

Quality of Hip Fracture Care in Major Trauma Centres: a National Observational Study

Abstract

This study aimed to determine whether designation as a Major Trauma Centre (MTC) affects the quality of hip fracture care. All cases within the UK National Hip Fracture Database between April 2010 and December 2013 were included. The care quality measures were time to arrival on an orthopaedic ward, geriatrician review, and to operation. The clinical outcomes were development of pressure sores, discharge home, length of stay, in-hospital mortality, and re-operation within 30 days. There were 289,466 patients, 49,350 of which were treated in hospitals that are now MTCs. Within multivariable logistic and generalised linear regression models, there were no significant differences across any of the care quality indicators or clinical outcomes. These findings suggest that regionalisation of major trauma in England did not improve or compromise the overall care of older adults with hip fractures.

Key words

Hip fractures; trauma centres; trauma units

Introduction

There is strong evidence from the United States (US) that severely injured patients are optimally treated in dedicated trauma centres.¹ Many developed countries have implemented systems in which major trauma patients are triaged directly to specialist hospitals. Clinical networks based on designated Major Trauma Centres (MTCs) were established across England as part of a national service reconfiguration in April 2012.²

It has been suggested that the pooled resources and expertise in MTCs could improve outcomes for other patient groups in addition to those that are severely injured.³⁻⁵ For example, outcomes for patients with ruptured abdominal aortic aneurysms improved following trauma centre accreditation in the United States.^{4,5} However, MTC designation is associated with a substantially increased clinical burden.^{3,6} There is a risk that some patient groups (e.g. older adults with hip fractures) might compete ineffectively for resources with higher priority cases (e.g. polytrauma and open fractures). Studies from the UK⁷ and the Netherlands⁸ have reported that hip fracture care may worsen in new trauma centres.

The aim of this study was to determine whether hip fracture care is enhanced or compromised in MTCs using data from a national hip fracture registry.

Methods

An observational study was performed using the UK National Hip Fracture Database (NHFD).

Data source

The NHFD is the largest hip fracture registry in the world, with over 750,000 cases. It receives data from 182 eligible hospitals and captures over 95% of hip fractures treated in England, Wales, and Northern Ireland. The NHFD is commissioned by the Healthcare Quality Improvement Partnership (HQIP) and primarily functions as an audit and quality improvement tool. It has a role both

in providing audit data to participating hospitals and for payment of the NHS Best Practice Tariff.

Inclusion criteria

The study period was 1st April 2010 until 31st December 2013. Our inclusion criteria were those used by the NHFD: all patients aged ≥ 60 years admitted to a hospital in England, Wales, or Northern Ireland with a proximal femoral fracture. We excluded patients that were transferred between institutions to minimise selection bias of complex cases towards regional centres. The dataset underwent minimal “cleaning” by removing whole records in which any inpatient event (e.g. operation, discharge) preceded admission.

Risk adjustment and outcome measures

Demographic and risk-adjustment variables included age, sex, admission source (own home, residential care, nursing care, residential or nursing care, already a hospital inpatient), pre-morbid mobility (regularly walked without aids, with one aid, with two aids or frame, or wheelchair/bedbound), pre-operative Abbreviated Mental Test Score (AMTS), and American Society of Anesthesiologists (ASA) score. The AMTS is a test of ten questions (e.g. “what is the year?”) that gives a score from 0 (severe cognitive impairment) to 10 (all questions correct).⁹ The ASA score ranges between 1 (healthy patient) and 5 (moribund patient not expected to survive for 24 hours with or without surgery) and is usually assessed by an anaesthetist.¹⁰

Socioeconomic status was estimated using lower layer super output areas (derived from postcodes at admission) and English Indices of Deprivation 2010. Indices of Multiple Deprivation (IMD) scores are based on work commissioned by the UK Department for Communities and Local Government. They reflect deprivation related to income, employment, health and disability, education, barriers to housing and services, living environment, and crime.¹¹

The outcome variables extracted from the NHFD were quality standards (time to an orthopaedic ward, geriatrician review, and to surgery in hours) and clinical

outcomes (length of stay, pressure sores, discharge destination, in-hospital mortality, and re-operation within 30 days).

