Optimising the In-Hospital Management of Hip Fracture Using the Irish Hip Fracture Database

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Declarations

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I declare that the work presented in this thesis is my own. The co-authored publications included are the greater part my own work, more specifically:

- Paper 1

  Ferris H, Brent L, Coughlan T. Early Mobilisation Reduces the Risk of In-Hospital Mortality Following Hip Fracture. European Geriatric Medicine, 2020.

  I conceptualised and designed the paper. I undertook a comprehensive literature review and synthesised the evidence. LB provided the data. I conducted the statistical analysis. I interpreted the findings in the clinical context in collaboration with TC and LB. I prepared the first draft of the manuscript; all authors contributed to and approved the final paper.

- Paper 2

  Ferris H, Brent L, Sorensen J, Ahern E, Coughlan T. Discharge Destination After Hip Fracture: Findings from the Irish Hip Fracture Database. European Geriatric Medicine, 2021.

  I conceptualised and designed the paper. I undertook a comprehensive literature review and synthesised the evidence. LB provided the data. JS conducted the statistical analysis.

I interpreted the findings in the clinical context in collaboration with LB, EA and TC. I prepared the first draft of the manuscript; all authors provided feedback, contributed to and approved the final paper.

- Paper 3

Ferris H, Brent L, Sorensen J. Cost of Hospitalisation for Hip Fracture – Findings from the Irish Hip Fracture Database. Osteoporosis International, 2022.

I conceptualised and designed the paper. I undertook a comprehensive literature review and synthesised the evidence. LB provided the data; JS performed the analysis. I interpreted the findings in the clinical context in collaboration with LB. I prepared the first draft of the manuscript; all authors provided feedback, contributed to and approved the final paper.

Ethical approval was received from the Royal College of Surgeons in Ireland Research Ethics Committee (REC202001017). Informed consent was not required as this research involved secondary analysis of anonymised data from the Irish Hip Fracture Database.

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List of Abbreviations

ASA	American Society of Anaesthesiology
ANOVA	Analysis of Variance
BPT	Best Practice Tariff
CAS	Cumulative Ambulatory Score
CI	Confidence Interval
DAL	Discharge to an Alternative Location
DDH	Discharge Directly Home
DVR	Data Validation Reports
EQ-5D-5L	EuroQol 5 Dimension 5 Level
FI	Frailty Index
FLS	Fracture Liaison Service
HIPE	Hospital In-Patient Enquiry
HipForge	Hip Fracture Outcome Recording and Geographic Equality
HPO	Healthcare Pricing Office
HRQoL	Health Related Quality of Life
HSE	Health Service Executive
IGS	Irish Geriatric Society
IHFD	Irish Hip Fracture Database
IHFS	Irish Hip Fracture Standards
IQR	Inter Quartile Range
ITOS	Irish Trauma and Orthopaedic Surgeons
NOCA	National Office of Clinical Audit
OR	Odds Ratio
PROM	Patient Reported Outcome Measures
QALY	Quality Adjusted Life Years
RR	Relative Risk
SCOPE	Scorecard for Osteoporosis in Europe
SD	Standard Deviation
TILDA	The Irish Longitudinal Study on Ageing
WHiTE	World Hip Trauma Evaluation

Executive Summary

Hip fracture can have a devastating impact on older adults as it is associated with reduced life expectancy, loss of independence and poorer quality of life. Each year in Ireland approximately 3,600 patients experience a hip fracture, most commonly due to a low-impact fall in their own home. These are a vulnerable cohort of patients with a mean age of 81 years and a high degree of comorbidity and frailty. Not only is hip fracture costly in terms of the human cost involved, but with a mean length of stay of 17 days in the acute hospital, it has a considerable impact on healthcare utilisation. Our challenge is to optimise the management of hip fracture so patients can rehabilitate to their pre-fracture state and live independently.

We are fortunate in Ireland to have the Irish Hip Fracture Database, a high-quality database that captures hip fracture cases in adults over 60 years of age across all 16 trauma units in the Republic of Ireland. Currently, over 25,000 hip fracture cases are recorded and this rich data source allows the most influential points of care in the patient journey to be identified. The Irish Hip Fracture Standards are the evidenced-based gold standards of care against which Irish services are benchmarked. In turn, these standards are linked to a Best Practice Tariff system, which rewards hospitals financially for each case that is managed in keeping with all 9 standards.

The research in this thesis centred on three core aspects of hip fracture care; mortality, discharge destination and financial costs. The first paper sought to identify the determinants of in-hospital mortality and demonstrated that 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 finding led to the addition of a new formal standard of care to the Irish Hip Fracture Standards with an associated best practice tariff, in keeping with international best practice.

The second paper identified inherent differences between those discharged directly home following hip fracture as opposed to discharged to an alternative location, both in terms of patient characteristics and care pathway. The results of the analysis demonstrated that younger patients independently mobile prior to fracture, who received timely surgery and early post-operative mobilisation were more likely to be discharged home directly. The Irish

Hip Fracture Standards incorporate 2 out of the 3 modifiable factors identified, which reinforces the importance of these National standards in improving patient outcomes.

The third paper quantified the cost of hospitalisation for hip fracture in Ireland in terms of bed days and direct hospital costs. For the time period 2014-2020, the total cost of hospitalisation for 23,494 cases in the Irish Hip Fracture Database was approximately €296 million, equating to €11,700 per episode of care. In 2020, the mean length of stay for hip fracture was 17 days, which accounted for >62,600 acute hospital bed days. This paper provided up-to-date robust data on the impact of hip fracture on healthcare utilisation, which will facilitate efficient health service planning and aid the delivery of cost-effective patient care.

The most important take-home message from the research presented is that early post-operative mobilisation is one of the most influential modifiable factors for improving patient outcomes. Not only does it reduce the risk of dying in-hospital but it also increases the likelihood of being discharged home directly from hospital. Furthermore, early mobilisation confers a cost benefit as patients mobilised early in the post-operative period are more likely to have a shorter length of stay in the acute hospital, which is a key driver of the costs of hip fracture care.

Looking to the future, the Irish Hip Fracture Database will expand to include long-term outcomes such as survival at 1 year and health related quality of life. Internationally, the Irish Hip Fracture Database will continue to collaborate with the global Fragility Fracture Network to develop a minimum common dataset for hip fracture registries. This will serve as an accepted framework for monitoring and improving hip fracture services worldwide.

Lay Abstract

Hip fracture is common in older adults and is associated with a high risk of death and functional impairment. Each year approximately 3,600 cases of hip fracture occur in adults >60 years and are recorded in the Irish Hip Fracture Database. The analysis of the Irish Hip Fracture Database presented in this thesis demonstrates how interventions such as getting patients up and moving after hip fracture surgery have the greatest impact on outcomes. Patients who are able to stand with the assistance of a physiotherapist on the day of or after surgery have a lower risk of dying in hospital and are more likely to be discharged home directly from hospital. In addition, patients who are mobilised early in the post-operative period are more likely to have a shorter length of hospital stay, which reduces the cost to the health service.

The findings of this research have led to the addition of mobilisation on the day of or after surgery as a new formal standard of care in the Irish Hip Fracture Standards. This illustrates the value of having timely and accurate data to identify the parameters of care that have a real impact on patient outcomes, which in turn, informs the gold standards of care.

Aim and Objectives

Aim

To optimise the management of hip fracture in the acute hospital setting using the Irish Hip Fracture Database (IHFD).

Objectives

- To identify the determinants of in-hospital mortality post hip fracture in Ireland (Paper 1).

- To identify factors influencing discharge directly home from an acute hospital following hip fracture, as opposed to discharge to an alternative location (Paper 2).

- To quantify the impact of hip fracture on the Irish health service in terms of bed days and direct hospital costs (Paper 3).

Key Outputs

Peer Reviewed Publications:

- Paper 1

Ferris H, Brent L, Coughlan T. Early Mobilisation Reduces the Risk of In-Hospital Mortality Following Hip Fracture. European Geriatric Medicine, 2020.

- Paper 2

Ferris H, Brent L, Sorensen J, Ahern E, Coughlan T. Discharge Destination After Hip Fracture: Findings from the Irish Hip Fracture Database. European Geriatric Medicine, 2021.

- Paper 3

Ferris H, Brent L, Sorensen J. Cost of Hospitalisation for Hip Fracture – Findings from the Irish Hip Fracture Database. Osteoporosis International, 2022.

Presentations:

Key Stakeholders & Senior Decision Makers

- IHFD Governance Committee, 2019.
- National Quality Improvement Team, HSE, 2019.

International Conferences

- European Public Health Conference, Marseille, France, 2019.
- Fragility Fracture Network Global Congress, Oxford, 2019.

National Conferences

- Irish Hip Fracture Conference, RCSI, 2019.
- Irish Geriatric Society Annual Scientific Meeting, Cork, 2019.
- Royal College of Physicians Ireland William Stokes Award for Research (1 of 3 finalists nationally), 2019.

Irish Hip Fracture Database Annual Reports:

- Key messages from the research presented have been communicated to a wide range of stakeholders via the Irish Hip Fracture Database annual report 2020 and 2021.

Value of Research

The findings of this research have been implemented and have implications at a national and local level:

National Health Policy

- One new formal standard for early mobilisation by a physiotherapist on the day of or after surgery has been added to the Irish Hip Fracture Standards.

Hospital Level

- A Best Practice Tariff for early mobilisation by a physiotherapist on the day of or after surgery has been operationalised as part of Ireland's activity-based funding model.

Patients/ Society

- Given the majority of hip fractures occur as a result of a low-impact fall in the home, there is a renewed focus on supporting older adults to stay safe in their own environment. Advice pertaining to bone health and staying active has been incorporated into patient information leaflets and the Irish Hip Fracture Database annual reports.

Scientific Contribution

- The research findings have been widely disseminated in peer-reviewed journals, presented at national and international conferences and to key stakeholders within the Health Service Executive and National Office of Clinical Audit. Key messages from this research have been shared among the scientific community, as evidenced by 54 citations to date of the 3 published papers.

Chapter 1: Introduction

1.1 Background

Hip fracture is an important public health issue owing to its negative impact on mortality, morbidity and healthcare utilisation. It is a common injury in older adults with approximately 3,600 cases per annum in Ireland[1]. The incidence of hip fracture is projected to increase substantially in parallel with an ageing population. Like many countries, Ireland is faced with the challenge of optimising the management of hip fracture to ensure the best outcomes for patients and the most efficient use of healthcare resources.

There is an extensive body of evidence to show that adherence to gold standards of care reduces variation in clinical practice, improves survival and functional outcomes[2],[3],[4]. The Irish Hip Fracture Standards (IHFS) are the quality standards against which Irish services are benchmarked. They are designed to streamline the care pathway, improve efficiencies in the service and optimise outcomes for patients. Data on Irish hip fracture patients are captured using the Irish Hip Fracture Database (IHFD), which provides a reliable infrastructure to evaluate clinical data and measure against the explicit standards of care[5]. Adherence to the IHFS is assessed systematically by the IHFD on a quarterly and annual basis, with regular feedback to participating hospitals. The timely and accurate data from the IHFD provides a standardised framework for each trauma unit to monitor the patient pathway, refine care processes and assess the subsequent impact on clinical outcomes in an iterative manner.

This thesis will focus on optimising the management of hip fracture in the acute hospital setting using the IHFD.

1.2 Epidemiology

Hip fracture places a considerable burden on healthcare systems and society across the globe. There is a wide geographical variation in the incidence of hip fracture ranging from an age-standardised incidence rate of over 500 per 100,000 in Denmark to less than 100 cases per 100,000 in South Africa[6]. Ireland sits in the crescent of high-incidence countries in Northern Europe with an age-standardised incidence rate of 423 per 100,000 for females and 225 per 100,000 for males[7]. The variation in incidence from country to country is not fully understood but is thought to be associated with urbanisation and lifestyle factors such as smoking, physical exercise and diet amongst other factors[8],[9],[10]. Although the age-specific incidence has decreased over time, the lifetime risk of hip fracture has not decreased as life expectancy has increased in parallel[11].

The distribution of hip fracture is bimodal with peaks in the second to third decades and in older adults. This is largely attributable to high-impact trauma in younger age groups and a decrease in bone mass and increased risk of falls in older adults[12]. The vast majority of cases occur in older adults, a growing concern due to the country's changing demographics. The population of men and women over 50 years is projected to increase by 38% in Ireland between 2019 and 2023, which is considerably higher than the EU average of 11.4%[13]. This is noteworthy as 18% of women and 7% of men over 50 years will experience a hip fracture, placing Ireland 7th in Europe in terms of the burden of disease[14],[15].

The risk factors for hip fracture are well documented with advancing age, female gender, poor mobility, cogitative impairment, multimorbidity and polypharmacy all increasing risk of falls and subsequent fracture[16],[17],[18]. While the incidence of hip fracture is considerably higher in females, secondary to the effect of menopause on bone health; mortality is twice as high in males[19]. Institutionalisation also increases the risk of hip fracture in both sexes, as patients living in residential care are more likely to be frail with a greater falls risk[20].

As Ireland's population ages, the burden of hip fracture will increase substantially. Every effort should be made to prevent hip fracture in the first instance by strengthening bone health throughout life, identifying and treating osteoporosis, in addition to minimising falls risk in older adults. Where hip fracture does occur, patients require a holistic approach with multidisciplinary input to minimise the impacts on health, society and the economy.

1.3 Mortality

Hip fracture is one of the most serious consequences of falls in older adults with an associated mortality of approximately 10% at one month and up to 30% at 1 year[21]. Mortality rates at one year post hip fracture are 3-4 times higher than expected in the general population, with the greatest excess mortality seen in older men[22]. Men who sustain a hip fracture at age 80 years have an excess annual mortality of 18%, 22% and 26% at 1, 2 and 5 years respectively[23].

A range of patient characteristics, process measures and organisational factors have been found to increase the risk of mortality following hip fracture[24]. Advancing age (OR 1.09, 95% CI 1.05-1.13), higher baseline Charlson comorbidity index (OR 1.25, 95% CI 1.11-1.41) and lack of recovery of ambulation (OR 1.73, 95% CI 1.11-2.70) have been shown to be independent predictors of survival one year after surgery[25]. A systematic review and meta-

analysis by *Chang et al* demonstrated that the presence of pulmonary disease (OR 1.52, 95% CI 1.37-1.69, p<0.001), diabetes (OR 1.41, 95% CI 1.19-1.67, p<0.001) or cardiovascular disease (OR 1.14, 95% CI 1.03-1.26, p<0.01) increases the risk of death after surgery[26]. This is relevant in the Irish setting as lifetime prevalence of multimorbidity (co-existence of two or more chronic conditions) in older Irish adults is 73%[27]. This impacts survival, healthcare usage and the ability to return to independent living after hip fracture.

Hip fracture mainly occurs in vulnerable older adults with poor physiological reserve, frailty and more complex care needs[28]. The mean age for Irish hip fracture patients is 81 years, with over half having severe systemic disease (ASA Grade III or higher) and one-third of patients having cognitive impairment on admission[1]. Patients with delirium or dementia are twice as likely to have died in the year following hip fracture compared to those without cogitative impairment[29],[30]. Furthermore, data from the Irish Longitudinal Study on Ageing (TILDA) shows that almost 1 in 5 adults over 70 years are frail and half are pre-frail[31]. This is important as even a moderate degree of frailty is associated with an almost three-fold increase in the adjusted odds of in-hospital mortality (OR 2.94, 95% CI 1.91-5.41), increased length of stay and increased hospital costs[32],[33], [34], [35].

In relation to process factors, timely surgery within 48 hours is associated with a lower risk of death (RR 0.80, 95% CI 0.66-0.97) and a lower rate of postoperative complications such as pneumonia and pressure injuries[36],[37],[38]. At an organisational level, inadequate theatre space, particularly at weekends, and the lack of a seven day a week multidisciplinary team contribute to surgical delay and can impact survival. Hip fracture patients admitted over the weekend have a greater risk of adjusted 30-day mortality (OR 1.40, 95% CI 1.02-1.80, p<0.03)[39].

