BRITISH JOURNAL OF HOSPITAL MEDICINE

ARTICLE

Evolution of Modern Acute Pathways to Evaluate Key Performance Indicators and Outcomes in Femoral Fragility Trauma

Panagiotis Konstantinou[1,*], Ashraf Amin Ariff[1], Charmaine Riley Nelson[1], Ahmed Hamed[1], Panteleimon Tsantanis[1], Niraj Vetharajan[1], Anastasios P Nikolaides[1,*]

[1]University Hospitals Birmingham, NHS Foundation Trust, Birmingham, UK
*Correspondence: panagiotis.konstantinou@gmail.com (Panagiotis Konstantinou); anastasios.nikolaidis@uhb.nhs.uk (Anastasios P Nikolaides)

Abstract

Aims/Background The prevalence of fragility neck of femur (NOF) fractures among the elderly poses significant healthcare challenges. The Best Practice Tariff (BPT) was introduced to improve care standardization and outcomes for these high-risk patients. This study evaluates the effectiveness of transferring NOF fracture management to a specialized facility, focusing on BPT adherence, efficiency, and patient outcomes.

Methods Employing a mixed-method cohort design, the study contrasted retrospective data pre-transition with prospective data post-transfer from Queen Elizabeth Hospital Birmingham (QEHB) to Birmingham Heartlands Hospital (BHH). A pivotal change was the introduction of a standardized electronic NOF Fracture Proforma. Comparison of demographic data, BPT adherence, 30-day mortality and post-operative care was made.

Results The move to BHH resulted in a significant rise in BPT compliance rising from 40.5% at QEHB to 59.9% at BHH ($p < 0.001$), as well as a higher percentage of patients reaching operating theatres within 36 hours ($p < 0.001$). Despite improved adherence and operational efficiencies, no statistically significant reduction in 30-day mortality was observed.

Conclusion NOF fracture management relocation to BHH yielded higher BPT compliance and greater operational efficiency. The lack of significant mortality reduction underlines the multifaceted nature of influencing patient outcomes. Specialized, multidisciplinary care has the potential to elevate the standard of patient care for NOF fractures, but continuous service optimization is critical for significant outcome improvements.

Key words: hip fractures; osteoporotic fractures; patient care; critical pathways; treatment outcome

Submitted: 23 September 2024 Revised: 30 January 2025 Accepted: 6 February 2025

How to cite this article:
Konstantinou P, Ariff AA, Nelson CR, Hamed A, Tsantanis P, Vetharajan N, Nikolaides AP. Evolution of Modern Acute Pathways to Evaluate Key Performance Indicators and Outcomes in Femoral Fragility Trauma. Br J Hosp Med. 2025. https://doi.org/10.12968/hmed.2024.0681

Introduction

Fragility neck of femur (NOF) fractures represents a prevalent and consequential orthopaedic condition predominantly affecting the geriatric population (Marsh et al, 2007). Characterized by a fracture in the proximal femur, these injuries often occur due to low-energy trauma in individuals with compromised bone strength, frequently associated with osteoporosis (Sözen et al, 2017). Despite advancements

in surgical techniques and perioperative care, neck of femur fragility fractures remain a significant healthcare challenge due to their profound impact on morbidity and mortality rates among affected individuals.

The mortality and morbidity rates following neck of femur fragility fractures are notably high, constituting a critical concern in clinical management and public health strategies. The mortality rate following a hip fracture within the initial 30 days continues to be substantial, ranging between 8% and 10% (Iliopoulos et al, 2024; Konstantinou et al, 2024). Furthermore, the one-year mortality rate post-fracture is approximately 20% to 21% (Ferris et al, 2023). Moreover, mortality rates extend beyond the immediate postoperative period, with substantial excess mortality observed in the long term, often attributed to complications such as pneumonia, cardiovascular events, and immobility-related complications like deep vein thrombosis and pressure ulcers (Friedman et al, 2008).

In addition to mortality, neck of femur fragility fractures impose a substantial burden of morbidity on affected individuals, leading to diminished functional independence, reduced quality of life, and increased healthcare utilisation (Baghdadi et al, 2023; Konstantinou et al, 2024). Common complications include postoperative delirium, surgical site infections, acute respiratory distress syndrome, and prolonged hospital stays, further exacerbating the physical and psychological toll on patients. Moreover, the substantial socioeconomic implications stemming from prolonged rehabilitation, institutionalisation, and long-term care requirements underscore the multifaceted impact of these fractures on both individuals and healthcare systems.

As longevity indices augment globally, the prevalence of trauma-related presentations in medical settings is poised to escalate, disproportionately so within geriatric demographics. Projections articulated by Gullberg et al (1997), in the late 20th century intimated a potential doubling of femoral fracture incidences by the quarter-century mark from the baseline in 1990, with a subsequent duplication forecasted by the year 2050, estimating a global burden of 7.3 to 21.3 million fractures. Complementary analyses have postulated an upsurge from 1.26 million incidents in 1990 to 4.5 million by 2050. Specifically, fractures at the proximal end of the femur represent a salient clinical challenge due to their correlation with heightened morbidity and mortality rates, alongside the prodigious economic implications stemming from extended inpatient care and the imperative for rehabilitative services (Walter et al, 2023).

Neck of femur fragility fractures impose substantial direct healthcare costs in the UK, encompassing hospitalization, surgical interventions, rehabilitation services, and post-acute care. A study by Leal et al (2016) estimated the annual cost of osteoporosis-related hip fractures in the UK to be €5.32 billion, with neck of femur fractures comprising a significant proportion of this expenditure.

The National Hip Fracture Database (NHFD) is a pivotal initiative designed to facilitate the continuous improvement of care for patients suffering from hip fractures. Established in the United Kingdom, the NHFD operates as a comprehensive audit program, meticulously gathering, analysing, and reporting data on the management and outcomes of hip fracture treatments across hospitals (Johansen et al,

2017). This initiative plays a crucial role in enhancing patient care by identifying areas of excellence and opportunities for improvement in the treatment protocols for one of the most common and impactful injuries among the elderly population.

