Delayed admission of patients with hip fracture from the emergency department is associated with an increased mortality risk and increased length of hospital stay

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Handling editor Ellen J Weber

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Received 12 January 2023
Accepted 19 July 2024

To cite: Clement ND, Farrow L, Chen B, *et al*. *Emerg Med J* Epub ahead of print: [*please include* Day Month Year]. doi:10.1136/emermed-2023-213085

ABSTRACT

Background The aims of this study were to assess whether delayed admission from the ED influenced mortality risk, length of acute hospital stay, risk of developing delirium and return to domicile for patients presenting with a hip fracture.

Methods A single centre service evaluation was undertaken including patients aged over 50 years who were admitted to a Scottish hospital through the ED with a hip fracture during a 42-month period (from January 2019 to June 2022). Delay was defined as spending >4 hours in the ED from arrival. Patient demographics and perioperative variables and mortality were collected. Cox regression analysis (adjusting for age, sex, season, socioeconomic status, American Society of Anesthesiologists grade, place of residence, fracture type, delirium and time from ward to theatre) was used to determine the independent association between delayed disposition from the ED and mortality (90 days and final follow-up) as recorded on a regional database.

Results The cohort consisted of 3266 patients with a mean age of 81 years, of which 2359 (72.2%) were female. 1261 (38.6%) patients stayed >4 hours in ED. The median follow-up was 529 days, during which time there were 1314 (40.2%) deaths. Survival at 90 days was significantly lower (hazard ratio [HR] 0.76, 95% CI 0.63 to 0.91) for patients who stayed >4 hours (92.9%) compared with those who stayed ≤4 hours (95.7%). Delayed disposition was independently associated with an increased mortality risk at 90 days (adjusted HR 1.36, 95% CI 1.12 to 1.63, p=0.001) and at final follow-up (adjusted HR 1.15, 95% CI 1.03 to 1.29, p=0.017). Delay was also associated with a longer length of hospital stay (difference in medians of 1 day, p<0.001). There were no differences in the risk of delirium on the ward (p=0.256) or return to place of residence (p≥0.315).

Conclusion Delayed disposition from our ED was associated with an increased mortality risk and longer length of hospital stay in patients presenting with a hip fracture.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ It is estimated that worldwide, approximately one in three women and one in five men, by age 80, will have experienced hip fractures in their lifetimes.
⇒ Early hip fracture surgery either on day of admission or the following day is associated with lower patient mortality and perioperative complication rates.
⇒ Prior studies have suggested that delay in moving patients from the ED to the wards increases mortality.

WHAT THIS STUDY ADDS

⇒ In this single centre service evaluation, approximately a third (38.6%) of our patients with a hip fracture stayed in the ED beyond the 4-hour standard.
⇒ Delay in leaving the ED was associated with an increased 90-day mortality risk and longer length of hospital stay.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Adoption of an ED-accelerated care pathway in our institution may help improve their outcomes.

BACKGROUND

By the age of 80 years or more, it is estimated that a third of females and 17% of males will have suffered a hip fracture,[1] and it is predicted that the incidence will likely double by 2033.[2] Early hip fracture surgery is associated with lower patient mortality and perioperative complication rates.[3] The hip fracture management guidelines produced by the National Institute of Clinical Excellence support early surgery either on the day of admission or the following day.[4] With longer ED waiting times being observed across the UK and elsewhere currently, a patient's time to theatre for surgical management of their hip fracture may be delayed with the potential of increased mortality risk and complications.

