European Geriatric Medicine (2020) 11:527–533
https://doi.org/10.1007/s41999-020-00317-y

RESEARCH PAPER

Early mobilisation reduces the risk of in-hospital mortality following hip fracture

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Received: 27 November 2019 / Accepted: 31 March 2020 / Published online: 9 April 2020

Key Summary Points

Aim To identify the determinants of in-hospital mortality post-hip fracture in Ireland 2013–2017.

Findings Older males with poor pre-fracture mobility who were not mobilised on the day of/after surgery had the highest risk of in-hospital mortality.

Message Early mobilisation on the day of/after surgery should be added as a new formal hip fracture standard of care in keeping with best international practice.

Abstract

Purpose Hip fractures are associated with considerable morbidity, excess mortality, and significant healthcare expenditure. There are approximately 3700 hip fractures in Ireland per annum and this figure is set to rise in the next decade in parallel with the ageing population. Approximately 5% of patients who sustain a hip fracture will die in hospital, with less than half of survivors regaining their pre-operative level of function. The authors aimed to identify the determinants of in-hospital mortality post-hip fracture in Ireland 2013–2017.

Methods A secondary analysis of 15,603 patients in the Irish Hip Fracture Database (IHFD) was conducted. Both descriptive and analytical statistics were produced. Univariate and multivariate logistic regression was carried out.

Results 31% ($n=4796$) of patients were male and 69% ($n=10{,}807$) were female. Mean age for males was 75 years (SD 13.5) and 79 years for females (SD 10.5). Median in-hospital mortality was 4.7% ($n=711$) (range 2.7–6.2). Univariate logistic regression revealed 11 statistically significant predictors of in-hospital mortality; however, only four remained statistically significant on multivariate analysis [not mobilised day of/after surgery (OR 1.46, 95% CI 1.25–1.70, $p<0.001$), independent mobility pre-fracture (OR 0.84, 95% CI 0.79–0.89, $p<0.001$), female gender (OR 0.56, 95% CI 0.41–0.76, $p<0.001$), and older age (OR 1.05, 95% CI 1.03–1.06, $p<0.01$)].

Conclusion Older males with poor pre-fracture mobility who were not mobilised on the day of/after surgery had the highest risk of in-hospital mortality. This research supports the adoption of early mobilisation (day of/after surgery) as a new formal hip fracture standard in keeping with best international practice.

Keywords Hip fracture · Mortality · In-hospital mortality · Survival

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Introduction

Hip fractures are associated with considerable morbidity and excess mortality, in addition to constituting a major source of healthcare expenditure [1]. There are approximately 3700 hip fractures in Ireland per annum, with this figure projected to increase 100% by the year 2026 [2]. Despite advances in orthopaedic surgery, anaesthetics, geriatric medicine, and perioperative care, up to 5% of patients who sustain a hip fracture will die during hospitalisation [3]. Furthermore, reported 1-year mortality in individuals over 65 years

is in the order of 20–30%, with less than half of survivors regaining their pre-operative level of function [4]. However, the factors that predict mortality following hip fracture are not well defined, nor have they been studied extensively in the Irish population. Furthermore, the lack of data linkage in Ireland to the National Death Register renders it more challenging to determine longer term outcomes. However, in-hospital mortality is one quality indicator that can be accurately measured. This research aimed to identify the determinants of in-hospital mortality post-hip fracture in Ireland 2013–2017.

Methods

The authors conducted a secondary analysis of 15,603 cases in the Irish Hip Fracture Database (IHFD). The IHFD was established in 2012 with a clear focus on driving improvements in patient care and data quality. It is a clinically led, web-based system where data are collected through the Hospital In-Patient Enquiry (HIPE) portal, in association with the Healthcare Pricing Office (HPO). The audit is clinically supported by the Irish Institute of Trauma and Orthopaedic Surgery (IITOS) and the Irish Gerontological Society (IGS), and operational management is provided by the National Office for Clinical Audit (NOCA). The IHFD focuses on six clinical standards of care known as the Irish Hip Fracture Standards (IHFS). Each of these standards has an associated Best Practice Tariff (BPT) (Fig. 1). All 16 trauma units in the Republic of Ireland voluntarily submit data on all patients over age 18 that are discharged following hip fracture. Data are entered locally via IHFD audit coordinators, with support from the local IHFD clinical lead and NOCA. A specific HIPE portal data entry form is used to record details of an extensive number of variables ranging from the patients' pre-operative functional status to the

