WHO checklist and proceed with the first incision. As they rush to deliver the fetus, they encounter severe intraoperative haemorrhage from the lower uterine segment after dis-impacting the fetus. To complete the scenario successfully, the team has to complete the steps illustrated in Figure 27. The scenario is completed when the facilitators believed the team had successfully managed to arrest bleeding or resuscitate the patient, or when the ten-minute mark is reached.

Figure 26: Structure of the training session

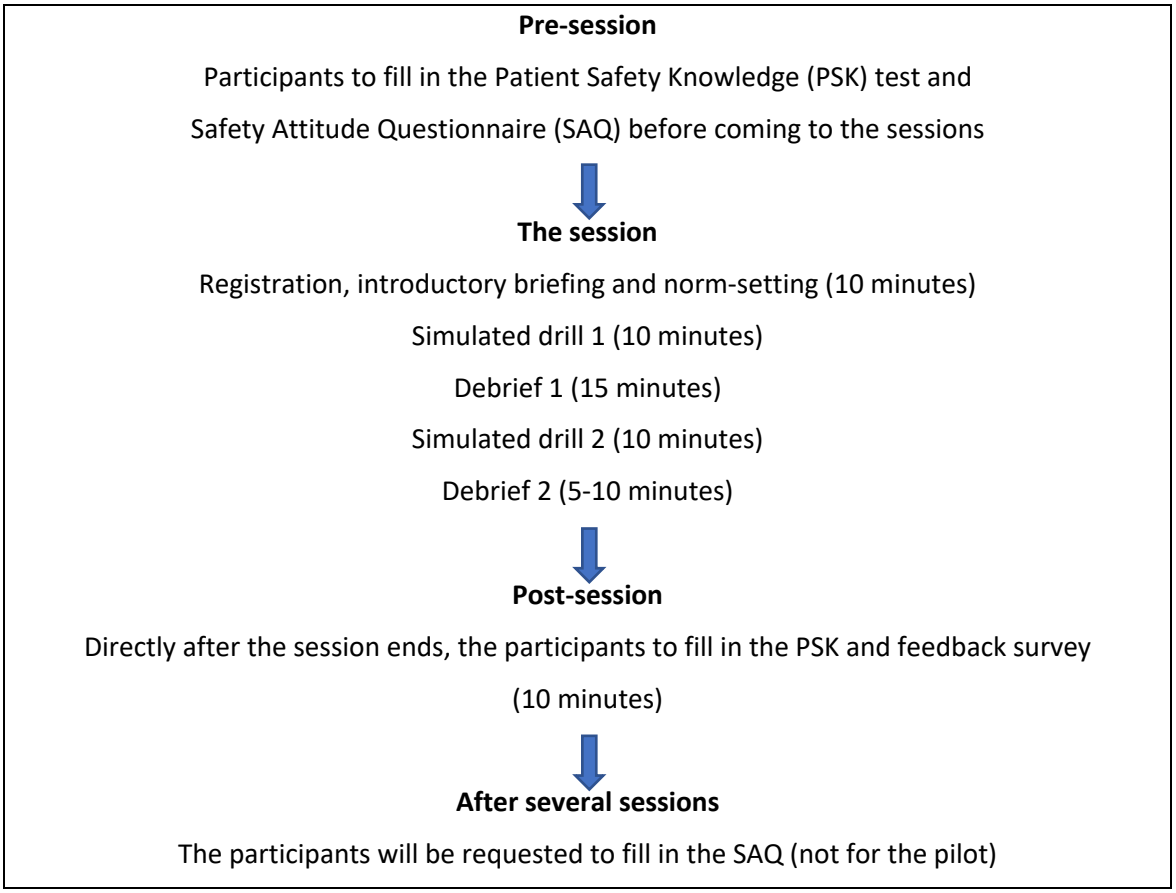


Figure 27: Facilitator's guide to conducting the simulated surgical crisis drills

Intraoperative haemorrhage during a caesarean section scenario (Repeat x 2)

An obstetric surgeon accepts a patient needing an emergency caesarean section from a nearby midwife obstetric unit.

A 35-year-old patient, G1P0, arrives from a nearby midwife obstetric unit in early shock with a history of failure to progress.

Her antenatal record indicates she has a normal antenatal history.

The medical officer does a rapid ultrasound scan that confirms a live fetus. The team prepares for an emergency caesarean section and anticipates delivery of the impacted fetus may be difficult.

The anaesthesia medical officer (MO) completes a preoperative assessment. Her ward Hb is 11g/dl. Her vitals are as follows: BP 90/80 mmHg and her heart rate is 120. She is in pain, thirsty and complains of exhaustion. She last ate food 12 hours ago. The anaesthesia MO gains IV access (large bore) and begins to resuscitate the patient with a normal saline solution and glucose. The anaesthesia MO opts for a rapid sequence induction. The scrub nurse, obstetric surgeon and assistant obstetric surgeon begin reading the WHO Checklist prior to incision.

THE TEAM BEGINS THE SIMULATION HERE. EVERYONE IS SCRUBBED AND READY TO START.

The obstetric surgeon delivers a live baby. The process of dis-impacting the fetus from the lower uterine segment causes lower uterine tear. The repair is very difficult because the bleeding site is difficult to see and control.

The participants are informed that the patient's blood pressure is plummeting and the patient is tachycardic. The facilitators allow the simulation device to bleed at a torrential pace.

The anaesthetist, under pressure, tries to communicate his/her concerns about the patient's worsening haemodynamic status to the obstetric surgeon. This leads to increased tension. The team must work together effectively to control bleeding by following intraoperative haemorrhage control and resuscitation guidelines.

The simulation exercise stops when the operating team achieves haemostasis or when the facilitators decide to stop. The patient never dies – this is in order to protect the confidence of the team. The only outcome is a postoperative high care admission.

DEBRIEF COMMENCES.

Figure 28: Introductory briefing

1. This drill is about severe bleeding during a caesarean section. We are going to be pretending this is a real operation. The patient is already under general anaesthetic and sleeping.

2. Roles:

- The anaesthetist will start by leading the team in completing the WHO checklist.
- The anaesthetist is expected to carry out the rest of the case as they would a real case; you can ask for vital signs, SATS, blood gas results, order drugs and blood as you would in a normal case. Please draw up one 10ml syringe of normal saline and call it polydrug. This will be your adrenaline, oxytocin and tranexamic acid.
- The surgeon will start by making an incision and then deliver the fetus. The surgeon will repair the uterus after delivery. The surgeon will come across anatomical difficulties, poor visibility and bleeding. Act as you would in a real case. Ask for suction, light, instruments, diathermy and suture (**DO NOT USE DIATHERMY).**
- The scrub nurse and assistant surgeon should carry on their roles as normal, assisting the surgeon in problem-solving and physical tasks to complete the operation and control haemorrhage.
- Floor nursing staff are expected to support the operating team and anaesthetist with the operation and resuscitation. Act as you would normally to help in an emergency. Pretend to go and order blood, take blood to a gas machine, find instruments and count swabs.

3. To complete the case, the surgeon must be able to control haemorrhage before the patient haemorrhages and goes into cardiac arrest – tip, if the container (point) runs out of water then the patient will have arrested. By resuscitating the patient, the anaesthetist will delay the rate of blood loss and arrest. The better the resuscitation, the less severe the bleeding.

4. Act out every task, don't just say it: We'd like it if you carried out the tasks, e.g. don't say you would give adrenaline - draw up some fake adrenaline and give it via the fake line.

8.3.5 Debriefing

Each drill was followed by a debrief using Jaye et al. (209) diamond debrief model (Figure 29). During the debrief, the participants had to first agree on a narrative of what happened during the exercise. Following this, the facilitator guided the participants to identify their non-technical skills deficits. The debrief ended with a discussion about how the participants could improve their performance and apply the feedback to their daily practice. These debriefs were filmed and reviewed by the author. Key themes raised by participants were summarised and discussed with a study participant to corroborate the author's findings.

Figure 29: *A suggested debrief framework for the scenario based on the "diamond" debrief model by Jaye et al.* (209)

Description phase: **You are trying to make sure everyone has the same picture of what happened** 1. Can we describe what happened in the case? 2. …. And then what happened next? 3. … Is there anything else we can add to that? 4. Can we now say that we can describe what happened? 5. Relay what happened back to the team taking in all the points mentioned.
Phase transition question: *How do we normally deal with this situation?*
Analysis phase: **Reflection and learning** 1. How did that make you feel? 2. Why did you respond in that way? 3. What was particularly difficult for you? 4. Why? 5. How do you normally do that? 6. How is that different to what happened in the scenario? 7. This links with …… human factor skill, which means…… 8. Can you see how…. might be linked with….
Phase transition statement: *We can agree that 'X' has been an important part of the last scenario. Let's see how we could deal with that/apply that in different situations.*
Application phase: **How would we apply this to other situations?** 1. To what other situations could we apply what we talked about? 2. How could you see this happening in that situation? 3. When would this approach not work? 4. Who are the key people who would be affected by this new behaviour? 5. How can we encourage more people to try this out? 6. How will this change your everyday practice?

8.3.6 Post-training knowledge test and a feedback survey

After the discussion, the teams completed a second drill, followed by a final debrief and completion of a post-training knowledge test (the same as the one completed prior to the drill) and a feedback survey.

8.3.7 The simulation device

The author, with the assistance of Prof Peter McCulloch[17] and Dr Rowan Duys[1819], designed and piloted a low-cost, low-fidelity and gravity-assisted simulation system that can be built with

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[18] Consultant Anaesthetist, Groote Schuur Hospital, Cape Town.
[19] Dräger Research Fellow, Department of Anaesthesia and Perioperative Medicine, University of Cape Town.

materials from a hardware store in an African context (Figure 30 and Figure 31). The simulation system is made of three parts (Figure 32): a raised water tank, a box-like device that functions as an abdominal cavity and a water collection tank placed on the ground. Water flows from the raised tank to the collection tank using gravity. As it flows via the abdominal cavity to the ground tank, it simulates bleeding at the operational site. When assembled, the simulation system is set up as shown in Figure 32. Water used for simulated haemorrhage was coloured red to appear like blood based on participant feedback. The author avoided changing the viscosity of the water because doing so would make it more difficult to clean the simulator. The author also wanted to minimise water loss because Cape Town was experiencing a historic drought, the worst in over a century (210). The system costs £60 to build without 3D-printing (excluding labour), £150 as a 3D-printed model and £200 if it includes a pump.

