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RESEARCH PAPER

Multiple hospital organisational factors are associated with adverse patient outcomes post-hip fracture in England and Wales: the REDUCE record-linkage cohort study

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Abstract

Objectives: Despite established standards and guidelines, substantial variation remains in the delivery of hip fracture care across the United Kingdom. We aimed to determine which hospital-level organisational factors predict adverse patient outcomes in the months following hip fracture.

Methods: We examined a national record-linkage cohort of 178,757 patients aged ≥ 60 years who sustained a hip fracture in England and Wales in 2016–19. Patient-level hospital admissions datasets, National Hip Fracture Database and mortality data were linked to metrics from 18 hospital-level organisational-level audits and reports. Multilevel models identified organisational factors, independent of patient case-mix, associated with three patient outcomes: length of hospital stay (LOS), 30-day all-cause mortality and emergency 30-day readmission.

Results: Across hospitals mean LOS ranged from 12 to 41.9 days, mean 30-day mortality from 3.7 to 10.4% and mean readmission rates from 3.7 to 30.3%, overall means were 21.4 days, 7.3% and 15.3%, respectively. In all, 22 organisational factors were independently associated with LOS; e.g. a hospital's ability to mobilise $>90\%$ of patients promptly after surgery predicted a 2-day shorter LOS (95% confidence interval [CI]: 1.2–2.6). Ten organisational factors were independently associated with 30-day mortality; e.g. discussion of patient experience feedback at clinical governance meetings and provision of prompt surgery to $>80\%$ of patients were each associated with 10% lower mortality (95%CI: 5–15%). Nine organisational factors were independently associated with readmissions; e.g. readmissions were 17% lower if hospitals reported how soon community therapy would start after discharge (95%CI: 9–24%).

Conclusions: Receipt of hip fracture care should be reliable and equitable across the country. We have identified multiple, potentially modifiable, organisational factors associated with important patient outcomes following hip fracture.

Keywords: hip fracture, organisational factors, patient outcomes, mortality, length of stay

Key Points

- We simultaneously assessed a range of organisational factors against important patient outcomes post-hip fracture.
- Comprehensive national data identified several modifiable organisational factors associated with improved patient outcomes.
- A hospital's ability to mobilise >90% of patients promptly after surgery was associated with a 2-day shorter length of hospital stay.
- Discussion of patient experience feedback at clinical governance meetings was associated with 10% lower 30-day mortality.
- The ability of hospitals to report how soon community therapy starts after discharge was associated with 17% fewer emergency 30-day readmissions.

Introduction

Each year more than 70,000 older adults are admitted to a UK hospital after a hip fracture [1]; events that lead to substantial loss of quality of life [2], high mortality risk [3] and, after discharge, high risk of emergency hospital readmission [4]. Hip fracture services are provided through complex multidisciplinary organisational structures. There are established national standards, guidelines, audit (National Hip Fracture Database, NHFD), and financial incentives (Best Practice Tariff, BPT) for hip fracture care [5]. The latter is a reimbursement to hospitals based on achievement of seven nationally agreed quality metrics. Through transparent reporting and benchmarking, the NHFD audit has improved overall hip fracture care over the last decade [6]. However, we and others have shown that substantial variation in hospital delivery of hip fracture care persists [7–9]. Nationally, we see marked differences between hospitals in patient outcomes; mortality, functional recovery and need for institutional care [3]. Whilst this is in part explained by patient-level characteristics, we hypothesized that much of the remaining variation in hip fracture care delivery can be explained by organisational factors. Understanding predictors of variation in care delivery, and the effects on patient outcomes, will inform service-level interventions to reduce unwarranted variation, maximise health equity and ultimately improve patient experience.

We linked data from multiple national datasets quantifying elements of hip fracture care at both patient- and hospital-levels. Using hospital-level metrics, we quantified each hospital's organisational capacity to manage fragility fractures across a range of care domains, including the delivery of emergency, surgical, orthogeriatric and rehabilitation services, along with overarching governance structures. We then examined which hospital-level organisational factors, and corresponding care domains, predicted patient outcomes post-hip fracture across England and Wales.