Admission to an orthopaedic ward within 4 hours of presentation has also been shown to improve survival outcomes for hip fracture patients. Fast tracking patients with a suspected hip fracture from the Emergency Department to a dedicated orthopaedic ward enables prompt access to a multidisciplinary team and facilitates the provision of adequate analgesia, improved recognition of delirium and early mobilisation post-operatively[40]. Furthermore, a recent Cochrane Review showed the beneficial effects of Orthogeriatric co-management including reduced waiting times for surgery, shorter length of stay and improved survival[41]. More specifically, Orthogeriatric co-management is associated with a reduction in both in-

hospital mortality (RR 0.60, 95% CI 0.43-0.84) and long-term mortality (RR 0.83, 95% CI 0.74-0.94)[42].

Despite advances in medical, surgical and rehabilitation practices, hip fracture can be a life limiting injury. It is imperative that modifiable patient and system factors are targeted to ensure the best outcomes for patients.

1.4. Morbidity

The optimal management of hip fracture requires a coordinated approach between medical, surgical, allied health, rehabilitation and community teams so that patients can return home with minimal functional impairment. For many patients, hip fracture can result in loss of independence and a change in residence[43]. Although 82% of Irish hip fracture patients are admitted from home, less than one-third are Discharged Directly Home (DDH) from the acute hospital[1]. Research has shown that 10-20% of patients are newly institutionalised within 12 months of fracture[44],[45]. This has a detrimental impact on quality of life and places a burden on community services.

Regaining mobility after surgical repair is a primary goal for both patients and clinicians as up to 60% of patients are unable to regain their pre-fracture level of mobility[46]. The factors that influence functional recovery are multifactorial. Older adults with poor pre-fracture mobility are most vulnerable to poorer outcomes[47]. Age >80 years, delirium, high burden of comorbidities and nursing home residence before the fracture are associated with not regaining basic mobility at discharge[48]. Recovery can also be hindered by new onset depression after fracture in up to one-third of patients, which can impair the ability to actively engage with rehabilitation[49],[50]. Conversely, timely surgery and early post-operative mobilisation have been shown to improve functional outcomes[51]. Being able to complete the first day of physiotherapy on the ward is a key milestone for patients and increases the likelihood of functional recovery[52].

Hip fracture is associated with a deterioration in Health-Related Quality of Life (HRQoL), especially in the area of self-care, daily activities and mobilisation[53],[54]. Mean loss of Quality Adjusted Life Years (QALY) is 0.27 in the first-year post fracture[55]. A recent analysis of >6,500 patients across 20 UK hospitals in the World Hip Trauma Evaluation (WHiTE) cohort showed that case management in accordance with all of the national standards of care is associated with a large clinically relevant increase in four-month post injury quality of life

(0.09, 95% CI 0.04-0.14), as measured by the EuroQol 5 Dimension 5 Level questionnaire (EQ-5D-5L)[56]. This emphasises the importance of national standards of care in improving patient outcomes.

1.5. Cost

The direct, indirect and human costs associated with hip fracture are substantial. The recent Scorecard for Osteoporosis in Europe (SCOPE) project showed a staggering total direct cost of €56 billion for fragility fractures in the European Union[13]. As the vast majority of cases require hospitalisation and surgical fixation, the direct costs are high, with the index hospital admission being the major driver. In Ireland, the total cost of hospitalisation for hip fracture was approximately €296 million for the period 2014–2020, equating to €11,700 per episode of care[57]. The majority of costs are attributable to hospital bed days with costs increasing with length of stay[58,59]. In 2020, the mean length of stay for hip fracture in Ireland was 17 days accounting for >62,600 acute hospital bed days[1]. The human cost of hip fracture is extensive and includes pain, fear of falling and loss of independence, which can lead to social isolation and increasing frailty[60]. This is compounded by the wider societal cost of loss of productivity, demand for community care and the opportunity costs of informal care provided by family members[61].

The economic burden of hip fracture is immense and underscores the importance of prevention of fragility fractures. Primary prevention is the ultimate goal, however secondary prevention is also key as the risk of subsequent fracture after initial osteoporotic fracture is 3 times higher than baseline[62]. Within the IHFD, only 13% of patients are on bone health medication pre-admission, despite one-third of patients having previously sustained a fragility fracture[1]. A recent study by *Nayak et al* demonstrated that secondary prevention by way of pharmacotherapy could reduce the number of fractures by 5% over a 5-year period and increase QALY's by 0.03 per patient[63]. Fracture Liaison Services (FLS) have an important role to play in improving the rate of and adherence to osteoporosis treatment in a cost-effective manner[64]. Currently, FLS in Ireland are heterogenous and suboptimal[65]. A national FLS will be established in the coming year with the aim of reducing the burden of fragility fractures on patients and the healthcare system.

1.6 Irish Hip Fracture Standards (IHFS)

The IHFS are the best practice standards and quality indicators for the management of hip fracture in Ireland. They are evidence-based guidelines derived from the British Orthopaedic Association (BOA) & British Geriatric Society (BGS) "*Blue Book*" and are adapted for the Irish setting (Figure 1)[2]. The IHFS focus on 9 core measures: 7 clinical and 2 for data quality and governance. The combination of explicit standards of care with regular feedback from the national hip fracture audit has been shown to enhance the quality of patient care, confer a survival benefit and increase cost-effectiveness[66]. The IHFS are in alignment with a Best Practice Tariff (BPT), which is a 'pay per performance' incentive that rewards hospitals with a payment of €1,000 for each case that is managed in accordance with all 9 IHFS.

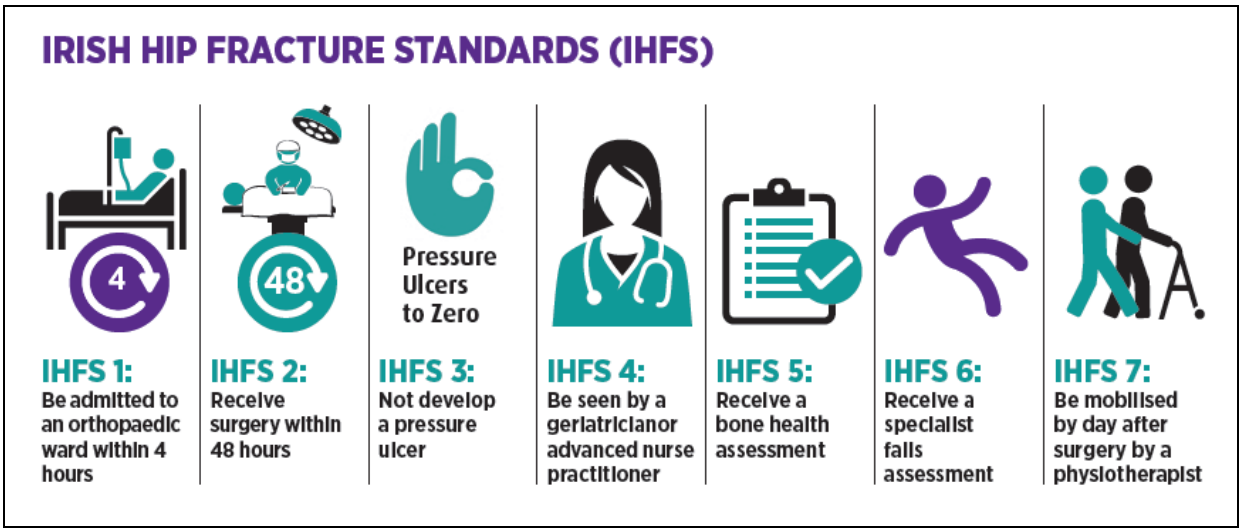

Figure 1 Irish Hip Fracture Standards[1]

1.7 Aim

To optimise the management of hip fracture in the acute hospital setting using the IHFD.

1.8 Objectives

1.8.1 To identify the determinants of in-hospital mortality post hip fracture in Ireland (Paper 1).

1.8.2 To identify factors influencing Discharge Directly Home (DDH) from an acute hospital following hip fracture as opposed to Discharge to an Alternative Location (DAL) (Paper 2).

1.8.3 To quantify the impact of hip fracture on the Irish health service in terms of bed days and direct hospital costs (Paper 3).

Chapter 2: Methods

2.1 Data Source

In 2012, the National Office of Clinical Audit (NOCA) established the IHFD with the associated national clinical audit, in collaboration with the Health Service Executive (HSE) and the Healthcare Pricing Office (HPO). This venture was influenced by evidence from other countries such as Sweden, Denmark, Scotland and the UK which demonstrated the positive impact of implementing a clinically led national hip fracture audit on patient outcomes such as survival[67].

The aim of the IHFD is to maintain a prospective database of all patients in Ireland aged 60 years and over with hip fracture to drive continuous quality improvement for better, safer care[1]. It is clinically endorsed and supported by the Irish Gerontological Society (IGS) and the Irish Institute of Trauma and Orthopaedic Surgery (ITOS), with operational management provided by NOCA. Each hospital has a local IHFD audit coordinator, an IHFD clinical lead and a local governance committee. In addition, there is an IHFD Audit Manager within NOCA and a National IHFD Governance Committee.

The IHFD actively engage with all 16 trauma units in the Republic of Ireland so that each unit can use the data to benchmark its performance against other hospitals nationally and internationally (Figure 2). Quarterly and annual reports provide feedback to participating hospitals, identify areas of excellence in patient care and opportunities for improvement. This timely and accurate clinical information provides a platform for continuous quality improvement and facilitates evidence-based decision making at both a local and national level.

Data coverage is 99%, which sets the IHFD apart from many other international registries. To date, the IHFD has captured data on >25,000 cases and has published 8 national reports. This rich data characterises the Irish hip fracture population and provides detailed information in relation to the care processes and outcomes for patients.

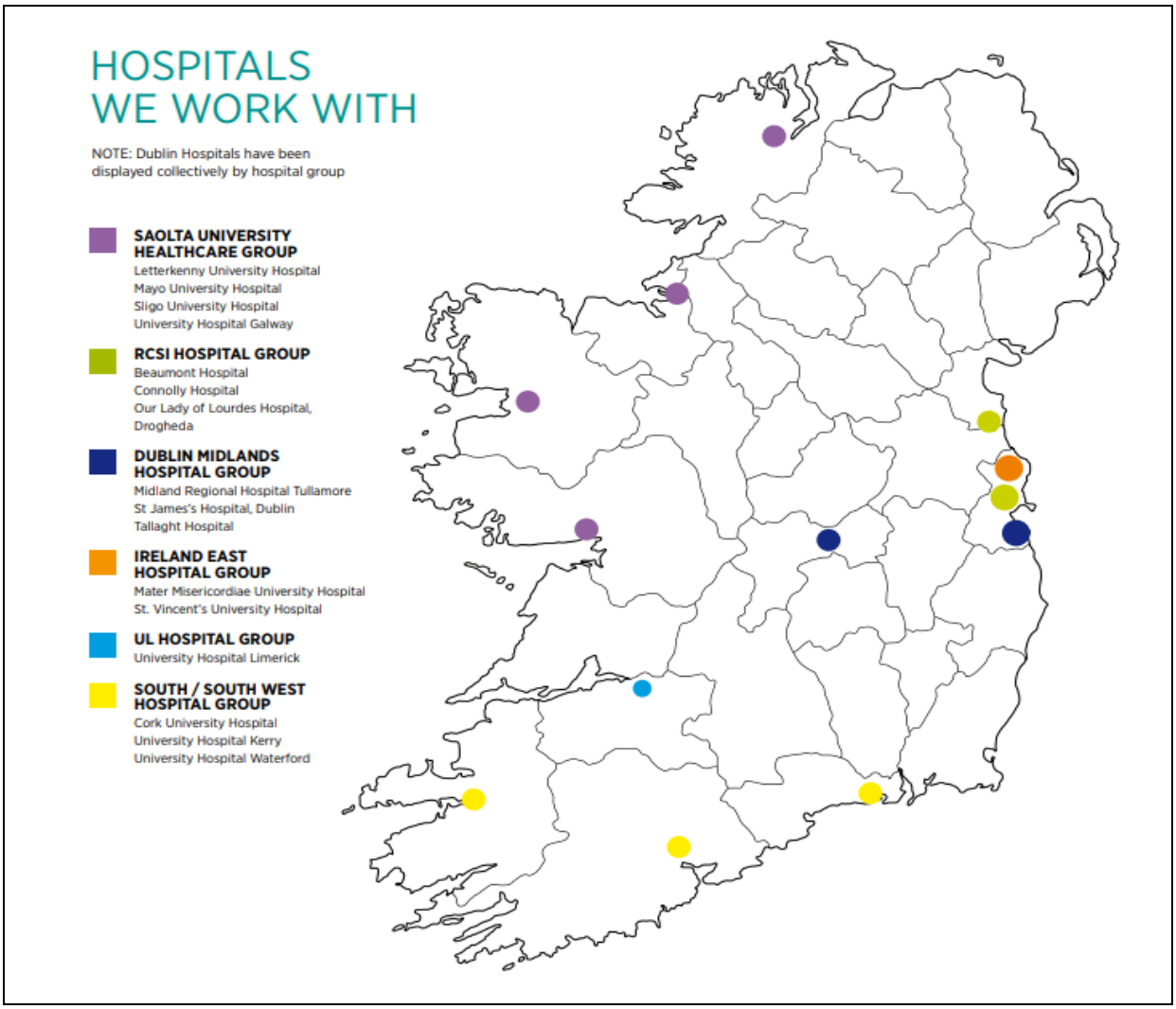

Figure 2 IHFD Participating Hospitals[68]

2.2 Eligibility Criteria

(i) Diagnosis on HIPE of either hip fracture due to injury (ICD-10-AM diagnosis codes S72.00 to S72.2) or with a specified type of fracture (e.g., intracapsular displaced, intracapsular undisplaced, intertrochanteric, subtrochanteric) other than periprosthetic.

(ii) Aged 60 years or over.

2.3 Data Entry & Collection

Data are entered locally from patients' medical records by IHFD audit coordinators. This is a computerised process using an online IHFD portal on the Hospital In-Patient Enquiry (HIPE) system. The HIPE system is the principal source of demographic and clinical information on

all discharges from publicly funded hospitals in Ireland and is managed by the HPO[69]. An extensive number of variables ranging from the patients' pre-operative functional status to the type of surgery and clinical outcomes are captured by the IHFD dataset (Appendix A). The HPO issues an anonymised extract to NOCA on a quarterly basis for analysis and validation.

2.4 Data Quality & Validation

NOCA issues Data Validation Reports (DVR) to participating hospitals along with quarterly reports from the HPO. Once the data are verified by the contributing hospitals and any discrepancies reconciled, the internal data analytics team in NOCA finalise the data for inclusion in the annual report. Subsequently, the data are measured against the IHFS and linked to the BPT. Data quality is assessed using the dimensions of data quality set out by the Health Information Quality Authority (HIQA)[70]. Data from the IHFD are relevant, accurate, comparable, timely and accessible and meet the criteria for high-quality data.

2.5 Patient Population

The mean age of Irish hip fracture patients is 81 years, with home being the most frequent source of admission (Table 1). Cemented hemiarthroplasty is the most common fixation type, usually carried out under spinal anaesthesia. Despite over one-third of patients having previously sustained a fragility fracture, only 13% of patients are taking bone health medication on admission[1]. Mean length of stay is 17 days with 5% of patients dying during admission.

In relation to the care pathway, 75% of patients are operated on within 48 hours of admission, with three-quarters of patients mobilised on the day of or after surgery. The majority of patients are reviewed by a Geriatrician during their inpatient stay and receive a specialist falls and bone health assessment.