This data-driven approach informed the development of the Best Practice Tariff (BPT), which financially incentivizes hospitals to adhere to specified best practice standards, thus aiming to standardize care, improve patient outcomes, and reduce mortality and morbidity associated with hip fractures. The BPT is a policy instrument designed to align hospital reimbursement with the quality of care delivered, thereby encouraging healthcare providers to adopt evidence-based practices and protocols for the management of hip fractures.

The BPT was introduced in 2010 and subsequently expanded in 2011, offering a financial bonus of €1615 per patient (Oakley et al, 2017). This bonus is awarded to hospitals when they meet specific quality indicators, which include criteria such as time to surgery within 36 hours of arrival, admission under joint care of a consultant geriatrician and orthopaedic surgeon, using an agreed assessment protocol, and perioperative assessment by a geriatrician. These quality indicators serve as a standard measure to assess the level of care provided. Achieving the BPT criteria was associated with a significant reduction in 30-day mortality, a survival benefit at 1 year, and a decrease in the time from admission to theatre. Of the BPT criteria, abbreviated mental test (AMT) monitoring and expedited surgery significantly influenced survival.

With an annual occurrence of approximately 80,000 hip fractures, the NHS has faced significant challenges, which have led to an integration of orthopaedic and geriatric care models to better manage these complex cases (Baker et al, 2014). The BPT's financial incentives are particularly valuable during economically challenging times as they not only provide immediate fiscal benefits but can also result in cost savings through more efficient care leading to shorter hospital stays and expedited surgical times.

The purpose of this research is to assess the outcomes of shifting femoral neck fracture treatment to a specialised facility, separate from the main major trauma unit, where more severe injuries take precedence. Such prioritization often relegates femoral neck fractures lower on the treatment list, leading to missed Best Practice Tariff targets, particularly the crucial within 36 hours surgery window. By transferring these cases to a designated hospital trust, the study will evaluate whether concentrating care in this manner improves patient results. This will include a review of operational efficiency, enhanced quality of post-operative care, and improved rehabilitation services in a setting that is not a large trauma centre. Ultimately, this investigation will determine if dedicated treatment of femoral neck fractures away from the demands of a major trauma centre can lead to superior medical attention and better recovery outcomes for patients.

Methods

General Information

University Hospitals Birmingham (UHB) NHS Foundation Trust, encompassing the major Level 1 Trauma centre Queen Elizabeth Hospital Birmingham (QEHB) and several other key facilities, is one of the largest teaching hospitals in the UK, treating up to 1300 neck of femur (NOF) fracture patients per year, which makes it one of the most significant NOF fracture services in the country. Historically, the QEHB has been the primary site for managing these cases. However, the Covid-19 pandemic precipitated a re-evaluation of this structure as all trauma patients, including those with fragility fractures, were directed to QEHB. This resulted in a dramatic failure to meet the major Key Performance Indicators (KPIs) of the BPT, with the workflow for fragility fractures often being deprioritized in favor of major trauma patients. Consequently, in October 2021, a strategic decision was taken to redesign the fragility fracture service, transitioning it away from the overstretched facilities at QEHB and redirecting the service to Birmingham Heartlands Hospital (BHH). In the background of the reconfigured fragility fracture service at University Hospitals Birmingham (UHB) NHS Foundation Trust, an ambitious pathway improvement project was initiated.

Methodology

Study Design

The study employed a mixed-method cohort design, incorporating both retrospective and prospective data collection methodologies. Initially, retrospective data were gathered to analyse the status of care prior to the transition of services from the Queen Elizabeth Hospital Birmingham (QEHB) to the Birmingham Heartlands Hospital (BHH) from October 2020 to October 2021. Subsequent to this service relocation away from the primary trauma centre, the research team, comprised of multidisciplinary experts, developed a standardized electronic version of the neck of femur (NOF) fracture proforma (See Appendix 1). The principal objective of the NOF fracture proforma was to homogenize the care pathway for patients with fragility fractures of the femur and to expedite their readiness for surgical intervention, aiming to meet the crucial threshold of surgery within 36 hours post-admission.

Upon the establishment of the new proforma, the study transitioned to a prospective data collection phase. This phase involved the systematic gathering of data post-implementation of the proforma and other integrated care improvements from October 2021 to October 2022. This methodology was chosen because it enabled a comparative analysis of pre- and post-intervention periods, thereby assessing the efficacy of the implemented changes in patient care and outcomes. The procedures were compliant with the institutional guidelines and the Declaration of Helsinki. After consultation with the UHB NHS Foundation Trust Clinical Research Committee (Research Ethics Service), the study does not require an approval number as it is not a research project but a retrospective evaluation of the new fragility service. All data were deidentified and anonymized throughout the analysis. The require-

ment for informed consent was waived by the Ethics Committee of UHB and the Research Governance Lead Committee.

Patients Enrolled the Study

All patients aged 60 years old and above presenting with fragility proximal femoral fracture following a low energy trauma at UHB are included in this study. In scenarios where patients presented to other hospitals within the trust [i.e., QEHB or Good Hope Hospital (GHH)], patients are then transferred directly to the Accident & Emergency (A&E) department in BHH after discussion between the Trauma & Orthopaedics (T&O) on-call team on both sites. The patients are then immediately seen by the T&O on-call team upon arrival where the NOF proforma is completed and are prepared for surgical intervention. The remainder of the BPT criteria is implemented throughout the inpatient stay.

Patients who are younger than 60 years old and presented with high energy trauma was excluded and transferred to QEHB to undergo further management. Patients who are deemed unsuitable for surgical management (i.e., patient who are medically unstable, died or opted for non-operative management) or not eligible for BPT are excluded from the data collection. A total of 2344 patients were admitted for NOF fractures during the study period in both sites. A total of 120 patients were excluded as not eligible for BPT and therefore 2224 patients were enrolled in our study (Fig. 1).

