Cost Analysis of a Falls-prevention Program in an Orthopaedic Setting

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Abstract

Background Falls by orthopaedic patients may lead to negative outcomes such as injury, prolonged hospitalization, delayed rehabilitation, and increased costs.

Questions/purposes We examined the impact of a multidisciplinary Falls-prevention Program (FPP) on the incidence of inpatient falls and fall-related injuries in an orthopaedic hospital during a 6-year period.

Methods Patient data and fall incident report data were reviewed to identify risk factors associated with falls and fall-related injuries. A cost analysis was performed to calculate costs incurred as a result of falls.

Results A total of 415 falls occurred during a 5-year period preintervention. The fall rate preintervention was significantly higher than the fall rate postintervention (3.49 versus 2.68 per 1000 bed days). Eighty-five falls occurred

in the 12 months preintervention. A total of 15.29% (13 of 85) of falls resulted in minor injuries, and 9.42% (eight of 85) resulted in major injuries. The total cost incurred during this period as a result of falls was \$117,754.12. Of this, 95.5% resulted from patients who sustained a hip fracture ($n = 4$). The total cost of implementing the FPP was \$15,694.46. In the 12 months postintervention, 52 falls occurred. Twenty-five percent (13 of 52) of falls resulted in minor injuries, and 5.76% (two of 52) resulted in major injuries (no hip fractures). The total costs accrued during this period as a result of falls was \$811.70.

Conclusions After implementation of a FPP, there were significant decreases in fall incidence, fall-related morbidity, and consequent costs.

Level of Evidence Level III, economic and decision analyses. See the Guidelines for Authors for a complete description of levels of evidence.

Each author certifies that he or she has no commercial associations (eg, consultancies, stock ownership, equity interest, patent/licensing arrangements, etc) that might pose a conflict of interest in connection with the submitted article.

Each author certifies that his or her institution approved the human protocol for this investigation and that all investigations were conducted in conformity with ethical principles of research. This work was performed at the Department of Trauma & Orthopaedic Surgery, St Mary's Orthopaedic Hospital, Gurrabraher, Cork, Ireland.
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Introduction

Falls are a common occurrence among hospital inpatients. Rates between 2.2 and 17.1 falls per 1000 patient days depending on hospital type and patient populations have been reported [14, 21, 25]. Although falls in the community and long-term care facilities have been relatively well studied, less is known about the demographics of inpatient falls. Injuries resulting from falls have been reported to occur in 15% to 50% of these incidents and can range from bruises and minor injuries (28%) to severe soft tissue wounds (11.4%) and skeletal fractures (5%) [18]. A hip fracture is one of the most serious complications and can result in generalized decline in overall health, resulting in death in approximately 15% to 25% of patients within 1 year for patients 60 years or older [24]. In addition, falls

may lead to patients developing a fear of falling with subsequent activity restriction [20, 29], a prolonged hospital stay [6], increased healthcare costs [2], and potential legal liability [12]. Therefore, fall incidents and their resultant negative outcomes are a considerable problem for the inpatient population and healthcare providers and warrant implementation of preventive strategies to avoid these undesirable outcomes.

Various FPPs have been implemented in hospitals in the past [8, 18]. However, none of the studies of these programs has had a sustained effect [23]. In one study, a 25% reduction of falls-related injuries was reported during a 5-year period after implementation of a prevention program [4]. The majority of studies to date assessing inpatient falls have evaluated patients of all medical specialties, mainly focusing on the geriatric [30] and neurosurgical populations [27]. There has been one study to date assessing falls in the orthopaedic patient population [1]. Falls in orthopaedic patients undoubtedly can lead to negative patient outcomes such as injury, prolonged hospitalization, and delayed rehabilitation. There is also a major economic burden associated with such fall incidents. For these reasons, falls prevention is imperative in the orthopaedic setting.

We aimed to examine the incidence of inpatient falls before and after implementation of a multidisciplinary FPP in an orthopaedic setting. We also compared and analyzed the risk factors for falls before and after implementation of the FPP. Finally, we performed a cost analysis to analyze costs relating to falls before postintervention and costs arising from implementing the FPP.