Data analysis

The study compared outcomes longitudinally *within* MTCs (before and after each MTC was fully “live”); and *between* MTCs and non-MTC hospitals.

Major trauma leads at all 22 MTCs in England were contacted to determine the date on which each hospital began functioning as an MTC. In the case of phased launches, we sought the dates on which reconfigurations began and were considered complete. Hip fracture patients treated in these hospitals were then divided into two groups – those before and after MTC designation. Patients treated during individual MTC phasing periods were not analysed. Quality indicators and clinical outcomes were then compared between the “before” and “after” groups. In the second analysis, outcomes in MTCs were compared with those in non-MTC hospitals.

Chi squared tests were used for categorical outcome variables and Kruskal-Wallis one way analysis of variance for non-normally distributed continuous variables. Risk-adjusted associations between MTC status and outcomes were examined using multivariable logistic regression models. The co-variables were age, sex, admission source, pre-morbid mobility (regularly walked without aids, with one aid, with two aids or frame, or wheelchair/bedbound), pre-operative AMTS, ASA score, and IMD. These have individually been identified as having strong predictive value for mortality within the NHFD.¹²

Timing variables (including orthopaedic ward, operation, geriatrician review, and length of stay) were found to be non-normally distributed. The modified Park test identified a gamma distribution and so log-linked generalised linear models were used to examine associations with MTC status. All models used robust standard errors and accounted for clustering of patients within hospitals.

Forest plots were created from multivariable regression outputs (odds ratios and predicted mean differences with 95% confidence intervals) to explore adjusted outcomes between individual hospitals. This is because it is possible that hip fracture outcomes could worsen in some new MTCs but improve in others. Statistical analyses were performed using Stata v.13.0 and $p < 0.05$ was adopted as the threshold for statistical significance.

Results

There were 289,466 hip fractures in the cohort with a mean age of 82.8 (SD 8.4). The patients were predominantly female (73.1%), admitted from their own home (75.3%), and had a median ASA score of 3. 49,350 patients were treated in hospitals that are now MTCs: 22,190 (46.4%) before MTC designation, 25,325 (51.3%) after, and 1,115 (2.3%) during transition periods. Patient characteristics across the three groups (MTCs before designation, after designation, and non-MTC hospitals) are shown in Table 1.

Changes on MTC designation

In the unadjusted analysis, there were a number of apparent improvements in hospitals that became MTCs (Table 2). Although there was a greater delay in transferring patients to an orthopaedic ward (median 4.05 versus 3.82 hours $p < 0.001$), they were reviewed by a geriatrician (median 25.5 versus 29.6 hours, $p < 0.001$), and underwent an operation (median 23.3 versus 24.6 hours, $p < 0.001$) faster in the post-MTC period. In addition, fewer patients developed pressure sores (3.4 versus 4.0%, $p = 0.001$) or died in hospital (8.8 versus 8.1%, $p = 0.006$). However, there were no significant differences in any of the outcomes in the adjusted multivariable analyses (Table 3).

Exploratory analysis of forest plots was limited by low numbers of events (e.g. death) in some hospitals pre- or post-MTC opening. However, there were substantial differences between individual MTCs in terms of time to operation (Figure 1) and length of stay (Figure 2). Fewer important differences were observed for the other outcomes, including mortality (Figure 3).

Differences between MTCs and non-MTCs

Table 4 shows a number of statistically significant differences between MTCs and non-MTCs. Patients treated in MTCs were transferred to an orthopaedic ward (median 4.0 versus 4.1 hours, $p < 0.001$) and received an operation (median 23.3 versus 24.2 hours, $p < 0.001$) faster. A lower proportion died in hospital (8.8 versus 8.1%, $p = 0.006$). However, patients in non-MTCs were reviewed by a geriatrician more promptly (median 25.4 versus 25.5 hours, $p < 0.001$) and were more likely to be discharged to their own home (64.4 versus 63.2%, $p = 0.006$). Although these differences were statistically significant, they were small in real terms and may not be clinically meaningful. There were no differences between MTCs and non-MTCs in the adjusted multivariable analyses (Table 5).