Data Collected

We have collected data regarding: age, gender, fracture type according to Arbeitsgemeinschaft für Osteosynthesefragen/Orthopedic Trauma Association (AO/OTA) classification (see Appendix 2), abbreviated mental test (AMT10) score (see Appendix 3), American Society of Anesthesiologists (ASA) score, reason for delayed operation, type of operative procedure, post-op physiotherapy mobilization, post-op bone protection plan, post-op destination, compliance with BPT protocol, reaching theatre within 36 hours, length of hospital stay, delirium assessment, orthogeriatrician review, physiotherapy assessment and 30-day mortality.

Statistical Analysis

Data were analysed for compliance with the KPIs for BPT set by the NHFD and 30-day mortality using statistical software SPSS 21.0 (IBM, Armonk, NY, USA). Normal distribution consistency was assessed using the Kolmogorov-Smirnov test. Categorical variables are presented by total number and frequencies while continues variables with mean and standard deviation. Comparisons between the two groups were conducted using *t*-tests for quantitative values and chi-square tests for categorical values. A *p*-value of <0.05 was considered statistically significant. Undisplaced intracaapsular (IC) was not statistically analyzed because the number of undisplaced IC cases is low, likely due to an omission in classification, which could lead to misleading results.

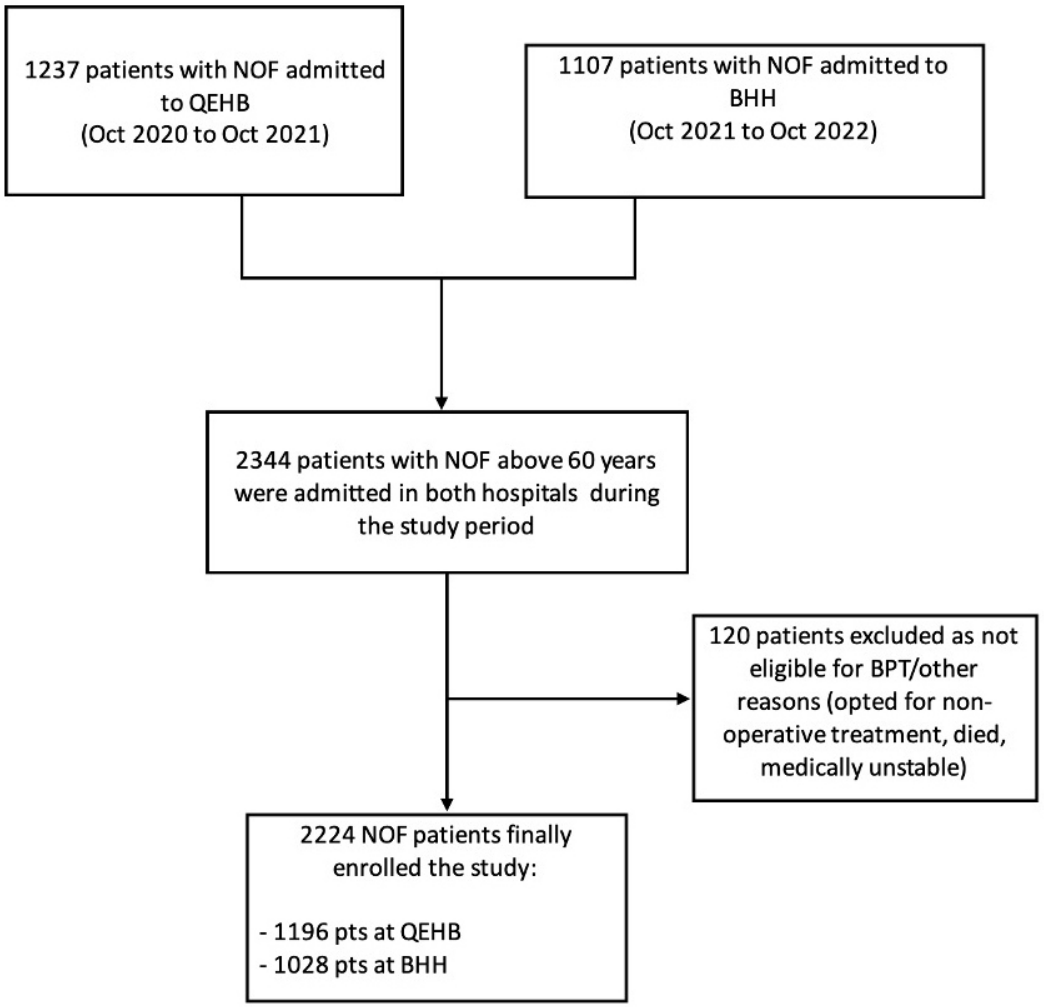

Fig. 1. Patients enrolled the study. Notes: QEHB, Queen Elisabeth Hospital Birmingham; BHH, Birmingham Heartlands Hospital; BPT, Best Practice Tariff; NOF, neck of femur.

Results

Demographics and Clinical Characteristics

From October 2020 to October 2022, a total of 1237 patients with NOF fractures were admitted to QEHB and 1107 were admitted to BHH. Among these, 1196 patients were deemed eligible for the Best Practice Tariff (BPT) at the QEHB site and 1028 at BHH, who were finally enrolled in the study. The mean age, gender, type of fracture, and AMT10 score showed no statistically significant differences. Due to the high rate of unrecorded ASA scores at QEHB, we decided not to perform a comparison of this score between the two sites, as it may lead to biased conclusions. The average age and gender distribution remained relatively consistent between the two settings, suggesting that the patient populations were comparable. A slight shift in fracture types treated was observed, with BHH treating a slightly lower percentage of subtrochanteric A3 and displaced IC fractures. A significant difference noted in Intertrochanteric A1/A2 and Extraarticular distal femoral and femoral shaft fractures. All the relevant data are presented in Table 1.

Table 1. Demographics data of patients enrolled the study.