Patients and Methods

This was a prospective cohort study using an historical control group to analyze fall incidence, risk factors associated with falls, and costs arising before and after implementation of a FPP. We conducted this study in a 91-bed elective orthopaedic hospital. The majority of this hospital's inpatient volume (approximately 80%) is elective admissions for orthopaedic procedures, including THA and TKA. A minority of patients (approximately 20%) are transfers from an affiliated trauma center mainly consisting of patients with orthopaedic trauma who have undergone surgery and are awaiting placement in rehabilitation. The study population included all patients hospitalized within a 5-year period preintervention from January 1, 2003, to December 31, 2007, and for 1 year postintervention from July 1, 2008, to June 30, 2009.

We used administrative data to identify variables relating to the entire population during the study period, including age, length of stay, and reason for admission. Fall

incident report forms, which are handwritten at the time of the incident, were reviewed to identify patients who fell during the 6-year study period (JGG, RTM). The falls incident report form is a standardized document that has a checklist for information relating to a fall event, including date, time, location, circumstance, use of devices, and any injuries received. This form has a section that must be filled out by the nurse who discovers the patient who fell. This form also has a section that must be filled out by the in-house doctor. This means that a doctor must review the patient after any fall regardless of how innocuous a fall may seem. In this section, the doctor gives his or her clinical impression of the fall, likely injuries if present, and a plan for further management. The decision to order radiologic investigation is based on the clinical judgment of the doctor reviewing the patient. It is based on mechanism of the fall, findings on physical examination, previous orthopaedic procedures, and clinical suspicion of injury. We analyzed the medical records of all patients who fell to identify risk factors associated with falls, fall-related injuries, and all related costs for the year preintervention and the year postintervention. This project was reviewed by our institutional ethics board, which waived the need for approval.

In February 2008, a multidisciplinary task force was established to develop a FPP with the aim of creating a safe environment for inpatients and to reduce the incidence of falls and consequent injuries. The various elements of the plan were introduced in stages during a 6-month period and the FPP was fully operational by July 1, 2008 (Table 1).

Starting July 1, 2008, all patients, on admission to the ward, received a falls risk assessment from the nurses. Patients deemed at high risk of a fall were placed in designated beds on that particular ward next to the nursing station where they could be closely monitored. Falls assessment was performed using the Falls Risk Assessment Scale for the Elderly (FRASE) risk assessment tool. This tool was selected because it has been prospectively validated [7].

Staff education and training were priorities in the FPP. An initial 1-hour structured education session on the fall prevention interventions was provided for all staff. Specific roles were highlighted for the different health workers, including nursing staff, support staff, occupational therapy, and physiotherapy staff. Information on patient transfer, provision of mobility devices, and provision of adequate footwear were among the topics discussed. Voiding was highlighted as a major risk in falls and focus was placed on this aspect of patient care. In addition to patient assessment and staff training, changes to the infrastructure of wards also were implemented. The falls prevention committee, representing the involved healthcare professionals, was

Table 1. The Falls Prevention Program

Falls Prevention Program design	
• Establishment of a Task Force	
• Consisted of an orthopaedic surgeon, a geriatrician, two nursing directors, a physiotherapist, an occupational therapist, and a social worker	
• Review of literature on preexisting fall prevention programs	
• Risk factor in hospital identified from patients' charts, incident report forms, and nursing notes	
• Target identified risk factors by Falls Prevention Program	
Staff training	
• Initial 1-hour structured education session for all staff	
• Specific roles were highlighted for the different health workers	
• Information on patient transfer, provision of mobility devices, and adequate footwear	
Interventions affecting all admitted patients	
• Screening on admission for falls risk using FRASE tool	
• Set up auxiliary nursing station at night on larger wards for better supervision	
• Ward modifications including nonslip mats, hand rails, and better lighting	
• Nursing staff encouraged to toilet patients regularly	
• Information leaflets on falls prevention available on wards for all patients and family	
Interventions for all high-risk patients	
• Assigned to designated beds near nursing station for better supervision	
• "Risk alert" sign was placed above the patient's bed and notes	
• Assistance provided when ambulating	
• Gait and balance training sessions with physiotherapist	
• Use of commodes for females and hand held urinals for males was encouraged	
• Education on falls prevention for the patient and their family where possible	
Ongoing interventions	
• Meeting of Task Force for review of progress every 2 months	
• Additional training for any new staff employed	

installed to audit the progression of the FPP every 2 months.