The 4-hour wait standard in the ED was established in England in 2004 and was subsequently adopted across the UK and as a national standard in other countries; under this standard, most patients arriving at the ED must be admitted or discharged within 4 hours.[5] Although this standard was not based on evidence,[5 6] there has been a growing body of evidence that failure to achieve this timeframe is associated with increased patient mortality.[7–11]

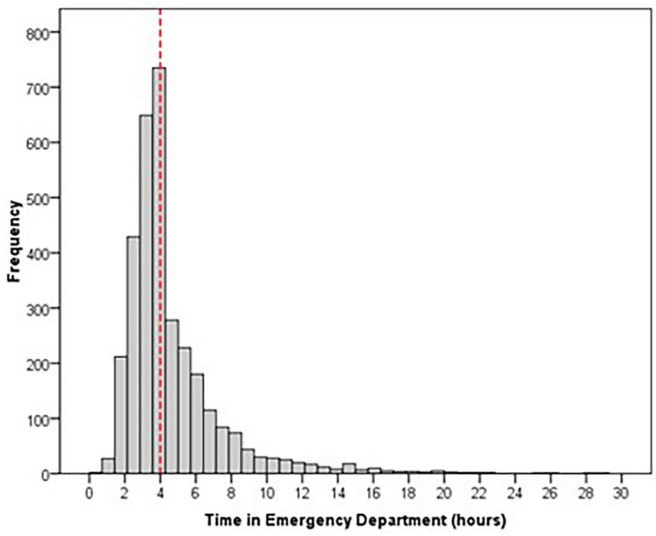

Figure 1 Histogram of length of time in the ED for the patient cohort. The dashed red line indicates a 4-hour timeline.

Jones *et al*[10] assessed nearly 27 million patients presenting to the ED between 2016 and 2018, of which 5.2 million were admitted and 38% breached the 4-hour waiting standard. They found that breaching the 4-hour standard was independently associated with an increased 30-day mortality risk (OR 1.35, 95% CIs 1.33 to 1.37).[10] Their cohort however was inclusive of all patients admitted to hospital from the ED. It is recognised that patients admitted with a hip fracture have a significantly increased mortality risk and represent a frail group of patients.[12 13] Therefore, patients with a hip fracture may be more adversely affected by delayed discharge from the ED, resulting in an increased mortality risk for these frailer individuals.

The primary aim of this study was to assess whether patients with a hip fracture that remained longer than 4 hours in the ED had an increased mortality risk at 90 days after their injury. The null hypothesis was that there was no difference in mortality for patients who waited 4 hours or less in ED compared with those that waited more than 4 hours. The secondary aims were to assess whether staying longer than 4 hours in the ED influenced (1) mortality risk at 30 days, 60 days, 1 year and at final follow; (2) length of acute hospital stay; (3) risk of developing delirium during hospital stay; or (4) return to domicile.

METHODS

Setting and participants

This was a retrospective service evaluation including all patients aged 50 years or more who were admitted with a hip fracture to the study centre over a 42-month period (from 1 January 2019 to 30 June 2022) and had a minimum of 8-month follow-up (February 2023). The study centre is the only trauma centre serving a catchment population of approximately 916 310 (Lothian, Scotland) and manages more than a thousand hip fractures annually.[14] The inclusion criteria were patients admitted from home or a care home with either an intracapsular or extracapsular (no more than 5 cm of distal extension from the lesser trochanter) fracture of the proximal femur, resident in the catchment population and had presented to the ED. Patients had to be admitted to the ward before going to theatre. Patients with isolated fractures of the acetabulum, pubic ramus, greater trochanter and periprosthetic fractures were excluded, or those that did not have recorded ED times (arrival and discharge).

Patients were retrospectively identified from the local hip fracture database which is collected prospectively on a continuous basis for submission to the Scottish Hip Fracture Audit (SHFA) and is inclusive of all patients. Patient demographics, season of admission, place of domicile, fracture type, ED presentation and discharge times, delirium status in ED and ward, time to theatre, American Society of Anesthesiologists (ASA) grade, length of stay (LoS), place of discharge and mortality were collected from the patients e-health records and service documentation. The ASA grade was obtained from the anaesthetic notes, recorded at the time of surgery. Time in ED was taken as the time of presentation to the time of discharge from ED, which was recorded electronically in the patient's electronic notes (TRAKcare). Time to theatre was taken as per the SHFA guidelines, from time to admission to the ward to commencement of anaesthesia. These data were compiled by specialist local audit coordinators familiar with the clinical condition and the trauma unit. The data were collected as part of the routine activity of the SHFA and assessed for completeness by a senior analyst (AD) who was blinded to the aim of the study. All data were handled in accordance with the UK Caldicott principles and registered at the study centre as a quality improvement project.