Figure 30: The basic implements used to construct a low-cost and low-fidelity simulator

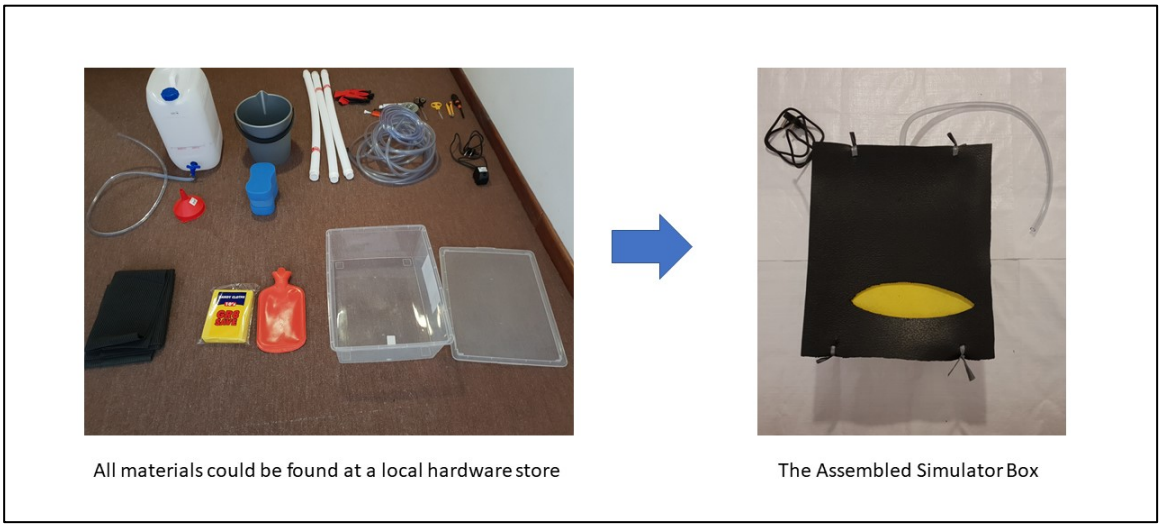


Figure 31: A fully assembled simulator system in a real operating theatre

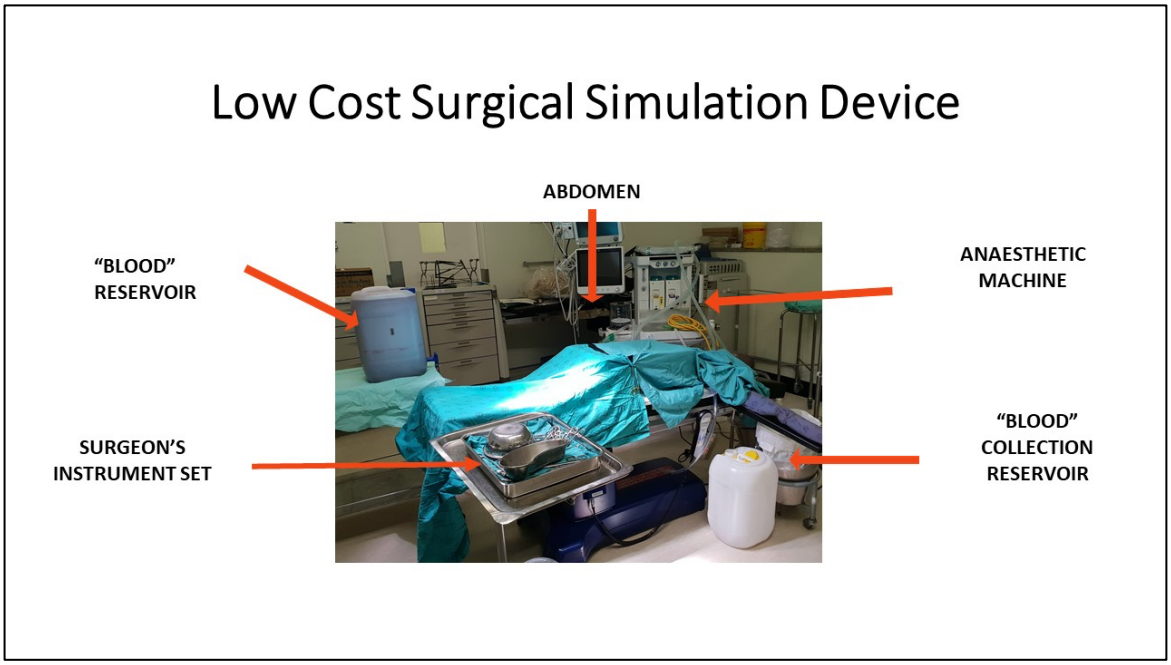
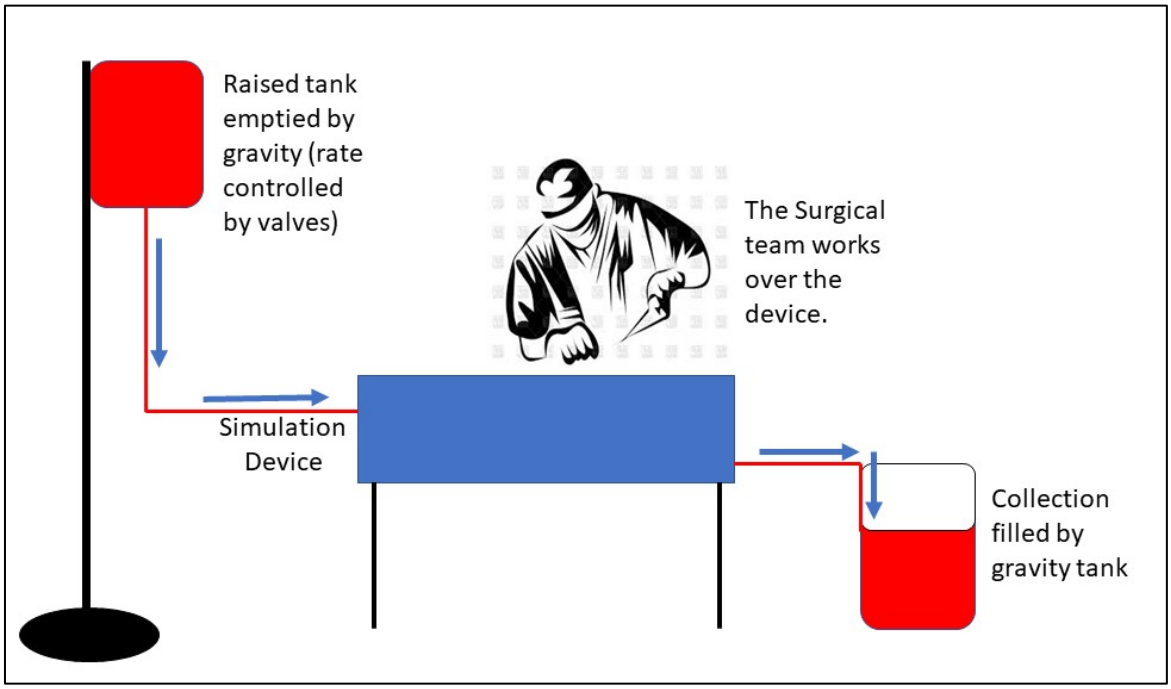


Figure 32: The low-cost, low-fidelity and gravity-assisted simulation system for non-technical skills training



8.3.8 Venue

A mothballed operating theatre was used for the exercise at Site 2, a large Level 2 hospital within the Cape Town metropolitan area. The theatre layout and equipment were identical to the functional theatres usually used by the participants.

8.3.9 Recruitment and team composition

Staff were recruited through convenience sampling. Verbal announcements were made at the weekly department meetings and the relevant Heads of Department recruited participants from their teams. Risks and benefits were explained verbally before each training session. Willing participants then signed voluntary informed consent forms. The biggest barrier to participation was lack of time due to heavy clinical loads. We were able to recruit nine staff members and split them into two teams: team 1 and team 2. Team 1 received training on the first day, while team 2 received training on the second.

8.3.10 Study cohort

Table 27: Demographics of participants

	Profession	**Rank**	**Gender**	**Age Range**	**Both teams**
Team 1:					
Participant 1	Obstetric surgeon	Trainee specialist	F	30-35	No
Participant 2	Anaesthesia provider	Trainee specialist	M	30-35	No
Participant 3	Nursing provider	Scrub nurse	F	50-60	No
Participant 4	Nursing provider	Scrub nurse	F	50-60	No
Participant 5	Surgical provider	Medical officer	F	25-30	Yes
Team 2:					
Participant 6	Obstetric surgeon	Trainee specialist	M	30-35	No
Participant 7	Anaesthesia provider	Medical officer	M	25-30	No
Participant 5	Surgical provider	Medical officer	F	25-30	Yes
Participant 8	Nursing provider	Floor nurse	F	30-40	No
Participant 9	Nursing provider	Floor nurse	F	30-40	No
NB: The trainers played the roles of a consultant obstetric surgeon (author) and consultant anaesthetist (Dr Duys) to fully staff the teams					

Nine participants were recruited to take part in the intervention. All were permanent surgical staff from Site 2. The demographic breakdown of this cohort can be seen in Table 27. All the participants knew one another from working together on surgical cases. None of them had previously taken part in a simulated obstetric surgical crisis. Only one participant, participant 5, joined both teams. Each surgical team was composed of seven team members: five participants and two trainers who

took on the roles of consultant staff. In general, the nursing staff were older and more experienced than the medical staff, who were mainly medical officers and trainee obstetric surgeons.

8.3.11 Roles played by trainers

The trainers played the roles of a consultant obstetric surgeon (author) and consultant anaesthetist (Dr Duys) to fully staff the teams. The consultant obstetrician's role was to place the obstetric surgical team under additional pressure by observing the trainee surgeon's attempts to control haemorrhage. As the consultant anaesthetist, Dr Duys' role was to guide the junior anaesthetists through the scenario. Dr Duys also led the debriefing sessions. In addition, participant 5 was asked to play the role of a "conspirator" in both drills; this participant was given advanced instructions to keep the trainee surgeon calm despite the obstetric consultant's interference.

8.4 Results

8.4.1 Kirkpatrick Level 1 reactions assessment: Feedback survey responses

Overall, the staff responses to the simulation exercise were positive (Table 28). All nine participants felt the introductory brief was clear, easy to understand and taught them something new about the WHO checklist.

All nine participants felt that the preoperative phase was structured well enough that they understood their roles in the exercise and that they could complete the checklist easily. In the operative phase, 7/9 participants felt they experienced similar stress levels to real surgery. 2/9 gave a neutral response. All participants said the exercise was a good test of teamwork in theatre.

With reference to the postoperative phase, 7/9 participants felt they understood what instructions to give the recovery team. 1/9 gave a neutral response and 1/9 said the exercise was poor at helping them understand what instructions to give the recovery team. Regarding the debriefing phase, 9/9 participants felt they had a safe environment to explore what happened and gain insights into their team's performance.

Overall, 9/9 participants felt the facilitators were attentive and helpful, and that the simulation sessions were a useful teambuilding exercise. 8/9 participants responded that their clinical practice would change because of the session. 8/9 reported that they liked the food.