Methods

Study population

The REDUCE study (REducing unwarranted variation in the Delivery of high-qUality hip fraCture services in England and Wales) used linked anonymised patient-level data for index hip fracture cases from the routinely collected Hospital Episodes Statistics (HES) Admitted Patient Care database, Office for National Statistics (ONS) Civil Registration Deaths and NHFD, a Healthcare Quality Improvement Partnership (HQIP) clinical audit of hip fracture care (Figure S1) [10–12]. This included hip fracture admissions to all English hospitals within the National Health Service (NHS). The equivalent patient-level Patient Episode Database for Wales (PEDW) data for admitted patient care was linked for Wales.

Our study population consisted of all index hip fracture cases (i.e. first occurrence of hip fracture), among English or Welsh residents aged 60 years or more, admitted to an English or Welsh hospital between 1 April 2016 and 31 March 2019. Patient follow-up was analysed for 12 months post-hip fracture (last follow-up: 31st March 2020) (see [Supplementary Methods](#)).

Patient outcomes

These were: (i) acute NHS 'superspell' length of stay (LOS), (ii) cumulative (all-cause) mortality at 30 days from hospital admission and (iii) emergency (all-cause) readmissions to any English/Welsh NHS hospital within 30 days of discharge. 'Superspell' LOS starts from the date of admission for the index hip fracture to the final date of discharge alive from an NHS acute or rehabilitation hospital; it includes the index hip fracture admission, plus any planned or unplanned hospital transfers for elective or emergency care, respectively.

Table 1. Characteristics of patients admitted to hospital with a hip fracture in England and Wales from 2016 to 2019

Pre-fracture characteristics and post-fracture outcomes		All	England			Wales		
		<i>N</i>	<i>N</i>	%	Mean (SD)	<i>N</i>	%	Mean (SD)
<i>N</i> patients		178,757	168,359	94		10,398	6	
<i>N</i> hospitals		172	159	92.4		13	7.6	
Age (years)		178,757			82.7 (8.6)			82.3 (8.6)
Age (years)	60–69	16,062	15,082	9		980	9	
	70–79	41,096	38,562	23		2,534	24	
	80–89	80,863	76,177	45		4,686	45	
	90+	40,736	38,538	23		2,198	21	
Sex	Female	126,278	118,859	71		7,419	71	
ASA grade	I and II	45,222	42,272	25		2,975	29	
	III	102,323	96,460	57		5,836	56	
	IV and V	31,212	29,627	18		1,587	15	
			105,082	99,029	59		6,053	58
Hip fracture type	Intracapsular	105,082	99,029	59		6,053	58	
	Inter, subtrochanteric or other	73,675	69,330	41		4,345	42	
Pre-fracture residence	Own home/sheltered housing	146,642	137,877	82		8,761	84	
	Not from own home	32,115	30,482	18		1,637	16	
Pre-fracture mobility	Freely mobile without walking aids	66,440	62,598	37		3,872	37	
	Mobile outdoors with 1 or 2 aids or frame	66,521	62,499	37		3,977	38	
	Some indoor, or no functional, mobility	45,796	43,262	26		2,549	25	
Post-fracture outcomes	‘Superspell’ LOS	165,350			21.4 (19.6)			21.4 (23.4)
	Cumulative 30-day mortality	178,757	12,321	7		805	8	
	Emergency 30-day readmissions	165,350	24,499	16		740	8	

SD = standard deviation.

Patient case-mix

Case-mix adjustment was the same as that used in the NHFD clinical audit (Table 1) [13] and included age, sex, American Society of Anesthesiologists’ (ASA) classification of pre-operative physical status [14], hip fracture type, pre-fracture residence and pre-fracture mobility [13].

Organisational-level data

Publicly available hospital/trust provider-level data were extracted from 18 national audits, data series or ratings [12], generating 231 organisational factors, characterising each stage of the hip fracture care pathway from admission to discharge (Table S1). We used a systematic approach, as previously described [12], to categorise organisational factors that could potentially be associated with patient outcomes. Firstly, we mapped each factor to one or more of 14 *a priori* defined hip fracture care domains by stakeholder consensus (see Supplementary Methods) [12]. Each organisational-level factor was mapped as potentially relevant to one or more patient outcomes by expert consensus [12]. Secondly, each factor was assigned to one overarching theme (pre-, peri-, post-op, governance or workload). Time-specific organisational-level factors were linked to patient-level data using hospital/trust provider codes and the year (and month/quarter if available) appropriate to the date of hip fracture admission.