Table 1 Patient Characteristics and Care Pathway for Irish Hip Fracture Patients 2020[57]

Parameter	Percentage
Gender	
Female	67%
Male	33%
Mean age	81
Over 80 years	43%
Admission source	
Home	85%
Nursing home	11%
Acute hospital transfer	4%
Cognitive status on admission	
Normal cognition	69%
Cognitive impairment (AMT <7)	31%
Pre-fracture mobility	
Low functional ability	53%
High functional ability (NMS>6)	47%
Previous fragility fracture	
Yes	35%
No	65%
Bone health	
Bone health medication pre-admission	13%
Bone health medication started during admission	59%
Awaiting dual energy x-ray absorptiometry scan	5%
Assessed – no bone protection needed	6%
Not assessed	9%
Awaiting out-patient assessment	8%
Type of trauma	
Low energy	95%
High energy	2%
Unknown	3%
ASA grade	
I or II	37%
III	55%
IV or V	8%
Fracture type	
Intracapsular displaced	40%
Intracapsular undisplaced	8%
Intertrochanteric	37%
Subtrochanteric	6%
Other	9%
Type of anesthetic	
Spinal only	55%
Spinal and nerve block	21%
GA only	13%
GA and nerve block	8%
GA and spinal	3%
Type of surgery	
Arthroplasty hemi cemented	36%
Internal fixation – IM nail short	18%
Internal fixation – IM nail long	14%
Internal fixation – dynamic hip screw	12%
Arthroplasty hemi uncemented	12%
Arthroplasty THR cemented	3%
Arthroplasty THR uncemented	2%
Internal fixation screws	1%

Other	2%
Irish Hip Fracture Standards (IHFS)	
IHFS 1 (Admitted to orthopaedic ward <4hrs)	33%
IHFS 2 (Surgery within 48hrs)	75%
IHFS 3 (Pressure ulcer)	3%
IHFS 4 (Review by Geriatrician)	82%
IHFS 5 (Bone health assessment)	91%
IHFS 6 (Specialist falls assessment)	85%
IHFS 7 (Early mobilisation by Physiotherapist)	78%
Length of stay	
Mean	17 days
Median	11 days
Discharged home directly	28%
In hospital mortality	5%

2.6 Statistical Methods

Data were exported from Microsoft Excel into Stata® (version 17) for analysis. Descriptive statistics were used to describe patient demographics, in-hospital journey and outcomes. Categorical variables were presented as percentages and continuous data were shown as the mean and Standard Deviation (SD) or median and Inter Quartile Range (IQR) range, as appropriate.

A preliminary analysis of the data was performed using a one-way Analysis of Variance (ANOVA) to determine if the difference between groups was statistically significant. Following this, univariate and multivariate logistic regression was used to assess the impact of variables routinely collected by the IHFD on the likelihood of outcomes such as in-hospital mortality or DDH. Logistic regression was selected for the analysis as the most appropriate statistical test for predicting the probability of a dichotomous dependent variable (i.e., death yes/no) given a set of independent variables[71]. This method also supports the categorisation of data into classes and facilitates the exploration of the relationship between variables. A value of $p<0.05$ indicated statistical significance.

Chapter 3: Results

Paper 1:

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RESEARCH PAPER

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

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Early Mobilisation Reduces the Risk of In-Hospital Mortality Following Hip Fracture

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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 3,700 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 preoperative 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=4,796) 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 4 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.

Key Words: Hip Fracture, Mortality, In-Hospital Mortality, Survival.

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 3,700 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 preoperative 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 death records renders it more challenging to determine longer term outcomes. Notwithstanding, 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 clinical audit is clinically supported by the Irish Institute of Trauma and Orthopaedic Surgery (IITOS) and the Irish Gerontological Society (IGS), with operational management 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) (Figure 3). All sixteen 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 type of surgery and clinical outcomes. These variables are measured against the IHFS and are linked to the BPT. The IHFD dataset 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.

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.**

Figure 3 Irish Hip Fracture Standards and Best Practice Tariff

Results

Descriptive Statistics

In this cohort, 31% (n=4,796) 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=4,600) 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=9,652) of hip fracture patients were medical card holders 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=3,212) 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 2.

Table 2 Statistically Significant Univariate Logistic Regression Models

In-Hospital Mortality	Number (n)/ Percentage (%)	Odds Ratio	P	95% CI
Age Category:				
60-69	1,935 (13.26)	1(base)		
70-79	4,109 (28.17)	2.93	0.00	1.86-4.61
80-89	6,358 (43.58)	5.18	0.00	3.36-8.00
90-99	2,186 (14.98)	8.18	0.00	5.23-12.78
Gender:				
Male	4,796 (30.74)	1(base)		
Female	10,807 (69.24)	0.60	0.00	0.51-0.70
Medical Card Status:				
No	5,885 (37.72)	1(base)		
Yes	9,652 (61.86)	1.50	0.00	1.27-1.77
Unknown	66 (0.42)	0.85	0.83	0.20-3.52
ASA Grade:				
1	728 (4.96)	1(base)		
2	5,490 (37.41)	5.50	0.01	1.35-22.04
3	6,525 (44.46)	20.63	0.00	5.13-83.01
4	722 (4.92)	59.71	0.00	14.67-243.02
5	13 (0.09)	311.14	0.00	53.26-1817.47
Undocumented	1,198 (8.16)	12.53	0.00	3.02-52.03
Specialist Falls Assessment:				
No	7,425 (49.08)	1(base)		
Yes	7,526 (49.75)	0.77	0.01	0.66-0.90
Yes-Awaits Further OPD Ass	177 (1.17)	0.76	0.50	0.35-1.65
Previous Fragility Fracture:				
Yes	3,212 (21.54)	1(base)		
No	10,581 (70.96)	1.09	0.36	0.90-1.33
Undocumented	1,119 (7.50)	1.35	0.05	1.00-1.84
Mobilised Day of/after Surgery:				
Yes	8,170 (76.53)	1(base)		
No	2,242 (22.59)	4.38	0.00	3.61-5.32
Undocumented	93 (0.87)	3.78	0.57	1.81-7.92
Ward Type:				
Ortho Ward	13,732 (88.45)	1(base)		
Never Admit to Ortho Ward	1,726 (11.12)	1.82	0.00	1.49-2.22
Undocumented	67 (0.43)	2.25	0.05	0.97-5.23
MDT Rehab:				
Yes	13,563 (90.08)	1(base)		
No	1,415 (9.40)	2.03	0.00	1.65-2.51

Undocumented	79 90.52)	0.91	0.88	0.28-2.91
***New Mobility Score:**				
0	84 (1.47)	1(base)		
1	192 (3.37)	1.04	0.94	0.63-5.95
2	481 (8.43)	0.88	0.76	0.64-5.34
3	396 (6.93)	0.98	0.96	0.65-5.45
4	687 (12.05)	0.60	0.21	0.46-3.81
5	341 (5.98)	0.52	0.15	0.43-3.93
6	698 (12.24)	0.41	0.03	0.29-2.52
7	241 (4.23)	0.67	0.38	0.49-4.46
8	71 (1.24)	0.27	0.11	0.10-3.26
9 (Independent)	2,510 (44.01)	0.10	0.00	0.09-0.77
Reason for Surgery Delay:				
No Delay- Surgery <24 hrs	10,821 (73.83)	1(base)		
Awaiting Ortho Dx/Ix	182 (1.24)	2.03	0.02	1.09-3.77
Awaiting Med Rev/Stabilisation	1,795 (12.25)	3.17	0.00	2.61-3.85
Awaiting In-patient/HDU bed	53 (0.36)	1.89	0.28	0.58-6.10
Awaiting Space on Theatre List	504 (3.44)	1.03	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	0.03	0.16-0.95
Other	581 (3.96)	2.02	0.00	1.41-2.89
Undocumented	243 (1.66)	0.93	0.86	0.43-2.00

**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, 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].*

The 11 statistically significant predictor variables on univariate analysis were included in the multivariate model. Only 4 variables remained statistically significant on multivariate analysis (mobilised day of/after surgery, pre-fracture mobility, gender and age) (Table 3):

- 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 the 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).

Table 3 Multivariate Logistic Regression Model

In-Hospital Mortality	Odds Ratio	P	95% CI
Age Category	1.05	0.00	1.03-1.06
Female Gender	0.56	0.00	0.41-0.76
Not Mobilised Day of/after Surgery	1.46	0.00	1.25-1.70
Independent in Mobility Pre-Fracture (New Mobility Score)	0.84	0.00	0.79-0.89
Medical Card Status	1.12	0.53	0.77-1.63
ASA Grade	0.99	0.87	0.90-1.09
Specialist Falls Assessment	0.88	0.40	0.65-1.18
Previous Fragility Fracture	1.04	0.22	0.97-1.13
Ward Type	1.18	0.17	0.92-1.53
MDT Rehab	1.13	0.47	0.80-1.59
Reason for Surgery Delay	1.00	0.87	0.93-1.08

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 4 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 early post-operative ambulation has been shown to reduce the incidence of delirium, 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 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 7,000 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 NICE guidelines on the management of hip fracture 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 hours 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 physiotherapy service at weekends (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 the 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 (HR1.06, $p < 0.001$) 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 is likely due to the large number of confounding variables associated with length of stay. Finally, surgical volume has also been shown to positively impact in-hospital mortality and this variable is not currently recorded in the IHFD [18].

Strengths & 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 death records, 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.

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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RESEARCH PAPER

Discharge destination after hip fracture: findings from the Irish hip fracture database

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Discharge Destination After Hip Fracture: Findings from the Irish Hip Fracture Database

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Key Summary Points

Aim

To identify factors influencing Discharge Directly Home (DDH) from an acute hospital following hip fracture, as opposed to Discharge to an Alternative Location (DAL).

Findings

Younger patients who were independently mobile pre-fracture were more likely to be DDH. Timely surgery with early post-operative mobilisation and a shorter length of stay increased the odds of DDH.

Message

The Irish Hip Fracture Standards incorporate 2 out the 3 modifiable factors identified, which reinforces the importance of the IHFS in improving patient outcomes.

Abstract

Purpose:

Although home continues to be the place from which the majority of patients are admitted, less than one third of patients are Discharged Directly Home (DDH) following hip fracture. Once ready for discharge, DDH as opposed to Discharge to an Alternative Location (DAL) i.e., community care, rehabilitation facility or long-term care, is a high priority for patients and clinicians alike. Not only is DDH integral to the quality of life of patients, it is also an essential driver of the socioeconomic cost of hip fracture care.

Methods:

We analysed 21,819 cases in the Irish Hip Fracture Database from 2013 to 2019. Descriptive and analytical statistics were conducted.

Results:

29% (n=6,476) of patients were DDH during the study period. On multivariate analysis, the odds of DDH decreased as age increased (OR 0.28, $p<0.01$, 95% CI 0.24-0.34). Patients who were independently mobile prior to fracture were 47% more likely to be DDH (OR 1.47, $p<0.01$, 95% CI 1.29-1.68). Those mobilised early post-operatively were 24% more likely to be DDH (OR 1.24, $p<0.01$, 95% CI 1.06-1.45). Patients who waited >72hrs prior to surgery were 30% less likely to be DDH (OR 0.70, $p<0.01$, 95% CI 0.56-0.88).

Conclusion:

The authors identified patient characteristics that increased the likelihood of DDH i.e. younger patients independently mobile prior to fracture, who received timely surgery and early post-operative mobilisation. The Irish Hip Fracture Standards (IHFS) incorporate 2 out the 3 modifiable factors identified, which reinforces the importance of the IHFS in improving patient outcomes.

Keywords: Hip fracture, discharge destination, discharge directly home, discharge to alternative location.

Introduction:

Hip fracture is a serious public health issue owing to an ageing population and increasing frailty in older adults. In Ireland, there are approximately 3,700 hip fractures per annum, with 60% of cases occurring in those over 80 years [1]. Hip fractures among older adults are one of the leading causes of hospitalisation and result in considerable morbidity, mortality and healthcare usage [2]. Although there is much evidence underpinning outcome measures such as mortality, less is known about the factors influencing discharge destination following hip fracture. Once ready for discharge, Discharge Directly Home (DDH), as opposed to Discharge to an Alternative Location (DAL) i.e., rehabilitation facility, community or long-term care, is a high priority for hip fracture patients and clinicians alike. Not only is DDH integral to the quality of life of patients, it is also a driver of the socioeconomic cost of hip fracture care.

Hip fracture patients incur three times the in-patient cost compared to age-matched non-hip fracture patients, and post-acute utilisation of healthcare is also substantial due to the need for rehabilitation after surgery [3]. From an Irish healthcare perspective, the estimated cost of one admission for hip fracture is approximately €12,687 with inpatient care being a significant component of the cost incurred [4]. The total direct and indirect cost of falls and fractures for people aged ≥65 years is estimated at €404 million per annum, accounting for an estimated 4.2% of all public health expenditure in Ireland [5]. Identifying factors to stratify hip fracture patients into those most likely to be DDH as opposed to DAL could help streamline the postoperative phase. In turn, this could facilitate efficient discharge planning to the most appropriate and cost-effective discharge destination.

Home continues to be the place from which the majority of Irish patients (85%) are admitted, however, less than one-third of patients are DDH from the acute hospital [1, 6]. Prognostic factors for DDH and remaining there 12 months after hip fracture are those that reflect better health prior to fracture and better functionality at hospital discharge [7]. *Salar et al* demonstrated that younger females without cognitive impairment who were independently mobile prior to fracture were most likely to be DDH from acute hospital following hip fracture [8]. A US based study of >33,000 hip fracture patients showed that increasing age and American Society of Anaesthesiologists (ASA) Grade II or greater predicted discharge to a destination other than home [9].

The rising incidence of hip fractures coupled with increasing frailty and potential for dependency post fracture has implications for service delivery, discharge planning and healthcare costs. Premature discharge or discharge to an unsuitable environment can result in the need for subsequent healthcare utilisation, such as visits to the emergency department or re-hospitalisation [10]. Furthermore, discharging patients to a location other than home frequently delays discharge whilst the necessary logistical arrangements are made [11]. Identifying subgroups most likely to be DDH on admission could make the discharge process more efficient [12].

Discharged Directly Home – International Landscape

There is considerable variation from country to country in terms of the proportion of hip fracture patients DDH following hip fracture. For instance, in England, Wales and Northern Ireland (NHFD) 52% of patients are DDH, which is the highest of the hip fracture registries [13]. In comparison, Italy has the lowest proportion of patients DDH at 11% [14]. Ireland sits midway amongst its international counterparts with 22% of patients DDH in 2018

(Figure 4) [15]. It is important to note that characteristics of the patient population and healthcare systems vary considerably from country to country, which renders direct comparisons challenging [16].