Variable	QEHB (n = 1196)	BHH (n = 1028)	*p*-value	χ^2/t
Average age (mean ± SD)	82.9 ± 7.4	82.4 ± 8.1	0.130	1.521
Gender (Female)	834 (69.7%)	701 (68.2%)	0.433	0.614
Type of fractures	n = 1146	n = 1021		
Intertrochanteric A1/A2	434 (37.9%)	335 (32.8%)	0.014	6.038
Subtrochanteric A3	44 (3.8%)	35 (3.4%)	0.610	0.260
Undisplaced IC	1 (0.001%)	79 (7.7%)	-	-
Displaced IC	636 (55.5%)	559 (54.8%)	0.726	0.122
Extraarticular distal femoral and femoral shaft	31 (2.7%)	13 (1.3%)	0.018	5.565
Unrecorded	50	7		
Average AMT10 score on admission	7 ± 2.6	7.2 ± 2.4	0.060	–1.874
AMT10 score <7	355 (29.7%)	298 (29%)	0.720	0.128
ASA score				
≤2	116 (9.7%)	170 (16.5%)	-	-
3	592 (49.5%)	668 (65%)	-	-
4	163 (13.6%)	121 (11.8%)	-	-
Unrecorded	324 (27.1%)	67 (6.5%)	-	-

Notes: 50 type of fracture out of 1196 were unrecorded in QEHB and 7 out of 1028 in BHH. IC, intracapsular; AMT10, abbreviated mental test 10; ASA, American Society of Anesthesiologists.

BPT and KPIs Comparison

Out of 1196 patients at QEHB, 484 (40.5%) completed the entire BPT protocol. In contrast, during the same timeframe, 616 out of 1028 patients (59.9%) at BHH achieved full compliance with the BPT protocol, representing a statistically significant increase ($p < 0.001$) in compliance rates. This can be attributed by the introduction of a standardised admission NOF fracture electronic proforma which takes into account of all the BPT criteria, ensuring that patients will receive standardised care and optimisation peri-operatively.

Comparison of the time taken to reach the operating theatre within 36 hours revealed a statistically significant rise in the percentage of patients undergoing surgery within this timeframe, increasing from 46.9% to 65.6% ($p < 0.001$), indicating enhanced operational efficiency and potentially contributing to improved patient outcomes.

Other outcomes, including length of hospital stay (16 days vs. 16.3 days), orthogeriatrician review (99.4% vs. 99.3%), and physiotherapy assessment (96% vs. 96.3%), exhibited slight variability but did not reach statistical significance with the exception of the delirium assessment (88.5% vs. 92.3%) that showed a significant improvement ($p = 0.002$). Although the average length of hospital stay showed a slight increase at BHH, this did not reach statistical significance ($p = 0.070$), suggesting that the increased BPT compliance and operational efficiencies did not adversely affect the length of stay.

Table 2. Comparison of BPT data before and after service relocation.

Variable	QEHB (n = 1196)	BHH (n = 1028)	*p*-value	χ^2/t
Compliance with BPT protocol (%)	484 (40.5%)	616 (59.9%)	<0.001	83.698
Reaching theatre within 36 hours (%)	561 (46.9%)	674 (65.6%)	<0.001	77.933
Length of hospital stay (mean ± SD)	16 ± 3.7	16.3 ± 4.1	0.070	1.810
Delirium assessment (%)	1058 (88.5%)	949 (92.3%)	0.002	9.324
Orthogeriatrician review (%)	1189 (99.4%)	1021 (99.3%)	0.777	0.080
Physiotherapy assessment (%)	1148 (96%)	990 (96.3%)	0.700	0.149
30-day mortality (%)	127 (10.6%)	83 (8.1%)	0.041	4.188

Notes: BPT, Best Practice Tariff.

Table 3. Reason for operation delays.

Reason for delay (%)	QEHB n = 635 (%)	BHH n = 354 (%)	*p*-value	χ^2
Awaiting space in theatre	316 (49.8%)	51 (14.4%)	<0.001	121.749
Cancelled/list down	50 (7.9%)	13 (3.7%)	0.010	6.727
Awaiting medical review/investigation	112 (17.6%)	102 (28.8%)	<0.001	16.743

Mortality

A decrease in 30-day mortality was observed (from 10.6% at QEHB to 8.1% at BHH) and this change was statistically significant ($p = 0.041$). This outcome suggests that as the overall patient management may have improved, it could lead to a statistically significant reduction in short-term mortality.

All the above data are displayed in Table 2.

Further investigation into the reasons for delays in undergoing surgery within the first 36 hours showed that the main issue appeared to be waiting for space in theatres, and this difference was significant ($p < 0.001$), as presented in Table 3.

Operative Methods

No statistically significant differences were observed in the treatment choices for neck of femur fractures between the two sites, except for a preference for short nailing over sliding hip screws (SHS) as the fixation method in BHH compared to QEHB (Table 4). This could reflect differences in clinical judgment, patient selection, or available surgical expertise.

Post-Operative Care and Outcomes

Post-operative physiotherapy mobilisation, orthogeriatrician assessment and delirium assessment rates showed improvement since the service transfer, however, were not statistically significant. Bone protection plan strategies varied, with BHH utilizing a broader range of medications, indicating a potentially more aggressive approach to osteoporosis management post-fracture. The transition to post-operative destinations shows a significant greater percentage of patients returning directly to their pre-injury residence from BHH ($p < 0.001$), which may reflect

Table 4. Operations performed for NOF fracture in each site.

Operative procedure	QEHB n = 1196 (%)	BHH n = 1028 (%)	*p*-value	χ^2
THR	74 (6.2%)	50 (4.9%)	0.175	1.839
Hemiarthroplasty (cemented)	349 (29.2%)	325 (31.6%)	0.213	1.551
Hemiarthroplasty (uncemented)	195 (16.3%)	152 (14.8%)	0.325	0.968
Cannulated screws	8 (0.7%)	10 (1%)	0.425	0.636
SHS	208 (17.4%)	122 (11.9%)	<0.001	13.347
Cephalomedullary nail (short)	49 (4.1%)	131 (12.7%)	<0.001	55.56
Cephalomedullary nail (long)	283 (23.7%)	211 (20.5%)	0.076	3.148
Others (combination of plates/nails/screws/cables)	31 (2.6%)	27 (2.6%)	0.964	0.002

Notes: THR, Total Hip Replacement; SHS, sliding hip screws.

differences in discharge planning, availability of rehabilitation services, or patient condition at discharge. Post operative care/measures are presented below in Table 5.