The Scottish Index of Multiple Deprivation (SIMD) was used to assign the socioeconomic status of each patient with assessment of seven domains: current income, employment, health, education, skills and training, housing, geographic access and crime.[15] The current study used the updated SIMD rankings published in 2020 to assign a patient to a quintile of local data zone deprivations (1=most deprived to 5=least deprived) according to their postcode at time of injury.

The four 'A's' test (4AT) is used internationally as a validated clinical tool for detecting delirium.[16] A score of 4 or more is suggestive of delirium but is not diagnostic. The 4AT is assessed and recorded as part of the 'standard' of care for the SHFA in the ED as part of the 'Big 6' assessment and again (second time) within 24 hours of admission to the ward as a screening tool for delirium. Data submitted to the SHFA were used to assess the association of ED waiting time on risk of having delirium in the ED and on the ward within 24-hours of admission.

Outcomes

Patient mortality status was obtained from the hospital's electronic records using each patient's unique Community Health Index number. The health board is the sole provider for national healthcare for the catchment population. LoS was defined as the number of days between admission to discharge from the trauma unit. Discharge destination after hospitalisation was obtained from the regionwide electronic health record system.

Patient and public involvement

No patient involved.

Statistics

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) software V.17 (IBM). Descriptive statistics were used to describe the data: mean for age, median for time and percentages for categorical variables. Continuous variables for patients staying ≤4 hours vs >4 hours in the ED were compared using an independant Student's t-test for normally distributed variables (age) and a Mann-Whitney U test for time (time to theatre and hospital LoS) . Categorical variables (sex, SIMD, ASA grade, pre-fracture residence, fracture type, and presence or absence of delirium) were compared using a χ^2

Table 1 Patient demographics, American Society of Anesthesiologists grade, place of domicile, fracture type, delirium status according the 4 'A's test and time to theatre according to group

Demographic	Descriptive	Group ≤4 hours (n=2005)	Group >4 hours (n=1261)	Difference/OR (95% CI)	P value
Sex (n, % of group)	Male	549 (27.4)	358 (28.4)	Reference	
	Female	1456 (72.6)	903 (71.6)	0.95 (0.81 to 1.11)	0.531*
Age (years: mean, SD)		81.2 (9.9)	80.6 (10.5)	0.6 (–0.1 to 1.3)	0.602†
SIMD (n, % of group)	1 (most)	229 (11.4)	141 (11.2)	1.00 (0.86 to 1.17)	0.999*
	2	460 (22.9)	278 (22.0)	0.99 (0.81 to 1.20)	0.888*
	3	308 (15.4)	206 (16.3)	1.09 (0.88 to 1.35)	0.427*
	4	336 (16.8)	224 (17.8)	1.09 (0.88 to 1.34)	0.431*
	5 (least)	672 (33.5)	412 (32.7)	Reference	
Season (n, % of group)	Winter	524 (26.1)	399 (31.6)	Reference	
	Spring	580 (28.9)	339 (26.9)	0.77 (0.64 to 0.93)	0.005*
	Summer	493 (24.6)	230 (18.2)	0.61 (0.50 to 0.75)	<0.001*
	Autumn	408 (20.3)	293 (23.2)	0.94 (0.77 to 1.15)	0.566*
American Society of Anesthesiologists grade (n, % of group)	1	42 (2.1)	25 (2.0)	0.86 (0.67 to 1.25)	0.566*
	2	463 (23.1)	292 (23.2)	0.91 (0.77 to 1.09)	0.319*
	3	1008 (50.3)	695 (55.1)	Reference	
	4	124 (6.2)	121 (9.6)	1.42 (1.08 to 1.85)	0.011*
	Missing	368 (18.4)	128 (10.2)	0.50 (0.40 to 0.63)	<0.001*
Pre-fracture residence (n, % of group)	Home	1639 (81.7)	1043 (82.7)	Reference	
	Care home	366 (18.3)	218 (17.3)	0.94 (0.78 to 1.13)	0.483*
Fracture type (n, % of group)	Intracapsular	1113 (55.5)	772 (61.2)	Reference	
	Extracapsular	865 (43.1)	463 (36.7)	0.85 (0.78 to 0.93)	<0.001*
	Other	27 (1.3)	26 (2.1)	1.39 (0.80 to 2.40)	0.237*
4 'A's test (n, % of group)	0–3	1021 (50.9)	626 (49.6)	Reference	
	4+	191 (9.5)	132 (10.5)	1.08 (0.88 to 1.44)	0.335*
	Missing	793 (39.6)	503 (39.9)	1.03 (0.89 to 1.20	0.655*
Ward admission to theatre (hours: median, IQR)		22.8 (16.1 to 35.9)	22.2 (15.7 to 35.8)	0.6	0.933§
Total time to theatre‡ (hours: median, IQR)		25.7 (18.8 to 39.0)	29.0 (22.0 to 42.5)	3.3	<0.001§