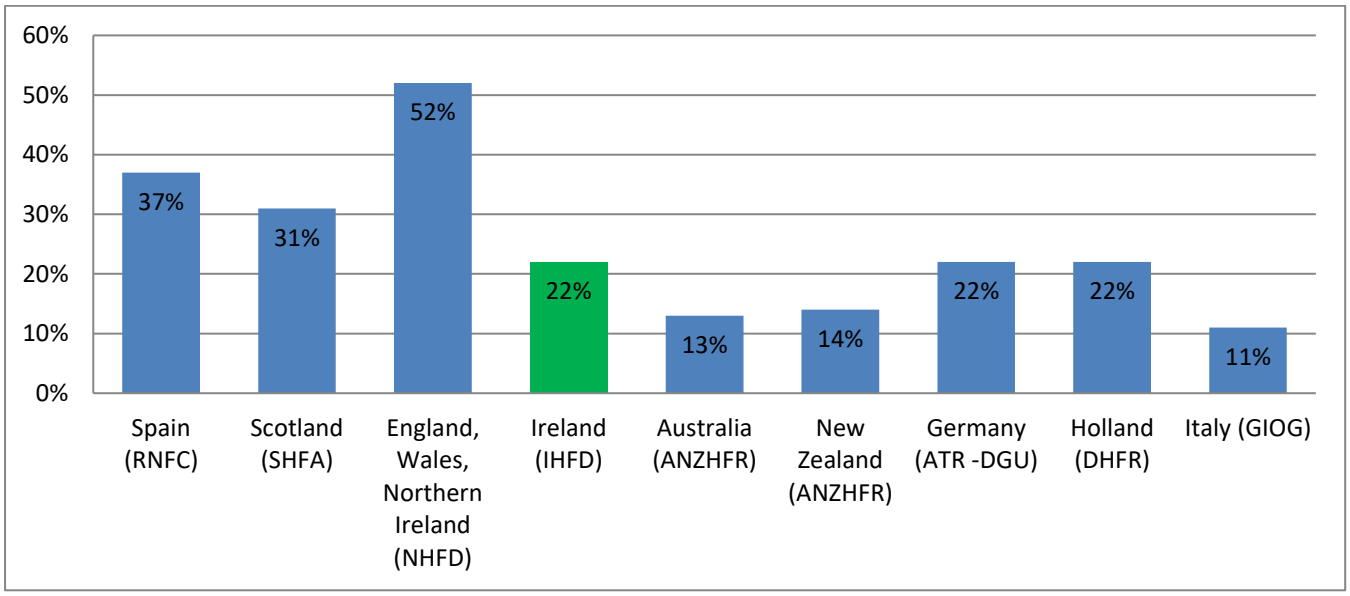
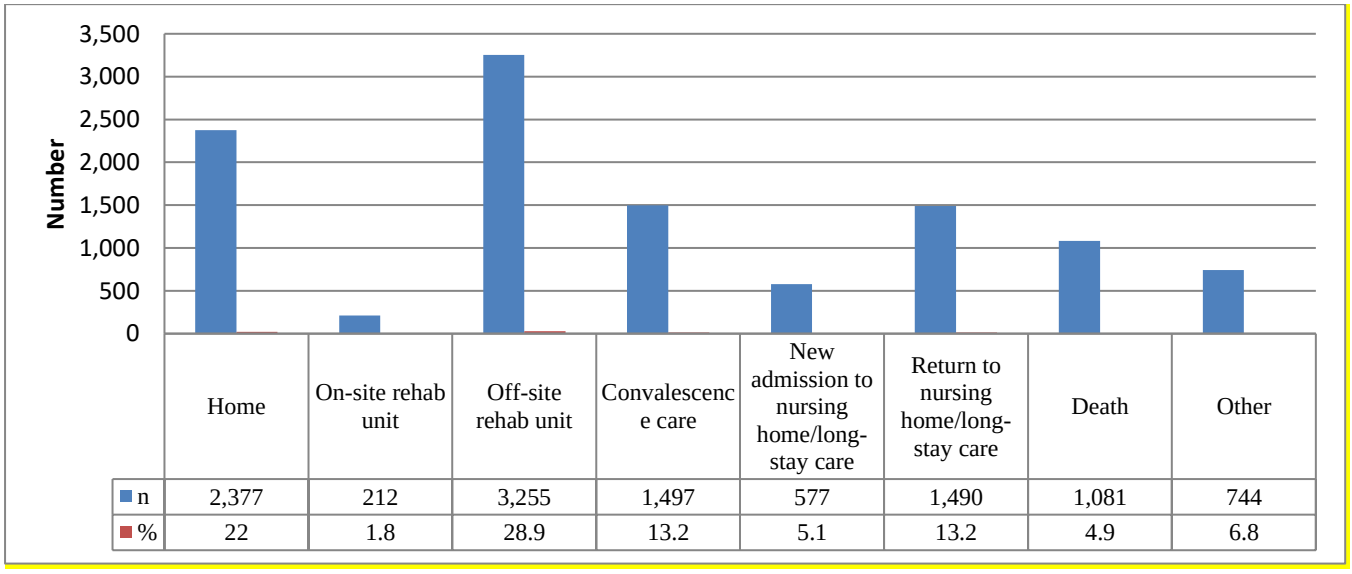


Figure 4 International Overview of Discharge Directly Home from Acute Hospital [15]

Discharged Directly Home – National Landscape

In 2017, the IHFD launched a quality improvement initiative with a specific focus on getting patients home following hip fracture. The theme of the campaign '*From Broken Bone to Walking Home'* focused on ensuring hip fracture patients received the right care at the right time to enable them to be discharged home directly. There was considerable engagement with the quality improvement initiative across all 16 trauma sites and a 4% improvement in DDH was seen the following year. The distribution of patients discharged to each discharge location is depicted in Figure 5.



	Home	On-site rehab unit	Off-site rehab unit	Convalescence care	New admission to nursing home/long-stay care	Return to nursing home/long-stay care	Death	Other
n	2,377	212	3,255	1,497	577	1,490	1,081	744
%	22	1.8	28.9	13.2	5.1	13.2	4.9	6.8

Figure 5 Distribution of Patients Discharged to Each Discharge Destination 2017-2019

Aim

This paper aims to identify factors influencing DDH from an acute hospital following hip fracture as opposed to DAL.

Methods:

Irish Hip Fracture Database

The Irish Hip Fracture Database (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 though 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). Operational management is provided by the National Office for Clinical Audit (NOCA). The Irish Hip Fracture Standards (IHFS) are the standards against which Irish healthcare services are benchmarked. The IHFS are in alignment with the Best Practice Tariff (BPT) for hip fractures, which focuses on 8 core parameters; 6 clinical and 2 for data quality and governance (Figure 6).

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.
		Minimum quarterly data coverage of 90% is required by individual hospitals.
		Evidence of a local HFGC must be present in each hospital.

Figure 6 Irish Hip Fracture Standards

All sixteen trauma units in the Republic of Ireland voluntarily submit data on all patients over age 18 that are discharged following hip fracture. Data are reported on patients over the age of 60 in the National report. Data are collected for each hip fracture episode from admission to 30 days post discharge. Data are entered locally via IHFD audit coordinators, with support from the local IHFD clinical lead and NOCA. A specific data entry form is used to record details of an extensive number of variables ranging from the patients' pre-operative functional status to the type of surgery and clinical outcomes. These variables are measured against the IHFS and are linked to the BPT. The IHFD dataset with full description of the variables collected is described in the most recent IHFD annual report [1]. The IHFD is a timely and accurate database with 99% coverage.

Within the IHFD, low-energy trauma is the most common cause of hip fracture with almost a quarter of patients recorded as having previously sustained a fracture. The most common type of surgical repair is cemented hemi-arthroplasty {36% (n=1,282)} followed by internal fixation with a short IM nail {16% (n=558)} [1]. Three-quarters of surgical repairs are conducted under spinal anaesthesia, either alone {53% (n=1,886)} or in combination with a nerve block {21% (n=757)}[1]. There has been an increase in the degree of comorbidity of patients i.e. ASA Grade III (severe systemic disease) admissions increased from 39% (n=767) in 2013 to 53% (n=1,799) in 2019 [1]. A full description of the trends in hip fracture care in the Republic of Ireland from 2013 – 2018 has been published elsewhere [17].

Statistical Analysis

We retrospectively analysed 21,819 cases in the IHFD from 2013 to 2019. Data were exported from Microsoft Excel into Stata® (version 16) for analysis. Descriptive statistics were used to describe the patient characteristics, care pathway and outcomes. Continuous variables such as time spent in the Emergency Department (ED) and time to surgery were divided into categories in keeping with the IHFS. A one-way analysis of variance (ANOVA) was used to measure variation between individual hospitals in relation to discharge practices. Univariate logistic regression was undertaken to assess the impact of variables routinely collected by the IHFD on the likelihood of DDH following hip fracture. A multivariate logistic regression model was constructed using the statistically significant variables from univariate analysis. Model fit for the final multivariate model was satisfactory (Pseudo R^2 0.11). Missing data was minimal and treated as missing at random. An adjustment for outliers was not required for this dataset. A value of $p<0.05$ indicated statistical significance.

Results:

Patient Characteristics

Data pertaining to discharge destination was available for 100% (n=21,819) of cases from 2013-2019, with 29% (n=6,476) of patients DDH from acute hospital. There were inherent differences between patient's DDH compared to those DAL. These differences ranged from general health and functionality pre-fracture to the care pathway during admission (Table 4).

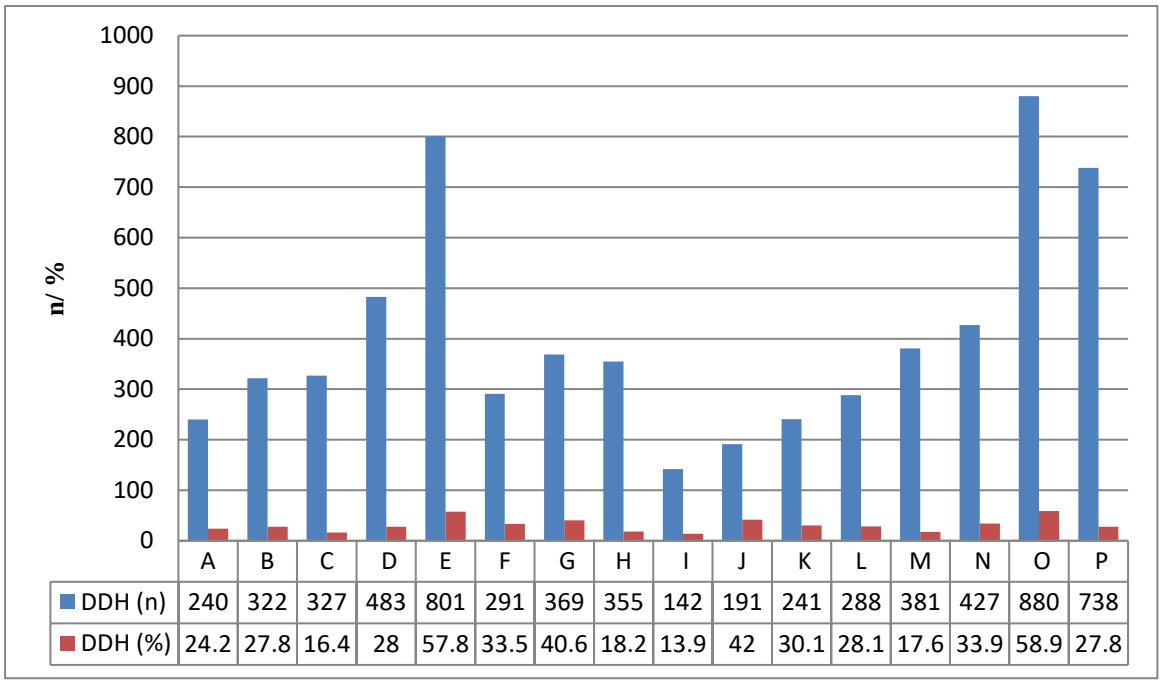
Table 4 Characteristics of Patients DDH Compared to DAL 2013-2019

Description	Home	Elsewhere	Total
n (%)	6476 (29.7)	15343 (70.3)	21819 (100.0)
Sex, n (%)			
Male	1985 (30.7)	4544 (29.6)	6529 (29.9)
Female	4491 (69.3)	10799 (70.4)	15290 (70.1)
Age group, n (%)			
60-69	1476 (22.8)	1377 (9.0)	2853 (13.1)
70-79	2298 (35.5)	3961 (25.8)	6259 (28.7)
80-89	2098 (32.4)	7263 (47.3)	9361 (42.9)
>90	604 (9.3)	2742 (17.9)	3346 (15.3)
Has medical card, n (%)			
No	2425 (37.6)	4667 (30.5)	7092 (32.6)
Yes	4031 (62.4)	10637 (69.5)	14668 (67.4)
Admission Source, n (%)			
Home	5945 (91.8)	11976 (78.1)	17921 (82.1)
Nursing Home/Conv. Home/Other Long-Stay Acc.	16 (0.2)	1976 (12.9)	1992 (9.1)
Transfer from Acute Hospital	458 (7.1)	1296 (8.4)	1754 (8.0)
All Other Sources	55 (0.8)	95 (0.6)	150 (0.7)
Pre-fracture mobility, n (%)			
Low functional mobility	993 (34.3)	4195 (58.7)	5188 (51.7)
High functional mobility (NMS>6)*	1901 (65.7)	2952 (41.3)	4853 (48.3)
AMT score, n (%)			
Impaired cognition 0-6	146 (18.8)	571 (32.1)	717 (28.0)
Normal cognition 7-10	631 (81.2)	1210 (67.9)	1841 (72.0)
ASA Grade, n (%)			
Healthy (I)	355 (6.2)	377 (2.8)	732 (3.8)
Mild symptomatic (II)	2706 (47.6)	4714 (35.0)	7420 (38.8)
Sever systematic (III)	2386 (42.0)	7405 (55.0)	9791 (51.1)
Severe/life threatening (IV)	231 (4.1)	946 (7.0)	1177 (6.1)
Moribund (V)	8 (0.1)	19 (0.1)	27 (0.1)
Hours in ED department, n (%)			
0-4h	1156 (29.5)	3260 (28.0)	4416 (28.4)
5-12h	1936 (49.5)	5746 (49.3)	7682 (49.4)
13-24h	631 (16.1)	2082 (17.9)	2713 (17.4)
25-48h	167 (4.3)	503 (4.3)	670 (4.3)
>48h	25 (0.6)	53 (0.5)	78 (0.5)
Hours until surgery, n (%)			
<24h	2672 (43.6)	5388 (37.1)	8060 (39.0)
24-47h	2059 (33.6)	4971 (34.2)	7030 (34.0)
48-71h	717 (11.7)	1987 (13.7)	2704 (13.1)
>72h	678 (11.1)	2190 (15.1)	2868 (13.9)
Length of stay, n (%)			
1-7d	1560 (24.1)	3616 (23.6)	5176 (23.7)
8-14d	2346 (36.2)	5170 (33.7)	7516 (34.4)
15-21d	1019 (15.7)	2763 (18.0)	3782 (17.3)
22-39d	876 (13.5)	2292 (14.9)	3168 (14.5)
40-59d	360 (5.6)	729 (4.8)	1089 (5.0)
>60d	315 (4.9)	773 (5.0)	1088 (5.0)

**New Mobility Score (NMS) is a composite score of a patient's ability to perform indoor walking, outdoor walking and shopping prior to hip fracture. Each parameter is scored between 0 and 3 (0: not at all, 1: with help from another person, 2: with an aid, 3: no difficulty) to give a maximum score of 9.*

Distribution of DDH from Individual Hospitals

The proportion of patients DDH varied according to each individual hospital (Figure 7). 'Hospital O' had the largest proportion of patients DDH [58.9% (n=880)], whereas 'Hospital I' had the lowest [13.9% (n=142)]. The difference in discharge practices between hospitals was statistically significant ($p<0.00$). However, it is important to note that each hospital varies in terms of case mix, staffing levels, presence of an orthogeriatrician, access to onsite/offsite rehabilitation etc., which may affect discharge practices. The IHFD strives to minimise variation between individual units and promotes a standardised approach to hip fracture care.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
DDH (n)	240	322	327	483	801	291	369	355	142	191	241	288	381	427	880	738
DDH (%)	24.2	27.8	16.4	28	57.8	33.5	40.6	18.2	13.9	42	30.1	28.1	17.6	33.9	58.9	27.8

Figure 7 Distribution of Patients DDH from Individual Hospitals 2013-2019

Univariate Logistic Regression

On univariate analysis, younger patients were more likely to be DDH than older patients (OR 0.26, p<0.01, 95% CI 0.24-0.29) (Table 5). Those with a high functional mobility pre-fracture [as defined by New Mobility Score (NMS) >6] were more than twice as likely to be DDH compared to those with poor pre-fracture mobility (OR 2.72, p<0.01, 95% CI 2.48-2.97). During the in-patient journey, the likelihood of DDH decreased as time to surgery increased by each 24hr increment (p<0.01). Patients who were not mobilised on the day of or after surgery were 33% less likely to be DDH (OR 0.67, p<0.01, 95% CI 0.62-0.73). In relation to length of stay, patients admitted for greater than 15 days were less likely to be DDH (OR 0.85, p<0.01, 95% CI 0.77-0.93). Sex was not a statistically significant predictor of discharge destination.