IRISH HIP FRACTURE STANDARDS		BEST PRACTICE TARIFF MEASURES
Standard 1: All patients with hip fracture should be admitted to an acute orthopaedic ward within four hours of presentation or brought directly to the theatre from the emergency department (ED) within four hours.		**If patients are admitted to an orthopaedic ward within four hours of presentation, or if they go straight from the ED to the theatre within four hours, they meet Standard 1.**
Standard 2: All patients with hip fracture who are medically fit should have surgery within 48 hours of admission, and during normal working hours (Monday to Sunday, 08.00–17.59).		**If patients receive surgery within 48 hours and during normal working hours, they meet Standard 2.**
Standard 3: All patients with hip fracture should be assessed and cared for with a view to minimising their risk of developing a pressure ulcer.		**If patients do not develop a new Grade 2 or higher pressure ulcer during admission, they meet Standard 3.**
Standard 4: All patients presenting with a fragility fracture should be managed on an orthopaedic ward, with routine access to acute orthogeriatric medical support from the time of admission.		**If patients are reviewed by a geriatrician at any point during their admission, they meet Standard 4.**
Standard 5: All patients presenting with a fragility fracture should be assessed to determine their need for therapy to prevent future osteoporotic fractures.		**If patients receive a bone health assessment, they meet Standard 5.**
Standard 6: All patients presenting with a fragility fracture following a fall should be offered multidisciplinary assessment and intervention to prevent future falls.		**If patients receive a specialist falls assessment, they meet Standard 6.**

Fig. 1 Irish hip fracture standards and best practice tariff

type of surgery and clinical outcomes. These variables are measured against the IHFS and are linked to BPT. The IHFD data set with full description of the variables collected can be viewed in the most recent IHFD annual report [5]. The IHFD is a timely and accurate database with 95% coverage.

Data were exported from Microsoft Excel into Stata® (version 15) for analysis. Descriptive statistics were used to describe the patient characteristics, surgical factors, and outcomes. Following data cleaning and re-coding of variables, univariate and multivariate logistic regression was undertaken to assess the impact of variables routinely collected by the IHFD on the likelihood of in-hospital mortality. A value of $p < 0.05$ indicated statistical significance.

Results

Descriptive statistics

In this cohort, 31% ($n = 4796$) were male and 69% ($n = 10{,}807$) were female. The mean age for males was 75 years (SD 13.5) and 79 years for females (SD 10.5). The largest proportion of hip fractures occurred in the 80–89 age category, with 72.3% ($n = 4600$) of these being female. Although incidence was higher in females, in-hospital mortality was higher for males [6.1% ($n = 297$)] than females [3.8% ($n = 414$)]. 61.8% ($n = 9652$) of hip fracture patients were medical card holders (free access to medical care and prescription medicines for individuals with low income) and in-hospital mortality was higher in medical card holders than non-medical card holders, i.e., [5.2% ($n = 502$)] versus [3.5% ($n = 207$)]. Of note, medical card holders had higher American Society of Anaesthesiology (ASA) grades than non-medical card holders. The majority of patients [81.5% ($n = 12{,}719$)] were admitted from home following low-energy trauma. Interestingly, 21.5% ($n = 3212$) of patients previously had a fragility fracture. Median length of stay was 12 days (IQR 13 days). Median in-hospital mortality post-hip fracture was 4.7% ($n = 711$) (range 2.7–6.2) for the study period.

Logistic regression

Univariate logistic regression was undertaken to assess the impact of 28 variables routinely collected by the IHFD on the likelihood of in-hospital mortality post-hip fracture. These variables incorporated a wide range of patient characteristics and hospital factors. The 11 statistically significant predictor variables on univariate analysis are presented in Table 1.

The 11 statistically significant predictor variables on univariate analysis were included in the multivariate model. Only four variables remained statistically significant on multivariate analysis (mobilised day of/after surgery, pre-fracture mobility, gender, and age) (Table 2).

