Age and Ageing 2009; **38:** 584–589
doi: 10.1093/ageing/afp124
Published electronically 13 July 2009

Outcomes in older patients after surgical treatment for hip fracture: a new approach to characterise the link between readmissions and the surgical stay

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Abstract

Background: in older patients, there is a high risk of hospital readmission within the first year after surgery for hip fracture, due to complications following treatment or to the evolution of prior comorbid conditions.
Objectives: to identify factors associated with readmissions related to the index surgical stay.
Design: retrospective cohort study.
Setting: administrative claims databases.
Subjects: patients over 75 surgically treated for hip fracture in Paris area.
Methods: we analysed all admissions in 2005, and tracked for 1-year readmissions. First readmissions (FRs) were classified as related or unrelated to the index stay, according to rules defined *a priori*. We analysed the association between patient characteristics and the FR.
Results: among 5,709 patients, 32% had at least one readmission, 53% were FR related. Near 80% of related readmissions occurred within 3 months from discharge. Surgical conditions caused 47% of all related readmissions, and male gender, dementia, cancer or kidney diseases were independent risks factors.
Conclusions: half of readmissions could be classified as related to the index stay and a great majority of these occurred early post discharge. Surgical conditions caused 47% of all related readmissions. Improvement in orthopedic-geriatric co-care is suitable to expect an impact on outcomes after surgery.

Keywords: *related readmission, hospital information systems, medical record linkage, hip fractures, elderly*

Introduction

In industrialised countries, hip fractures (HF) represent an increasing health care problem with the phenomenon of ageing, as the annual number of HF is expected to double by the year 2040 [1], associated with significant morbidity and mortality [2–5]. There is a high risk of hospital readmission within the first year after surgery treatment [6, 7] and a high risk of complications after surgery [3, 8] which is associated with an increased risk of mortality [9]. Hospital readmission among older adults with HF is a significant concern in as much as there is a trend towards the decreasing length of hospital stay, premature discharge being possibly a risk factor of readmission.

Readmission may be linked to complications following the fracture treatment or due to combination of surgery in older patients with concurrent medical problems and low physical reserve. It may also be linked to the evolution of comorbid conditions prior to the fracture with no direct link with the surgical procedure. Identifying the true relationship between the index surgical stay and the readmission could be of a major interest to implement specific preventive interventions to reduce hospital readmission rate after surgery.

Our objective was to identify factors associated with the risk of readmission related to the index stay for HF surgically treated in older patients.

Methods

Study design and setting

We performed a retrospective cohort study of patients older than 75 surgically treated for HF by applying record linkage to administrative claims databases. We analysed eligible admissions in 2005 (the enrolment period) in any of the 247 teaching, public or private hospitals in Paris area (Ile de France), and then we included an additional year (2006) to track for 1-year readmissions and in-hospital deaths (the look-forward period).

Study population and data sources

All admissions of patients over 75 years old with a principal discharge diagnosis of HF treated by osteosynthesis or hip replacement (French procedure codes NBCA003 to NBCA015, NBCB001 to 002, NBCB004 to 006, NFDC001, NFDA009, NEKA010 to 012, NEKA014, NEKA016 to 018 and NEKA020 to 021) were eligible. The categories of HF included femoral neck, trochanteric and subtrochanteric fractures (ICD-10 codes S720–S722). The chronologically first hospital admission for HF surgically treated during 2005 for each patient was considered as the index stay.

Data were retrieved from the French administrative claims database. In France, a unique national patient identifier has been introduced in national DRG-based information system in 2001 [10], allowing to apply record linkage techniques to the information system databases. It can give access to linked patient episodes over a long time period.

We extracted age and sex of patients, date of discharge, length of stay, type of surgery (hip replacement or osteosynthesis), the discharge mode (including death) and the principal and secondary discharge diagnoses, assigned by the physician at discharge according to the ICD-10. We also recorded whether the index event occurred in a public, teaching or private hospital. Coexistent illnesses were determined by searching up to five secondary diagnosis codes. We looked for a set of comorbidities known to be related with outcomes after hip surgery that we defined *a priori* according to a literature review: stroke, dementia, cancer, Parkinson disease, kidney disease, cardiac disease, diabetes and respiratory disease [8, 11–13].

Identification of readmissions in acute care units

The first readmission (FR) was defined as the first subsequent admission in acute care unit, in any hospital in Paris area, within 12 months from the index stay. For a given index record, we looked for readmissions by applying record linkage to the Paris area databases for 2005 and 2006. We tabulated the FR and subsequent readmissions when required. We also recorded deaths during readmission stays.