Table 5 Univariate Logistic Regression

Variable	Odds Ratio	P Value	95% CI
Sex			
Male	1 (base)		
Female	0.95	0.12	0.89-1.01
Age Category			
60-69	1 (base)		
70-79	0.54	0.00	0.49-0.59
80-89	0.26	0.00	0.24-0.29
>90	0.20	0.00	0.18-0.23
Medical Card Holder			
No	1 (base)		
Yes	0.72	0.00	0.68-0.77
Admission Source			
Home	1 (base)		
Nursing,convalescent or long stay	0.01	0.00	0.00-0.02
Transfer from another acute hosp	0.71	0.00	0.63-0.79
Other	1.16	0.36	0.83-1.62
Pre-Fracture Mobility			
Low functional mobility	1 (base)		
High functional mobility (NMS>6)	2.72	0.00	2.48-2.97
Mobilised Early			
Yes	1 (base)		
No	0.67	0.00	0.62-0.73
ASA Grade			
I	1 (base)		
II	0.60	0.00	0.52-0.71
III	0.34	0.00	0.29-0.39
IV	0.25	0.00	0.21-0.31
V	0.44	0.06	0.19-1.03

Hours in ED (Hours)			
0-4	1 (base)		
5-12	0.95	0.23	0.87-1.03
13-24	0.85	0.00	0.76-0.95
25-48	0.93	0.49	0.77-1.12
>48	1.33	0.24	0.82-2.15
Time to Surgery (Hours)			
<24	1 (base)		
24-47	0.83	0.00	0.77-0.89
48-71	0.72	0.00	0.66-0.80
>72	0.62	0.00	0.56-0.68
Length of Stay (Days)			
1-7	1 (base)		
8-14	1.05	0.19	0.97-1.13
15-21	0.85	0.00	0.77-0.93
22-39	0.88	0.01	0.80-0.97
40-59	1.14	0.05	0.99-1.31
>60	0.94	0.43	0.81-1.09

Multivariate Logistic Regression

A multivariate logistic regression model was constructed using the statistically significant variables from univariate analysis (Table 6). On multivariate analysis, the odds of being DDH decreased as age increased (OR 0.28, p<0.01, 95% CI 0.24-0.34). Patients who were independently mobile prior to fracture were 47% more likely to be DDH compared to those with low functional mobility pre-fracture (OR 1.47, p<0.01, 95% CI 1.29-1.68). In terms of source of admission, patients admitted from a nursing home or long-stay facility had little chance of being DDH.

During the course of hospital admission, patients who waited >72hrs prior to surgery were 30% less likely to be DDH (OR 0.70, p<0.01, 95% CI 0.56-0.88). Length of hospital stay was also a significant variable as patients admitted for less than 15 days had a greater chance of being DDH (OR 1.18 p <0.03, 95% CI 1.01-1.38). Patients who were mobilised early post-operatively were 24% more likely to be DDH (OR 1.24, p< 0.01, 95% CI 1.06-1.45).

Table 6 Multivariate Logistic Regression

Variable	Odds Ratio	P Value	95% CI
Age Category			
60-69	1 (base)		
70-79	0.56	0.00	0.47-0.66
80-89	0.28	0.00	0.24-0.34
>90	0.22	0.00	0.17-0.28
Medical Card Holder			
No	1 (base)		
Yes	0.89	0.09	0.78-1.02

Admission Source			
Home	1 (base)		
Nursing, convalescent or long stay	0.03	0.00	0.01-0.07
facility	0.84	0.45	0.55-1.30
Transfer from another acute hospital	1.51	0.17	0.83-2.76
Other			
Pre Fracture Mobility			
Low functional mobility	1 (base)		
High functional mobility (NMS>6)	1.47	0.00	1.29-1.68
ASA Grade			
I	1 (base)		
II	1.12	0.42	0.84-1.50
III	0.88	0.42	0.65-1.19
IV	0.95	0.94	0.67-1.44
V	0.60	0.64	0.06-5.24
Hours in ED (Hours)			
0-4	1 (base)		
5-12	1.05	0.42	0.92-1.20
13-24	1.08	0.41	0.89-1.30
25-48	1.30	0.14	0.91-1.85
>48	2.50	0.35	1.06-5.86
Time to Surgery (Hours)			
<24	1 (base)		
24-47	0.93	0.30	0.81-1.06
48-71	1.00	0.99	0.83-1.20
>72	0.70	0.00	0.56-0.88
Length of Stay (Days)			
1-7	1 (base)		
8-14	1.18	0.03	1.01-1.38
15-21	1.06	0.49	0.88-1.29
22-39	1.24	0.03	1.01-1.53
40-59	1.77	0.00	1.31-2.39
>60	1.89	0.00	1.39-2.56
Mobilised Early			
No	1 (base)		
Yes	1.24	0.00	1.06-1.45

Discussion:

This is the first time that factors influencing discharge destination for Irish hip fracture patients have been investigated on a national scale and the findings have implications for clinical practice. For many patients, hip fracture can mean a change in living accommodation after discharge from acute hospital. Although the vast majority (82%) of patients are admitted from home, less than one-third of patients are DDH. For those admitted

from locations other than home, discharge to the residence from which they were admitted is central to minimising disruption to the patient's social circumstances and quality of life post fracture. The findings of this paper illustrate the inherent differences between patient's DDH compared to those DAL, both in terms of pre-fracture functionality and care pathway. Some of these differences are modifiable, whereas others are not. Multivariate analysis showed that younger patients who were independently mobile pre-fracture were 47% more likely to be DDH (OR 1.47, p<0.01, 95% CI 1.29-1.68). The literature investigating post-acute pathways in hip fracture care supports the intuitive finding that patients in better health pre-fracture are more likely to be DDH. Other studies have found increasing age, presence of comorbidities, cogitative impairment and functional dependence to be significant predictors of discharge to a nursing home or long-term care facility [8, 18, 19].

Three modifiable factors within the care pathway were identified. Timely surgical intervention with early post-operative mobilisation and shorter length of stay were statistically significant predictors of DDH. Patients who waited >72hrs for surgical repair were 30% less likely to be DDH (OR 0.70, p<0.01, 95% CI 0.56-0.88). This finding is similar to other studies which showed that early operative treatment was associated with an improved ability to return to independent living and a shorter hospital stay. *Al-Ani et al* demonstrated that patients who were operated on >36 hours (OR 0.44) or >48 hours (OR 0.33) after admission were less likely to return to independent living after four months (p< 0.05) [20]. *Nanjayan et al* also demonstrated that patients who waited >36 hours to surgery for medical reasons were more likely to be discharged to a location other than from where they were admitted (OR 4.35, p< 0.01, 95% CI 1.21-15-79) [21].

In relation to length of stay, patients admitted for less than 15 days had a greater chance of being DDH (OR 1.18, p <0.03, 95% CI 1.01-1.38). However, the association between increased length of stay and DAL could be due to logistical issues. A recent study by *Salonga-Reyes et al*, showed that a lack of available rehabilitation facilities, residential care or supported care beds was the most common reason for discharge delay, followed by administrative delays in obtaining decisions on funding for home care packages [22]. Family refusal was also a factor in a small portion of cases. Proactively identifying patients with a high probability of returning home at an early stage in the care pathway could allow for suitable support services to be set up for those returning home, while allowing a timely search for rehabilitation, community or long-term care facilities for those with a low probability of being discharged home directly. The analysis in this paper has identified patient characteristics that increase the likelihood of DDH i.e., younger patients independently mobile prior to fracture, who receive timely surgery with early post-operative mobilisation.

There is a wide variation in length of stay across hip fracture registries worldwide, most likely due to different patient demographics, case mix, care pathways and healthcare systems. For instance, the mean (median) length of stay in Spain is 11 (9.4) days, UK 15.6 (12) days, Ireland 20 (13) days, Australia 9.2 (7.7) days and a mean of 8 days for both Sweden and Denmark [12]. Length of stay is a multi-faceted variable that involves a complex interplay between patient, process and organisational factors. Each region has a different proportion of patients operated on early, mobilised early, reviewed by a Geriatrician etc. all of which could affect the length of hospital admission. It is also important to note that length of stay can be somewhat of an artificial metric as patients may be discharged early from an acute hospital to another healthcare facility for a short period of time and subsequently discharged home. Currently, the IHFD is unable to capture secondary discharge location as it utilises HIPE data, which records the primary discharge destination only. Notwithstanding, there is an

opportunity to optimise each step of the patient journey, as encompassed by the IHFS so that patients have every chance of returning home post fracture.

Most strikingly, patients who were mobilised early post-operatively were 24% more likely to be DDH (OR 1.24, p< 0.01, 95% CI 1.06-1.45). This is not the first time that early mobilisation has been identified as a key factor in hip fracture care. *Sheehan et al* demonstrated that early mobilisation was associated with a 2-fold increase in the adjusted odds of being discharged within 30 days of surgery [23]. Similarly, *Ferris et al* investigated the impact of early mobilisation on in-hospital mortality and showed that older males who were not mobilised on the day of or after surgery had the highest risk of in-hospital mortality (p<0.01) [24]. Following on from this, one new standard for early mobilisation on the day of or after surgery was added to the IHFS. The ability to be mobilised early post-operatively is a reasonable indicator of both patient and organisational factors in orthogeriatric care.

The discharge of an older person from an acute hospital to the most appropriate setting following hip fracture surgery is complex. The findings presented in this paper further reinforce the importance of the IHFS in improving patient outcomes. More specifically, the IHFS incorporate 2 of the 3 modifiable process measures highlighted above i.e., surgical repair of the fracture within 48 hours (IHFS 2) and early post-operative mobilisation by a physiotherapist (IHFS 7). These are also quality standards of other international audits. The modifiable factors identified should be optimised so that patients can return home post hip fracture and regain their pre-fracture functionality.

Limitations:

The IHFD is a large dataset of over 21,000 hip fracture patients with excellent data coverage and data completeness. All 16 trauma centres in the Republic of Ireland are included therefore it is representative of the Irish population and there is no selection bias. It is important to note that a certain proportion of patients DAL may get home eventually after rehabilitation etc. However, the authors were not able to account for this as HIPE captures the initial discharge destination only and does not record follow up data on mid to long-term outcomes. Secondly, the authors were not able to address whether DDH or DAL was appropriate for the patient in the context of other variables not recorded by the IHFD. Moving forward, qualitative research capturing the patients' perspective on other variables that may influence discharge destination such as social support or home environment would be useful. Further analysis looking at the variability in discharge practices between hospitals is warranted.

Conclusion:

Although the majority of patients are admitted from home, less than one-third of patients are DDH. This paper identified inherent differences between those DDH as opposed to DAL, both in terms of patient characteristics and care pathway. Younger patients who were independently mobile pre-fracture were more likely to be DDH. Timely surgery with early post-operative mobilisation and a shorter length of stay increased the odds of DDH. The IHFS incorporate 2 of the 3 modifiable process measures identified, which reinforces the importance of the IHFS in improving patient outcomes.

Declarations:

Funding: No funding, grants or financial support was received.

Conflict of interest: The authors declare they have 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: Not applicable.

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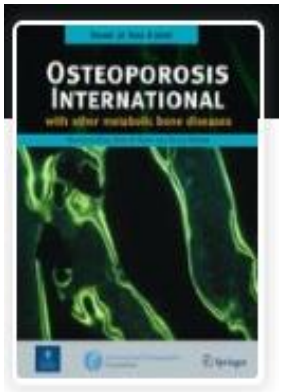
Paper 3:



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ORIGINAL ARTICLE

Cost of hospitalisation for hip fracture—findings from the Irish hip fracture database

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Cost of Hospitalisation for Hip Fracture – Findings from the Irish Hip Fracture Database

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Abstract

Purpose:

Hip fracture places a considerable clinical and financial burden on the healthcare system, with acute hospitalisation accounting for a substantial proportion of the costs incurred. This paper aimed to quantify the cost of hospitalisation for hip fracture in Ireland in terms of bed days and direct hospital costs.

Methods:

The authors analysed 23,494 cases in the Irish Hip Fracture Database (IHFD) from 2014 to 2020. Case numbers and length of stay were analysed annually. Hospital costs for hip fracture were described using the 2020 Activity Based Funding Price List, which outlines the fees paid to public hospitals for inpatient activity.

Results:

For the period 2014–2020, the total cost of hospitalisation for hip fracture was approximately €296 million, equating to approximately €11,700 per episode of care. The annual cost of hospitalisation increased from approximately €34 million in 2014 to €44 million in 2020. In 2020, the mean length of stay for hip fracture was 17 days accounting for >62,600 acute hospital bed days.

Conclusion:

The absolute number of hip fracture cases recorded by the IHFD has increased, as has the cost of hospitalisation. Given the current capacity issues and economic constraints, there is a growing need to prioritise time spent in the most expensive acute hospital setting to the immediate perioperative period and maximise the use of community services and early supportive discharge for the rehabilitation phase.

Keywords: Hip fracture, costs, economic burden, financial costs, length of stay, bed days.

Mini Abstract

The authors utilised the Irish Hip Fracture Database (IHFD) to quantify the impact of hip fracture on the health service in terms of incidence, bed days and financial costs. The absolute number of hip fracture cases recorded by the IHFD has increased, as has the associated costs of hospitalisation.

Declarations:

Funding: The Irish Hip Fracture Database is supported by the National Office of Clinical Audit, which is funded by the Quality Improvement Team of the Health Service Executive. No additional funding was received for the preparation of this paper.

Conflicts of interest: Helena Ferris, Louise Brent and Jan Sorensen declare that they have no conflicts of interest.

Ethical approval: Ethical approval was received from the Royal College of Surgeons in Ireland Research Ethics Committee (REC202001017).

Availability of data and material: Data from the Irish Hip Fracture Database can be requested from the National Office of Clinical Audit, Ireland.

Authors' contributions: HF conceptualised and designed the paper, LB provided the data, JS performed the analysis. All authors drafted the manuscript, provided feedback and approved the final draft.

Introduction:

Hip fracture places a considerable burden on society in terms of morbidity, mortality and healthcare utilisation. Ireland has one of the highest age-standardised incidence rates of hip fracture in the world at a rate of 406/100,000 for females [1]. In real terms, this equates to >3,600 cases per annum, with this figure purported to increase in parallel with the ageing population [2]. The direct costs associated with the acute management of hip fracture are substantial as surgical fixation and hospitalisation are key components of the care pathway for the majority of hip fracture patients.

The absolute number of all fragility fracture admissions increased by 30% between 2000 and 2014, with hip fracture accounting for a third of all admissions and almost half of all bed days [3]. Previous research has shown that healthcare costs for hip fracture patients are three times higher than age-matched counterparts [4]. This has considerable implications for the health service as the total direct and indirect cost of falls and fractures for people aged ≥65 years is estimated at €404 million per annum, accounting for 4.2% of all public health expenditure in Ireland [5]. As life expectancy continues to increase, so will the incidence of hip fracture with the associated need for hospitalisation, rehabilitation and community care. Robust data on the impact of hip fracture on healthcare utilisation is essential to facilitate efficient health service planning and the delivery of cost-effective patient care.

Aim

To identify the annual cost of inpatient care for hip fracture in Ireland 2014-2020 in terms of bed days and direct hospital costs.

Methods:

Data Source

The Irish Hip Fracture Database (IHFD) is a clinically led, web-based system where data are collected though the Hospital In-Patient Enquiry (HIPE) system, 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). Operational management is provided by the National Office for Clinical Audit (NOCA). The IHFD is a timely and accurate database with 99% coverage in recent years.

The Irish Hip Fracture Standards (IHFS) are the standards against which the Irish healthcare services are benchmarked. The IHFS are in alignment with the Best Practice Tariff (BPT) for hip fractures, which focuses on 8 core parameters: 6 clinical and 2 for data quality and clinical governance. IHFS 7 for early mobilisation is the latest standard to be introduced to the IHFD and will be included in the BPT from 2022.