Discussion

This study used a comprehensive national hip fracture registry and found that there were not any differences in the care of patients with hip fractures or outcomes between MTC and non-MTC hospitals.

National Health Service hospitals were required to satisfy a number of criteria before being designated as MTCs. These included a 24-hour consultant trauma team leader and a dedicated daily trauma operating list.² Many hospitals also expanded their team of orthopaedic trauma specialists in preparation for becoming MTCs.¹³ In addition, most new MTCs were already large regional hospitals^{13,14}, which have additional resources (e.g. senior medical personnel available on site) that could benefit patients with hip fractures. There is also evidence that some non-traumatic surgical populations might benefit from treatment in a designated trauma centre.^{4,5} These factors raise the possibility of improved outcomes for hip fracture patients in MTCs. However, our study did not identify any advantages for hip fracture patients treated in MTCs or in hospitals following MTC designation.

Although MTCs are well resourced, recent studies suggest that hip fracture outcomes might actually be compromised in busy trauma centres. This is because older adults with hip fractures may not compete effectively for resources (e.g. operating theatre time) with more urgent cases, such as open fractures and multiply injured patients.^{7,8} In the Netherlands, a number of outcomes (including time to operation, length of stay, complications, re-intervention, and mortality) were found to be worse at a level 1 trauma that at another hospital nearby.⁸ Similarly, in the United Kingdom, hip fracture operations were delayed in one hospital when it became an MTC, with an associated increase in post-operative medical complications.⁷ In contrast, a recent study from the US reported that hip fracture outcomes were comparable between higher- and lower-level trauma centres.¹⁵ However, trauma systems were established in the US as early as 1987 and so this finding might not be generalisable to the UK setting in which trauma care was only recently regionalised. Our study did not find any evidence of compromised hip fracture care in English MTCs and is therefore consistent with this evidence from the US. It is possible that the benefits of MTC designation (e.g. increased resources) are balanced against possible disadvantages (e.g. competing surgical priorities). Previous studies describing worse outcomes in trauma centres^{7,8} may reflect circumstances that were limited to specific institutions; and our forest plots (Figures 1-3) suggest that the overall finding of “no difference” could mask considerable differences between new MTCs.

The limitations of this study are related to our use of a retrospective dataset. In particular, the quality indicators reported by the NHFD are based largely on small observational studies and expert consensus rather than high-level evidence. Observational studies have reported associations between delayed operation, complications, and higher mortality.^{16,17} Similarly, prolonged time in the ED has been associated with worse outcomes across a number of patient groups.^{18,19} However, these studies could not completely eliminate confounding and it is possible that complex patients simply required more time for assessment and optimisation, both in the ED and pre-operation. The involvement of geriatricians within multidisciplinary hip fracture services has been

associated with reduced lengths of stay and mortality.²⁰ Although the precise mechanisms for this finding are not well understood, it may be related to better medical management and understanding of the needs that are particular to older adults with hip fractures. It is important to note that orthogeriatric models range from a single geriatrician review through shared care to treatment on a geriatric ward with orthopaedic consultation.²⁰ The NHFD records the time that patients are assessed by a geriatrician but does not distinguish between different models of care.

We were also only able to risk adjust using variables collected by the NHFD, which does not include specific co-morbidities. However, the ASA score provides a global measure of co-morbidity burden¹⁰ and has been shown to strongly predict mortality within the NHFD dataset.¹² We also could not report post-discharge outcomes, except for re-operation within 30 days. This was because the NHFD does not have high completion levels for post-discharge outcomes²¹ and linked mortality data from the Office for National Statistics could not be shared. However, a major strength of this paper is that the NHFD captured 95% of all hip fracture patients treated within England, Wales, and Northern Ireland during the study period.