We (JGG, ARM, JSB) identified all costs relating to falls for the 2-year study period. The cost of falls was subdivided into its major components: acute ward costs, operating room costs, nonoperating room treatment costs, transfer costs, and investigations performed. Ward expenses were computed with the aid of the financial department. We used patient charts, nursing notes, and operation notes where applicable to identify all costs relating to a fall episode. Using these data, the individual total cost incurred in the treatment of each patient was calculated. We also calculated the cost of the FPP. They were subdivided into staff and infrastructure costs. Initial staff-related costs resulting from protected time for training

Table 2. Fall rates among preintervention years

Parameter	2003	2004	2005	2006	2007	Total
Total falls	79	80	83	88	85	415
Total bed days	25,240	25,002	24,484	22,111	22,031	118,868
Fall rate	3.13	3.20	3.39	3.98	3.86	3.49
Bed days without falls	25,161	24,922	24,401	22,023	21,946	118,453

and audit meetings were calculated by matching pay grades to the numbers of hours spent by all staff in training. We calculated infrastructure costs from the accounting department relating to provision of new equipment, repairs, and labor costs.

Between January 1, 2003, and December 31, 2007, 19,057 orthopaedic patients were admitted to our hospital resulting in 118,865 bed days. A test for homogeneity of annual fall rates was performed using a chi square test through contingency tables. This showed no significant difference between years when comparing the falls incidence from 2003 through 2007 ($p = 0.245$), before formulation of the FPP (Table 2). Therefore, for further analysis, we grouped these observations together to make a more powerful inference with respect to the effects of the intervention implemented in 2008.

Frequency distributions and summary statistics, including count (percentage) and mean $\pm$ SD, were used to describe patient characteristics, prevalence of patient falls, and associated risk factors. We applied one-sided and two-sided z-tests for statistical analysis where appropriate using SPSS, Version 16.0 (SPSS Inc, Chicago, IL). p Values < 0.05 were considered to be statistically significant.

Results

The FPP initiated between July 1, 2008, and June 30, 2009, led to a significant reduction in falls ($p = 0.0182$). Before the intervention from 2003 to 2007, 415 falls over 118,865 bed days occurred resulting in a fall rate of 3.49 falls per 1000 bed days compared with 2.68 falls per 1000 bed days after the intervention (Table 3). This amounts to a relative risk reduction of 30.6%.

In the postintervention period, there were less falls relating to elimination ($p = 0.0025$), less falls by elective patients ($p = 0.0115$), and less falls occurring during the daytime shift ($p = 0.0073$). The risk factors leading to falls differed before and postintervention (Tables 4–6). There was no difference in the number of falls resulting in no injury ($p = 0.2189$), but there was a reduction in the number of falls requiring a radiologic investigation from 25 to nine ($p = 0.0086$) (Table 7). Five patients sustained a fracture as a direct consequence of their fall in the

Table 3. Falls and bed days by year

Parameter	2003	2004	2005	2006	2007	Year postintervention
Admissions	3749	3988	3895	3750	3675	3364
Total falls	79	80	83	88	85	52
Fall rate	3.13	3.20	3.39	3.98	3.86	2.68
Total bed days	25,240	25,002	24,484	22,111	22,031	19,427