*χ^2 test.
†Student's independant t-test.
‡Time from presentation to ED to theatre.
§ Mann-Whitney U test
SIMD, Scottish Index of Multiple Deprivation.

test. Kaplan-Meier time to event methodology was used to assess patient survival after their hip fracture. Log-rank (Mantel-Cox) test was used to assess differences in survival between those delayed and not delayed. Cox and linear regression analyses were used to assess the independent association of factors influencing patient mortality and LoS for patients alive at discharge, respectively, when adjusting for confounding variables (age, sex, season, socioeconomic status, ASA grade, placed of residence, fracture type, delirium and time from ward to theatre). Missing data were handled by including this as a separate group for categorical data or mean value for scalar data. A p value <0.05 was defined as statistically significant.

A power calculation was based on the suggested reduction in 90-day mortality as defined for the Hip Attack study that had a sample size of 3000 patients.[17] We assumed an expected baseline mortality risk of 13% and applied a desired HR of 0.7, which equates to an absolute reduction of 3.7% in 90-day mortality.[18] The trauma centre manages approximately 1000 hip fractures per year, of which it was estimated that 10% would be out of area or admitted straight to the ward and not via ED. We also estimated that approximately 50% of patients with hip fracture would remain in the ED for >4 hours. To allow for 8 months of follow-up, we therefore went back 42 months from our starting date of 30 June 2022 to 1 January 2019 to identify the patient cohort.

RESULTS

During the study period, 3611 patients presented to the ED with a hip fracture. We excluded 188 (5.2%) who sustained their injury while they were an inpatient at the study centre or a hospital within the catchment population (NHS Lothian), a further 117 patients who were admitted from a rehabilitation unit or 'other' institutions and 40 patients did not have a recorded admission and discharge time.

The study cohort consisted of 3266 patients that had sustained a hip fracture who were admitted from home or a care home. The mean age was 81.0 (SD 10.1, range 50–104) and 2359 (72.2%) were females. Median time in the ED was 3.9 (IQR 3.0–5.3) hours (figure 1). Median time to theatre from presentation to the ED (total time) was 27.0 (IQR 19.9–40.2) hours. Median time to theatre from admission to the ward was 22.5 (IQR 16.0–35.9) hours. Median length of acute hospital stay was 9.0 (IQR 6.0–15.0) days. The median follow-up was 529 (IQR 256–909) days.

Table 2 Patient survival following a hip fracture at different timepoints according to group

	Group survival (%, 95% CI)		
Timepoint	≤4 hours	>4 hours	P value*
30 days	98.6 (98.0 to 99.2)	97.7 (96.9 to 98.5)	0.114
60 days	97.1 (96.3 to 97.9)	95.4 (94.2 to 96.6)	0.023
90 days	95.7 (94.7 to 96.7)	92.9 (91.5 to 94.3)	0.003
1 year	81.8 (80.0 to 83.6)	75.6 (73.3 to 77.9)	0.173
Final follow-up	44.4 (40.7 to 48.1)	38.9 (32.1 to 45.7)	0.036

*Log rank (Mantel-Cox).