- Patients who were not mobilised on the day of/after surgery were 46% more likely to die in-hospital than those patients who were mobilised early (OR 1.46, 95% CI 1.25–1.70, $p < 0.001$).
- Patients who were independent in their mobility prior to hip fracture had a 16% reduction in odds of in-hospital mortality (OR 0.84, 95% CI 0.79–0.89, $p < 0.001$).
- Increasing age (OR 1.05, 95% CI 1.03–1.06, $p < 0.001$) and male gender were also significant predictors of mortality with females being 44% less likely to die in hospital following a hip fracture than males (OR 0.56, 95% CI 0.41–0.76, $p < 0.001$).

Discussion

Hip fractures are an important public health issue owing to the devastating impact on patients including death, disability, institutionalisation, and social isolation [7]. Between 2000 and 2014, the number of fragility fracture admissions in Ireland increased by 30%, with this figure set to increase considerably over the coming years in parallel with the ageing population [8]. This is the first time that predictors of in-hospital mortality have been investigated in the Irish setting on a national scale. As hip fractures tend to occur in frail older individuals with poor physiological reserve, it is imperative that the factors that predict in-hospital mortality are identified, so that the model of care can be optimised.

Univariate logistic regression revealed 11 statistically significant predictors of in-hospital mortality; however, only four remained statistically significant on multivariate analysis (not mobilised day of/after surgery, independent in mobility pre-fracture, female gender, and older age). Gender, pre-fracture mobility, and age are not modifiable risk factors. However, a key finding from this research is the beneficial effect of early mobilisation on in-hospital mortality. Patients who were not mobilised on the day of/after surgery were 46% more likely to die in-hospital than those patients who were mobilised early (OR 1.46, 95% CI 1.25–1.70, $p < 0.001$). This is in keeping with the international literature as the early post-operative ambulation has been shown to reduce the incidence of delirium and pneumonia, improve functional outcomes, and lower mortality [9]. Moreover, early mobilisation embodies the fundamental ethos of orthogeriatric care, which is to rehabilitate patients to their pre-operative functional status. Delayed mobilisation makes it more difficult to achieve this aim owing to diminished muscle mass and strength, increased joint stiffness, as

Table 1 Statistically significant univariate logistic regression models

In-hospital mortality	Number (*n*)/ percentage (%)	Odds ratio	Std. error	*Z*	*P*	95% CI
Age category						
60–69	1935 (13.26)	1 (base)				
70–79	4109 (28.17)	2.93	0.67	4.64	0.00	1.86–4.61
80–89	6358 (43.58)	5.18	1.14	7.44	0.00	3.36–8.00
90–99	2186 (14.98)	8.18	1.89	9.24	0.00	5.23–12.78
Gender						
Male	4796 (30.74)	1 (base)				
Female	10,807 (69.24)	0.60	0.04	−6.47	0.00	0.51–0.70
Medical card status						
No	5885 (37.72)	1 (base)				
Yes	9652 (61.86)	1.50	0.12	4.85	0.00	1.27–1.77
Unknown	66 (0.42)	0.85	0.61	−0.21	0.83	0.20–3.52
ASA grade						
1	728 (4.96)	1 (base)				
2	5490 (37.41)	5.50	3.94	2.38	0.01	1.35–22.04
3	6525 (44.46)	20.63	14.65	4.26	0.00	5.13–83.01
4	722 (4.92)	59.71	42.76	5.71	0.00	14.67–243.02
5	13 (0.09)	311.14	280.18	6.37	0.00	53.26–1817.47
Specialist falls' assessment						
No	7425 (49.08)	1 (base)				
Yes	7526 (49.75)	0.77	0.06	−3.24	0.01	0.66–0.90
Yes—awaits further OPD ass	177 (1.17)	0.76	0.29	−0.67	0.50	0.35–1.65
Previous fragility fracture						
Yes	3212 (21.54)	1 (base)				
No	10,581 (70.96)	1.09	0.10	0.91	0.36	0.90–1.33
Undocumented	1119 (7.50)	1.35	0.21	1.96	0.05	1.00–1.84
Mobilised day of/after surgery						
Yes	8170 (76.53)	1 (base)				
No	2242 (22.59)	4.38	0.43	14.90	0.00	3.61–5.32
Undocumented	93 (0.87)	3.78	1.42	3.54	0.57	1.81–7.92
Ward type						
Ortho ward	13,732 (88.45)	1 (base)				
Never admit to ortho ward	1726 (11.12)	1.82	0.18	5.90	0.00	1.49–2.22
Undocumented	67 (0.43)	2.25	0.96	1.89	0.05	0.97–5.23
MDT rehab						
Yes	13,563 (90.08)	1 (base)				
No	1415 (9.40)	2.03	0.21	6.67	0.00	1.65–2.51
Undocumented	79 90.52)	0.91	0.54	−0.14	0.88	0.28–2.91
New mobility score[a]						
0	84 (1.47)	1 (base)				
1	192 (3.37)	1.04	0.46	0.10	0.94	0.63–5.95
2	481 (8.43)	0.88	0.35	−0.30	0.76	0.64–5.34
3	396 (6.93)	0.98	0.40	−0.40	0.96	0.65–5.45
4	687 (12.05)	0.60	0.24	−1.25	0.21	0.46–3.81
5	341 (5.98)	0.52	0.23	−1.43	0.15	0.43–3.93
6	698 (12.24)	0.41	0.17	−2.13	0.03	0.29–2.52
7	241 (4.23)	0.67	0.30	−0.87	0.38	0.49–4.46
8	71 (1.24)	0.27	0.22	−1.60	0.11	0.10–3.26
9 (independent)	2510 (44.01)	0.10	0.04	−5.42	0.00	0.09–0.77