Discussion

Oakley et al (2017) conducted an observational analysis that scrutinized the ramifications of BPT adherence on the prognoses of patients suffering from hip fractures, with an investigative lens on mortality rates and hospitalization durations. The introduction of BPT, as posited by the study, while not radically altering the aggregate outcomes, was concomitant with a decrement in mortality rates and an augmentation in survival probabilities. These associations postulate the indispensability of stringent BPT criteria compliance for ameliorating patient outcomes post-hip fracture, thus reinforcing the exigency of individualized patient factors and the procedural care continuum, which constitute the conceptual bedrock of the present research inquiry. In our study, however, the increased compliance with BPT was not accompanied by a significant decrease in 30-day mortality. Another study by Whitaker et al (2019) showed that adherence to BPT reduced the relative risk of 1-year mortality by 10.3% in patients with fractured neck of femur. Additionally, meeting BPT criteria was associated with a 30% increase in the odds of 1-year post-op survival (Whitaker et al, 2019). Similar results were found in a study by Metcalfe et al (2019), which showed that both 30-day and 365-day post-intervention mortality for neck of femur fractures significantly decreased in England compared to Scotland, as the former participated in a pay-for-performance program while the latter did not. Similar improvements in mortality outcomes have been observed in other countries where Hip Fracture Standards for the delivery of care for neck of femur fractures are in place (Murphy et al, 2024). Adherence to BPT not only appears to improve mortality but also enhances quality of life, as patients who met BPT indicators had higher scores on the EuroQol five-dimension, five-level questionnaire (EQ-5D-5L) four months post-op (Griffin et al, 2021). However, a study suggests that adherence to BPT does not necessarily guarantee improved mortality outcomes in patients undergoing surgery for hip fractures (Khan et al, 2014).

Table 5. Post-operative data for physiotherapy, bone protection and discharge destination.

Variable	QEHB n = 1196 (%)	BHH n = 1028 (%)	*p*-value	χ^2
Post-op physiotherapy mobilisation	1017 (85%)	872 (84.8%)	0.890	0.019
Post-op bone protection plan				
Alendronate	330 (27.6%)	187 (18.2%)	-	-
IV zoledronate	0	219 (21.3%)	-	-
Denosumab	0	20 (1.9%)	-	-
Alfacalcidol/calcitriol	120 (10%)	38 (3.7%)	-	-
Patients under bone protection treatment	550 (46.7%)	464 (45.5%)	0.563	0.334
Assessed—no medication required	317 (27.0%)	327 (32.1%)	0.008	6.942
Pending DEXA result	309 (26.3%)	228 (22.4%)	0.034	4.495
Missing data	20	9		
Post-op destination	n = 1056	n = 1000		
Pre-injury residence	639 (60.5%)	677 (67.7%)	<0.001	11.521
Rehabilitation facility	384 (36.4%)	280 (28.0%)	<0.001	16.431
Dead	33 (3.1%)	43 (4.3%)	0.158	1.992
Missing data	140	28		

Notes: The total number for post-op destination is n = 1056 in QEHB and n = 1000 in BHH as there are missing data for 140 patients in QEHB and for 28 patients in BHH. The total number for bone protection category is n = 1196 in QEHB and n = 1128 in BHH as there are missing data for 20 patients in QEHB and for 7 patients in BHH. IV, intravenous; DEXA, Dual-energy X-ray absorptiometry.

The strategic transference of the fragility fracture service from Queen Elizabeth Hospital Birmingham to Birmingham Heartlands Hospital within a specialized trust delineated an augmentative shift in clinical praxis. The instantiation of a dedicated multidisciplinary service at BHH, with an emphasis on preoperative condition optimization, was reflected in a discernible amelioration in BPT adherence. Analytical scrutiny of this transition evidences a pronounced increment in the incidence of neck of femur (NOF) fracture patients undergoing timely surgical interventions within a 36-hour window subsequent to admission, with a prevalence ascending to 65.6%—a figure that surpasses the national average documented by the National Hip Fracture Database. Similar results, specifically improvements in surgical delays, have been reported in another study involving the development of regional pathways and collaboration between hospitals for managing trauma patients (Ahmed et al, 2023). The importance of performing surgery early after injury to reduce mortality rates in these patients is also supported by other studies (Keohane et al, 2022; Locke et al, 2024; Warren et al, 2024). Despite these findings, in our study, the improvement in achieving intervention within the first 36 hours did improve the 30-day mortality rate, but not to a significant extent. This may be attributed to the lack of a multivariate regression analysis.

The deployment of a uniform electronic proforma for NOF fracture patient management assures a homogenized approach to surgical assessment and preparation. This standardization conveys a plethora of benefits:

• Uniformity in Clinical Care: The proforma guarantees comprehensive preoperative assessments and preparations, culminating in a consistent calibre of patient care.

• Operational Efficiency: The digital proforma engenders a more streamlined data capture process, engendering an accelerated preoperative workflow and thus facilitating more prompt surgical scheduling.

• Data Integrity and Accessibility: Electronic records proffer enhanced data dissemination within the multidisciplinary cohort, fostering superior coordination, facilitating progress tracking, and ensuring facile information updates.

• Analytic Enhancement: Electronic data repositories allow for robust data analytics, enabling trend identification, performance monitoring, and the derivation of quality improvement stratagems.

• Diminished Variability-Induced Risk: The uniformity introduced by the proforma potentially mitigates the risk of complications, contributing to an overall improvement in patient outcomes.

The ascension in BPT conformity, subsequent to the electronic proforma's induction at BHH, is indicative of the tool's substantive contribution to fostering a consistent application of prescribed practices and protocols. It has ostensibly propelled operational efficiency and is correlated with an enhancement in patient surgical outcomes. Similarly to our findings, the implementation of an electronic pathway for hip fracture patients led to a significant reduction in delays to surgery, but did not affect hospital length of stay, according to a recent study (Talevski et al, 2020).