Approvals

These were obtained from: NHS Health Research Authority, London City & East Research Ethics Committee (20/LO/0101); Royal College of Physicians Falls and Fragility Fracture Audit Programme (FFFAP/2018/003) and HQIP330; NHS Wales Informatics Service (NWIS/30941), with an NHS Digital Data Sharing Agreement (DARS-NIC-334549-B1Y6X-v1.4).

Statistical analysis

Multilevel regression models estimated associations between organisational-level factors and patient-level outcomes, adjusting for patient case-mix. The hierarchical data structure consisted of patients (level 1), nested within hospitals (level 2). Using C-statistics or R², we identified the proportion of variance in each patient outcome that was explained by patient-level factors (i.e. case-mix) and quantified between-hospital variability explained by fixed organisational effects. Organisational factors were binarized, categorised or if continuous converted to linear splines at quartiles (or tertiles). Backward stepwise elimination determined organisational factors most strongly associated with each outcome. Organisational factors were simplified by expert review and splines binarized/categorised at appropriate threshold(s) or converted back to continuous measures on an appropriate scale. For each outcome, organisational

factors were added sequentially by domain to a case-mix adjusted multilevel model. Analyses of superspell LOS were limited to those who survived the admission to avoid bias by early mortality. Statistical analyses were performed in Stata 16.1 (StataCorp LP, College Station, TX) and MLwiN v3.01 (Centre for Multilevel Modelling, University of Bristol, UK). We followed STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidance [15].

Results

The characteristics of 178,757 patients admitted with a hip fracture between 2016 and 2019 were similar between England and Wales, with only 6% (10,398/178,757) admitted in Wales (Table 1, Figure S1). Annual admission numbers differed by hospital; from 168 to 2,552 in England and 349 to 1,495 in Wales. Average LOS was 21.4 days (standard deviation, 19.9 days); 13,126 (7.3%) patients died within 30 days (either in hospital or post-discharge) and 25,239 (15.3%) were readmitted within 30 days. Patient outcomes were similar between countries, other than lower 30-day readmissions in Wales (8%) versus England (16%). Across hospitals mean LOS ranged from 12 to 41.9 days, mean 30-day mortality from 3.7 to 10.4% and mean readmission rates from 3.7 to 30.3%.

Between-hospital variability explained by organisational factors

Prediction of all patient outcomes was improved by the addition of case-mix to our models (e.g. C-statistic for mortality increased from 0.55 [95% confidence interval, CI: 0.55, 0.56] without case-mix, to 0.76 [95%CI: 0.76, 0.77] with case-mix) but was unchanged by the addition of organisational factors (Table S2). The domains to which organisational factors were assigned did not discriminate for any outcome (data not presented). Hip fracture clinical governance was strongly associated with all outcomes (Figures 1–3).

Organisational factors associated with superspell LOS

In mutually adjusted analyses, hospitals with busier emergency departments (EDs) (i.e. with more emergency admissions per month), higher levels of non-consultant staffing (i.e. >34 full-time staff grades and/or junior doctors) and those giving a greater proportion of nerve blocks (femoral nerve or fascia-iliaca) pre-theatre were all associated with shorter LOS (Figure 1, Table S3). Hospitals reporting 100% compliance with the BPT qualifier 'nutrition assessment', conversely had longer LOS, as did hospitals reporting a pre-operative fluid management protocol. Perioperatively, hospitals where all patients received orthogeriatric assessment within 72 hours of admission had an ~1.5-day (1.65, 95%CI: 0.78, 2.53 days) shorter LOS, compared with hospitals where not all patients received timely assessment (only

17 hospitals reported 1 month or more where 100% of orthogeriatric assessments within 72 hours were achieved). Greater orthopaedic consultant staffing and provision of hip replacements in eligible patients were both associated with shorter LOS.