Data Collection & Data Entry

The IHFD collects data on hip fracture patients through a specific IHFD portal on the HIPE system. The HIPE system is the principal source of demographic, clinical and administrative information on all discharges and deaths from publicly funded acute hospitals in Ireland [6]. All sixteen trauma units in the Republic of Ireland

voluntarily submit data on patients that are discharged following hip fracture. Data from patient's medical records are entered retrospectively in each hospital by audit coordinators, with support from the local IHFD clinical lead and NOCA. A specific data entry form is used to record details of an extensive number of variables ranging from the patients' pre-operative functional status to the type of surgery and clinical outcomes. Data are collected for each hip fracture episode from admission to hospital discharge. Eligibility criteria are as follows:

Inclusion criteria:

(iii) Diagnosis on HIPE of either hip fracture due to injury (ICD-10-AM diagnosis codes S72.00 to S72.2) or with a specified type of fracture (e.g., intracapsular displaced, intracapsular undisplaced, intertrochanteric, subtrochanteric or open) other than periprosthetic.

(iv) Aged 60 years or over.

Data Quality & Data Validation

Data from HIPE are merged with additional IHFD data and an anonymised extract is sent to NOCA from the HPO. The data is assessed within NOCA using internationally agreed dimensions of data quality [7]. Data Validation Reports (DVR) are distributed to each hospital along with quarterly reports. The NOCA data analytics team verify the data with the contributing hospitals and HPO. Data quality is monitored through monthly meetings with the local audit coordinators and regular two-way feedback. Once data is validated, an annual report is produced and sent to the IHFD governance committee for approval. The IHFD data dictionary is available in the most recent IHFD annual report [2].

Patient Population

Within the IHFD, patient demographics and case mix have remained largely unchanged over the time period 2014-2020. The most notable change in the patient population over the study period is an increase in the degree of frailty and comorbidity of patients i.e., ASA Grade III (severe systemic disease) admissions increased from 39% in 2013 to 55% in 2020. A full description of the trends in hip fracture care in the Republic of Ireland has been published elsewhere [8]. The majority of Irish hip fracture patients are females aged 80 years or older who sustain a hip fracture from low-energy trauma i.e., fall less than 2 metres. Home is the most common source of admission (85%). The most common type of surgical repair is cemented hemiarthroplasty (36%) followed by internal fixation with a short IM nail (18%) [2]. Spinal anaesthesia continues to be the predominant type of anaesthesia, either on its own (55%) or in combination with a nerve block (21%) [2]. Patient demographics, clinical characteristics and care pathway are outlined in Table 7.

Table 7 Patient Characteristics and Care Pathway for Irish Hip Fracture Patients 2020 [2]

Parameter	Percentage
Gender	
Female	67%
Male	33%
Mean age	81
Over 80 years	43%
Admission source	
Home	85%
Nursing home	11%
Acute hospital transfer	4%
Cognitive status on admission	
Normal cognition	69%
Cognitive impairment (AMT <7)	31%
Pre-fracture mobility	
Low functional ability	53%
High functional ability (NMS>6)	47%
Previous fragility fracture	
Yes	35%
No	65%
Bone health	
Bone health medication pre-admission	13%
Bone health medication started during admission	59%
Awaiting dual energy x-ray absorptiometry scan	5%
Assessed – no bone protection needed	6%
Not assessed	9%
Awaiting out-patient assessment	8%
Type of trauma	
Low energy	95%
High energy	2%
Unknown	3%
ASA grade	
I or II	37%
III	55%
IV or V	8%
Fracture type	
Intracapsular displaced	40%
Intracapsular undisplaced	8%
Intertrochanteric	37%
Subtrochanteric	6%
Other	9%
Type of anesthetic	
Spinal only	55%
Spinal and nerve block	21%
GA only	13%
GA and nerve block	8%
GA and spinal	3%
Type of surgery	
Arthroplasty hemi cemented	36%
Internal fixation – IM nail short	18%
Internal fixation – IM nail long	14%
Internal fixation – dynamic hip screw	12%
Arthroplasty hemi uncemented	12%
Arthroplasty THR cemented	3%
Arthroplasty THR uncemented	2%
Internal fixation screws	1%

Other	2%
Irish Hip Fracture Standards (IHFS)	
IHFS 1 (Admitted to orthopaedic ward <4hrs)	33%
IHFS 2 (Surgery within 48hrs)	75%
IHFS 3 (Pressure ulcer)	3%
IHFS 4 (Review by Geriatrician)	82%
IHFS 5 (Bone health assessment)	91%
IHFS 6 (Specialist falls assessment)	85%
IHFS 7 (Early mobilisation by Physiotherapist)	78%
Length of stay	
Mean	17 days
Median	11 days
Discharged home directly	28%
In hospital mortality	5%

Activity Based Funding

Since 2016, Public hospitals in Ireland are funded using Activity Based Funding (ABF), as opposed to block funding. With this model of funding, hospitals are paid a fixed amount for inpatient and day case activity based on Diagnosis Related Groupings (DRG). Cases that are clinically similar and that are expected to consume a similar amount of resources are grouped into DRG [9]. Each DRG is represented by a number indicating a medical or surgical procedure, plus a code indicating the level of complexity. The price assigned to each DRG is applicable to the entire episode of care from admission to discharge. Outpatient activity and Emergency Department activity is not included. Ireland is currently using version 8.0 of the Australian Refined DRG system.

Analysis

We analysed 23,494 cases in the IHFD from 2014 to 2020. Data were exported from Microsoft Excel into Stata® (version 17) for analysis. Length of stay was measured as the number of calendar days from admission to discharge from hospital. The annual number of bed days in the acute hospital was calculated by multiplying the mean length of stay by the absolute number of hip fracture cases in the given year. Direct hospital costs were calculated using the 2020 ABF Price List from the HPO. Eight DRG codes were used for hip fracture patients: I03 A/B, I08 A/B, I78 A/B and W02 A/B. The 2020 list price for each specific procedure was multiplied by the number of episodes recorded by the IHFD. A small proportion of cases were coded as 'other'. In these cases, the case-weighted average price of the eight procedure codes used for hip fracture patients was applied. Logistic regression analysis was conducted to investigate the association between ASA Grade and length of stay.

Results:

Hip Fracture Incidence

Since 2014, there has been a 36% increase in the absolute number of hip fractures with data recorded by the IHFD (Figure 8). However, this is in the context of data completeness in the IHFD increasing from 84% in 2014 to 95% in 2017 and >99% thereafter. A slight reduction in incidence was seen in 2020 during the COVID-19 pandemic.

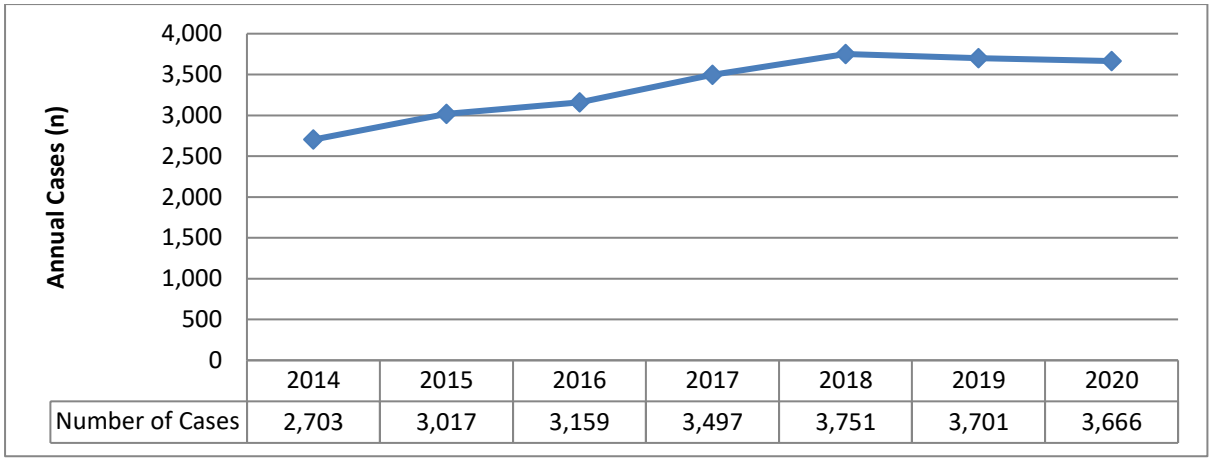

Figure 8 Hip Fracture Cases in Ireland 2014-2020

Although the absolute number of hip fracture cases has increased in recent years, incidence rates have declined both in Ireland and globally. The age-standardised rates for the susceptible population in Ireland have declined over the last decade from 538 to 423 per 100, 000 for females and from 285 to 225 per 100,000 for males [10]. The reasons for this are not fully understood.

Length of Stay – International Trends

There is considerable variation from country to country in terms of length of stay in an acute hospital following hip fracture. This is most likely due to different patient demographics, case mix, care pathways and healthcare systems. For instance, the mean (median) length of stay in Spain is 11 (9) days, UK 16 (12) days, Australia 9 (8) days and a mean of 8 days for both Sweden and Denmark (Figure No.9) [11]. The USA (Kaiser Permanente) has the shortest reported mean length of stay of 5 days. In contrast, Ireland has a longer mean length of stay of 20 (13) days and Germany reports the longest median length of stay at 16 days. As not all of the hip fracture registries report both the mean and median values, mean length of stay only is depicted in Figure 2.

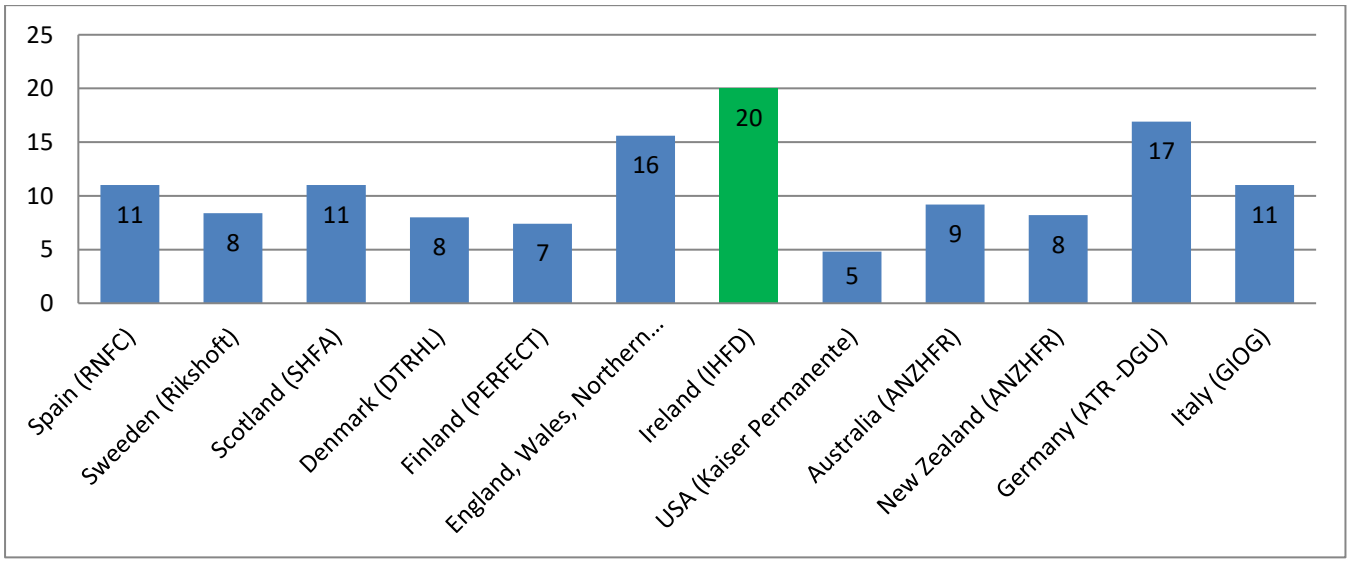

Figure 9 International Overview of Mean Length of Stay (Days) 2019 [9]

Length of Stay- National Trends

There was little fluctuation in length of stay during the time period 2014-2019 (Figure 10). However, a notable decline was seen in 2020 with a reduction in the mean (median) length of stay from 20 (12) days in 2019 to 17 (11) days in 2020, which equated to a saving of ~10,000 bed days. This substantial reduction is attributed to new internal patient pathways and greater communication between the acute hospitals and the community sector during the COVID-19 pandemic. More specifically, there was an increase in the number of internal rehabilitation beds, greater involvement with community intervention teams and early supported discharge teams, as well as an increase in transfers to off-site facilities such as private hospitals and stand-alone orthopaedic hospitals [12]. This collaborative effort resulted in a shorter length of stay and a greater proportion of patients discharged home directly.

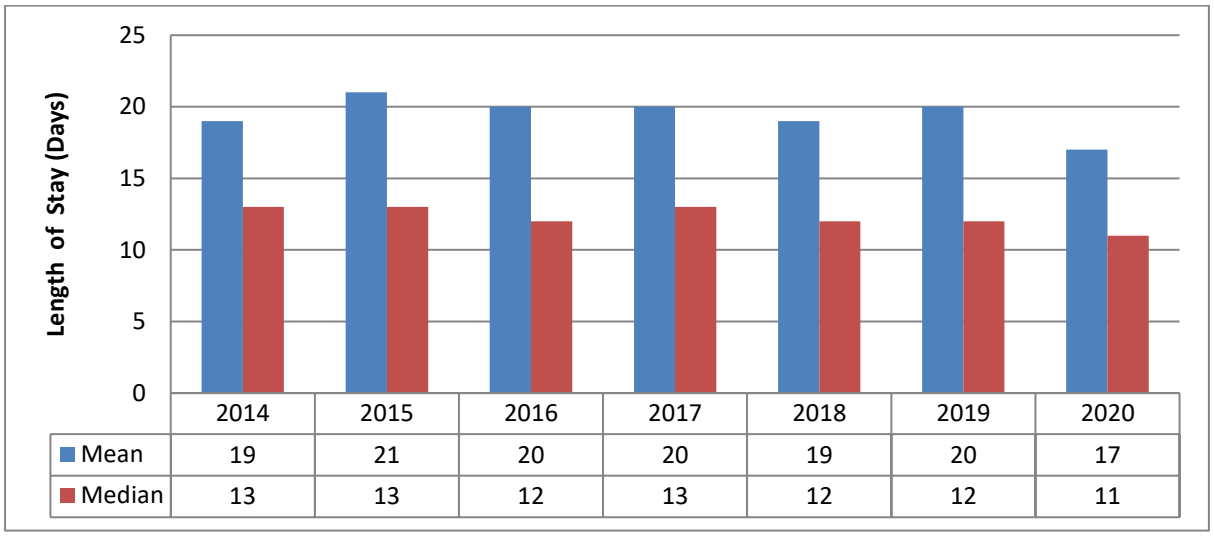

Figure 10 National Trends in Length of Stay 2014-2020

Within the IHFD, patients with higher ASA Grades had longer lengths of stay. Logistic regression analysis showed that patients with severe systemic disease (ASA Grade 3) were 3 times more likely to stay longer than the mean length of stay in hospital (OR 3.01, 95% CI 2.39-3.78, p<0.001) (Supplementary Table 1). Similarly, those with ASA Grade 4 disease were 4.5 times more likely to stay longer than the mean length of stay (OR 4.57, 95% CI 3.56-5.86, p<0.001). This is important as length of stay impacts bed days and the overall cost of hospitalisation.

Bed Days

Hip fracture places a considerable burden on the acute hospital sector. In 2020 alone, the mean length of stay for hip fracture was 17 days accounting for >62,600 bed days (Figure 11).