Table 1 (continued)

In-hospital mortality	Number (*n*)/ percentage (%)	Odds ratio	Std. error	*Z*	*P*	95% CI
Reason for surgery delay						
No delay—surgery < 24 h	10,821 (73.83)	1 (base)				
Awaiting ortho Dx/Ix	182 (1.24)	2.03	0.64	2.24	0.02	1.09–3.77
Awaiting med rev/stabilisation	1795 (12.25)	3.17	0.31	11.67	0.00	2.61–3.85
Awaiting in-patient/HDU bed	53 (0.36)	1.89	1.13	1.07	0.28	0.58–6.10
Awaiting space on theatre list	504 (3.44)	1.03	0.26	0.14	0.89	0.62–1.72
Problem with theatre/equipment	15 (0.10)	1 (empty)				
Problem with staff cover	55 (0.38)	1 (empty)				
Cancelled due to list run over	407 (2.78)	0.39	0.17	−2.06	0.03	0.16–0.95
Other	581 (3.96)	2.02	0.37	3.85	0.00	1.41–2.89
Undocumented	243 (1.66)	0.93	0.36	−0.17	0.86	0.43–2.00

[a]New mobility score is a composite score of the patient's ability to perform: indoor walking, outdoor walking, and shopping before the hip fracture, providing a score between 0 and 3 (0: not at all, 1: with help from another person, 2: with an aid, and 3: no difficulty) for each function, resulting in a total score from 0 to 9, with 9 indicating a high pre-fracture functional level [6]

Table 2 Multivariate logistic regression model

In-hospital mortality	Odds ratio	Std. error	*Z*	*P*	95% CI
Age category	1.05	0.00	5.29	0.00	1.03–1.06
Female gender	0.56	0.89	−3.64	0.00	0.41–0.76
Not mobilised day of/after surgery	1.46	0.11	4.84	0.00	1.25–1.70
Independent in mobility pre-fracture (new mobility score)	0.84	0.02	−5.58	0.00	0.79–0.89
Medical card status	1.12	0.21	0.62	0.53	0.77–1.63
ASA grade	0.99	0.04	−0.16	0.87	0.90–1.09
Specialist falls' assessment	0.88	0.13	−0.83	0.40	0.65–1.18
Previous fragility fracture	1.04	0.41	1.23	0.22	0.97–1.13
Ward type	1.18	0.15	1.35	0.17	0.92–1.53
MDT rehab	1.13	0.19	0.71	0.47	0.80–1.59
Reason for surgery delay	1.00	0.03	0.16	0.87	0.93–1.08

well as loss of confidence with the consequent fear of falling [10]. Given the profound effect on in-hospital mortality, mobilisation on the day of/after surgery should be added as a new standard of care to the Irish Hip Fracture Standards (IHFS). Many countries such as the UK and Denmark have already incorporated this standard as a quality indicator.