Table 4. Characteristics of admitted patients

Parameter	Year before intervention	Year after intervention	p Value
Total admissions	3675	3364	
Age, mean $\pm$ SD	53.92 $\pm$ 16.23	57.68 $\pm$ 17.75	< 0.0001
Number of patients aged older than 60 years (%)	1634 (44.46%)	1683 (50.03%)	< 0.0001
Males, number (%)	1763 (47.97)	1555 (46.22)	0.0711
Bed days	22,030	19,427	
Elective admissions, number (%)	2898 (78.86)	2688 (79.90)	0.1389
Transfer admissions, number (%)	777 (21.14)	676 (20.1)	0.1389
Mean length of stay	8.71	9.5	
Day cases, number (%)	1295 (35.24)	1472 (43.76)	< 0.0001
THA, number (%)	382 (10.39)	296 (8.8)	0.0117
TKA, number (%)	211 (5.74)	143 (4.25)	0.0021
Carpal tunnel releases, number (%)	146 (3.97)	192 (5.71)	0.0001
Knee arthroscopy, number (%)	312 (8.49)	188 (5.59)	< 0.0001
Shoulder arthroplasty, number (%)	5 (0.14)	14 (0.42)	0.0118

Table 5. Falls before and after introduction of the Falls Prevention Program

Parameter	Year before intervention	Year after intervention	p Value
Total falls, number	85	52	0.0182
Single falls, number	55	36	0.0812
Two or more falls, number	30	16	0.0382
Patients with recurrent falls, number	10	5	0.1309
Falls/1000 hospital days	3.86	2.68	
Age of patients who fell, mean $\pm$ SD	71.45 $\pm$ 14.90	72.2 $\pm$ 18.9	0.0662
Patients older than 60 years who fell, number (%)	56 (86.15)	31 (75.61)	0.2298
Falls by transfer patients, number (%)	67 (78.82)	46 (88.46)	0.0983
Falls by elective patients, number (%)	18 (21.18)	6 (11.54)	0.0115
Day shift falls, number (%)	54 (63.53)	27 (51.92)	0.0073
Night shift falls, number (%)	31 (36.47)	25 (48.08)	0.3696
Elimination-related falls, number (%)	55 (64.7)	25 (48.08)	0.0025
Falls on ward, number (%)	53 (62.4)	38 (73.08)	0.1644
Falls in bathroom, number (%)	24 (28.2)	9 (17.31)	0.0120
Falls in corridor, number (%)	4 (4.7)	4 (7.69)	
Falls outside, number (%)	4 (4.7)	1 (1.92)	
Witnessed, number (%)	15 (17.65)	5 (9.62)	0.0250
Found on floor, number (%)	67 (78.82)	47 (90.38)	0.1137
Self-reported, number (%)	3 (3.53)	0 (0)	
Mean length of stay all fallers $\pm$ SD	29.45 $\pm$ 41.51	39.08 $\pm$ 45.02	0.2724

preintervention period. This included four patients had hip fractures who required transfer to the nearby trauma hospital for operative management (Table 8). One patient sustained a severe head injury requiring suturing and CT of the skull and brain to rule out intracranial hemorrhage. Another patient dislocated his THA and had to be transferred for relocation. In the postintervention group, one patient sustained a fractured distal radius, which was treated nonoperatively. No patients required transfer for further investigation or treatment.

Falls occurring before the FPP resulted in greater costs of care than after the FPP implementation, amounting to a cost difference of \$116,880.46 between the preintervention and postintervention years. The total cost incurred during

the preintervention period (2007) (excluding medication costs) as a result of falls was \$117,754.12. Treatment of the four patients who sustained hip fractures amounted to \$112,398.21; of this, acute ward costs amounted to \$89,692.47. Acute ward costs relating to “hotel” costs for each bed day, which results from bed occupancy and nursing costs but excludes any treatment costs, accounted for \$85,442.21. These four patients had to be transferred to the nearby acute trauma center for surgery costing \$971.95. Operating room-related costs amounted to \$16,488.74 and investigations cost an additional \$6149.46. Treatment for the remainder of the 81 falls cost \$5324.80. Of this, all investigations cost \$3247.06, transfers cost \$485.91, and the remainder was spent on treatment costs. The total cost incurred between July 1, 2008, and June 30, 2009, as a result of falls (excluding medication costs) was \$811.70. The cost of investigations was calculated to be \$712.65. The cost of treatment was \$98.02. There was no increased cost relating to increased length of hospital stay, operating room costs, or transfer costs. The total cost of implementation of the FPP amounted to \$15,694.46. The cost of the FPP was broken down into initial costs and ongoing costs. Initial costs can be subdivided into training costs and infrastructure costs. Total initial training costs amounted to \$4793.75. This results from cost of devising the FPP by the task force of \$1011.93 and cost of training all relevant staff grades was \$3781.88. Infrastructure costs amounted to \$8573.44. Ongoing costs related to audit and implementation of FPP by the falls prevention committee, which meets for 1 hour every 2 months, costs \$2318.37 per annum. There were no ongoing costs related to infrastructure for the year postintervention.