During the follow-up period, there were 1314 (40.2%) deaths identified. There were 1261 (38.6%) patients who waited longer than 4 hours in the ED. Those who stayed more than 4 hours were significantly more likely to be admitted during the winter, to have an ASA grade of 4 relative to grade 3, to have sustained an intracapsular fracture and to have a longer total time to theatre (presentation to ED to theatre) compared with those waiting 4 hours or less (table 1).

Unadjusted analyses demonstrated that patients that waited longer than 4 hours in the ED had significantly lower survival at 60 days (p=0.023), 90 days (p=0.003) and at final follow-up (p=0.036) when compared with those that waited less than 4 hours (table 2, figure 2). The survival at 90 days was 95.7% (95% CI 94.7% to 96.7%) for those that waited less than 4 hours, whereas for those that waited more than 4 hours survival was 92.9% (95% CI 91.9% to 94.3%). This 2.8% difference equates to one additional death at 90 days for every 36 patients who waited in the ED for longer than 4 hours.

When adjusting for confounding factors, having waiting longer than 4 hours in the ED was independently associated with an increased mortality risk at 90 days (HR 1.36, 95% CI 1.12 to 1.63) (table 3). Male sex (p<0.001), increasing age (<0.001), being admitted during winter relative to summer (p=0.046), increasing ASA grade, care home residence (p<0.001) and increasing time to theatre from admission to ward (p=0.001) were also all independently associated with the 90-day mortality (table 3). Using the same regression model for each timepoint assessed also identified that a wait more than 4 hours was independently associated with an increased risk of 60-day (p=0.019) mortality and at final follow up (p=0.017) (table 4).

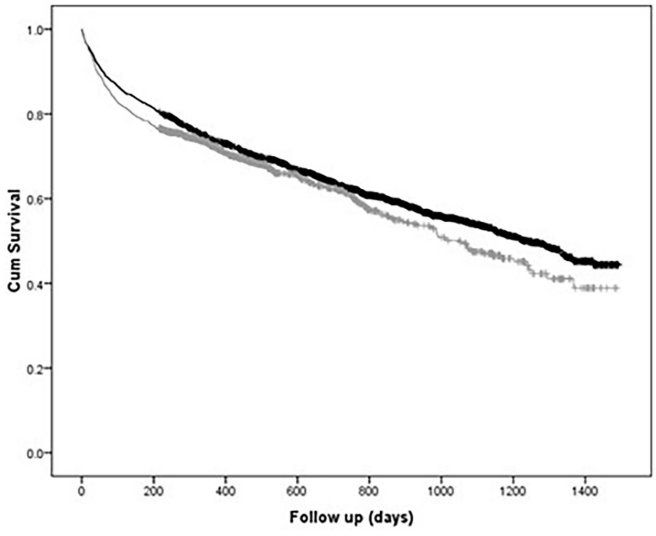

Figure 2 Kaplan-Meier curves for survival after a hip fracture according to group (black is ≤4 hours group and grey is >4 hours group).

Table 3 Cox regression model for variables associated with patient mortality at 90 days after a hip fracture