Post-operatively, the organisational factor most strongly, and independently, associated with reduced superspell LOS was the ability to get patients out of bed by the day after surgery. Sixty hospitals reported being able to mobilise >90% of patients within this window, during some or all of the 3-year study period. Each patient these hospitals managed achieved a 2-day (−1.93, 95%CI: −2.64, −1.21 days) shorter LOS, compared with hospitals where fewer than 70% were promptly mobilised. A strong dose–response association was seen between prompt mobilisation and LOS. Paradoxically, hospitals reporting 100% compliance with the BPT qualifier of 'physiotherapy assessment' had longer LOS. Several governance-related factors were independently associated with LOS. Hospitals holding monthly hip fracture service clinical governance meetings had on average shorter LOS. However, whilst attendance at these meetings by the orthogeriatric consultant, pharmacist and physiotherapist was associated with shorter LOS, attendance by the orthopaedic consultant was associated with longer LOS.

Organisational factors associated with 30-day mortality

ED performance predicted mortality: for every 5% increase in the proportion of ED (majors) attendances breaching the 4-hour trolley wait each month, mortality was 4% higher (Figure 2, Table S4). A total of 89 hospitals reported prompt surgery (within 36 hours of admission) for >80% of patients for ≥1 year; this was associated with a 10% (95%CI: −15%, −4%) lower mortality in these hospitals. Hospitals with an anaesthetic lead for hip fracture care, with time specified for this role in their job plan, had a 7% (95%CI: −13%, −1%) lower 30-day mortality. Those able to report reoperation rates after hip fracture surgery had 8% lower mortality than hospitals reporting zero reoperations or providing no data. Local awareness of post-operative duration of physiotherapy was associated with a higher 30-day mortality. Hospitals ($n = 112$) where the BPT qualifier 'physiotherapy assessment' was reported as being achieved 100% of the time had higher mortalities (and longer LOS, Table S3). In total, 103 hospitals reported discussion of patient experience feedback, and this element of clinical governance was the strongest independent factor associated with mortality, being associated with 10% (95%CI: −15%, −5%) lower mortality. Notably, physiotherapist attendance at clinical governance meetings was associated with 6% lower mortality.

Organisational factors associated with 30-day readmissions

Hospitals with busier EDs had increased readmissions; every additional 1,000 monthly (all cause) ED admissions was associated with a 3% (95%CI: 2%, 5%) increase in hip