Concomitant with these enhancements was the allocation of two dedicated trauma and orthopaedic wards at BHH, specifically for NOF fracture patients, alongside the establishment of designated daily theatres for such cases. Despite these service provision, the duration of hospital stays exhibited statistical invariance between comparative cohorts, highlighting the intricate web of factors that govern the hospitalization timeline, including the comprehensive amalgamation of postoperative services.

Furthermore, since the BPT was implemented, there has been a noticeable trend toward lower mortality rates within 30 days for patients with neck of femur fractures. This improvement is partly due to the combined efforts of the National Hip Fracture Database (NHFD) and BPT initiatives. The partnership between orthogeriatricians and orthopaedic surgeons is enhancing the speed and effectiveness of care for these patients (Tarazona-Santabalbina et al, 2021). Research in the field of geriatric orthopaedics supports the idea that coordinated care approaches lead to better clinical results, including lower mortality rates and improved performance on other key measures of quality. A recent publication suggests that implementing a multidisciplinary team approach that addresses not only the fracture but also considers the acute post-operative condition, rehabilitation planning, bone health optimization, fall prevention, nutritional support, and venous thromboembolism (VTE) prophylaxis can lead to improved outcomes and help prevent future fracture recurrence (Unnanuntana et al, 2023). Additionally, a multidisciplinary team comprising orthopaedic surgeons, emergency room traumatologists, anaesthetists, car-

diologists, rehabilitation physicians, neurologists, geriatricians, and osteoporosis treatment specialists can lead to not only improved outcomes but also reduced medical costs one year post-operatively for geriatric proximal femur fractures (Li et al, 2022). Similarly in our Trust, the restructured service model at BHH, characterized by dedicated wards and theatres, epitomizes a targeted and methodical paradigm for addressing the intricacies of NOF fracture cases. The orthogeriatric care model has played a pivotal role in these achievements, with the cross-disciplinary collaboration remaining foundational for the optimization of patient care and the enhancement of clinical outcomes.

However, it's important to recognize that while the BPT has incentivized improvements in care, its impact on overall organizational outcomes has been debated. A study suggests that while the introduction of BPT has not led to substantial improvements at the organizational level, patients who met all BPT criteria did experience better outcomes (Whitaker et al, 2019). This distinction underscores the potential of BPT to improve individual patient care when its criteria are fully met, yet it also points to the complexity of organizational change and the need for ongoing evaluation and adjustment of quality improvement strategies. The synergy of clinical standards set by the NHFD, alongside the financial incentives of BPT, is aimed at raising the bar of care for hip fracture patients across the UK (Neuburger et al, 2015) Despite mixed evidence regarding the impact on organizational outcomes, the approach serves as an economic opportunity to invest in healthcare improvements that can yield both direct patient benefits and long-term cost savings for the healthcare system.

Based on our findings, future research should focus on how the establishment of a specialized hospital dedicated to treating fragility hip fractures affects mortality, functional outcomes, and quality of life in such patients. Additionally, further investigations are needed to explore how a multidisciplinary team improves the healthcare services provided to NOF patients and which members should be included in this team. Another area that warrants investigation is whether the formation of care pathways and adherence to specific guidelines for optimizing preoperative care and providing appropriate treatment within the first 36 hours is a cost-effective approach.

Strengths and Limitations

The mixed-method approach of our study is a significant strength, as it enables a comparison between pre- and post-transition data. Additionally, the relatively large number of patients included further strengthens the study. However, there are several limitations: we did not explore comorbidities that could influence mortality rates, nor did we assess the quality of post-operative care or the multidisciplinary interventions in either hospital. Another limitation is the variability introduced by having a large number of surgeons performing the operations. Moreover, the study period was relatively short, with limited follow-up regarding mortality. Finally, as this study was conducted within a single specialized trust, the results may not be generalizable to other hospitals.

Conclusion

The transition of the fragility fracture service to BHH was marked by increased efficiency and BPT compliance, demonstrating the benefits of a dedicated, resource-specific approach. This transition of services significantly increased the number of patients receiving operative treatment within 36 hours post-injury and significantly reduced delays caused by waiting for theatre availability.

Continual evaluation and adaptation of service structure and care processes are necessary to achieve significant improvements in patient outcomes, including mortality rates. The findings underscore the potential of specialized, multidisciplinary services in enhancing the quality of patient care for those presenting with NOF fractures.

Key Points

- The transition to an organized fragility fracture service led to increased efficiency and improved compliance with BPT, demonstrating the benefits of a dedicated, resource-specific approach.
- With such a fragile fracture service, a significant reduction in delays related to theatre space availability was observed, potentially reflecting improvements in resource management and scheduling practices.
- While hospital stay durations and mortality rates did not show statistically significant changes, the overall trend towards improvement suggests a positive trajectory in patient outcomes.
- Ongoing assessment and adjustment of service structures and care processes are essential for achieving meaningful improvements in patient outcomes, including mortality rates.

Availability of Data and Materials

All data included in this study are available from the corresponding authors upon reasonable request.

Author Contributions

AN, PT and NV designed the research. PK, AA, AH, and PT performed the research. PK, AA, CN and NV analyzed the data. PK and AA drafted the manuscript. All authors contributed to important editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

After consultation with the UHB NHS Foundation Trust Clinical Research Committee (Research Ethics Service), the study does not require an approval number as it is not a research project but a retrospective evaluation of the new fragility

service. It was conducted according to the tenets of the Declaration of Helsinki. All data were deidentified and anonymized throughout the analysis. The requirement for informed consent was waived by the Ethics Committee of UHB and the Research Governance Lead Committee.

Acknowledgement

Not applicable.

Funding

This research received no external funding.

Conflict of Interest

The authors declare no conflict of interest.