Table 6. Reason for admission of patients who fell

Reason for admission	Year before intervention	Year after intervention
Hip fracture, number (%)	24 (36.92)	21 (51.22)
Lower limb fracture, number (%)	16 (24.62)	8 (19.51)
Upper limb fracture, number (%)	2 (3.08)	4 (9.76)
Pelvic fracture, number (%)	6 (9.23)	1 (2.44)
Spinal fracture, number (%)	0 (0)	1 (2.44)
Septic arthritis, number (%)	1 (1.54)	0 (0)
THA, number (%)	7 (10.77)	2 (4.88)
TKA, number (%)	5 (7.69)	1 (2.44)
Knee arthroscopy, number (%)	0 (0)	2 (4.88)
Carpal tunnel release, number (%)	3 (4.62)	1 (2.44)
Shoulder arthroplasty, number (%)	1 (1.54)	0 (0)

Table 7. The outcome of falls

Parameter	Year before intervention	Year after intervention	p Value
Falls with no injury to patient, number	64	36	0.2189
Falls with minor injury to patient, number	13	13	0.0799
Falls with severe injury to patient, number (%)	3 (3.36)	1 (1.92)	
Falls with patient experiencing fracture, number (%)	5 (5.88)	1 (1.92)	
Falls requiring patient to have radiologic test, number (%)	25 (29.41)	9 (17.31)	0.0086
Falls resulting in transfer of patient to trauma center	6 (6.72)	0	

Table 8. Characteristics of patients sustaining hip fractures

Patient number	Age (years)	Gender	Source	Original operation	Required procedure
1	75	Female	Transfer	Posthip fracture	Hemiarthroplasty
2	83	Female	Transfer	Posthip fracture	Dynamic hip screw
3	85	Female	Elective	PostTKA	Hemiarthroplasty
4	86	Female	Transfer	Posthip fracture	Dynamic hip screw

Discussion

Our study outlines the healthcare effects of the introduction of a tailored FPP to an exclusively orthopaedic patient population. We examined fall rates, consequent injuries, and characteristics of hospitalized patients before and after the implementation of the program. A cost analysis then was performed to investigate the cost-effectiveness of the FPP. This is the first study of its type to evaluate the impact of a FPP on an exclusively orthopaedic population.

There are several limitations to our study that should be considered. First, the trial design, an historical cohort study, has been criticized for confounding by secular changes in fall rate, case-mix, and practice [22]. Despite this fact, the majority of studies on this subject still follow this trial design. The reason for this is there are issues relating to randomization making a randomized control trial difficult to assess falls adequately. Second, there was a significant decrease in THAs and TKAs performed between the pre-intervention and postintervention periods. There was also a substantial increase in the number of upper limb procedures being performed. Postoperative patients with procedures on their lower limbs are at higher risk of falling for reasons previously outlined. This variation in case-mix may have had an effect on the significant decrease of falls by elective patients between the two cohorts. However, the proportion of falls relating to these procedures is small and unlikely to affect the overall result. Finally, the study period is short, in particular the postintervention period. Although 1 year is a short period to measure the true effectiveness of the FPP, the results are promising.