Multiple hospital organisational factors are associated

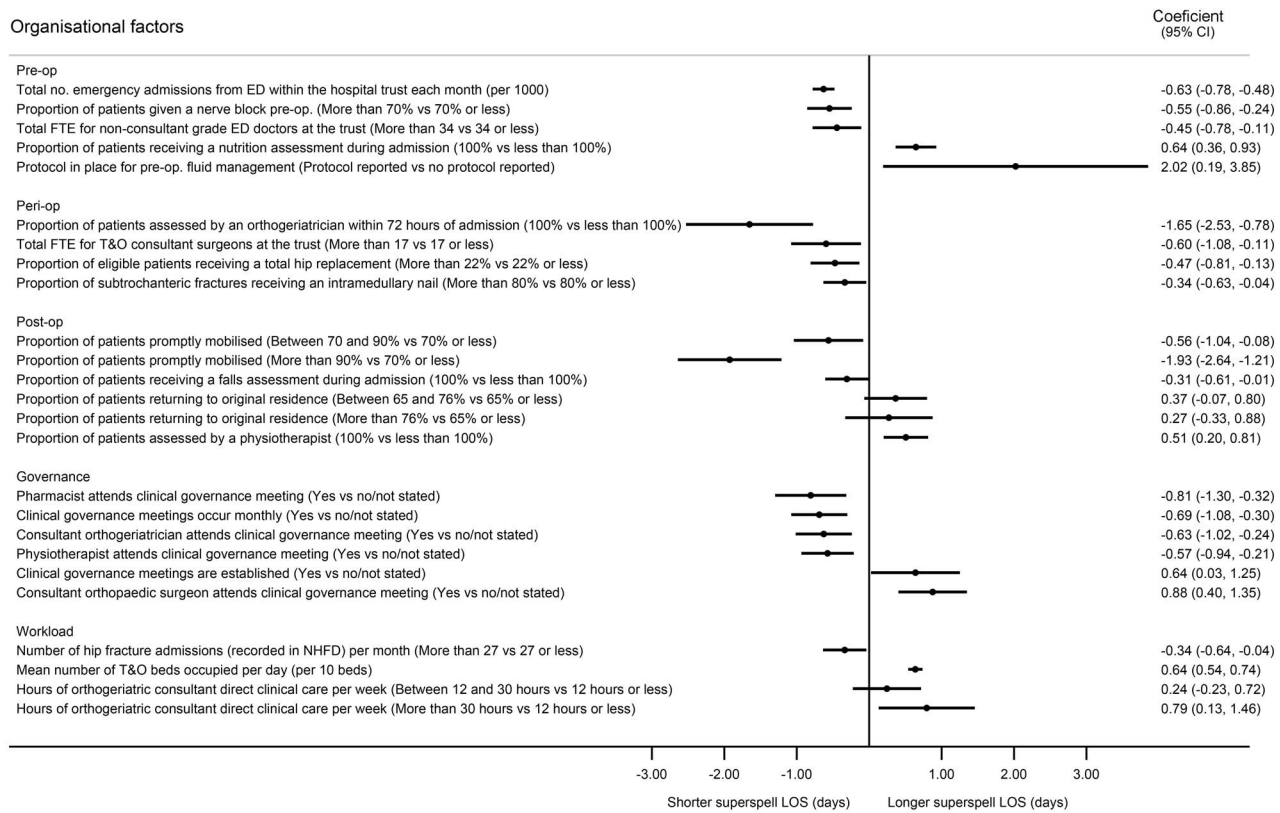


Figure 1. The association between organisational factors and superspell LOS, after accounting for patient case-mix. Organisational factors are adjusted for case-mix (age, sex, ASA classification, hip fracture type, pre-fracture residence and pre-fracture mobility) and mutually adjusted for all backward selected factors reported in Supplementary Table S2. Factors with P -value < 0.1 shown. $N = 165,350$. ED = emergency department. FTE = full time equivalent. op = operative. Rehab. = rehabilitation. T&O = Trauma and orthopaedic.