8.4.2 Kirkpatrick Level 2: Knowledge assessment

A patient safety knowledge test covering aspects of caesarean section non-technical skills and technical skills was administered to the nine participants (Appendix 3, Figure 39). Participants completed the test both before and after the intervention. The average score of the participants before the test was 23.6 out of 30. The average score for the participants after the intervention was 24 out of 30, a non-significant improvement.

8.4.3 Kirkpatrick Level 3: Behaviour assessment

8.4.3.1 Social network analysis

The author attempted to conduct a social network analysis of the communication patterns in the team using recorded video footage. The angle of the camera concealed the assistant surgeon and scrub nurse. This meant that a comparison of both teams' average density scores could not be calculated.

8.4.3.2 Notechs II non-technical skills assessment

The average Notechs II score for both teams was 55.75 (team 1=62.5; team 2=49.0) in the first drill and 77.5 in the second drill (team 1=75.5; team 2=79.5) as shown in Table 29. Thus, the trend is toward Notechs II scores increasing after a facilitated debriefing intervention. Team 2 had the most substantial performance increase, from 49 to 79.5 in the second exercise (a 30.5 point increase) in comparison to the first team (only a 13 point margin of increase). The second team had less experienced nursing and anaesthesia participants in comparison to the first team. If a sufficient sample size were reached, it would be possible to investigate whether debriefing sessions lead to a statistically significant rise in Notechs II scores post-debrief.

Table 28: Summary of simulation session feedback

	Poor or very poor	Average	Good or very good	No answer
INTRODUCTORY BRIEF				
The explanation of the exercise was clear	0	0	9/9	0
I understood the purpose of the exercise	0	0	9/9	0
I learnt something new about the WHO checklist	0	0	9/9	0
PREOPERATIVE PHASE (SIGN IN & TIMEOUT)				
I understood my role in the exercise	0	0	9/9	0
The briefing prepared us to fill in the checklist properly and quickly	0	0	9/9	0
OPERATIVE PHASE				
I felt a similar level of stress that I would feel in a real case	0	2/9	7/9	0
I felt like our ability to work as a team was being tested	0	0	9/9	0
POST-OPERATIVE PHASE (SIGN OUT)				
I understood what instructions should be given to the recovery team	1/9	1/9	7/9	0
DEBRIEF				
This was safe environment to reflect on what happened	0	0	9/9	0
I was able to gain insight into the team's performance	0	0	9/9	0
OVERALL				
The facilitators were attentive and helpful	0	0	9/9	0
This was a useful team building exercise	0	0	9/9	0
My clinical practice will change because of today	0	0	8/9	1/9
We liked the food	0	0	8/9	1/9

Table 29: Notechs II scores of the two surgical teams before and after the debriefing intervention

	Team 1 Reviewer 1	Team 1 Reviewer 2	Team 2 Reviewer 1	Team 2 Reviewer 2
Pre-debrief Notechs II score	50	75	45	53
Post-debrief Notechs II score	70	81	70	89

	Team 1 Average	Team 2 Average
Pre-debrief Notechs II score	62.5	49.0
Post-debrief Notechs II score	75.5	79.5

8.4.4 Debriefing findings

8.4.4.1 Description of what happened

The groups were able to reach consensus on what happened. They agreed that poor non-technical skills had negatively impacted their clinical responses to a case of life-threatening intraoperative haemorrhage. They cited communication, situational awareness, conflict, leadership and hierarchy as major themes.

8.4.4.2 Teamwork, co-operation and communication

The participants noted that teamwork and communication between the anaesthetic provider and surgical provider can result in conflict if the motive of either party is incorrectly perceived. The anaesthetists have a good picture of the physiological status of the patient, but when they communicate information indicating haemodynamic instability, the surgical provider may perceive this as "implying that I am not doing my job correctly".[20] This is because the surgical provider "can see what's happening, I'm trying to clamp the bleeder".[21] The anaesthetic providers were surprised to hear this. However, the nurses reported that the physiological information the anaesthetist communicates to the surgeon is useful for them to hear because they cannot see the extent of

[20] Remark made by a trainee surgeon during a recorded debriefing.
[21] Remark made by a trainee surgeon during a recorded debriefing.

bleeding. The nurses said they wanted to be included in the discussions because it would help them anticipate what the anaesthetist and surgeons needed next.

8.4.4.3 Situational awareness

The participants discussed how deficits in situational awareness impacted their response to the intraoperative emergency. The anaesthetic provider in team 1 argued strongly that making the team aware of the patient's worsening haemodynamic status gave him warrant to challenge the surgeon to consider temporary haemorrhage control strategies, even if this risked the ire of the surgeon. The anaesthetic provider felt that speaking up would lead to the team focusing on resuscitating the patient's blood volume and recruiting more resources to the operating theatre (blood, equipment and experienced staff). The facilitator related an experience when he challenged a senior surgeon to stop operating so he could resuscitate a patient whose tumour bed was bleeding profusely. The patient was able to survive the torrential episode of bleeding because the operating team focused on resuscitation instead of controlling the bleeding with sutures. The teams agreed that constantly sharing information about what was really happening would help the operating team to remain focused on the right objectives throughout a major intraoperative crisis.

8.4.4.4 Problem-solving and decision-making

A major difference between the non-technical skills performance of the teams in the first drill versus their performance in the second drill was their ability to share mental models of a problem and generate solutions across professional ranks. In the first drill, the anaesthetic provider would discuss problems with their consultant and relay a decision to the obstetric team. In the second drill, there were more instances in which staff shared mental models of the severity of uterine haemorrhage and atony before proceeding to call for help. This also gave the nurses the opportunity to suggest equipment and drugs.

8.4.4.5 Leadership

The nurses complained that they do not have a platform to display leadership during intraoperative emergencies because the surgeon and anaesthetist are seen as higher-ranking team members. Instead, they opt to "vent in the tearoom". The teams struggled to define who should be in overall charge in a crisis or to define how they would optimally share leadership duties in a crisis.

8.4.4.6 Hierarchy and conflict

The participants discussed the impact of hierarchy on communication and safety. During the simulation exercises, the consultant obstetric surgeon and anaesthetists were asked by the facilitator to create a stressful operating environment by interrupting the flow of the team by asking questions that were not relevant to the case, questioning the decisions of their junior team members and the competency of other professionals in the team. Such behaviour mirrored tensions that arise during emergencies. The participants said they "managed out" the difficult senior team member during the simulation exercise by asking them to do a difficult task so they could focus on saving the patient. They said that a senior team member is often correct in pointing out "things that aren't being done" and that junior team members should do what they are asked to do.

With regard to speaking up/challenging authority, the nurses pointed out that "it would be okay to speak to [a] person alone after the case",[22] while others felt that it would never be right to challenge a senior. The nurses also suggested that "it would be better to pass the message on to seniors so they can talk together".[23] Other team members agreed that equivalent rank staff members would be on a better professional footing to discuss the difficult behaviour of a staff member. The staff all agreed "not to question the motives" of difficult co-workers "but to focus on the behaviour or outcome" that is problematic.[24] Ultimately there was broad agreement that a patient's care comes

[22] Remark made by nurses during a recorded debriefing.
[23] Remark made by nurses during a recorded debriefing.
[24] Remark made by team members during a recorded debriefing.

first. Hierarchical team structures appear to make it more difficult for team members to raise potential safety problems.

8.5 Discussion

Training imparted through simulation of obstetric emergencies has been shown to improve neonatal outcomes in HIC settings (211,212). There is evidence that simulation in surgery can improve clinician performance, reduce complications and improve team skills (213–215). Pucher et al. (216) suggest that "integration of simulation into the various facets of a learning healthcare system" is essential for sustainable improvement in surgical outcomes (p.3). A similar conclusion led to the establishment of a countrywide simulated maternity crisis programme called ESMOE in South Africa (217); however, this programme lacks a strong in-situ surgical simulation component.

The objective of this pilot study is to explore the acceptability and feasibility of a non-technical skills intervention that could cover this gap in obstetric surgical skills training. This pilot study could be considered a foundational study upon which other African PSC researchers can build.

8.5.1 Acceptability and feasibility

The Kirkpatrick 1 evaluation of the intervention showed that the survey used was acceptable to the study cohort. The pilot was logistically feasible at this small scale, but further testing is required to determine if it is feasible at a system level. The positive indicators of acceptability and feasibility include the following:

- The pilot addressed an unmet need to improve non-technical skills
- Local staff bought into the intervention
- Local resources matched the requirements of the intervention
- The pilot study team had the capability to implement the intervention
- The budget required for the intervention is low
- Regular simulations could be implemented without significant impact on the operations of hospitals

The unmet need for non-technical skills training in obstetric theatres had been identified through a series of interviews with staff and the outcomes of a completed safety climate survey. In addition, the heads of anaesthesia, obstetrics and the nursing departments supported the pilot, as did the hospital CEO. This support allowed the author to recruit participants for the study and to use an operating theatre for the simulation.

The team had sufficient financial resources from a research grant to design the simulation exercise, build the device and purchase research equipment to carry out the project. Both pilot sessions only cost ZAR850 (£100 GBP at the time) to run, largely because the only transport cost required was transporting off-duty nurses to come to the hospital. If the training programme were to be integrated into mandatory continual education for obstetric practitioners, the costs of transport could be significantly reduced or removed altogether. The cost of building the simplest version of the simulation device was £60. This is affordable in comparison to expensive simulation dolls that cost tens of thousands of pounds.

The pilot demonstrated that only one full-time trainer and two junior medical doctors or nurses would be required to run the programme. Because the programme is so light on personnel—as well as on logistics and cost—it would be quite possible for the Western Cape Department of Health to make regular training mandatory for all its obstetric staff without interfering with the workings of the hospitals. To be specific, monthly training conducted on a specified day, possibly on a Friday morning or afternoon, would minimise the impact on the clinical service.

8.5.2 Barriers to implementation: Similarities to ESMOE

Moran at el.(217) identified several barriers to scaling up the ESMOE simulation programme in South Africa. These included lack of on-site champions, lack of integration of emergency obstetric skills training in undergraduate medical training and in nurse training, lack of enforcement of standard operating procedures, lack of clinical leadership and lack of a systems approach to learning from adverse events.

Similar barriers were encountered in this study, but these were overcome by identifying a motivated local simulation facilitator and getting the buy-in of the local hospital CEO as well as the heads of nursing, anaesthesia and obstetrics. As a result, the author was granted permission to train staff during clinical time and provided with space for conducting the simulations. Future iterations of the programme would require measurement via regular evaluation at the monthly morbidity and mortality meetings to become entrenched.