Variable	Descriptive	HR	95% CIs	P value
Sex	Male	Reference		
	Female	0.60	0.50 to 0.71	<0.001
Age		1.05*	1.03 to 1.06	<0.001
SIMD	1 (most)	1.05	0.76 to 1.45	0.761
	2	0.97	0.75 to 1.25	0.836
	3	0.94	0.70 to 1.26	0.688
	4	0.89	0.68 to 1.17	0.401
	5 (least)	Reference		
Season	Winter	Reference		
	Spring	0.85	0.66 to 1.09	0.205
	Summer	0.76	0.59 to 1.00	0.046
	Autumn	0.94	0.73 to 1.22	0.661
American Society of Anesthesiologists grade	1	0.44	0.11 to 0.78	0.250
	2	0.40	0.27 to 0.58	<0.001
	3	Reference		
	4	2.15	1.66 to 2.78	<0.001
	Missing	1.34	0.99 to 1.80	0.058
Pre-fracture residence	Home	Reference		
	Care home	2.29	1.84 to 2.85	<0.001
Fracture type	Intracapsular	Reference		
	Extracapsular	1.25	1.03 to 1.51	0.027
	Other	11.35	7.85 to 16.41	<0.001
4 'A's test	0–3	Reference		
	4+	1.08	1.80 to 1.43	0.618
	Missing	0.86	0.67 to 1.10	0.224
Ward admission to theatre		1.006*	0.003 to 1.010	0.001
ED time	≤4 hours	Reference		
	>4 hours	1.36	1.12 to 1.63	0.001

*For each increase in year of age or hour for time to theatre.
SIMD, Scottish Index of Multiple Deprivation.

Patients who waited longer than 4 hours in the ED had a significantly longer length of acute hospital stay (median 9, IQR 6– 14, vs 10 (IQR 6–16) days, p<0.001 Mann-Whitney). Adjusting for confounding using regression analysis found that patients who waited >4 hours had a 1.8 (95% CI 0.8 to 2.8,

Table 4 Cox regression models for mortality at different timepoints according to group

Mortality at	Group	HR	95% CIs	P value*
30 days	≤4 hours	Reference		
	>4 hours	1.25	0.95 to 1.65	0.113
60 days	≤4 hours	Reference		
	>4 hours	1.29	1.04 to 1.59	0.019
90 days	≤4 hours	Reference		
	>4 hours	1.36	1.12 to 1.63	0.001
1 year	≤4 hours	Reference		
	>4 hours	1.13	0.99 to 1.30	0.078
Final follow-up	≤4 hours	Reference		
	>4 hours	1.15	1.03 to 1.29	0.017

*Cox regression analysis adjusting for sex, age, Scottish index of multiple deprivation, American Society of Anesthesiologists grade, pre-fracture domicile, fracture type, delirium in ED and time to theatre.

p=0.001) day greater length of acute hospital stay. There was no difference in the risk of delirium on the ward (≤4 hours, n=277/1402, vs >4 hours, n=198/912; OR 1.13, 95% CI 0.92 to 1.38, p=0.256). However, there was a high level of missing data for this outcome (n=952/3266, 29.9%) and therefore may not a reliable finding. Time in the ED did not influence place of discharge for those patients admitted from home (p=0.777) or care home (p=0.315).

DISCUSSION

This study has demonstrated that in patients with a hip fracture at our trauma centre, staying longer than 4 hours in the ED was independently associated with a significantly greater mortality risk at 60 and 90 days and at final follow-up. More than one-third of the cohort incurred this exposure. This risk increase translated into one additional death at 90 days for every 36 patients who waited longer than 4 hours in the ED. When adjusting for confounding factors, a wait longer than 4 hours was associated with a 29%, 36% and 15% increase in mortality risk at 60 days, 90 days and at final follow-up, respectively. Waiting longer than 4 hours in the ED was also associated with a 1-day longer length of hospital stay but was not associated in this study with the risk of developing delirium on the ward or return to domicile.

Our findings are broadly consistent with previous published works examining the impact of ED delay on the outcomes of all patients, where a clear association between longer LoS in the ED and increased mortality has been identified.[8–11 19] Effect sizes were also similar, for example, Jones *et al*[10] identified a 6% higher standardised mortality ratio for patients delayed for 4–6 hours versus those without delay. The 4-hour standard of care has been a source of potential controversy[6 7]; however, research has identified a 14% reduction in mortality in the UK to be associated with its use,[20] which is further supported by our study findings.