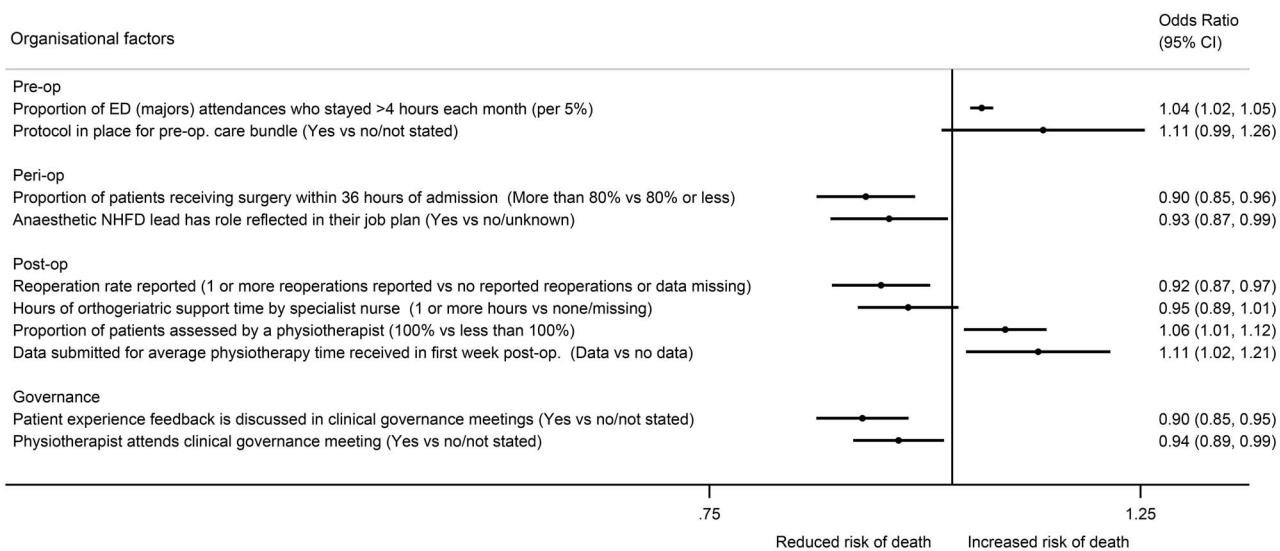


Figure 2. The association between organisational factors and mortality at 30 days, after accounting for patient case-mix. Organisational factors adjusted for case-mix (age, sex, ASA classification, hip fracture type, pre-fracture residence and pre-fracture mobility) and mutually adjusted for all backward selected factors reported in Supplementary Table S3. Factors with P -value < 0.1 shown. $N = 178,757$.

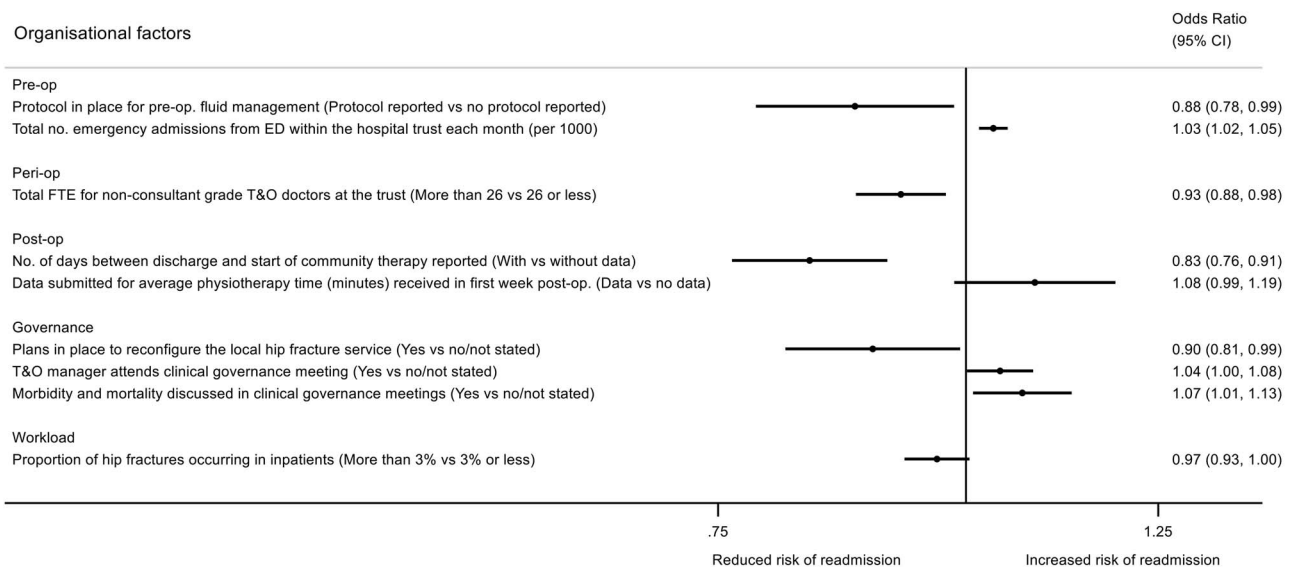


Figure 3. The association between organisational factors and emergency readmissions within 30 days of discharge, after accounting for patient case-mix. Organisational factors adjusted for case-mix (age, sex, ASA classification, hip fracture type, pre-fracture residence and pre-fracture mobility) and mutually adjusted for all backward selected factors reported in Supplementary Table S4. Factors with P -value < 0.1 shown. $N = 165,350$.

fracture patient readmissions (Figure 3, Table S5). Hospitals with a preoperative fluid management protocol had on average 12% (95%CI: -22% , -1%) fewer readmissions. Perioperatively, orthopaedic staffing was important; hospitals with >26 full-time non-consultant grade doctors (i.e. staff grades and/or junior doctors) had on average 7% (95%CI: -12% , -2%) fewer readmissions. Post-operatively, hospitals able to provide data regarding the time between discharge and initiation of community therapy ($n = 50$) saw on average 17% (95%CI: -24% , -9%) fewer readmissions. As with mortality, those hospitals able to provide physiotherapy audit data on whether patients would receive physiotherapy in their 1st week post-operatively had a trend towards higher readmissions. In terms of governance, hospitals reporting plans in place to reconfigure local hip fracture services had lower readmissions. However, clinical governance meeting attendance by orthopaedic departmental managers was associated with 4% higher readmissions (95%CI: 0, 8%), as was discussion of morbidity and mortality with 7% higher readmissions (95%CI: 1%, 13%).