References

Ahmed HE, Baldock T, Wei N, Walshaw T, Walker R, Trompeter A, et al. Lack of regional pathways impact on surgical delay: Analysis of the Orthopaedic Trauma Hospital Outcomes-Patient Operative Delays (ORTHOPOD) study. Injury. 2023; 54: 111007. https://doi.org/10.1016/j.injury.2023.111007

Baghdadi S, Kiyani M, Kalantar SH, Shiri S, Sohrabi O, Beheshti Fard S, et al. Mortality following proximal femoral fractures in elderly patients: a large retrospective cohort study of incidence and risk factors. BMC Musculoskeletal Disorders. 2023; 24: 693. https://doi.org/10.1186/s12891-023-06825-9

Baker PN, Salar O, Ollivere BJ, Forward DP, Weerasuriya N, Moppett IK, et al. Evolution of the hip fracture population: time to consider the future? A retrospective observational analysis. BMJ Open. 2014; 4: e004405. https://doi.org/10.1136/bmjopen-2013-004405

Ferris H, Merron G, Coughlan T. 1 year mortality after hip fracture in an Irish urban trauma centre. BMC Musculoskeletal Disorders. 2023; 24: 487. https://doi.org/10.1186/s12891-023-06605-5

Friedman SM, Mendelson DA, Kates SL, McCann RM. Geriatric co-management of proximal femur fractures: total quality management and protocol-driven care result in better outcomes for a frail patient population. Journal of the American Geriatrics Society. 2008; 56: 1349–1356. https://doi.org/10.1111/j.1532-5415.2008.01770.x

Griffin XL, Achten J, Parsons N, Costa ML, WHiTE collaborators. Does performance-based remuneration improve outcomes in the treatment of hip fracture? The Bone & Joint Journal. 2021; 103-B: 881–887. https://doi.org/10.1302/0301-620X.103B5.BJJ-2020-1839.R1

Gullberg B, Johnell O, Kanis JA. World-wide projections for hip fracture. Osteoporosis International. 1997; 7: 407–413. https://doi.org/10.1007/pl00004148

Iliopoulos E, Tosounidis T, Moustafa RM, Tilkidis F, Daskalakis I, Melissaridou D, et al. The use of minimum common data set in the development of the Greek Fragility Hip Fracture Registry in the Greek health care setting: the first year of its pilot implementation. Archives of Osteoporosis. 2024; 19: 85. https://doi.org/10.1007/s11657-024-01443-x

Johansen A, Boulton C, Hertz K, Ellis M, Burgon V, Rai S, et al. The National Hip Fracture Database (NHFD) - Using a national clinical audit to raise standards of nursing care. International Journal of Orthopaedic and Trauma Nursing. 2017; 26: 3–6. https://doi.org/10.1016/j.ijotn.2017.01.001

Keohane D, Downey C, Sheridan GA, O'Kelly P, Quinlan JF. Hip fracture surgery within 36 hours reduces both 30-day and 1-year mortality rates. The Surgeon. 2022; 20: 262–267. https://doi.org/10.1016/j.surge.2021.05.008

Khan SK, Shirley MDF, Glennie C, Fearon PV, Deehan DJ. Achieving best practice tariff may not reflect improved survival after hip fracture treatment. Clinical Interventions in Aging. 2014; 9: 2097–2102.

https://doi.org/10.2147/CIA.S65736

Konstantinou P, Kostretzis L, Fragkiadakis G, Touchtidou P, Mavrovouniotis A, Davitis V, et al. Exploring Quality of Life and Mortality in Pertrochanteric Fragility Hip Fractures in Northern Greece: A Single Tertiary Center Study. Journal of Clinical Medicine. 2024; 13: 2478. https://doi.org/10.3390/jcm13092478

Leal J, Gray AM, Prieto-Alhambra D, Arden NK, Cooper C, Javaid MK, et al. Impact of hip fracture on hospital care costs: a population-based study. Osteoporosis International. 2016; 27: 549–558. https://doi.org/10.1007/s00198-015-3277-9

Li Y, Tung KK, Cho YC, Lin SY, Lee CH, Chen CH. Improved outcomes and reduced medical costs through multidisciplinary co-management protocol for geriatric proximal femur fractures: a one-year retrospective study. BMC Geriatrics. 2022; 22: 318. https://doi.org/10.1186/s12877-022-03014-6

Locke S, Doonan J, Jones B. Advancements in the Management of Fragility Fractures in Orthopaedic Patients. Cureus. 2024; 16: e74065. https://doi.org/10.7759/cureus.74065

Marsh D, Colin C, Brown P, Cooper A, Elliott J, Griffiths R, et al. The Care of Patients with Fragility Fracture. British Orthopaedic Association. 2007.

Metcalfe D, Zogg CK, Judge A, Perry DC, Gabbe B, Willett K, et al. Pay for performance and hip fracture outcomes: an interrupted time series and difference-in-differences analysis in England and Scotland. The Bone & Joint Journal. 2019; 101-B: 1015–1023. https://doi.org/10.1302/0301-620X.101B8.BJJ-2019-0173.R1

Murphy EP, Murphy RP, McKenna D, Miller P, Doyle R, Hurson C. Improved adherence to hip fracture standards reduces mortality after hip fractures. The Surgeon. 2024; 22: 25–30. https://doi.org/10.1016/j.surge.2023.06.007

Neuburger J, Currie C, Wakeman R, Tsang C, Plant F, De Stavola B, et al. The impact of a national clinician-led audit initiative on care and mortality after hip fracture in England: an external evaluation using time trends in non-audit data. Medical Care. 2015; 53: 686–691. https://doi.org/10.1097/MLR.0000000000000383

Oakley B, Nightingale J, Moran CG, Moppett IK. Does achieving the best practice tariff improve outcomes in hip fracture patients? An observational cohort study. BMJ Open. 2017; 7: e014190. https://doi.org/10.1136/bmjopen-2016-014190

Sözen T, Özışık L, Başaran NÇ. An overview and management of osteoporosis. European Journal of Rheumatology. 2017; 4: 46–56. https://doi.org/10.5152/eurjrheum.2016.048

Talevski J, Guerrero-Cedeño V, Demontiero O, Suriyaarachchi P, Boersma D, Vogrin S, et al. Implementation of an electronic care pathway for hip fracture patients: a pilot before and after study. BMC Musculoskeletal Disorders. 2020; 21: 837. https://doi.org/10.1186/s12891-020-03834-w