Table 1. Classification rules of first readmissions as likely related or not to the index hospital stay

Diagnosis	Type of complication	Readmission delay from the index stay
Pneumonia	Infectious	2 months
Bronchitis	Infectious	1 month
Urinary tract infection	Infectious	1 month
Prostatitis	Infectious	2 months
Wound infection	Infectious	3 months
Pulmonary embolism	Pulmonary	2 months
Deep vein thrombosis	Pulmonary	2 months
COPD exacerbation	Pulmonary	2 months
Congestive heart failure	Cardiac	2 months
Ischemia or infarction	Cardiac	2 months
Arrhythmia	Cardiac	1 month
Stroke	Neurologic	2 months
Confusion	Neurologic	1 months
Bedridden	Neurologic	2 months
Haemorrhage	Bleeding	2 months
Anaemia	Bleeding	2 months
Haematoma	Bleeding	2 months
Intestinal obstruction	Gastrointestinal	1 months
Pain	Rheumatic	1 year
Wound	Skin	3 months
Falls	Rheumatic	1 year
Non union or osteonecrosis	Surgical	1 year
Prosthetic dislocation	Surgical	1 year
Loosening	Surgical	1 year
New fracture	Surgical	1 year
Loss of fixation	Surgical	6 months
Periprosthetic infection	Infectious	1 year

Classification of readmissions as related or unrelated to the index stay

The FR was classified as related or unrelated to the index stay. This was established according to rules defined *a priori*, which took into account the type of complication leading to readmission (identified through the principal diagnosis) and the delay from index discharge to FR (Table 1). We recorded the type of complications (using principal diagnosis) that led to related readmissions.

Statistical analysis

Concerning the classification of the FR as related or unrelated to the index stay, two geriatricians independently performed the manual coding of the first 10% of all identified readmissions. Because they showed a very good agreement (Cohen's kappa coefficient 0.81), each of them achieved manual coding of half of the remaining records separately.

Related and unrelated FR defined a 'competing risk' situation: the observation of one type of readmission prevented the observation of another type. To estimate the specific readmission rates, we used the cumulative incidence function, which is the probability of occurrence by time t of a particular type of readmission in the presence of other risks. The associated cumulative incidence plots were constructed.

To assess the predictive value of patient characteristics during the index stay for related and unrelated FR, we used the proportional subdistribution hazard model [14]. This model is an extension of the Cox proportional hazards model to the competing risk situation. Multivariate analysis was performed in a backward selection fashion for related and unrelated FR subdistribution hazards to construct a set of independent predictors. All predictors achieving a *P*-value below 0.15 in univariate analysis were considered and sequentially removed if the *P*-value was above 0.05 in multivariate analysis. The covariate 'type of surgery' was forced during all the process. *P*-values inferior to 0.05 were deemed significant. The analyses were performed using the R software (cmprsk package) [15].

Results

Study population

We retrieved 6,198 records corresponding to older patients surgically treated for HF in 2005. Among those, 216 (3%) had an invalid identifier, due to the same coding error of the social security number and were excluded. Among patients with a valid identifier, 273 died during the index stay. The 5,709 survivors constituted the final analysis population. Characteristics of this population are presented in Table 2. The mean age at index admission was 86 years old, 77% were women. Osteosynthesis was used for 57% of cases and hip replacement for 43%. The major discharge mode was rehabilitation care (2,218 records, 39%).

Readmissions

Over 12 months of follow-up, 1,842 patients (32% of the index population) were concerned by at least one readmission. A total number of 2,870 readmissions was identified in the database. The maximum number of readmissions per patient was 10.

Classification of readmission as related or unrelated to the index stay

We found 974 (53%) FR related to the index stay. Complications that led to a related FR were surgical (458 records, 47%), infectious (125, 13%), cardiac (85, 9%), neurologic (71, 7%), rheumatic (60, 6%), pulmonary (53, 5%), bleeding (45, 5%) and other complications (82 records, 8%).

Near 80% (756 records, 78%) of related FR occurred within 3 months post-discharge from the surgery. Less than a third (241 records, 28%) of unrelated FR occurred within 3 months post-surgery, while the frequency of unrelated FR was stable over the 12 months following the index discharge. The cumulative incidence rate of related and unrelated FR were equal to 13% and 4% at 3 months, 15% and 9% at 6 months and 17% and 15% at 12 months, respectively (Figure 1).

In the multivariate time-to-readmission analysis, we found that male gender [HR: 1.25 (1.08; 1.46), $P < 0.001$], the presence of cancer [HR: 1.41 (1.03; 1.94), $P = 0.03$], kidney disease [HR: 1.38 (1.00; 1.9), $P = 0.05$] and dementia [HR: 1.21 (1.01; 1.46), $P = 0.04$] were independent risk factors of related FR, while an index stay in a teaching hospital exposed patients to a lower risk than public hospitals [HR: 0.86 (0.79; 0.95), $P < 0.01$].