The programme requires champions at facility, provincial and national level. Such a programme could only succeed at scale with the support of the National Committee for Confidential Enquiries into Maternal Deaths (NCCEMD). Gaining such support is feasible because the programme could potentially complement the existing ESMOE programme by adding an in-situ surgical simulation element to the existing curriculum.

8.5.3 Structured debriefing aids non-technical skills improvement

The facilitators and participants created a positive and safe learning environment because they adhered to five principles to help facilitators run the simulation exercises, as shown in Appendix 3, Figure 37. The facilitators' use of a structured debriefing protocol enabled participants to describe how deficits in communication and situational awareness hampered their ability to work optimally as individuals and as a team. They described how hierarchy makes it difficult for lower ranking professionals to challenge authority without fear and without it leading to conflict. It was remarkable to observe the "lightbulb moment" when the anaesthetic providers and surgeons realised that they were trying to achieve the same goal and not trying to undermine one another.

During the structured debriefing, it became apparent that for inexperienced staff, the simulation exercise was a technical test of their resuscitation skills and a non-threatening opportunity for a facilitator to remedy their skills deficits. More experienced staff were surprised by the impact that non-technical skills had on their performance, particularly leadership, situational awareness and communication skills.

8.5.4 Functional fidelity

The functional fidelity of the pilot was essential to achieving the pilot outcomes. The recreation of an immersive intraoperative environment led to staff buying into the simulation. The staff were asked to complete all the processes they would usually do prior to surgery, such as checking drugs, draping, wearing theatre gowns and completing the WHO safe surgery checklist. Theatre sounds were replicated using recordings of anaesthesia machines. Furthermore, the surgeons were required to follow the same steps they would complete when operating. This included cutting through the simulation's rubber "abdominal skin", moving obstructions that represented the lower intestines and locating the lower uterine region for an incision (a rubber water bottle). Cutting through the uterus caused massive haemorrhage. The surgical team were surprised by the visual impact of watching how quickly the water reservoir emptied itself into the abdominal cavity. The added tension of confederates stirring up trouble by issuing unreasonable instructions re-created conflict that occurs in operating theatres between professionals. It certainly helped that the mothballed theatre looked like the operating theatre the team normally uses. It is reasonable to conclude that the simulation was able to achieve face and functional validity for the above reasons.

8.5.5 Kirkpatrick evaluation findings

With regard to Kirkpatrick level 1 assessment (initial reactions), the feedback forms show the nine participants responded positively to the programme. For junior staff members and nurses, this was an opportunity to receive additional training. For the senior staff members, it was an opportunity to try something different. The knowledgeable and supportive simulation facilitators were able to convince the participants that non-technical skills training was extremely useful. Their facilitation created an open and safe platform that encouraged nurses and junior members to raise issues and diffuse tension between the anaesthetic providers and obstetric surgeons. This skill of creating a blame free debriefing environment would be the most difficult to replicate in a larger trial. A train the trainer programme, short debriefing skills videos designed for African theatre settings and printed guides would be necessary to take this programme forward.

Changes in Kirkpatrick level 2 assessment (improvement in knowledge) were difficult to assess due to the small sample size of this population (n=9). Analysis of the knowledge tests showed a non-significant improvement in the participants' knowledge levels post-training.

With regard to Kirkpatrick level 3 assessment (measurement of behavioural change), the Notechs II scores of both surgical teams increased after the teams received a structured debriefing. In particular, team 2 improved its score substantially (first drill Notechs II= 49, second drill Notechs II =79). This is potentially because team 2 was comprised of a relatively junior surgeon, anaesthetist and nurses whose base performance was inferior to that of team 1 due to lack of experience. The debrief gave the team a chance to reflect on their errors, bond, share ideas and strategise as to how they would improve their performance in a second drill. This prepared them for a much-improved second attempt. Thus, it appears that surgical teams led by junior surgical staff could potentially stand to gain the most from this intervention because of their lack of entrenched experience in managing intraoperative crisis. It is worth noting that South African district and secondary level hospitals are predominantly staffed by junior medical doctors completing their community service. Thus, an African non-technical skills training programme for managing intraoperative bleeding could have a significant impact on the preparedness of these teams, potentially leading to reduced maternal mortality.

8.6 Limitations

This study could have been improved by the addition of a control arm. This was logistically feasible; however, the author decided to expose as few participants as possible to the intervention at the pilot stage in the hope of running a larger intervention in future.

In addition, the sample size for this pilot was extremely small. In order to determine the validity of this intervention and its impact on clinical outcomes, a larger trial with more participants and contact sessions would be required. However, the next appropriate step would be further piloting, programme design and the development of a true theory of change.

A third limitation is that sampling and inter-rater bias could impact the results of this pilot. The participants for this study were recruited by convenience sampling. This could introduce bias by attracting the most motivated operating staff or, alternatively, demotivated staff who are looking for an opportunity to rest from normal clinical duties. Randomisation could reduce the impact of this, but randomisation was not possible at the time due to difficulties in recruiting staff. A possible solution would be to make training mandatory for all staff at a study site.

Similarly, inter-rater reliability of the Notechs II scores needs to be tested for potential bias in a larger trial. A solution would be to ensure that assessors receive similar training and compare scores for several sessions until they achieve parity before starting to record Notechs II scores of the trial population. In addition, both raters participated in the drills. Thus, there is risk of bias. In future, it would be better to identify raters who do not participate in the drills.

A further limitation is that this intervention requires significant investment in simulation trainers in order to scale. One model would be to train a single simulation team that rotates training at various facilities. Another model would be train trainers at each facility. A third model would be to do both for a potentially higher impact.

Because a validated, widely used African non-technical skills scoring system has not been developed, scoring systems developed for HIC settings such as Notechs II and NOTTS must be used in the interim. The author attempted to conduct a retrospective social network analysis assessment of the teams' behaviour using video recordings, but the angle of the video and the quality of the sound were too poor for an accurate assessment.

8.7 Relevance of these findings within the wider dissertation

The pilot demonstrated that non-technical skills simulation intervention targeted at improving intra-operative obstetric haemorrhage outcomes in South African hospitals is both acceptable and feasible at a small scale. Safety culture themes noted in Chapter 5 surfaced during the debriefing sessions. The pilot attempted to improve the participant's competency in non-technical skills,

specifically communication, leadership, situational awareness and problem solving. Further scale up is required to determine if the intervention is feasible and can demonstrate improvement in maternal outcomes at scale. Furthermore, research is required to adapt non-technical skills simulation interventions to other resource-constrained African surgical settings.

Chapter 9: Reflections, strengths and limitations

9.1 What was the primary objective of this research?

As described in 1.2 and 2.2, the primary objective of this dissertation was to produce a foundational study of South African obstetric surgical PSC that other South African and African PSC researchers could build on to develop a wider understanding of PSC in African obstetric theatres, in the hope that this could reduce maternal mortality.

9.2 How did existing PSC research in HICs influence this investigation?

The pioneering work of Leape (12,13) influenced the author's perspective on how cultural views of PSC evolve over time from a reliance on individual excellence toward a systems view of error prevention. The publications of Vincent (14–16) and Amalberti (17,18) on PSC gave the author a conceptual understanding of PSC in HIC settings. In the same vein, the publications of Carayon (5,6), Dixon-Woods (7,8), Gawande (9,10) and Catchpole (11) were useful in deepening the author's understanding of human factors, surgical checklists and high performance in non-surgical healthcare teams. Sevdalis' (19–21) work on multi-disciplinary teams, the impact of stress on decision-making and simulation training were useful in interpreting the simulation study results.

9.3 What was known about PSC in Africa before this research?

A very limited number of publications address African PSC in great depth. While the author was conducting this study, Scott et al. (96) and Lin et al. (145) published in-depth assessments of safety culture in Rwanda. They found that their Rwandan participants battled with providing safe surgery in resource-constrained and resource-variable environments. These publications corroborated the SAQ study findings that suggested that there is a need for purpose-built African safety climate surveys. More broadly, Fawcus et al. (26) identified that bleeding during and after caesarean section was a major source of maternal mortality in South Africa. They attributed this to poor operative skills, lack of good post-operative monitoring and wider system issues. Biccard et al. (99) and Bishop et al. (24) confirmed these findings were applicable to the rest of sub-Saharan Africa in

the landmark “Africa Surgical Outcomes Study”. Worryingly, Bishop et al. (24) noted that “maternal mortality after caesarean delivery in Africa is 50 times higher than that of high-income countries and is driven by peripartum haemorrhage and anaesthesia complications” (p.e513). However, PSC was not explicitly mentioned as a contributor to poor maternal outcomes.

Finally, the substantial works of Epiu, Ellard and Nyamtema documented the unequal distribution of surgical services, workforce shortages and the poor quality of care in central and east Africa (101,102,119,120,137,219,220). Here again, PSC was not explicitly mentioned as a contributor to quality of care.

9.4 How did the design of each study contribute to a model of PSC?

A historical analysis (Chapter 3) and literature review (Chapter 4) set the context for the latter three analytical research studies: in-depth interviews (Chapter 5), SAQ safety climate survey adaption study (Chapter 6) and an observational social network analysis study (Chapter 7). These analytical chapters were used to triangulate a description of PSC in this setting that could be explained using Schein’s model. Where necessary, Schein’s model was adapted to incorporate the findings of the analytical studies; the findings of the in-depth interviews were particularly useful in forming a view of PSC in this context (Figure 33). The findings of Chapters 6 and 7 corroborated many of the sentiments expressed in prior interviews. Finally, an experimental pilot of an in-situ surgical crisis simulation training programme was carried out to determine the acceptability and feasibility of such an intervention in South African obstetric facilities. In totality, these studies enable the foundational description of PSC in South African obstetric surgical theatres and provide insight into the historical and structural factors that underpin it.

9.5 What is the model of PSC in South African operating theatres?

From a broad perspective, the South African surgical teams studied in this dissertation are transitioning from a culture where individual excellence is seen as the main bulwark against patient harm toward a systems approach to patient safety. Figure 33 illustrates a three-layer adaption of

Schein's model of organisational culture including i) beliefs, values and assumptions, ii) behaviours and practices and iii) the external environment.

9.5.1 Beliefs and values

As described in Chapter 5's interview study, the belief system expressed by many participants was that patient safety in this setting is associated with the competence of individual staff, which in turn is associated with personal endurance and vocational willpower. This type of culture has great respect for experience and hierarchy, leading to predictable problems in communication and teamwork. It tends to consider failure as a matter of personal guilt, blame or litigation, making learning from failures difficult.