Discussion

Main findings

We have identified multiple organisational-level factors throughout the hip fracture care pathway, many potentially amenable to change, which are associated with important clinical outcomes. The ability to mobilise $>90\%$ of patients by the day after surgery was associated with substantially shorter superspell LOS. Discussion of feedback from patients about their hospital experience at clinical governance meetings was associated with a similar (10%) lower 30-day

mortality as was seen in centres providing prompt surgery (within 36 hours of admission) to $>80\%$ of patients. Hospitals able to report time between discharge and community therapy start-up had on average 17% fewer readmissions.

Comparison with other literature

Hip fracture clinical governance was strongly associated with all outcomes. The strong association between routine review of patient experience feedback at governance meetings and mortality may be explained by other unmeasured characteristics. The Friends and Family Test (FFT) was rolled-out across the NHS in 2014 as a system for providing patient experience feedback [16, 17], producing over 75 million pieces of feedback to date; it is the largest source of patient feedback worldwide [18]. It may be that teams prepared to put time aside to examine their patients' experience are motivated to improve services. The association may also reflect the original intention of FFT that time taken to listen to patient views helps identify what in a service works well and what can be improved upon and how this might be achieved [18]. Planning to reconfigure services may similarly serve as a marker of active interest in improvement of services, and this too was associated with improved patient readmission outcomes.

The ability to get people out of bed promptly after surgery was the strongest predictor of hospital stay, with a clear dose-response. Prompt mobilisation reduces LOS [19] and mortality [20]. Extrapolating our rates, we estimate that if all hospitals could mobilise $>90\%$ of patients by the day after surgery, this would save 16,550 bed-days/year nationally. Prompt orthogeriatric assessment was associated with shorter LOS. Hitherto studies have focussed on the effect of single organisational factors across hospitals, for example

showing interventions such as increased orthogeriatrician involvement reduces mortality [21, 22]. Only one previous study attempted to compare multiple aspects of the hip fracture care pathway simultaneously to identify the most important targets for intervention. Using 1 year of data, authors assessed hospital-level factors associated with 30-day mortality and overall LOS (rather than superspell in our study); hospitals involved in research trials had lower mortality, and hip fracture admission volume, and inpatient bed and theatre availability all predicted LOS [23]. However, only hospital-level aggregated outcomes were included in a univariable analysis, without adjusting for patient case-mix or other competing factors that our study included [23].

Since the introduction of BPT in 2010, mortality, readmissions and LOS have improved in England (compared with Scotland where no tariffs apply) [24]. The BPT financially incentivises timely geriatrician assessment (within 72 hours) and assessments addressing physiotherapy, falls risk, bone health, cognition and nutrition [5]. The tariff also incentivises timely operation (within 36 hours), which we found had a strong association with lower 30-day mortality, consistent with other studies [24, 25]. If the prompt surgery rates achieved in the best category (>80%) were generalised to all hip fracture patients, we estimate that 182 excess deaths within 30-days could be avoided in England and Wales each year. Unlike time-to-surgery, case definitions for physiotherapy assessment (associated with higher mortality) and nutrition assessment (associated with longer LOS) are non-specific; 'assessment', a process measure is open to interpretation and is not a delivered 'intervention'. We speculate some units reporting 100% compliance are simply 'ticking a BPT box' and not actioning assessment as thoroughly as other units that report more realistic figures. Hospitals submitting data on reoperation rates had lower mortality, potentially indicating organised services more able to audit surgical outcomes.