In summary, outcomes for patients with hip fractures are equivalent between MTCs and non-MTCs. Contrary to earlier reports, there is no evidence on a national level that regionalisation of major trauma services in England has compromised the overall care of older adults with hip fractures.

References

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Table 1

	MTCs before designation	MTCs after designation	P*	Non-MTC hospitals	P**
Age (years)	82.5 (SD 8.4)	82.3 (SD 8.6)	0.040 [¥]	82.8 (SD 8.4)	<0.001 [¥]
Sex					
Male	6,103 (26.6%)	7,284 (28.8%)		64,219 (26.8%)	
Female	16,807 (73.4%)	18,040 (71.2%)	<0.001 [§]	175,889 (73.3%)	<0.001 [§]
Pre-morbid mobility					
Walking independently	10,453 (47.3%)	8,323 (49.9%)		91,987 (47.3%)	
Walking with one aid	5,781 (26.2%)	4,076 (24.5%)		48,869 (25.1%)	
Walking with two aids	5,307 (24.0%)	3,918 (23.5%)		48,936 (25.1%)	
Wheelchair or bedbound	546 (2.5%)	349 (2.1%)	<0.001 [§]	4,852 (2.5%)	<0.001 [§]
ASA score	3.0 (IQR 2.0-3.0)	3.0 (IQR 2.0-3.0)	0.439 [¥]	3.0 (IQR 2.0-3.0)	<0.001 [¥]
Pre-operative AMTS	9.0 (IQR 4.0-10.0)	9.0 (IQR 5.0-10.0)	<0.001 [¥]	10.0 (IQR 6.0-10.0)	<0.001 [¥]
Index of multiple deprivation	18.8 (IQR 10.4-34.9)	19.1 (IQR 10.7-34.8)	0.338 [¥]	16.0 (IQR 9.49-26.9)	<0.001 [¥]
Admission source					
Own home	16,951 (74.6%)	19,180 (76.3%)		180,815 (75.9%)	
Rehabilitation unit	172 (0.8%)	157 (0.62%)		1,575 (0.7%)	
Residential care	1,829 (8.1%)	2,642 (10.5%)		23,575 (9.9%)	
Residential/nursing care	1,505 (6.6%)	73 (0.3%)		7,654 (3.2%)	
Nursing care	1,026 (4.5%)	1,775 (7.1%)		15,070 (6.3%)	
Hospital	1,247 (5.5%)	1,319 (5.3%)	<0.001 [§]	9,407 (4.0%)	<0.001 [§]

Table 2

	Before	After	P
Time to ward (hours)‡	3.8 (3.0-4.8)	4.1 (3.5-6.0)	<0.001*
Time to geriatrician review (hours)‡	29.6 (17.6-60.6)	25.5 (16.8-47.9)	<0.001*
Time to operation (hours)‡	24.6 (13.67-41.9)	23.3 (17.8-35.5)	<0.001*
Length of stay (days)‡	15.0 (10.0-26.0)	15.0 (9.0-26.0)	0.005*
Pressure sores	4.0%	3.4%	0.001**
Discharge home	58.9%	64.4%	<0.001**
In-hospital mortality	8.8%	8.1%	0.006**
Reoperation within 30 days	1.2%	1.1%	0.214**

Table 3

	Before	After	P
Time to ward (hours)	-	-0.83 (-3.73 to 2.07)	0.575*
Time to geriatrician review (hours)	-	-5.40 (-14.94-4.15)	0.268*
Time to operation (hours)	-	-2.39 (-4.93-0.14)	0.064*
Length of stay (days)	-	0.62 (-1.79-3.04)	0.613*
Pressure sores	-	OR 0.85 (0.55-1.29)	0.434**
Discharge home	-	OR 1.31 (0.87-1.95)	0.193**
In-hospital mortality	-	OR 0.95 (0.82-1.11)	0.544**
Reoperation within 30 days	-	OR 0.97 (0.62-1.53)	0.904**