9.5.2 Behaviours and practices

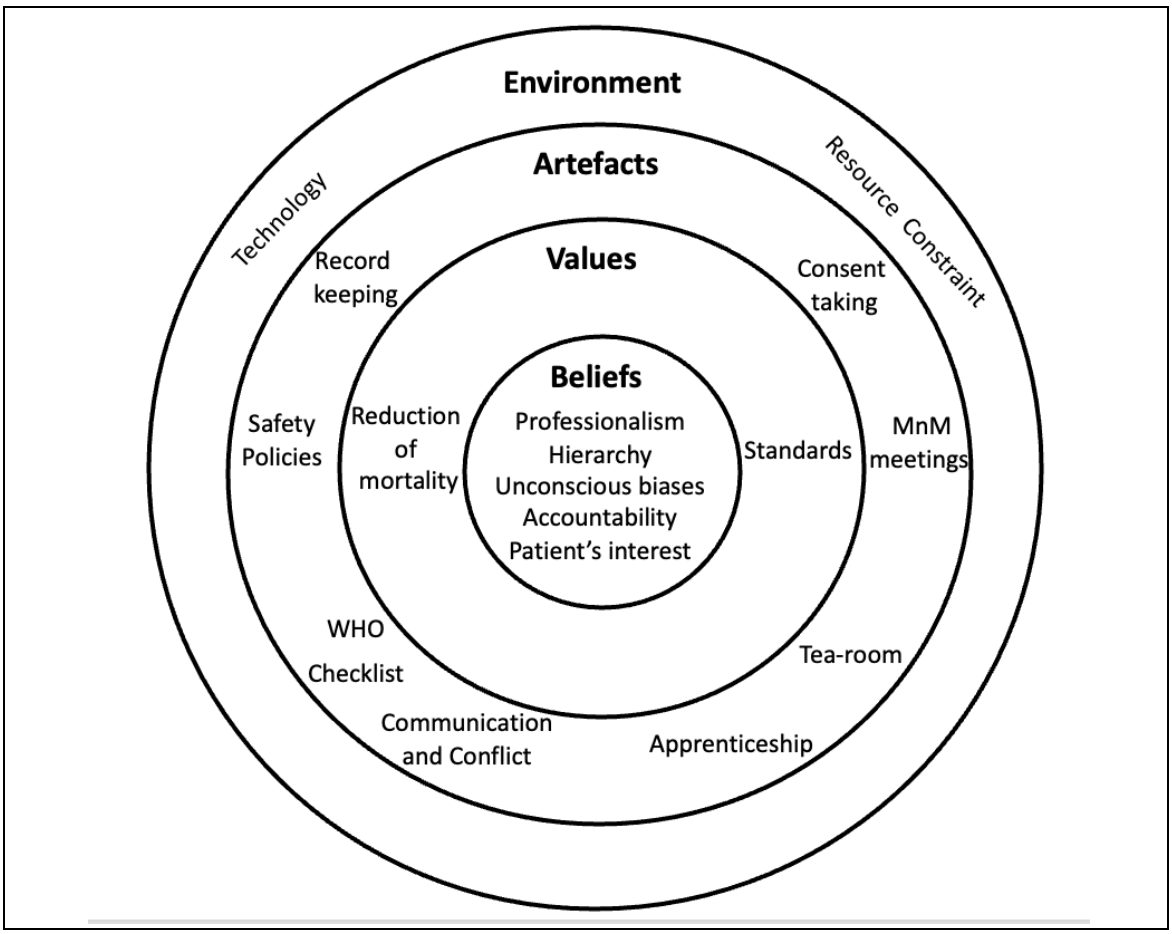
The most frequently described behaviour and practice associated with patient safety was use of the WHO surgical checklist. This was corroborated by the rates of checklist usage described in Chapter 7, which were higher than those described elsewhere in East Africa (101). Missing from this list was skills training (ESMOE programme). Safe surgery skills training was described as an area of unmet need, which was addressed by the author through the pilot described in Chapter 8. All study sites had well-developed systems of tracking WHO safe surgery checklist use, sepsis and mortality rates, suggesting the emergence of a data-driven systems approach to thinking about surgical team performance. However, it was not always clear whether the results of these audits were communicated to all surgical staff, particularly the theatre nurses. This is significant because objective data on adverse events is required to drive improvements in quality of care (2).

9.5.3 External environment

The original description of Schein's model does not have an environmental sphere incorporating beliefs, values and artefacts. The findings of a historical analysis (Chapter 3), literature review (Chapter 4) and the interview study (Chapter 5) highlighted that resource constraint and structural barriers impact safety beliefs and practices in this LMIC setting. Firstly, resource constraint affects

the quality of resourcing of surgical teams and directly impacts their ability to manage heavy clinical loads. Secondly, resource constraint impacts quality of care and PSC by shaping ideas of what is possible and desirable. Interview participants (Chapter 5) describe how they feel rushed to complete caesarean sections, to the detriment of quality, to keep up with heavy clinical loads. This constant level of stress leads to staff attrition, workforce burnout and potential compromises of PSC. These factors necessitated the modification of the original Schein model to include an additional sphere, which the author has termed "external environment", in order to account for the impact of resource constraint and other structural barriers noted in Chapter 4 and Chapter 5 on PSC (Figure 33).

Figure 33: A model of PSC in South African obstetric surgical teams based on Schein's model of organisational culture



9.6 What research gaps were identified?

The following research gaps were identified:

i) A lack of research that adequately described patient safety culture in resource-constrained LMIC settings like South Africa and sub-Saharan Africa more generally;

ii) A lack of research describing intraoperative non-technical skills performance in African operating theatres; and

iii) A lack of validated instruments to measure PSC in South Africa and sub-Saharan Africa more generally.

9.7 What were the key findings of each study?

9.7.1 Historical analysis

A narrative review of the historical development of the South African health system was conducted, with a particular focus on obstetric services (Chapter 3). This exercise linked contemporary patient safety issues to their historical roots. A legacy of institutionalised discrimination within medical culture and broader society, dating from Dutch settlement to contemporary times, coupled with resource constraint within the public sector, were identified as key historical factors that continue to impact PSC today.

9.7.2 Narrative review of PSC in sub-Saharan African obstetric surgery

A narrative review of the literature relevant to PSC in sub-Saharan African obstetric surgery identified barriers to achieving high-quality services. Themes were drawn from 64 publications and categorised into the six barriers to achieving high performance systems described by Bate et al. (2008) (98). The literature included in the review only highlighted challenges with four of the six barriers in the Bate framework; there was an absence of literature mentioning the remaining two barriers.

9.7.3 Qualitative interviews

Qualitative interviews led to the identification of 118 themes related to patient safety culture in three Cape Town obstetric theatre facilities. A constructivist-grounded theory approach was used to aggregate these themes and create a new model of PSC (section 5.3.5). This new model incorporates adaptations of Schein's model of organisational culture. The proposed South African PSC model consists of four layers: basic assumptions (core beliefs), espoused values (articulated goals), artefacts (symbols, behaviours and processes) and environment (resource availability, technology and the built environment).

9.7.4 Psychometric survey validation (semi-quantitative approach)

The validity of a widely used international patient safety climate tool was tested in a South African setting. A working group modified the language of the Safety Attitudes Questionnaire (SAQ) so that it would have face validity in a South African setting. The survey was distributed to participants in four obstetric surgery facilities and achieved an 82% response rate. The instrument had good internal reliability (cronbach alpha of 0.89). However, it had a poor goodness-of-fit (RMSEA 0.09, CFI, 0.75 and SRMR of O.1). The likely reason for this was the small sample size (n=155). Similar validation exercises by Li et al. (37) and Sexton et al. (35) had sample sizes of thousands of respondents. Nonetheless, the results could usefully indicate a problem with the underlying six-factor structure of the SAQ in a South African setting. In this study the SAQ was modified to produce a valid construct composed of only three factors: teamwork, safety climate and job satisfaction.

9.7.5 Social network analysis (quantitative approach)

A social network analysis (SNA) of communication patterns amongst theatre staff during obstetric emergencies at three health facilities illuminated the hidden influence of anaesthetists and scrub nurses. SNA was used to calculate the centrality (influence) and network dynamics of surgical teams. The findings were used to describe collaboration and communication in theatre teams.

9.7.6 Exploratory pilot building on research findings

The research findings were drawn on to design and implement a targeted pilot study. A low-cost, low-fidelity simulation programme was implemented at a Level 2 obstetric health facility. The goals of the programme were twofold: first, to assess the feasibility of a brief simulation intervention to impart non-technical skills to a small group of participants (n=9) who took part in two surgical crisis drills; and second, to generate preliminary evidence about whether the programme appeared to have useful effects. A debriefing session was conducted between the two surgical drills. Improvement in non-technical skills was assessed using the Kirkpatrick score: reactions were measured with feedback forms (level 1), knowledge with a test (level 2) and behaviour with the Notechs II scoring instrument (level 3). Impact on clinical outcomes was not measured due to the short duration of the pilot.

9.8 What insights were gained from this research?

9.8.1 Insight 1: Historical socio-economic inequality continues to impact maternal outcomes

The first major insight was that South Africa's history of race-based separate development continues to reverberate through contemporary health services. Under colonial and apartheid administrations, non-white populations travelled greater distances to receive care. They also had inferior emergency transport services, inferior delivery services and up to three times less healthcare spend per capita than white populations (57,65,85,87). Maternal deaths in South African homelands were poorly recorded (69).

From 1994, the post-apartheid government integrated fourteen previously segregated health departments into a single national department of health that caters for all ethnic groups (221). However, improvements in care experienced setbacks due to the Human Immunodeficiency Virus (HIV) pandemic and the misguided response to it by the government of the time. MMR rose to a peak of 190/100,000 live births in 2009 as infectious disease became the leading direct cause of

maternal mortality (23). A national antenatal screening programme coupled with a subsequent antiretroviral programme led to a reduction in MMR to 130/100,000 live births by 2017 (23). The implementation of high-quality universal health coverage in South Africa could address inequities in accessing safe surgical services.

9.8.2 Insight 2: Structural barriers are a major obstacle to high quality obstetric care

A narrative review of PSC practices in sub-Saharan Africa highlighted that structural barriers are a major barrier to providing high-quality care obstetric surgical care. Resource constraint, resource variability, resource allocation and lack of outcomes monitoring are highlighted as major structural factors that lead to African women having a fifty times greater risk of maternal mortality (24). At an international level, the Lancet Global Surgery commissioners (1) call for African governments to adopt national surgical obstetric anaesthesia plans because "better global surgical and anaesthesia care will only be realised through increased investment in human and physical resources for surgery and anaesthesia, accompanied by a focus on safety, quality, and efficiency" (p.615). Streamlined public health planning could address the lack of equipment, workforce shortages and poor standards highlighted by Epiu et al. (101,119), Nyamtema (130) and Biccard et al. (99).

9.8.3 Insight 3: Schein's model of organisational culture requires adaption to account for environmental factors in PSC in a South African context

Most values that underpin PSC in the resource-constrained South African setting were positive: beliefs about hierarchy, professionalism and accountability create a discipline around following the command of experienced health care professionals. For example, junior doctors know the limits of their practice, because it is accepted that junior doctors must pass their supervised caesarean section before they become the lead surgeon. This discipline protects patients from unnecessary harm.