There is limited other direct evidence regarding the impact of ED delays on patients with hip fracture, with only one other study, to the authors knowledge, that also detected a significantly higher risk of mortality with a longer than 4-hour ED wait.[21] Other studies have however identified potential linked associations, for example, the negative impact of prolonged time from injury/admission to surgery management[22] and the positive influence of hip fracture standard attainment which includes avoidance of ED delay.[23] The current study showed that winter was independently associated with increased mortality risk, relative to the summer, which is consistent with the finding of Ogawa *et al*,[24] who suggested this was due to an increased prevalence of respiratory infection during the winter months. A novel aspect of the current study was identifying the independent association of time to theatre, from admission to the ward to commencement of anaesthesia, on postoperative mortality. For every 1-hour delay to theatre, there was an increase in 90-day mortality risk with a HR of 1.006 (table 3); therefore, with a 24-hour delay, the mortality risk is increased by nearly 14%. This is consistent with the review from Welford *et al*[3] that found a 0.86 risk reduction at 30 days for patients undergoing surgery within 24 hours. Therefore, reducing time to theatre through the implementation of system improvement programmes,[25] with fast track care and early medical optimisation,[26] and having daytime trauma theatre availability[27] may result in better outcomes for patients.

The exact reason(s) for the identified associations between prolonged time in ED and hip fracture outcomes are unclear, with concerns potentially raised about the influence of unadjusted confounders, such as acute medical issues. However, there were no differences in age, ASA grade, delirium or place of residence (independence) between those patients that were and were not delayed and, when adjusting for confounding factors, including age, ASA grade and season, delayed discharge from the ED remained associated with an increased mortality risk. The observed (unadjusted) increased LoS resulted in an extra 1261 days of hospital inpatient stay for the group that waited longer than 4 hours in ED. This had a potential cost implication of approximately £770 000 to our trauma centre if it is assumed that the cost per day on acute trauma ward was £610 in Scotland, but this is likely to be more now as this cost was estimated in 2014.[28]

Limitations of the study include the single centre retrospective nature of design, with a relatively small number of patients included compared with larger registry-based analysis. However, we did achieve the numbers set out in our predefined power calculation. There was also a large amount of missing data for the assessment of the 4AT in the ED (n=1296, 39.7%) and on the ward (n=952, 29.9%); therefore, the non-significant effect observed of delay in discharge from the ED on the incidence of delirium may not be reliable. The major limitation is that we did not adjust for patient acuity and factors delaying their admission such as being medically unwell, which may be influencing their outcome. Further work should include a more detailed analysis of patient characteristics and the impact of the individual stages of care across the urgent care pathway, including associations to key healthcare outcomes, in a larger cohort of patients. In the knowledge that greater time from admission to the ward to theatre was associated with an increased mortality, potentially direct transfer to theatre from the ED may improve patient outcome in our centre. This was one of the aims of the Hip Attack study which showed no difference of an accelerated care pathway on 90-day mortality risk; however, their cohort was highly selective and had a lower than anticipated mortality risk in the standard control cohort.[17]

CONCLUSION

In this service evaluation, we found that over a third of patients with a hip fracture spent more than 4 hours in the ED and there was an association between ED waiting time and poorer hip fracture outcomes. Adoption of ED-accelerated care pathways in our institution may help improve their outcomes.

Contributors NDC: Conceived study, obtained data, analysed data, wrote manuscript andresponsible for the overall content as guarantor. LF: Edited manuscript. BC: Edited manuscript. AD: Data processing. KM: Edited manuscript. ADD: Edited manuscript.

Funding BC's living stipend in the UK was funded by the National Natural Science Foundation of China (Grant No. 81903326) and Chinese Scholarship Council (Grant No. 201905320001).

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This study was classed as a service evaluation project and did not meet the Medical Research Council NHS Health Research Authority criteria to require ethical approval. The project was registered with the institution's quality improvement team and was conducted in accordance with the Declaration of Helsinki and the guidelines for good clinical practice. In addition, the project was registered with Public Health Scotland, as owners of the Scottish Hip Fracture Audit data, who support collection of the data used in the study. Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. Anonymised data are available on reasonable request to the corresponding author.

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