The 2017 physiotherapy audit of hip fracture practice found that 79% of patients waited over a week for rehabilitation to begin at home following discharge [26]. It is therefore not surprising that we found hospitals that showed understanding of delays between discharge and initiation of community therapy had substantially fewer readmissions, as this knowledge would contribute to risk mitigation when discharge planning [27]. We estimate 890 excess readmissions/year might be avoided in England and Wales if hospitals not providing these data were able to do so.

Our finding that hospitals investing in job-planned anaesthetic leadership for hip fracture care had lower 30-day mortality further supports the importance of anaesthetic practices. Use of femoral or fascia-iliaca nerve blocks pre-surgery reduces opiate analgesic use and associated side-effects, reducing delirium [28], and in our analyses was associated with reduced LOS. However, in 2020, nationally only 60% of hip fracture patients received a nerve block, with use varying from 2% to 98% between hospitals [6]. Consistent with our findings, in Canada variation in nerve block use is explained by structures and processes at the

hospital and anaesthetist level, rather than by patient-specific factors [29]. We cannot be sure whether the benefits we observe reflect the direct effects of nerve block intervention or indirect effects of better organised anaesthetic services.

Strengths and limitations

We used a unique linkage of national databases for NHS-treated patients across two nations, with 18 different organisational data sources. The 3-year study period allowed for temporal fluctuations giving representative overall estimates for each hospital. Multilevel analysis, accounting for within-hospital clustering, enabled a true hospital-level assessment of associations. Large sample sizes can generate associations that appear important statistically, which may not be clinically meaningful and are prone to type 1 error. Causality cannot be inferred from these observational data and despite our multivariable models there may still be trust-level residual confounding. There is also the risk of the ecological fallacy, so that protective factors that operate at a trust level may not apply at an individual level, e.g. preoperative nerve block. However, many of these organisational factors are ecological in nature, e.g. governance procedures, and would apply to all patients within a trust. Consistent with other studies, the discriminatory abilities of models for all outcomes were improved by the addition of case-mix adjustment, and organisational factors explained minimal amounts of between-hospital variation, with the remaining variation potentially explained by unobserved patient- or hospital-level factors, or patient factors associated with organisational factors [30]. Whilst these organisational factors were derived from high-quality NHFD and other publicly available audits and NHS data, these could not be independently validated. Some audits were troubled by missing data, such that some variables could not be used, meaning some components of the care pathway could not be operationalised, and remain unmeasured. Other audits with fewer missing data required inclusion of a missing category or were supplemented with data from available years. Outcomes were limited as patient-reported outcomes collected at this scale are not available. Our study population includes patients with a first hip fracture during the 3-year study period, who may be expected to be healthier than those who went on to have a second hip fracture during this period, which we did not examine. Had all hip fractures been included, mortality, LOS and readmissions would likely have been higher, and certain organisational factors, such as orthogeriatrician input, may have been associated with greater benefits than reported here. Stepwise selection may detect coincidental associations whilst missing some causal associations; multilevel models made bootstrapping too computationally intensive to provide internal validation.

Conclusions

Hip fractures are a devastating injury, for which health care should be reliable and equitable, across the country. We have

identified multiple, potentially modifiable, organisational-level factors associated with important clinical outcomes. Our findings, if causal, support performance incentives if they promote time-specific ‘outcome measures’ for orthopaedic surgery and post-operative mobilisation. Our results highlight the importance of well-embedded, multi-disciplinary clinical governance systems and favour consideration of incentivisation of routine review of patient experience feedback in monthly governance meetings.

Supplementary Data: Supplementary data mentioned in the text are available to subscribers in *Age and Ageing* online.

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Transparency Statement: C.L.G. affirms that the manuscript is an honest, accurate and transparent account of the study being reported that no important aspects of the study have been omitted and that any discrepancies from the study as originally planned have been explained.

Data Sharing: Linked data are available through data applications to Royal College of Physicians Falls and Fragility Fracture Audit Programme and Healthcare Quality Improvement Partnership, NHS Wales Informatics Service and NHS Digital.

Data Declaration: This publication is based on data collected by or on behalf of the Healthcare Quality Improvement Partnership, who have no responsibility or liability for the accuracy, currency, reliability and/or correctness of this publication.

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