Environmental factors such as high caseloads, aging equipment and poor infrastructure were major themes in this South African setting. Due to this, the author adapted Schein's model of

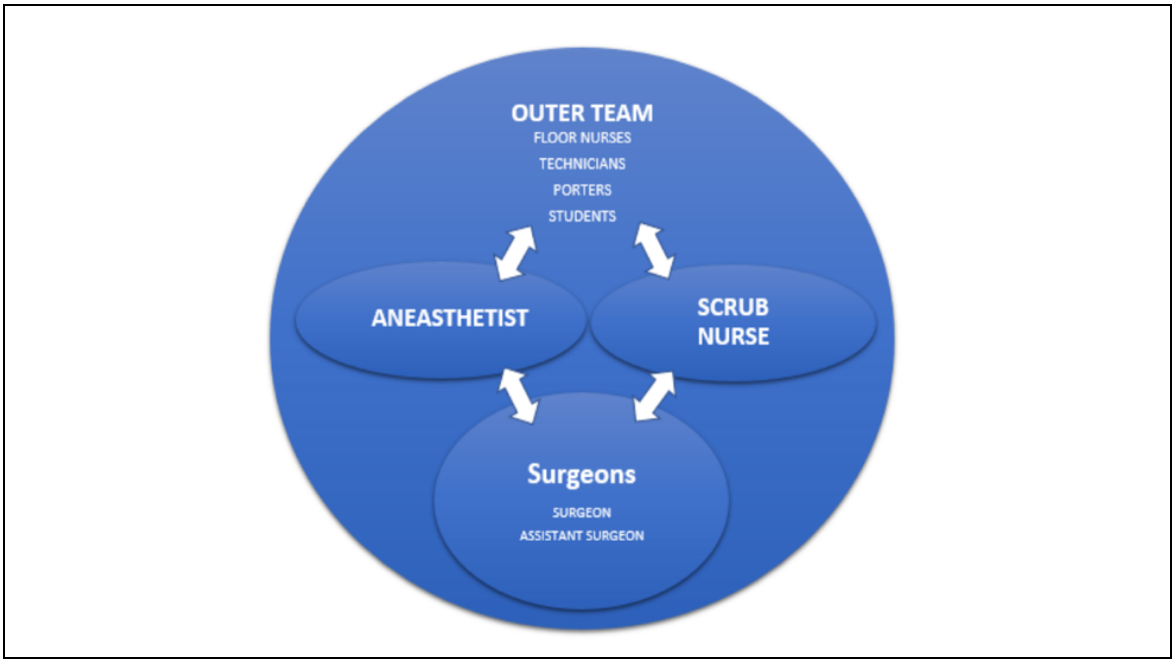
organisational culture by adding an environmental layer to produce a PSC model that better depicted how basic assumptions and espoused values of surgical teams are influenced by a resource constrained environment. This adapted model of PSC is shown in Figure 33.

9.8.4 Insight 4: South African PSC requires tailored instruments

The process of validating the SAQ required consideration of local South African obstetric theatre culture and challenges. The SAQ-SA working group recommended the addition of new professional categories, the use of simpler language and the addition of questions covering resource constraint (e.g. water supply, temperature control and drug stock-outs). The SAQ-SA six-factor structure did not achieve construct validity, probably due to the small sample size, but potentially because South African surgical staff misinterpreted questions dealing with the perceptions of management, working conditions and stress recognition domains of the SAQ. Similar problems with these domains, particularly the stress recognition domain, have been noted by Taylor et al. (184). This suggests the need for a novel South African safety climate survey. Running an additional trial with a larger sample size could also clarify these problems.

9.8.5 Social network analysis and the hidden structure of surgical teams

Figure 34: Illustration to show the dynamic and collaborative nature of surgical team communication found in this research



Social network analysis (SNA) showed that South African operating teams functioned collaboratively, rather than within a structure dominated by a single professional (Figure 34). While the surgeon had the highest degree score (one of four properties of centrality/influence in a network), the anaesthetists and scrub nurses had the highest scores for the other three measures of centrality (betweenness, closeness and eigenvector).

As shown in Figure 34, SNA showed that surgeons, scrub nurses and anaesthetists form a communication triad, an "inner team" of sorts. The obstetric surgeon initiates the majority of communication events within this triad, but these communications are focused on a narrow group of two to three people. The anaesthetists and scrub nurses act as "brokers", constantly communicating with an "outer team". In addition to recruiting for additional resources for the surgeons, the anaesthetists and scrub nurses use their unique network positions to maintain the situational awareness and co-ordinate the activities of the entire team. This research shows that scrub nurses and anaesthetists play key leadership roles that could be enhanced through additional teamwork training.

9.8.6 SNA can be used to draw insights from surgical team communication patterns

Average undirected (AU) density could be applied as a quantitative measure of collaboration within surgical team networks. AU density measures the ratio of utilised communication ties to maximum possible communication ties. Teams that rely on communication to flow through a few individuals have values closer to 0, whereas highly connected teams have AU density values closer to 1.

Similarly, *average directed (AD) density* could be applied as quantitative measure of hierarchy between surgical team members. AD density measures the reciprocation of communication between actors in a network, that is, it is the ratio of the number of communication events started by person 1 to person 2 (forward direction) to the number of communication events started by person 2 to person 1 (backward direction). A value closer to 1 indicates that relationships in the network are more reciprocal, whereas a value closer to 0 indicates a higher likelihood that certain

actors are dominant over others. Thus, AD density approximates the hierarchy of certain individuals over others in a network.

9.8.7 Insight 6: South African teams can benefit from non-technical skills training

The author designed a low-cost, low-fidelity simulation training intervention. The objective was to equip South African obstetric teams with non-technical and technical skills they could use to manage severe intraoperative haemorrhage. Both teams performed poorly during the first attempt but showed improvement in the second attempt. The possible cause of improvement was a debriefing session held between the two simulations which was led by an experienced local simulation facilitator. The facilitator used the diamond debrief format to facilitate discussions about the team's non-technical skills and technical errors. The teams then collaborated in devising an improved strategy for carrying out the second drill. Improvement was measured using the Kirkpatrick levels of change. As described in Chapter 8, feedback showed participants responded positively to the intervention and judged the scenarios to be believable. Knowledge improvement was measured using before and after tests, but the difference in scores was non-significant. A larger sample size would help determine whether the intervention could reliably improve the knowledge of participants. Encouragingly, the Notechs II scores showed improvement in this small cohort.

This training intervention could empower junior healthcare workers to manage healthcare teams more effectively in a crisis. Most intra- and post-operative maternal deaths attributed to haemorrhage occur in Level 1 and Level 2 facilities. These are often staffed by inexperienced community services officers. The training intervention described could make a positive difference to patient outcomes achieved by teams operating in these settings.

9.9 What is the novel contribution of this research?

This thesis offers two novel contributions to the understanding of PSC in LMIC settings. Firstly, the author has described a South African model of PSC in operating theatres in Chapter 5. This simple model identifies the basic assumptions and values that shape safety practices and processes. It also

explains the impact of environmental factors, including resource constraint and high caseloads, on safe practices and behaviour. This model needs further development to fully define PSC in an African LMIC environment, much like researchers in HIC settings have developed comprehensive models over time. The model offered in this thesis can be used as the basis of factor structures for novel African patient safety climate instruments. The author acknowledges that there is more complexity to patient safety in this setting than he has described in this first attempt. Further research is encouraged.

Secondly, the author has adapted and applied SNA to examine the network structure of communication within surgical teams. The findings of this research highlight the important leadership function played by scrub nurses and anaesthetists in enhancing team communication and co-operation during caesarean sections. The SNA and SAQ findings appear to be closely related. This signals the possibility of combining both measures to create a combined SAQ-SNA score for PSC in African surgical theatres. In addition, the author hopes that further research will explore the use of AU density and AD density to measure collaboration and hierarchy in surgical teams.

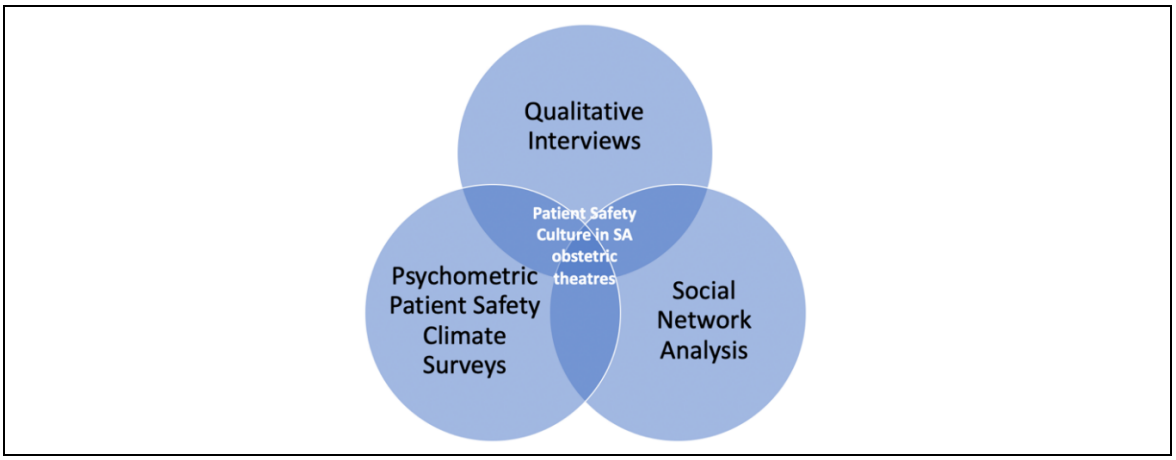
9.10 What are the strengths and limitations of this research?

9.10.1 Strengths

Firstly, this research was participatory in nature. The author immersed himself in the world of the participants over two years. Bonds were built with local staff, enabling him to have privileged access to their theatres, their thoughts and their fears. The author became part of the teams in order to identify the meanings of rituals and practices he observed.

Secondly, the combination of multiple research methods allowed the author to develop a 360-degree view of safety culture. Qualitative methods were useful in delving into the basic assumptions and values that underpin safety culture. Psychometric surveys were used to gauge current opinions on safety climate. In addition, SNA acted as a complimentary visual and mathematical tool to analyse the structure and workings of these teams (see Figure 35).

Figure 35: Venn diagram to demonstrate the complementary nature of the chosen research methods



Finally, the author had the privilege of being a naturalised South African (originally born in Zimbabwe). Thus, the author had deeper insights into how people who could be seen as "outsiders" adapt and integrate into South African culture. The author's understanding of insider/outsider status made him relatable for participants engaging with similar sensitivities.