In 2017, the Chartered Society of Physiotherapy (CSP) commissioned the Royal College of Physicians in the UK to conduct the *Sprint Audit* of hip fracture rehabilitation provision [11]. The audit included over 7000 hip fracture patients and showed wide variation in the extent and quality of rehabilitation. This prompted the CSP to create standards for the provision of hip fracture rehabilitation [12]. These guidelines are in line with the NICE guidelines on the management of hip fracture patients and state that all patients should be mobilised on the day of or the day following surgery [13]. The CSP guidelines also specify that all patients should receive daily physiotherapy which should total at least 2 h in the first 7 days post-surgery. However, there are barriers to the implementation of these guidelines in practice. While all of the 16 hospitals in the IHFD have a physiotherapy service operating from Monday to Friday, only 6 out of 16 have a weekend physiotherapy service (two of which are only operational on Saturdays) [5]. Given the growing appreciation of the importance of early mobilisation and functional status at discharge on patient outcomes, NOCA and IHFD have committed to monitoring access to physiotherapy services in a bid to improve access to this vital service in the coming years [14].

Another key finding from this analysis is the association between pre-fracture mobility, as indicated by the new mobility score, and in-hospital mortality. Patients who were independently mobile prior to hip fracture had a 16% reduction in odds of in-hospital mortality (OR 0.84, 95% CI 0.79–0.89, $p < 0.001$). This finding is corroborated by a UK systematic review and meta-analysis by Smith et al., where

pre-fracture mobility was shown to be a significant indicator of mortality following surgery (RR 0.13, 95% CI 0.05–0.34) [15]. Increasing age and male gender were also significant predictors of mortality with females being 44% less likely to die in hospital following a hip fracture than males (OR 0.56, 95% CI 0.41–0.76, $p < 0.001$). This is also consistent with the literature with a recent analysis of the Swedish registry by Ahman et al., demonstrating that age (*HR* 1.06, $p < 0.001$) and male gender (HR 1.45, $p < 0.001$) were associated with higher mortality [16].

Furthermore, the findings presented are similar to that of the Scottish Hip Fracture Audit database by Holt et al., where age ($p < 0.001$), gender ($p < 0.001$), and pre-fracture mobility ($p < 0.007$) were significant predictors of 30-day and 120-day mortality [17]. Similar to this research, time to surgery did not confer a survival advantage in terms of early mortality. However, it is important to distinguish between 'time to surgery from admission' and 'time from fracture to surgery'. This may be an important confounding variable, especially considering the geographical distribution of the population and variation in access to trauma centres. In cases where time of fracture is known, this information should be included as a variable in the IHFD. Furthermore, one could postulate that patients who were mobilised early would also have shorter length of stay, which, in turn, could be associated with lower in-hospital mortality. However, length of stay was not predictive of in-hospital mortality on univariate analysis. This may be due to the large number of confounding variables associated with length of stay. Finally, surgical volume has also been shown to positively impact on in-hospital mortality and this variable is not currently recorded in the IHFD [18].

Strengths and limitations

This is the first time that predictors of in-hospital mortality have been investigated on a national scale in the Irish setting. All 16 trauma centres in the Republic of Ireland were included in the analysis, thus, there was no selection bias and the findings are representative of the Irish population. However, owing to the lack of data linkage to the National Death Register, this research investigated in-hospital mortality only and not 1-year mortality. Further research into longer term outcomes is underway. In relation to the statistical methodology, the authors reported odds ratios as the output from the logistic regression analysis, which may result in an overestimation of the protective effect of some variables. Moving forward, outcomes other than survival should be incorporated into the IHFD, so that the importance of quality of life and the patient's experience can be emphasised. Notwithstanding, the IHFD is a large and rich database and is an important source of health intelligence.

Conclusion

Older males with poor pre-fracture mobility who were not mobilised the day of/after surgery had the highest risk of in-hospital mortality. The ability to be mobilised on the day of/after surgery is a good composite measure of both patient and organisational factors in orthogeriatric care. The findings of this research support the adoption of early mobilisation on the day of/after surgery as a formal best practice standard in hip fracture care.

Funding Funding was not received for this research.

Compliance with ethical standards

Conflict of interest There are no conflicts of interest.

Ethical approval Research ethics approval was obtained from the St James Hospital/ Tallaght University Hospital Research Ethics Committee, in accordance with the European Communities (Clinical Trials on Medicinal Products for Human Use) Regulations 2004 & ICH GCP Guidelines.

Informed consent For this type of research, informed consent was not required.

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