Table 4

	Non-MTCs	MTCs	P
Time to ward (hours)‡	4.1 (3.5-6.0)	4.0 (3.2-6.0)	<0.001*
Time to geriatrician review (hours)‡	25.4 (16.6-52.0)	25.5 (16.8-47.9)	<0.001*
Time to operation (hours)‡	24.2 (18.5-40.5)	23.3 (17.8-35.5)	<0.001*
Length of stay (days)‡	15.0 (9.0-26.0)	15.00 (9.0-26.0)	0.043*
Pressure sores	3.3%	3.4%	0.527**
Discharge home	64.4%	63.2%	0.002**
In-hospital mortality	8.8%	8.1%	0.006**
Reoperation within 30 days	1.2%	1.1%	0.064**

Table 5

	Non-MTCs	MTCs	P
Time to ward (hours)	-	-7.48 (16.40-1.45)	0.101*
Time to geriatrician review (hours)	-	-3.00 (-9.68-3.69)	0.380*
Time to operation (hours)	-	-1.39 (-3.92-1.15)	0.283*
Length of stay (days)	-	1.02 (-1.30-3.34)	0.389*
Pressure sores	-	1.02 (0.69-1.52)	0.691**

Discharge destination	-	1.15 (0.76-1.72)	0.510**
In-hospital mortality	-	0.90 (0.77-1.05)	0.188**
Reoperation within 30 days	-	0.96 (0.65-1.42)	0.836**

Captions

Table 1: Characteristics of patients treated in Major Trauma Centres (before and after MTC designation) and non-MTC hospitals. * MTCs before designation versus MTCs after designation; ** MTCs after designation versus non-MTC hospitals; ¥ Kruskal-Wallis one-way analysis of variance test; § Chi squared test; ASA score, pre-operative AMTS, and index of multiple deprivation presented as median with interquartile ranges.

Table 2: Quality indicators and clinical outcomes before and after MTC designation. * Kruskal-Wallis one-way analysis of variance test; ** Chi squared test; ¥ medians with interquartile ranges.

Table 3: Adjusted quality indicators and clinical outcomes before and after MTC designation. * generalised linear model (log-linked gamma distribution) with output as predicted mean difference with 95% confidence intervals; ** logistic multivariable regression with output as odds ratio and 95% confidence intervals; co-variates were age, sex, pre-morbid mobility, ASA score, pre-operative AMTS, index of multiple deprivation, and admission source. The latter was omitted from the “discharge home” model as collinear.

Table 4: Quality indicators and clinical outcomes in MTCs and non-MTCs. * Kruskal-Wallis one-way analysis of variance test; ** Chi squared test; ¥ medians with interquartile ranges.

Table 5: Adjusted quality indicators and clinical outcomes in MTCs and non-MTCs. * generalised linear model (log-linked gamma distribution) with output as predicted mean difference with 95% confidence intervals; ** logistic multivariable regression with output as odds ratio and 95% confidence intervals; co-variates were age, sex, pre-morbid mobility, ASA score, pre-operative AMTS, index of multiple deprivation, and admission source. The latter was omitted from the “discharge home” model as collinear.

Figure 1: Adjusted time to operation from generalised linear regression models. Diamonds represent the predicted mean difference (in hours) for each new MTC, horizontal lines 95% confidence intervals, and the square for all new MTCs overall. Institutions with too few observations for analysis were excluded.

Figure 2: Adjusted length of stay from generalised linear regression models. Diamonds represent the predicted mean difference (in hours) for each new MTC, horizontal lines 95% confidence intervals, and the square for all new MTCs overall. Institutions with too few observations for analysis were excluded.

Figure 3: Adjusted mortality from multivariable logistic regression models. Diamonds represent the predicted mean difference (in hours) for each new MTC, horizontal lines 95% confidence intervals, and the square for all new MTCs overall. Institutions with too few observations for multivariable analysis were excluded.