9.10.2 Limitations

The author acknowledges that there are limitations to this body of work. Observational work, specifically the SNA study, can be affected by bias as a result of the Hawthorne effect. However, the findings of the SNA study are supported by participant responses in the qualitative interview study, adding further credibility to these findings. Bias could have also impacted the interpretation of the interviews, but this was mitigated against by discussing emerging interview themes with participants and other researchers.

It is possible that some interview themes were diluted while others were amplified during the process of thematic analysis. The author mitigated this risk by keeping a log of themes on NVivo, presenting the data to the participants to confirm if it made sense to them, and involving other researchers in checking his codes. The author also acknowledges that his own personal biases could have impacted the analysis of qualitative interviews.

Due to the small number of publications directly addressing African PSC, a narrative review was preferred in order to access a broad range of literature. The narrative review conducted carries a

greater possibility of selection bias, and the possibility of this resulting in a distorted picture cannot be excluded.

The author acknowledges that the SAQ required a much larger sample size. The author would have liked to conduct the validation study in more hospitals to reach a sample size >500, but this was not feasible in this study due to resource constraints. Further research on the SAQ in a larger study is recommended. Similarly, the SNA could have been improved upon by using a larger sample size in order to make statistical comparisons between patterns of day and night cases, emergency and elective cases or even between different combinations of surgical team members. This was not feasible because SNA is extremely intensive. A researcher must be present and observe all events in theatre for the duration of surgery. It is only feasible to record four to five cases a day because of the intensity of the process. The hospitals did not have space for the author to sleep overnight, and the risk of crime made it unsafe to travel to or from hospitals at night, a situation which in turn made it difficult to increase the sample size.

9.11 Recommendations

The aim of this thesis was to provide a foundational set of studies from which PSC in South African surgical settings could be described. Further research is required to develop valid instruments and interventions that are appropriate to the local context. The author proposes the creation of an African Maternal Outcomes and Implementation Science research group based in South Africa. This group would focus on collecting, organising, analysing and disseminating accurate maternal outcomes data that can be used to advocate for evidence-based changes to PSC. This group could support researchers across the African continent in developing policies, instruments and evaluation systems for monitoring quality of care.

In addition, the evidence suggests that implementing intraoperative simulation crisis training at outlying Level 1 and Level 2 hospitals in South Africa's Western Cape region could help to improve the technical and non-technical skills of district hospital surgical teams during emergencies. The

evidence base from this dissertation is small and subject to a range of potential biases, so more work is needed on a larger scale before strong recommendations can be made.

9.12 Further research

The author encourages further research in order to:

i) Continue developing validated African patient safety climate tools.

ii) Continue applying SNA to study the non-technical skills performance of surgical teams in emergency cases. Further research is needed to determine if certain network patterns of communication are linked to improved outcomes or poor outcomes.

iii) Define how error and adverse events occur in South African obstetric surgical settings. Further research could yield novel African frameworks for analysing error.

9.13 Summary and conclusion

This body of work has attempted to produce a foundational description of PSC in South African obstetric surgical theatres and, building on that foundation, has proposed a model for PSC that requires more extensive testing and research. The author initially intended to compare PSC in HIC settings to PSC in an LMIC South African setting, but the sparsity of PSC data and published literature led the author to focus on developing a model of PSC in a South African obstetric setting based on the study of these Cape Town hospitals.

The study suggests that resource constraint and historical inequities mean that instruments designed to measure PSC in HIC settings require validation and modification for use in an LMIC setting. In addition, this research, through the novel use of social network analysis, has demonstrated that anaesthetists and scrub nurses play important leadership roles in facilitating intra-operative communication in South African theatres. The study identified potential novel measures for surgical team hierarchy (average directed density) and collaborative communication (average undirected density). Furthermore, a prototype simulation team training intervention for African obstetric surgical teams was deemed acceptable and feasible at a small scale. Taken

together, these findings contribute fresh perspectives on PSC in LMIC settings, perspectives which have important value globally in the fight to reduce preventable maternal mortality. The findings also highlight the need for further research on PSC in South Africa. It is the author's hope that the body of knowledge generated in this dissertation will help prevent the avoidable deaths of African women, like Ms X described in the introductory chapter, through the improvement of PSC.

Appendix 1: Themes collected from qualitative interviews

The 118 basic themes collected from interviews were organised into 14 organising themes as follows.

Defining patient safety	**Team formation and maintenance**
What is patient safety	Team formation |(integration)
Values governing patient safety	Collaboration
Personalities	Rotating staff
Motivation	Architecture
Professionalism	Tearoom
Attitude	Teamwork
Experience	Community
Accountability	Heroes
Transparency	Positive recognition
Tolerance of error	Resilience
Generational differences	Stability
	Support
	Workforce
Communication and conflict	**Stress adaptation strategies**
Communication	Adaptation
Languages	Relationships
Conflict	Managing expectations
Initiative	Briefing and the WHO Checklist
Territory	Debriefing
Obstruction	Safeguarding
Respect	Speaking up
Trust	Escalation
Avoidance	De-escalation
Frustration	Ganging up
Referrals	Environment (ambiance)
Day vs night shifts	Protection of patients
Doctors vs nurses	Emergency response
Distractions	
Near misses	
Silence	

Resource limitation	**Hospital safety cultures**
Resource constraint Factors that worsen resource constraint High clinical loads Aging and lack of equipment and infrastructure Shortage of staff Stock supplies Fragmentation of services and protocols Inefficiency Other barriers	Site 1 MMH sub-culture Site 2 NSH sub-culture Site 3 MPH sub-culture Overall culture Differences between districts Professional safety cultures Nursing Anaesthetists Obstetric surgeons Generalists Porters
Outcomes of resource constraint	**Social power dynamics**
Low staff morale Overwhelming stress Cognitive loading Burnout Absenteeism Backlog of cases Declining sterility Malpractice Shortage of staff Shortage of resources	Diversity Hierarchy Racism Gender Disempowerment Stereotypes Xenophobia
Patient safety strategies	**Error reporting**
WHO Checklist Consent Levels of care Leadership Protocols Records Caesarean section licensing exam Continuation of care	Reporting error Learning from error Morbidity and mortality Feedback Anonymity Pharmacy errors

Training and learning	**Medico-legal pressure**
Learning Learning curves Training Simulation Esmoe (Essential Steps in Managing Obstetric Emergencies) Confidence	Record-keeping Risk aversion Distrust
Adoption of change	**Mobile technology**
Innovation Change Readiness for change Implementation Autonomy	WhatsApp groups

Appendix 2: Raw responses to all SAQ-SA items

Table 30: Participant responses to questions 1-23 of the SAQ-SA. [25]

Question	Disagree strongly		Disagree slightly		Neutral		Agree slightly		Agree Strongly		Sum
1. Nurse input is well received by other professionals in this operating theatre.	**14**	(9.2%)	**17**	(11.1%)	**28**	(18.3%)	**41**	(26.8%)	**53**	(34.6%)	153
2. In this operating theatre, it is difficult to speak up if I perceive a problem with patient care.	**36**	(23.5%)	**56**	(36.6%)	**18**	(11.8%)	**26**	(17.0%)	**17**	(11.1%)	153
3. Disagreements in this operating theatre are resolved appropriately (i.e., with a focus on what is right for the patient, not who is to blame)	**8**	(5.2%)	**20**	(13.0%)	**37**	(24.0%)	**47**	(30.5%)	**42**	(27.3%)	154
4. I have the support I need from other staff to care for patients.	**2**	(1.3%)	**9**	(5.9%)	**14**	(9.2%)	**51**	(33.3%)	**77**	(50.3%)	153
5. It is easy for staff here to ask questions when there is something that they do not understand.	**3**	(2.0%)	**17**	(11.3%)	**15**	(9.9%)	**49**	(32.5%)	**67**	(44.4%)	151
6. The doctors and nurses here work together as a well-coordinated team.	**11**	(7.2%)	**12**	(7.8%)	**21**	(13.7%)	**54**	(35.3%)	**55**	(35.9%)	153
7. I would feel safe being treated here as a patient.	**14**	(9.2%)	**15**	(9.9%)	**31**	(20.4%)	**52**	(34.2%)	**40**	(26.3%)	152
8. Medical errors are handled appropriately in this operating theatre.	**5**	(3.2%)	**11**	(7.1%)	**24**	(15.6%)	**48**	(31.2%)	**66**	(42.9%)	154
9. I know the proper channels to direct questions regarding patient safety in this operating theatre.	**3**	(2.0%)	**10**	(6.5%)	**15**	(9.8%)	**52**	(34.0%)	**73**	(47.7%)	153
10. I receive appropriate feedback about my performance.	**14**	(9.2%)	**17**	(11.2%)	**31**	(20.4%)	**54**	(35.5%)	**36**	(23.7%)	152
11. In this operating theatre, it is difficult to discuss errors.	**18**	(11.8%)	**53**	(34.9%)	**32**	(21.1%)	**32**	(21.1%)	**17**	(11.2%)	152
12. I am encouraged by my colleagues to report any patient safety concerns I may have.	**3**	(1.9%)	**11**	(7.1%)	**34**	(21.9%)	**37**	(23.9%)	**70**	(45.2%)	155
13. The culture in this operating theatre makes it easy to learn from the errors of others.	**4**	(2.6%)	**19**	(12.4%)	**41**	(26.8%)	**45**	(29.4%)	**44**	(28.8%)	153
14. My suggestions about safety would be acted upon if I expressed them to management.	**6**	(3.9%)	**15**	(9.9%)	**44**	(28.9%)	**40**	(26.3%)	**47**	(30.9%)	152
15. I like my job.	**2**	(1.3%)	**6**	(3.9%)	**16**	(10.3%)	**37**	(23.9%)	**94**	(60.6%)	155
16. Working here is like being part of a large family.	**5**	(3.2%)	**13**	(8.4%)	**22**	(14.3%)	**42**	(27.3%)	**72**	(46.8%)	154
17. This is a good place to work.	**5**	(3.2%)	**9**	(5.8%)	**24**	(15.5%)	**42**	(27.1%)	**75**	(48.4%)	155
18. I am proud to work in this operating theatre.	**2**	(1.3%)	**6**	(3.9%)	**24**	(15.6%)	**52**	(33.8%)	**70**	(45.5%)	154
19. Morale in this operating theatre is high.	**5**	(3.3%)	**22**	(14.5%)	**27**	(17.8%)	**64**	(42.1%)	**34**	(22.4%)	152
20. When my workload becomes too heavy, the quality of my performance is reduced.	**14**	(9.0%)	**16**	(10.3%)	**23**	(14.8%)	**50**	(32.3%)	**52**	(33.5%)	155
21. I am less effective at work when I am tired.	**12**	(7.8%)	**12**	(7.8%)	**20**	(13.1%)	**46**	(30.1%)	**63**	(41.2%)	153
22. I am more likely to make errors when there are tensions or conflict situations in the theatre..	**17**	(11.3%)	**17**	(11.3%)	**35**	(23.2%)	**31**	(20.5%)	**51**	(33.8%)	151
23. Being tired reduces my performance during emergency situations (e.g. emergency resuscitation, seizures, heavy bleeding).	**17**	(11.3%)	**21**	(14.0%)	**26**	(17.3%)	**34**	(22.7%)	**52**	(34.7%)	150

[25] A total of 155 responses were received. Some sections were left blank, leading to sum totals below 155.