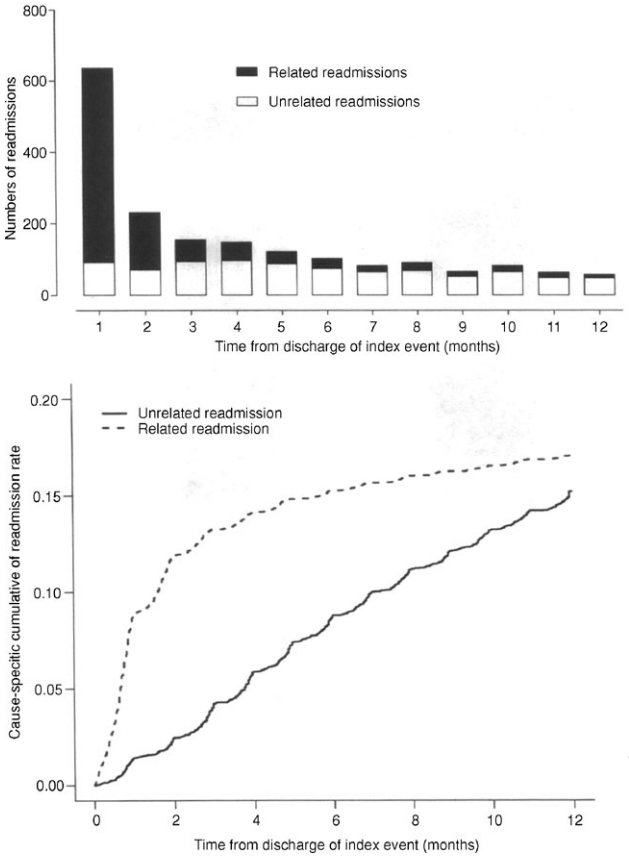

Figure 1. Histogram showing the distribution of time to first related or unrelated readmission from discharge of the index event (upper panel) and the corresponding cumulative incidence functions (lower panel).

Conversely, male gender [HR: 1.36 (1.16; 1.59), $P = 0.03$] increased the risk of an unrelated FR, while an increased age [HR associated with an increase of 5 years: 0.94 (0.89; 0.99), $P = 0.03$], the presence of a known dementia [HR: 0.68 (0.53; 0.87), $P < 0.01$] and an index stay in a private hospital [HR vs public hospital: 0.78 (0.67; 0.9), $P < 0.001$] or in a teaching hospital [HR vs public hospital: 0.87 (0.79; 0.95)] independently decreased the risk of unrelated FR.

These results are adjusted on the type of surgery. For both related and unrelated FR, the duration of the index stay was not independently associated with the risk of readmission.

Lastly, 246 deaths occurred in acute care units among the 2,870 readmissions, 52% of which occurred within 3 months of discharge from the index stay. The overall observed 1-year hospital mortality (index hospitalisation and readmission mortality) was 9% (519 deaths).

Table 2. Patients characteristics at the index stay

Variables	All patients ($n = 5,709$)	Patients without readmission ($n = 3,867$)	Patients with a first unrelated readmission ($n = 868$)	Patients with a first related readmission ($n = 974$)
Type of hospital, *n* (%)				
Teaching	1,058 (18)	775 (20)	143 (16)	140 (14)
Private	2,043 (36)	1,389 (36)	278 (32)	376 (39)
Public	2,608 (46)	1,703 (44)	447 (51)	458 (47)
Age, years	85 ± 6	86 ± 6	85 ± 6	85 ± 6
Female, *n* (%)	4,647 (81)	3,222 (83)	666 (77)	759 (78)
Length of stay, days	15 ± 8	15 ± 9	15 ± 8	15 ± 8
Type of surgery, *n* (%)				
Osteosynthesis	3,267 (57)	2,189 (57)	524 (60)	554 (57)
Hip replacement	2,442 (43)	1,678 (43)	344 (40)	420 (43)
Comorbidity, *n* (%)				
Dementia	644 (11)	444 (11)	72 (8)	128 (13)
Cancer	167 (3)	92 (2)	35 (4)	40 (4)
Parkinson disease	145 (3)	87 (2)	30 (3)	28 (3)
Diabetes	356 (6)	223 (6)	60 (7)	73 (7)
Respiratory disease	420 (7)	274 (7)	68 (8)	78 (8)
Kidney disease	180 (3)	108 (3)	31 (4)	41 (4)
Cardiac disease	2,291 (40)	1,524 (39)	351 (40)	416 (43)
Stroke	177 (3)	123 (3)	25 (3)	29 (3)
Type of discharge, *n* (%)				
Home	2,031 (36)	1,404 (36)	281 (32)	346 (36)
Acute care unit	1,113 (20)	733 (19)	173 (20)	207 (21)
Rehabilitation care	2,218 (39)	1,500 (39)	362 (42)	356 (37)
Long-term care	347 (6)	230 (6)	52 (6)	65 (7)

Data are summarised using mean ± standard deviation, unless stated otherwise.