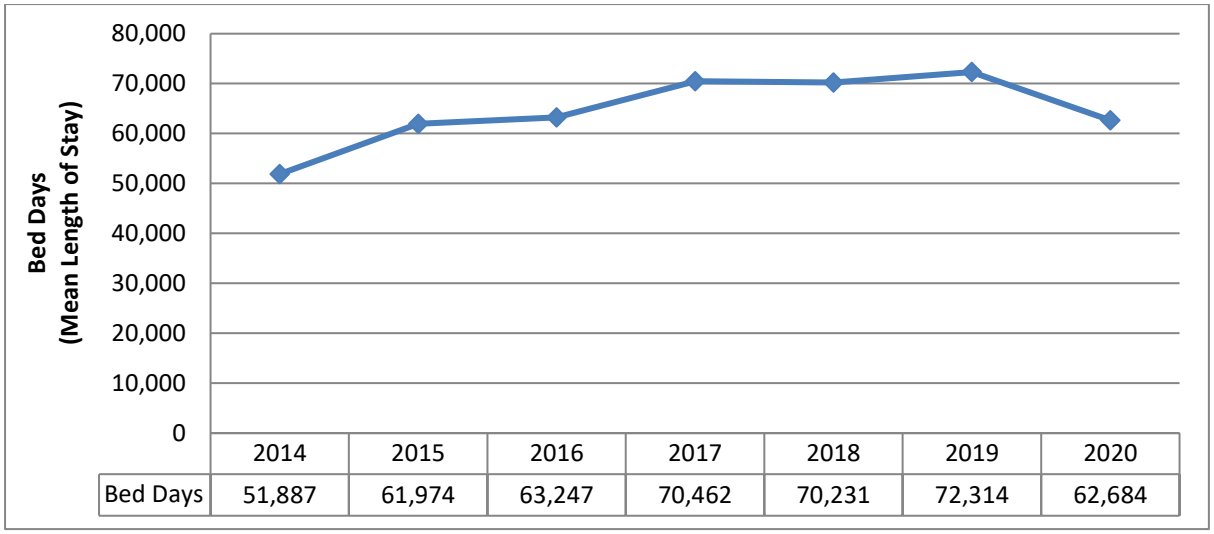

Figure 11 Acute Hospital Bed Days for Hip Fracture 2014-2020

Direct Costs of Inpatient Care

The direct hospital costs of hip fracture care are tabulated using the 2020 ABF Price List from the HPO, which outlines the fee paid to public hospitals for inpatient activity (Table 8). Hip replacement of minor complexity was the most common procedure code used for hip fracture patients. For the time period 2014–2020, hospitalisation for hip fracture cost the Irish health service approximately €296 million, which equates to a cost of approximately €11,700 per episode of care. The cost of hospitalisation increased over the study period from approximately €34 million in 2014 to €44 million in 2020. This 28% increase in costs over a 6-year period is substantial.

Table 8 Activity Based Funding by Discharge Year 2014-2020

DRG	Description	Price*	2014 No of Episodes/ Cost	2015 No of Episodes/ Cost	2016 No of Episodes/ Cost	2017 No of Episodes/ Cost	2018 No of Episodes/ Cost	2019 No of Episodes/ Cost	2020 No of Episodes/ Cost	Total No of Episodes/ Cost
I03 A	Hip Replacement, Major Complexity	€19,680	262 / €5,156,160	359/ €7,065,120	390/ €7,675,200	280/ €5,510,400	244/ €4,801,920	251/ €4,939,680	229/ €4,506,720	2015/ €39,655,200
I03 B	Hip Replacement, Minor Complexity	€10,967	967/ €10,605,089	1053/ €11,548,251	1066/ €11,690,822	1315/ €14,421,605	1503/ €16,483,401	1482/ €16,253,094	1420/ €15,573,140	8806/ €96,575,402
I08 A	Other Hip & Femur Procedure, Major Complexity	€21,703	304/ €6,597,712	330/ €7,161,990	393/ €8,529,279	272/ €5,903,216	284/ €6,163,652	295/ €6,402,385	299/ €6,489,197	2177/ €47,247,431
I08 B	Other Hip & Femur Procedure, Minor Complexity	€10,337	974/ €10,068,238	997/ €10,305,989	1031/ €10,657,447	1250/ €12,921,250	1307/ €13,510,459	1245/ €12,869,565	1323/ €13,675,851	8127/ €84,008,799
I78 A	Fracture Neck of Femur, Major Complexity	€8,905	48/ €427,440	49/ €436,345	47/ €418,535	47/ €418,535	43/ €382,915	39/ €347,295	45/ €400,725	318/ €2,831,790
I78 B	Fracture Neck of Femur, Minor Complexity	€4,148	50/ €207,400	63/ €261,324	57/ €236,436	70/ €290,360	106/ €439,688	76/ €315,248	90/ €373,320	512/ €2,123,776
W02 A	Hip, Femur & Lower Limb Procedure for MT, Major Complexity	€46,539	13/ €605,007	25/ €1,163,475	27/ €1,256,553	8/ €372,312	3/ €139,617	9/ €418,851	5/ €232,695	90/ €4,188,510
W02 B	Hip, Femur & Lower Limb Procedure for MT, Minor Complexity	€21,708	11/ €238,788	16/ €347,328	12/ €260,496	55/ €1,193,940	62/ €1,345,896	61/ €1,324,188	48/ €1,041,984	265/ €5,752,620
X	Other		74/ €867,280	125/ €1,465,000	136/ €1,593,920	200/ €2,344,000	199/ €2,332,280	243/ €2,847,960	207/ €2,426,040	3072/ €13,876,480
Total			2703/ €34,773,114	3017/ €39,754,822	3159/ €42,318,688	3497/ €43,375,618	3751/ €45,599,828	3701/ €45,718,266	3666/ €44,719,672	25382/ €296,263,008

***Price as per 2020 Activity Based Funding Price list**

Discussion:

Hip fracture places a considerable clinical and financial burden on the healthcare system, with acute hospitalisation accounting for a substantial proportion of the costs incurred. Since 2014, there has been a 36% increase in the absolute number of hip fractures recorded by the IHFD. The cost of hospitalisation for hip fracture 2014–2020 was approximately €296 million, equating to approximately €11,700 per episode of care. This finding is in keeping with previous research showing an average cost of €12,687 per admission in Ireland [6]. Similarly, in Italy, the cost of acute hospitalisation for hip fracture is €10,079 [13]. In the UK, hospitalisation costs associated with admission for primary hip fracture are approximately £8,663 [14]. In a systematic review and meta-analysis of over 100 studies looking at the cost of fragility fractures globally, *Williamson et al* showed a pooled estimated cost of $10,075 for the index hospital admission [15].

Although the costs of hospitalisation are similar from country to country, the staggering costs involved in hip fracture care provide a stark incentive to look at more sustainable ways of delivering healthcare at the lowest level of complexity once the patient is medically fit for discharge. Recently, *Ferris et al* highlighted how not only is Discharging Directly Home (DDH) integral to the quality of life of patients; it is also a key component of the socioeconomic cost of hip fracture. In terms of the modifiable factors, patients who are mobilised early post-operatively are 24% more likely to be DDH (OR 1.24, $p<0.01$, 95% CI 1.06-1.45) [16]. Conversely, patients who experience surgical delay are less likely to be DDH (OR 0.70, $p<0.01$, 95% CI 0.56-0.88).

Timely surgery can impact length of stay and reduce the cost of admission. *Castelli et al* analysed data from >60,000 hip fracture patients across 152 hospitals in the UK and showed that costs are lower for those who received surgery on the same day of admission and discharged to their own home [17]. Currently, only 75% of Irish hip fracture patients are operated on within 48hrs of admission [2]. This is in contrast to countries such as Germany and Sweden where 72% and 66% of patients respectively are operated on within 24 hours of admission [18]. An Orthogeriatric model of care has also been shown to reduce time to surgery, improve the overall quality of care and enhance patient outcomes [19].

In Ireland, the IHFS are the quality standards against which services are benchmarked. The IHFS encompass process measures that improve patient outcomes i.e., prompt admission to an orthopaedic ward, timely surgery and early post-operative mobilisation [20]. Hospitals that adhere to the IHFS are rewarded with a Best Practice Tariff, which is a financial incentive for providing high quality patient care. A payment of €1000 is paid to the hospital for each case that meets the IHFS. 70% of this payment goes to the trauma service and 30% to hospital management. Since its introduction in 2018, the number of hospitals qualifying for the BPT has increased year on year. Financial payments of €278,000 were made in 2018, which increased to €548,000 in 2019 and to €710,000 in 2020 [2]. The IHFS and BFT serve to improve patient outcomes by optimising the care pathway, reducing the length of stay in the higher acuity hospital setting and enabling patients to return to independent living following hip fracture. Further analysis of the impact of the BPT on costs and bed days will be conducted when more years of data are available.

Length of stay is often used as a surrogate marker of the efficiency of a service. In recent years length of stay has remained relatively stable at a mean (median) of 20 (17) days despite an increase in the degree of frailty of

the patient cohort. An improvement was seen in 2020 during the COVID pandemic when there was greater emphasis on early supported discharge and more effective communication between the various teams involved in the care of hip fracture patients. Given that hip fracture accounts for >62,600 bed days per year at considerable cost to the health service, there is a strong economic incentive to identify cost-effective approaches to the management of hip fracture [21]. It is important to note that in addition to differences in the patient population and clinical practice, some of the variation in length of stay internationally may be due to differences in the place of residence pre-fracture. *Ireland et al* showed that hip fracture patients admitted from residential care have widely different lengths of stay compared to those admitted from the community, with delays in transfer to a rehabilitation facility being the major obstacle [22]. *Salonga-Reyes et al* also highlighted how the lack of available supported care beds, residential care beds and difficulties in obtaining funding for home care packages compounds the issue of delayed discharge from an acute hospital [23].

Finally, but perhaps most importantly, hip fracture is preventable. Given the majority of hip fractures occur as a result of a low-impact fall in the home, it is imperative that we support older adults to stay safe in their own environment. During the COVID-19 pandemic, many people were spending more time in their homes, which prompted NOCA to devise some practical tips for older adults on how to stay safe at home (Supplementary Figure 1). Promoting bone health through education on the importance of diet and exercise, as well as early identification and treatment of osteoporosis are key to improving the health outcomes of those at risk of sustaining a fragility fracture.

Limitations:

This paper utilises a large national database of older adults to describe the impact of hip fracture on the acute hospital system and associated financial costs. Although the IHFD was established in 2012, data completeness in the earlier years was sub-optimal, therefore the authors analysed the database from 2014-2020.

Data pertaining to diagnoses and procedures is coded directly from patients' hospital records by trained HIPE coders. The accuracy of the HIPE system is dependent on the accuracy of the discharge summary, which is completed by a member of the medical team at the time of discharge. Although the HIPE system is open to human error, it is the only record of acute hospital admissions in Ireland.

Direct hospital costs for hip fracture were calculated using the ABF Price List from the HPO, which assigns a fixed value to the episode of care from admission to discharge based on DRG. ED attendance and outpatient visits are not included in the DRG system, therefore the costs outlined in this paper do not capture the full patient journey. In addition, costs are not calculated separately for specific individual comorbidities, as this information is not captured by the IHFD. ASA grade is used as an indication of the burden of systemic disease. In the absence of a Unique Health Identifier, it is not possible to take other costs such as ambulance transportation or rehabilitation into consideration.

Conclusion:

This paper utilised the IHFD to quantify the impact of hip fracture on the Irish health service in terms of bed days and direct hospital costs. The absolute number of registered hip fracture cases has increased and places a

considerable burden on the acute hospital system at a substantial financial cost. There is a strong economic incentive to identify cost effective approaches to the management of hip fracture at the lowest level of complexity such as early supported discharge and discharge directly home when medically fit. This will require strategies at a national and regional level to improve access to lower acuity healthcare settings and multi-disciplinary care in the community.

Acknowledgements

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Chapter 4: Discussion

4.1 Introduction

Hip fracture is an important public health issue with substantial costs to both patients and the healthcare system. Hip fracture in older adults can be a devastating injury as many who survive do not regain their baseline level of functioning or independence[72]. The IHFS outline the best practice care pathway for patients in a bid to standardise the in-hospital journey and ensure the best outcomes for patients. Evidence-based quality standards of care in combination with national clinical audit work in synergy to provide healthcare providers with high quality data to benchmark their own performance, both nationally and internationally[73].

This chapter will discuss the clinical impact of the research presented and will outline how the work makes a coherent and important contribution to knowledge.

4.2 Contribution to New Knowledge

The research presented in this thesis utilises routinely collected data to improve services and enhance patient outcomes. The published papers focus on three broad facets of hip fracture care, namely mortality, morbidity and costs. Prior to this, there were considerable gaps in the knowledge base. The determinants of in-hospital mortality following hip fracture were not well defined nor had they been studied extensively in the Irish population. Similarly, the factors influencing discharge destination had not previously been investigated on a national scale. In addition, the impact of hip fracture on the health service in terms of incidence, bed days and financial costs had not been quantified in recent years.

The early mobilisation paper showed that older males with poor pre-fracture mobility who were not mobilised the day of or after surgery had the highest risk of in-hospital mortality. The beneficial effect of early mobilisation was in keeping with research from other National hip fracture registries and international guidance such as NICE, Scottish Intercollegiate Guidelines Network and the Australian & New Zealand Hip Fracture Registry. The findings of this research have been implemented and translated into clinical practice. A new formal standard for early mobilisation by a physiotherapist on the day of or after surgery has been added to the IHFS with an associated BPT. This illustrates how the IHFD is a vehicle for change and a catalyst for improvement, as it facilitates evidence-based decision making[74].

Interestingly, none of the IHFS significantly influenced in-hospital mortality after multivariate analysis. However, they do influence the ability to return home and may well affect other outcomes such as 1-year mortality, which is not captured by the IHFD at present.

The Hip Fracture Outcome Recording and Geographic Equality (HipFORGE) project is currently underway and will explore long-term outcomes in hip fracture patients using both quantitative and qualitative methodologies.

The paper on discharge destination researched the factors behind the low number of patients not returning directly home after hip fracture. This was the first time that factors influencing discharge destination were explored nationally, incorporating a focus on variation in discharge practices across participating hospitals. To date, much of the research in hip fracture care has focused on endpoints such as survival. Discharge destination is an equally important outcome for patients and is a key component of quality of life post hip fracture. This paper highlighted how the majority of patients are admitted from home, yet less than one-third return to their original place of residence directly following hip fracture. A range of patient characteristics and process factors were identified as being important in determining whether patients are DDH or DAL. Younger patients independently mobile prior to fracture, who received timely surgery and early post-operative mobilisation were more likely to be DDH from the acute hospital. The positive impact of early mobilisation post-operatively was evident again, in addition to compliance with the IHFS, which incorporates 2 out of the 3 modifiable factors identified. This new knowledge tailored to the Irish hip fracture population could facilitate more efficient discharge planning. High-risk patients most likely to be DAL could be identified early in the care pathway and prioritised for review by an Orthogeritrician, which would allow a timely search for suitable support services on discharge.

The findings illustrate the scale of the problem in terms of the large proportion of hip fracture patients DAL, such as community care or long-term care. This has considerable implications for service delivery and the socioeconomic costs of hip fracture. Given the rate at which the population is ageing, the increasing degree of frailty and the potential for dependency post hip fracture, a needs assessment of community services after hip fracture would be a useful adjunct to the findings presented in this thesis.

The final paper quantified the cost of hospitalisation for hip fracture in terms of bed days and direct hospital costs. Enhancing outcome and process data with costing information is key to augmenting our understanding of the attributable costs of hip fracture care. Each episode of care costs approximately €11,700, which is in keeping with previous research in the Irish setting and is comparable internationally. This does not include the cost of rehabilitation,

home care packages, out-patient assessments or medication. Acute hospitalisation is an essential but costly component of the care pathway. In 2020, the mean length of stay for hip fracture was 17 days accounting for >62,600 acute hospital bed days. Although length of stay is a somewhat artificial metric with many contributory factors, it is an important driver of the cost of hip fracture care and Ireland has one of the longest lengths of stay of all the hip fracture registries. This reinforces the strong economic incentive to identify cost-effective approaches to the management of hip fracture at the lowest level of complexity, such as early supported discharge and DDH once medically fit. The analysis in this paper provides up-to-date robust data on the impact of hip fracture on healthcare utilisation and its financial impact. In turn, this facilitates efficient health service planning and aids the delivery of cost-effective patient care.