Table 31: Participant responses to questions 24-42 of the SAQ-SA.

Question	Disagree strongly		Disagree slightly		Neutral		Agree slightly		Agree strongly		Sum
24. Management supports my daily work.	**15**	(9.7%)	**19**	(12.3%)	**42**	(27.3%)	**49**	(31.8%)	**29**	(18.8%)	154
25. Management doesn't knowingly worsen patient safety	**12**	(7.9%)	**15**	(9.9%)	**45**	(29.6%)	**40**	(26.3%)	**40**	(26.3%)	152
26. Management is doing a good job.	**14**	(9.1%)	**19**	(12.3%)	**47**	(30.5%)	**42**	(27.3%)	**32**	(20.8%)	154
27. Problem staff are dealt with constructively by our management.	**21**	(13.6%)	**19**	(12.3%)	**56**	(36.4%)	**32**	(20.8%)	**26**	(16.9%)	154
28. I get adequate, timely information from management about events that might affect my work.	**11**	(7.2%)	**23**	(15.0%)	**45**	(29.4%)	**49**	(32.0%)	**25**	(16.3%)	153
29. The levels of staffing in this operating theatre are enough to handle the number of patients.	**39**	(25.3%)	**42**	(27.3%)	**23**	(14.9%)	**26**	(16.9%)	**24**	(15.6%)	154
30. This hospital does a good job of training new staff.	**14**	(9.3%)	**22**	(14.6%)	**29**	(19.2%)	**51**	(33.8%)	**35**	(23.2%)	151
31. All the necessary information is often available for me to make good decisions regarding patient care.?	**6**	(3.9%)	**16**	(10.5%)	**36**	(23.5%)	**64**	(41.8%)	**31**	(20.3%)	153
32. Trainees in my discipline are adequately supervised.	**4**	(2.6%)	**6**	(3.9%)	**26**	(17.1%)	**57**	(37.5%)	**59**	(38.8%)	152
33. I experience good teamwork with nurses in this operating theatre.	**4**	(2.6%)	**11**	(7.2%)	**20**	(13.1%)	**52**	(34.0%)	**66**	(43.1%)	153
34. I experience good teamwork with doctors in this operating theatre.	**8**	(5.2%)	**18**	(11.7%)	**21**	(13.6%)	**54**	(35.1%)	**53**	(34.4%)	154
35. I experience good teamwork with pharmacy, stores and procurement pharmacists in this operating theatre.	**6**	(4.1%)	**13**	(8.8%)	**49**	(33.1%)	**42**	(28.4%)	**38**	(25.7%)	148
36. Communication breakdowns that lead to delays in delivery of care are common.	**10**	(6.5%)	**25**	(16.3%)	**28**	(18.3%)	**57**	(37.3%)	**33**	(21.6%)	153
37. Sterility and correct draping principles are adhered to.	**3**	(2.0%)	**10**	(6.6%)	**14**	(9.2%)	**36**	(23.7%)	**89**	(58.6%)	152
38 We have a working recovery area	**3**	(1.9%)	**3**	(1.9%)	**12**	(7.8%)	**46**	(29.9%)	**90**	(58.4%)	154
39 The temperature in our operating theatres is maintained to allow us to focus and maintain sterility	**15**	(9.7%)	**30**	(19.5%)	**17**	(11.0%)	**44**	(28.6%)	**48**	(31.2%)	154
40 We have regular meetings to discuss problems affecting our theatre e.g. broken autoclave	**22**	(14.5%)	**29**	(19.1%)	**38**	(25.0%)	**27**	(17.8%)	**36**	(23.7%)	152
41 Shortage of water and electricity supply do not impact theatre operations at our hospital	**19**	(12.5%)	**38**	(25.0%)	**15**	(9.9%)	**33**	(21.7%)	**47**	(30.9%)	152
42 Bed shortages that result in a backlog of elective theatre cases frequently occur here	**18**	(11.8%)	**17**	(11.1%)	**19**	(12.4%)	**35**	(22.9%)	**64**	(41.8%)	153

Appendix 3: Supporting materials for a pilot study to investigate the feasibility of a South African non-technical skills intervention for obstetric surgical teams (Chapter 8)

Figure 36: Checklist of required instruments for the simulation exercise

Documents	**Simulator**
- Anaesthetic charts (1) - Blank WHO checklist (1) - Mock-up theatre case folder (1) - Cards to assign roles to all team members - Print out of the local haemorrhage protocol (1) - Consent forms (20) - Pre-test documents (20) - Feedback forms (20)	- The torso (a 30-litre plastic box) (1) - 3 plastic two-way valves (3) - 1 transparent plastic jerry can with tap at base (1) - 10 litre bucket (1) - 10-meter plastic hosing (1cm wide) - Hot water bottle with a slit at the base to look like a lower uterine incision and pre-fashioned suture holes in it (1) - Fake baby: any object that can fit in the hot water bottle to represent a baby (1) - Suction (1)
Theatre instruments	**Water**
- Surgical needle holder (1) - Blunt needles (2) - Vascular clamp (1) - Retractors (2) - Blade (1) - Blade handle (1) - Gloves (at least for the operating team) - Syringes for fake drugs (adrenaline, tranexamic acid and oxytocin) - Masks for at least the obstetric surgeon, assistant surgeon and scrub nurse (x3)	- 10 litres water - Red food colouring
Recording device	**General**
- 1 camera recording device (charged) - Micro SD card - Laptop to review video (charged)	- Confirm venue booking - Obtain documented consent of staff participating in drills
Staff	**Venue**
- Surgeon (1) - Assistant surgeon (1) - Scrub nurse (1) - Anaesthetist (1) - Anaesthetic nurse (1) - General floor nurse (1) - Paediatrician (1) - Paediatric nurse (1) - Consultant obstetrician (1) - Consultant anaesthetist (1)	- Ideally an operating theatre the staff are familiar with - Good lighting - Source of water - Mop for cleaning

Figure 37: The five principles to help facilitators run the simulation exercises

1. The purpose of this drill is to improve the spirit of teamwork and preparation for a serious theatre emergency. Today we will be working on severe bleeding during and after caesarean section.

2. Your objective is to complete 2 drills today and 2 debriefing sessions:

- One inside the operating theatre (obstetric haemorrhage)
- Then a debrief session discussing what happened, what could be improved and how it can be improved.
- A second drill in the operating theatre (obstetric haemorrhage)
- Then a debrief session discussing what happened, what could be improved and how it can be improved.

3. This is a safe space where we can learn, ask questions and give feedback. We are all expected to be supportive of one another.

4. Although there is no real patient, please ask the participants to take this seriously and pretend there really was a patient. Where there are gaps, participants are encouraged to improvise and give feedback at the end.

5. Please explain that all the activities will be recorded on a camera for discussion, analysis, academic publications and presentations. The videos are not for public dissemination.

Figure 38: The feedback survey for the pilot study

	Very poor	Poor	Average	Good	Very good
INTRODUCTORY BRIEF					
The explanation of the exercise was clear	1	2	3	4	5
I understood the purpose of the exercise	1	2	3	4	5
I learnt something new about the WHO checklist	1	2	3	4	5
PREOPERATIVE PHASE (SIGN IN & TIME OUT)					
I understood my role in the exercise	1	2	3	4	5
The briefing prepared us to fill in the checklist properly and quickly	1	2	3	4	5
OPERATIVE PHASE					
I felt a similar level of stress that I would feel in a real case	1	2	3	4	5
I felt like our ability to work as a team was being tested	1	2	3	4	5
Did this scenario challenge your ability to follow the difficult airway scenario/ resuscitation of the patient with PPH					
POST-OPERATIVE PHASE (SIGN OUT)					
I understood what instructions should be given to the recovery team	1	2	3	4	5
DEBRIEF					
This was safe environment to reflect on what happened	1	2	3	4	5
I was able to gain insight into the team's performance	1	2	3	4	5
OVERALL					
The facilitators were attentive and helpful	1	2	3	4	5
This was a useful team-building exercise	1	2	3	4	5
My clinical practice will change because of today	1	2	3	4	5
We liked the food	1	2	3	4	5
PROFESSIONAL ROLE PLAYED	Surgical provider	Nursing provider	Anaesthetic provider	Paediatric provider	

Figure 39: The pre- and post-intervention knowledge test

1 THE WHO SAFETY CHECKLIST IS MADE UP OF THE FOLLOWING PARTS		
Sign Out	True	False
Time out	True	False
Sign in	True	False
2 THE WHO CHECKLIST		
Works even if the anaesthetist does it by themselves	True	False
Can reduce the chances of a patient dying/being disabled in an operation	True	False
Has not actually been tested in countries like South Africa	True	False
Only needs to be done for the first case of the day	True	False
Requires antibiotic prophylaxis to be checked	True	False
Is the same at every hospital in South Africa	True	False
3 SITUATIONAL AWARENESS		
Means “knowing what’s going on around you”	True	False
Is not affected by getting tired	True	False
Can be improved by sharing what’s going on with teammates	True	False
Can be lost	True	False
4 LEADERSHIP AND COMMUNICATION		
Sharing leadership with other teammates can make the theatre team work better	True	False
Team leaders should ask team members to point out potential problems	True	False
Repeating the instructions back to the person who gave them can reduce the chances of patient harm	True	False
Debriefing after a difficult case allows teams to learn and improve	True	False
5 SEVERE BLEEDING DURING A CAESEREAN SECTION		
Is a major cause of mothers dying during birth in South Africa	True	False
May require cold blood transfusion	True	False
Can be controlled by a B-Lynch suture	True	False
Can be managed with only 1 site of venous access (drip)	True	False
A B-Lynch suture is the last step a surgeon can take to control bleeding	True	False
Monitoring of blood loss does not have to be done until the end of a procedure	True	False
Carries a small risk of death or re-bleeding when the patient returns to the ward	True	False
6 NON-TECHNICAL SKILLS		
Refers to leadership, how well you suture and resuscitate	True	False
Have a small impact on the chances of a patient being harmed	True	False
Can be given a score and followed for improvement	True	False
Can be improved with feedback	True	False
Non-technical skills only matter in hospitals with resources	True	False
Focusing on fixing a system can reduce the chances of individual error	True	False

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