The FPP resulted in a significant reduction in falls amounting to a relative risk reduction of 30.6%. This reduction is in accordance with the results of a recent meta-analysis [11]. Of the eight studies included in this meta-analysis, only one study had interventions that closely matched ours [26]. This was a quasiexperimental study in the setting of an acute general medical unit. The intervention was directed toward modifying the hospital environment, supporting patient activities, and increasing staff awareness. They focused on patients identified as being at high risk of falling as determined using the Morse Fall Scale with audits being held every other week for nurses in the intervention group. The intervention program showed a lower fall rate in the intervention group (11.5 falls per 1000 bed days) compared with the control group (15.7 falls per 1000 bed days), but this was not found to be significant ($p = 0.342$). Their study [26] did not show any significant reduction in injuries. However, three severe injuries, which included fractures, occurred in the control group with none occurring in the intervention group. Our study showed a similar decrease in the severity of injuries, including an 80% decrease in fractures, although our

sample was not adequately powered to show this significantly. The majority of studies reviewed failed to show a significant reduction in injuries after introduction of an FPP despite reducing fall rates. A large study done by Fonda et al. showed a significant reduction in fall-related serious injuries, including fracture, head injury, and death from 5.8% preintervention to 1.7% postintervention [13].

Postoperative orthopaedic patients have certain risk factors that predispose them to falls, including decreased mobility, use of opioids, and, in some cases, a history of previous falls. Ackerman et al. recognized this and was the first to look specifically at falls in postoperative orthopaedic patients [1]. This study focuses on an orthopaedic unit of postoperative patients, many of whom have undergone THA or TKA. They highlight characteristics of patients who sustained a fall and attempt to identify associated risk factors. Their observed fall rate of 2.5 falls per 1000 bed days was slightly lower than in our preintervention population (3.13–3.98 falls per 1000 bed days). This variation in falls rate probably is related to differing case-mixes. Approximately 20% of our study population consisted of postoperative orthopaedic trauma patients awaiting placement in rehabilitation. Many of these patients have undergone an orthopaedic procedure resulting from a recent fall and therefore are at higher risk for additional falls (Table 6). This was much lower than the reported fall rates from the major geriatric studies (up to 17.9).

Ackerman et al. also found that most falls (64%) in their study population were elimination-related while going to and from the bathroom, occurring in the bathroom, or while using a bedside commode [1]. This finding was consistent with those of previous studies [15, 16]. In our study, elimination-related falls accounted for 55 falls (64.7%) in the preintervention group. Interventions as part of the FPP were carefully tailored to complement the environment and address this issue placing particular emphasis on ensuring regular voiding. This resulted in a significant decrease in falls at these occasions.

A detailed cost analysis revealed the FPP had resulted in a large saving for the hospital in the short-term. There was a cost difference of \$116,880.46 between the preintervention and postintervention years. Considering total cost of implementing the FPP was only \$15,686.78 with a projected annual cost of \$2318.37 per annum for ongoing audit, this has a potential to result in a large saving in the long-term for the hospital. The cost analysis shows the majority of savings is related to preventing hip fractures. The high cost in falls resulting from hip fractures has been recognized [2, 5, 10]. In our study, the cost of a hip fracture is on average \$28,091.62, which is a similar to the inflation-adjusted costs that are described in previous studies from this country [10] and abroad [28]. A large proportion of the costs results from costs relating to length of stay in the

hospital [3]. The documented benefits from hip protectors [19] and steps to preserve bone mineral density [9] could be useful adjuncts to any FPP. According to Johansson et al., staff-led initiatives are more cost-effective than more expensive pharmacologic initiatives [17].

This is the first study to assess the effects of a FPP on an orthopaedic unit. After implementation of a FPP, the incidence of inpatient falls and consequent costs decreased substantially. The large proportion of savings results from preventing hip fractures. Although the reductions in fall and fracture rates seen in our study are encouraging, additional work is needed to investigate if there is a sustained reduction in falls in the long term. The clinical implications of this work highlight the important role that a FPP can have in an orthopaedic unit in preventing falls, further injury, and reducing economic burden. Our findings would be applicable to many orthopaedic units that have a similar patient case-mix.

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