4.3 Data Driving Quality Improvement

Clinical audit is an essential quality improvement and patient safety tool. At its most basic level, the simple act of collecting information in a standardised way, analysing it and presenting it in a manner that facilitates comparison between healthcare institutions drives change. Robust data from the IHFD guides decision making in relation to what aspects of the care pathway need resourcing to ensure high value healthcare. The timely and accurate nature of the data, in combination with in-depth interrogation and analysis is key to translating the findings into change on the ground. The peer-reviewed publications outlined in this thesis highlight the power of data and how it can be used to transform health services. The IHFD enabled the identification of patient and organisational factors that influence patient outcomes. In turn, the IHFD governance committee, clinical leads and multidisciplinary stakeholders embraced the findings and implemented the required changes at a local and national level for the benefit of patient care. This illustrates the importance of data to facilitate agile decision making and rapid learning.

The IHFD is an invaluable resource as it contains high-quality data with excellent data coverage and clinical support. It bridges the gap between service users, service providers and policy makers. The active participation of clinical leads across all participating trauma centres serves to translate the findings into action. At a patient level, the inclusion of public and patient representatives in the governance structure ensures that key findings reach a wider audience. Engaging with the public and advocating for healthy behaviours, encompassing bone health and the prevention of falls is a core part of the IHFD. This

improves health literacy, supports healthy ageing and empowers patients in their own healthcare journey. A meaningful partnership between healthcare providers, patients and the wider society is key to the success of the IHFD, as it fosters a shared understanding of quality in healthcare.

There is a need for a systematic approach to the end-to-end data collection from prevention to rehabilitation, where Patient Reported Outcome Measures (PROM) and symptom burden are incorporated into existing digital health systems. Linkage to other national databases would also enhance outcome reporting. It is clear that clinical audit is an essential mechanism for protecting patients and ensuring the best clinical outcomes. The IHFD provides a foundation from which hospitals can monitor care processes and evaluate the impact on clinical outcomes on an ongoing basis.

4.4 Implications:

The findings of the research presented have been implemented and have implications at a national and local level:

National Health Policy

- One new formal standard for early mobilisation by a physiotherapist on the day of or after surgery has been added to the IHFS (IHFS 7).

Hospital Level

- A BPT for early mobilisation by a physiotherapist on the day of or after surgery has been operationalised. This was originally intended for implementation in 2021 but was postponed due to the COVID-19 pandemic and HSE cyber-attack.

Patients/ Society

- Given the majority of hip fractures occur as a result of a low-impact fall in the home, there is a renewed focus on supporting older adults to stay safe in their own environment. Advice pertaining to bone health, early post-operative mobilisation and staying active has been incorporated into patient information leaflets and the IHFD annual reports.

4.5 Strengths & Limitations

Although the primary objectives of the thesis have been achieved, there are a number of limitations to note. Firstly, the research presented is retrospective and observational in design, based on routinely collected data, derived from HIPE. HIPE is the main source of demographic, clinical and administrative data on discharges and deaths nationally in publicly funded acute hospitals[75]. HIPE is a valuable source of health information which can be used to assess activity levels, compare performance indicators, costs and outcomes[76]. The addition of a unique personal identifier would allow the patient journey to be captured more comprehensively across inpatient, outpatient and community settings. Expanding the system to include small area coding and socio-economic status would also enhance the data[77]. This would facilitate an exploration of variations in access to healthcare services and health inequalities.

Secondly, the lack of longitudinal monitoring of outcome measures is an important limitation of the IHFD. The scope of data collection is expanding to include longer-term outcomes such as quality of life, mobility and survival up to 1- year post fracture, as part of the Health Research Board funded 3-year HipFORGE research project. Notwithstanding the limitations, the IHFD contains high-quality data on >25,000 hip fracture cases with excellent data coverage and geographical spread. It is a reliable data source that can be used to refine clinical pathways and improve patient outcomes.

4.6 Future research

The IHFD is a rich data source that facilitates the exploration of several aspects of patient care.

- *Time to Surgery*

Surgical fixation is the mainstay of treatment for hip fracture, yet the optimal timing of surgery to achieve the best outcomes has long been the subject of debate. Future research will investigate the impact of time to surgery on in-hospital mortality in Irish hip fracture patients, with a view to assessing the suitability of the current quality indicator for surgical repair i.e., within 48 hours of admission.

- *BPT*

Performance linked tariffs are designed to reward best practice, as defined by demonstrable adherence to defined standards of care[78]. Pay-per-performance initiatives have been used in several countries as an economic incentive to deliver high-quality clinical care in a cost-effective manner. In 2018, the BPT was introduced for hip fracture care in Ireland and is linked with the national standards of care. It is designed to drive improvements in patient care by reducing variation in clinical practice[79]. Hospitals that manage patients with hip fracture in accordance with all 9 IHFS are rewarded financially with a payment of €1000 per case. The funding is split with 70% ring fenced for the trauma service at the clinical level and 30% for the hospital. Future research will investigate the impact of the BPT on adherence to the IHFS and on patient outcomes.

- *Frailty*

Frailty is characterised by a decline in physiological reserve accompanied by an increased vulnerability to stressors and adverse outcomes such as falls, hospitalisation and mortality[80]. There is a need to accurately detect the presence and severity of frailty in clinical practice so that frail patients can be offered the most appropriate course of care[81]. Although several frailty screening tools exist, there is no gold standard tool for assessing frailty. Future research will look towards developing a Frailty Index (FI) within the IHFD and will explore its associations with various outcome measures. This may be of use clinically for risk stratification and the prioritisation of resources such as orthogeriatric assessment.

Appendix

Appendix A – IHFD Data Dictionary

Question	Options
1. Date of trauma causing hip fracture	
1A. Time of trauma causing hip fracture	
2. Type of trauma	1 High-energy trauma, 2 Low-energy trauma 8 Unknown, 9 Not documented
3. Date of arrival at first presenting hospital	
3A. Time of arrival at first presenting hospital	
4. Admission via ED in operating hospitall	1 Yes, 2 No
4A. Date of arrival in ED of operating hospital	
4B. Time of arrival in ED of operating hospital	
4C. Date left ED in operating hospital	
4D. Time left ED in operating hospital	
4E. Did patient go directly to theatre from ED?	1 Yes, 2 No
4F. Date seen by orthopaedic team in operating hospital (if not admitted via ED)	
4G. Time seen by orthopaedic team in operating hospital (if not admitted via ED)	
4H. Did patient fall during an existing inpatient admission in operating hospital?	1 Yes, 2 No
5. Type of ward admitted to in operating hospital	1 Orthopaedic ward 2 Never admitted to orthopaedic ward 9 Not documented
5A. Date of admission to orthopaedic ward	
5B. Time of admission to orthopaedic ward	
6. Is pre-fracture mobility documented?	1 Yes, 2 No
6A. Pre-fracture indoor walking	0 Unable 1 Assistance of one person 2 With an aid 3 Independent
6B. Pre-fracture outdoor walking	0 Unable 1 Assistance of one person 2 With an aid 3 Independent

Question	Options
6C. Pre-fracture shopping	0 Unable 1 Assistance of one person 2 With an aid 3 Independent
6D. Pre-fracture New Mobility Score (sum A+B+C)	
7. AMT performed	1 Yes, 2 No 3 Patient refused, 9 Not documented
7A. AMTS	00–10
7B. Delirium assessment 4AT Day 1	1 Yes, 2 No
7B2. If yes, enter score	00–12
7C. Delirium assessment 4AT Day 3	1 Yes, 2 No
7C2. If yes, enter score	00–12
7D. Delirium assessment 4AT any other time	1 Yes, 2 No
7D2. If yes, enter score	00–12
8. Side of fracture	1 Left, 2 Right, 3 Both
8A. Type of fracture	1 Intracapsular – displaced 2 Intracapsular – undisplaced 3 Intertrochanteric 4 Subtrochanteric 5 Periprosthetic 8 Other 9 Not documented
8B. Type of fracture (Other, please specify)	
8C. Type of fracture (right)	See Q8A
8D. Type of fracture (right, other, please specify)	
9. Pathological	1 Atypical, 2 Malignancy 3 No, 9 Not documented
10. History of previous fragility fracture(s)	1 Yes, 2 No, 9 Not documented
11. Pre-op medical assessment	1 Routine by geriatrician 2 Routine by medical physician 6 None 7 Geriatric review following request 8 Medical physician review following request 9 Not documented

Question	Options
11A. Assessed by geriatrician during this acute admission	1 Yes, 2 No, 9 Not documented
11B. Geriatrician assessment date	
11C. Geriatrician assessment time	
11D. Geriatrician grade	1 Consultant 2 SpR 3 Registrar 8 Other 9 Not documented
11E. Assessed by a cANP/ANP gerontology/ orthopaedics	1 Yes, 2 No, 9 Not documented
12. Nutritional risk assessment performed on admission	0 No 1 Indicates malnourished 2 Indicates risk of malnutrition 3 Indicates normal
13. Nerve block in ED or ward before arrival in theatre suite	1 Yes, 2 No, 9 Not documented
14. Operation	00 No operation performed 01 Int fix DHS 02 Int fix screws 03 Int fix IM nail long 04 Int fix IM nail short 05 Art uni-p hemi uncem uncoated 06 Art uni-p hemi uncem coated 07 Art uni-p hemi cem. 08 Art bi-p hemi uncem uncoated 09 Art bi-p hemi uncem coated 10 Art bi-p hemi cem. 11 Art THR uncem uncoated 12 Art THR uncem coated 13 Art THR cem. 88 Other 99 Not documented
14A. ASA grade	1 Normal healthy individual 2 Mild systemic disease that does not limit activity 3 Severe systemic disease that limits activity but is not incapacitating 4 Incapacitating systemic disease which is constantly life-threatening 5 Moribund – not expected to survive 24 hours with or without surgery 9 Not documented
14B. Type of anaesthesia	1 GA only 2 GA + nerve block 3 GA + spinal anaesthesia 4 GA + epidural anaesthesia 5 SA only 6 SA + nerve block 7 SA + epidural (CSE) 8 Other 9 Not documented

Question	Options
14C. Surgeon grade	1 Consultant 2 SpR 3 Registrar 4 SHO 8 Other 9 Not documented
14C2. Was consultant orthopaedic surgeon present in the operating room?	1 Yes 2 No 9 Not documented
14D. Anaesthetist grade	1 Consultant 2 SpR 3 Registrar 4 SHO 8 Other 9 Not documented
14D2. Was consultant anaesthetist present in the operating room?	1 Yes 2 No 9 Not documented
14E. Date of primary surgery	
14F. Time of primary surgery	
14H. Reason if delay >48 hours	0 No delay – surgery <48 hours 1 Awaiting orthopaedic diagnosis or investigation 2 Awaiting medical review investigation or stabilisation 3 Awaiting inpatient or high-dependency bed 4 Awaiting space on theatre list 5 Problem with theatre/equipment 6 Problem with theatre/surgical/anaesthetic staff cover 7 Cancelled due to list over-run 8 Other 9 Not documented
14H2. Other reason if delay >48 hours	
14J. Mobilised on day of or day after surgery	1 Yes 2 No, 9 Not documented
14J2. Mobilised by	1 Physiotherapist 8 Other, 9 Not documented
14J3. If no, reason why	1 Pain 2 Confusion/agitation/delirium 3 Patient declined 4 Medically not fit 5 Not mobile pre-fracture 6 Physiotherapy staffing issues 7 Other staffing issues 8 Other 9 Not documented

Question	Options
14J4. If no, reason why (other, please specify)	
14K. Physiotherapy assessment on day of or day after surgery	1 Yes 2 No, 9 Not documented
14L. Cumulative Ambulatory Score – day after surgery (0–6)	
14M. Reoperation within 30 days	0 None 1 Reduction of dislocated prosthesis 2 Washout or debridement 3 Implant removal 4 Revision of internal fixation 5 Conversion to hemiarthroplasty 6 Conversion to THR 7 Girdlestone/excision arthroplasty 8 Surgery for periprosthetic fracture 9 Not documented
15. Operation (right)	See Q12
16. Pressure ulcers	1 Yes, 2 No, 9 Not documented
17. Specialist falls assessment	0 No, 1 Yes – performed on this admission 2 Yes – awaits further outpatient assessment
18. Bone protection medication	0 No assessment 1 Started on this admission 2 Continued from pre-admission 3 Awaits DXA scan 4 Awaits outpatient assessment 5 Assessed – no bone protection medication needed/appropriate
18A. If medication type changed during admission, please document	1 Yes, 2 No, 9 Not documented
19. Multidisciplinary rehabilitation team assessment	1 Yes, 2 No, 9 Not documented
20. Cumulative Ambulatory Score – day of acute hospital discharge (0–6)	
21. Where was the patient discharged to following the acute hospital spell?	1 Home 2 On-site rehab unit 3 Off-site rehab unit 4 Convalescence care 5 New admission to nursing home or long-stay care 6 Return admission to nursing home or long-stay care 8 Other
21A. Discharged to (other, please specify)	
22. Is admission data entry complete for this episode?	1 Yes, 2 No

Appendix B – Published Papers

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

Helena Ferris[1] · Louise Brent[2] · Tara Coughlan[3]

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European Geriatric Medicine
https://doi.org/10.1007/s41999-021-00556-7

RESEARCH PAPER

Discharge destination after hip fracture: findings from the Irish hip fracture database

H. Ferris[1] · L. Brent[2] · J. Sorensen[3] · E. Ahern[4] · T. Coughlan[5]

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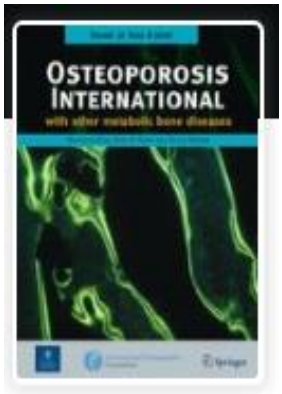


Osteoporosis International
https://doi.org/10.1007/s00198-021-06294-7

ORIGINAL ARTICLE

Cost of hospitalisation for hip fracture—findings from the Irish hip fracture database

H. Ferris[1] · L. Brent[2] · J. Sorensen[3]

Received: 1 November 2021 / Accepted: 29 December 2021

Appendix C – Co-Author Consent

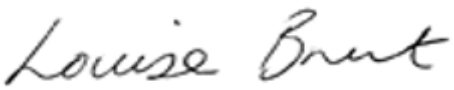
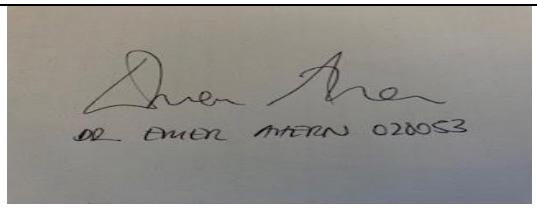
Dear Professor Romero-Ortuno,

I understand that Dr Helena Ferris is presenting the following papers as part of a submission for the degree of M.D by prior publication:

1. Ferris H, Brent L, Coughlan T. Early Mobilisation Reduces the Risk of In-Hospital Mortality Following Hip Fracture. European Geriatric Medicine, 2020.
2. Ferris H, Brent L, Sorensen J, Ahern E, Coughlan T. Discharge Destination After Hip Fracture: Findings From the Irish Hip Fracture Database. European Geriatric Medicine, 2021.
3. Ferris H, Brent L, Sorensen J. Cost of Hospitalisation for Hip Fracture – Findings from the Irish Hip Fracture Database. Osteoporosis International, 2022.

I grant my permission for Dr Helena Ferris to proceed in this manner.

Yours sincerely,

Ms Louise Brent Irish Hip Fracture Database & Major Trauma Audit Manager, National Office of Clinical Audit, Dublin	
Prof Tara Coughlan Consultant Geriatrician & Stroke Physician, Clinical Associate Professor Medical Gerontology, Tallaght University Hospital, Dublin	
Dr Emer Ahern Irish Hip Fracture Database Clinical Geriatrician Lead, Consultant Orthogeriatrician, Cork University Hospital, Cork	
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