Tarazona-Santabalbina FJ, Ojeda-Thies C, Figueroa Rodríguez J, Cassinello-Ogea C, Caeiro JR. Orthogeriatric Management: Improvements in Outcomes during Hospital Admission Due to Hip Fracture. International Journal of Environmental Research and Public Health. 2021; 18: 3049. https://doi.org/10.3390/ijerph18063049

Unnanuntana A, Kuptniratsaikul V, Srinonprasert V, Charatcharoenwitthaya N, Kulachote N, Papinwitchakul L, et al. A multidisciplinary approach to post-operative fragility hip fracture care in Thailand - a narrative review. Injury. 2023; 54: 111039. https://doi.org/10.1016/j.injury.2023.111039

Walter N, Szymski D, Kurtz SM, Lowenberg DW, Alt V, Lau EC, et al. Epidemiology and treatment of proximal femoral fractures in the elderly U.S. population. Scientific Reports. 2023; 13: 12734. https://doi.org/10.1038/s41598-023-40087-8

Warren M, Bretherton C, Parker M. Delay to surgery beyond 12 hours is associated with increased hip fracture mortality. European Journal of Orthopaedic Surgery & Traumatology. 2024; 34: 2973–2980. https://doi.org/10.1007/s00590-024-03997-5

Whitaker SR, Nisar S, Scally AJ, Radcliffe GS. Does achieving the 'Best Practice Tariff' criteria for fractured neck of femur patients improve one year outcomes? Injury. 2019; 50: 1358–1363. https://doi.org/10.1016/j.injury.2019.06.007

Appendix

See Appendices 1,2,3.

Appendix 1

Fractured Neck of Femur (NOF#) Proforma PICS template

Trauma consultant on-call:

Date and time of ED Referral

For in patient referral - Date and time of confirmed NOF# on x-ray:

Presenting Complaint:

Other injuries:

History Presenting Complaint:

Falls history:

Diagnosis: Clinical/Xray -

Site of Fracture: Left/Right

OTA Classification: (*Please review the OTA classification in reference and confirm with seniors)

- Extracapsular fracture (31) - A1/A2/A3
- Intracapsular fracture (31) - B1/B2/B3

Past medical history:

Presence of prosthetic material (e.g., heart valve, joint replacement) Yes/No

If yes:

Medications:

Allergies status:

Social history

- Smoking (pack years)/alcohol(units/week):
- Mobility pre-fracture
  - Indoors - Unaided/1 Aid/2Aids or frame/Wheelchair or bedbound/unknown
  - Outdoors - Unaided/1 Aid/2Aids or frame/Wheelchair or bedbound/unknown
- Patients residence: (Home/Warden controlled flat/Sheltered housing/Residential home/Nursing Home)
- Lives with:
- Carers:
- Power Of Attorney: Health and well-being/Financial. Documentation provided yes/no. Contact details:

Pre op AMT10 Score: /10 (*See references for guidance)

DNACPR status:

- Discussion with patient/family

Examination:

Fracture site skin condition: (Normal/Bruised/Fragile skin)

Pressure Ulcers: Sacral/Heel

Theatre plan: Admit patient on to take list and to the trauma board on Concerto

Concerning issues regarding theatre: Anticoagulation (DOAC/Warfarin/Clopidogrel/Aspirin) /further imaging/Medical review

Haemoglobin level pre-op: (**needs to be above >90 and in patients with cardiac Hx >100 to be fit for surgery**)

Plan – PLEASE ENSURE AND DOCUMENT THAT ACTIONS IN THIS PLAN HAVE BEEN COMPLETED

1. Analgesia: Paracetamol IV/PO QDS regular, Codeine: 30 mg–60 mg QDS regular. 15–30 mg QDS regular for frail patients,
   Oramorph 2.5–5 mg Hourly QDS PRN
2. Laxatives: Movicol TT BD, Senna T ON.
3. Prescribe regular meds **(All insulin dependent diabetics must commence a sliding scale when NBM for surgery)** and Fortisip BD.
4. Pause ACEi/ARB/Frusemide perioperatively
5. VTE prophylaxis: 40 mg Enoxaparin OD (20 mg if weight under 50 kg)/prescribe and pause oral anticoagulant/anti-platelet)
6. IV fluids pre-operatively: Hartmanns/0.9% NaCl 1000 mLs 12 hourly
7. Bloods: U&Es, FBC, CRP, CK, INR, PT/APTT, Vit D levels, B12, Folate and iron studies + **send 2x G&S**
8. FIB blocks – Date and time of completion
9. Consent form 1 or 4
10. Marking done
11. NBM from (date/time):
12. ECG
13. Chest X-ray requested
14. Ortho-geriatrician review

Appendix 2

OTA Classification of fracture

Side and Type of fracture: *Right* *Left*

OTA Classification:

- Extracapsular fracture (31) – A1(simple pertrochanteric fracture)/A2(multi-fragmented)/A3(intertrochanteric through lateral femoral wall/reverse oblique)
- Intracapsular fracture (31) – B1(subcapital fracture with slight or no displacement)/B2(transcervical fracture with some displacement)/B3(subcapital displaced fracture)

Appendix 3

Pre-Operative Cognition

ABBREVIATED MENTAL TEST SCORE

No	Item	Correct Score	Incorrect	Score
1	Age Score for exact age only	1	0	
2	Time Score if correct to the nearest hour	1	0	
-	Address for recall at end of test "42 West Street"	-	-	
3	Year Score for current year only	1	0	
4	Name of this place Score if exact address or name of hospital given ("in hospital" is insufficient)	1	0	
5	Identification of two persons (doctor, nurse etc.)? Score if roles of two people correctly recognised*	1	0	
6	Date of Birth Score for correct date and month, year not required	1	0	
7	Year of world war Score for year of start or finish	1	0	
8	Current Prime Minister/Queen	1	0	
9	Count Back 20-1 Score if no mistakes or subject corrects himself or herself spontaneously	1	0	
10	Recall address given above. Must be complete to score, no ½ marks	1	0	
Assessed by: _____		TOTAL SCORE	/10	

*Note – if there are not two people to hand, the alternative is to ask the patient the current month.