Discussion

In our large cohort study based on administrative claims data, we classified 974 FR (53% of all FR) as related to the index stay, near 80% of these occurring within the 3 months post-discharge from the surgery. Surgical conditions caused near 50% of all related FR.

Previous studies showed that the majority of readmissions were due to non-surgical causes, surgical conditions causing <15% of all readmissions [7, 16]. Our result could be partly explained by the fact that we focused on the clinical relationship between readmission and the index stay, while previous authors focused on the timing frame of readmissions (early or late readmissions). Our classification was motivated by our belief that elderly patients suffering from multiple comorbidities could require readmission due to these comorbidities and not to the surgery of HF itself [9, 17].

Our mode of readmissions classification allowed us to evaluate the risk of readmissions after surgery separately from the risk of readmissions attributable to patient medical history. In fact, we observed that the distribution of related readmissions was concentrated in the 3 months after the index stay and a rapid decrease after this period, while unrelated readmissions were distributed uniformly over the 1-year follow-up. These two different modes of readmissions distribution represent a strong argument to validate our choice in separating related from unrelated readmissions. We acknowledge that the rules of classifications we defined *a priori* are themselves debatable; in particular, the individual time limits may seem somewhat arbitrary.

Considering related FR, we found that the type of hospital, gender, cancer, kidney disease and dementia were risk factors in a multivariate model. Patients admitted in teaching hospitals were significantly less at risk of related FR than public hospitals, but private and public hospitals were similar. This result could be partly explained by the existence of multidisciplinary teams (including geriatricians) in teaching hospitals while they are less frequent in France, in the two other types of hospitals. In fact, many studies assessed the impact of orthopedic-geriatric co-care on HF outcomes and showed significant decreased readmission rates [18, 19]. We found that the presence of kidney disease majored the risk of related FR by near 40%. To reduce readmission rate, attention must focus on optimising health status preoperatively, preventing postoperative complications. Kidney diseases are common on geriatric population and could be precipitated by drugs interactions, dehydratation or anaemia. Providing more specialist medical care could probably help in preventing a major part of this kidney diseases which could have an impact in serious postoperative complications and non-fatal outcomes after surgical treatment.

Male gender is a well-known risk factor for mortality and morbidity [2, 4, 11, 20] and also for readmissions after surgery for HF [6, 21]. In previous studies, the presence of a poor mental status or dementia was found to be associated with excess risk of mortality after discharge from HF

surgically treated [12, 22, 23]. The same relation between cancer and mortality was found [12, 23]. But, to our best knowledge, there is no other study showing such relation between dementia or cancer and related readmissions.

Besides, the type of hospital, gender, age and known dementia were independently associated with unrelated FR in our study. Patients admitted to teaching as well as private hospitals were less at risk than those admitted in public hospitals. Was there a better medical management of comorbidities before, during and after the surgery at the index stay and after in the teaching and private hospitals than in public hospital?

We found that increased age was associated with lower risk of unrelated readmission. This finding could probably be explained by the naturally excess risk of death associated with ageing in this group of patients. This is strengthen by the fact that among patients with unrelated FR increased age was associated with increased number of comorbidities, which is known to be associated with increased risk of death.

Dementia was associated with a lower risk of unrelated FR. Some studies showed that dementia is associated with a lower rate of readmissions in acute care unit and focused on possible less aggressive plan of care in patients with dementia [9, 24]. But other studies showed that known dementia was a risk factor of morbidity or mortality after HF [13, 23]. When considering unrelated readmissions, we focused on pre-operative comorbidities impact and not on surgery itself. This apparent contradiction could be explained by the fact that physicians could use less aggressive plan of care in treatment of comorbidities. An another explanation could be the fact that dementia was associated with less comorbidities [25].

Concerning the rate of readmissions, our result is consistent with those previously reported. In our study, the risk of readmission was particularly high during the first 3 months after discharge. Indeed, a third of all readmissions occurred during the first month, and more than 50% during the first 3 months following discharge. This higher risk in the immediate postoperative period is also consistent with the literature [7, 16].

The use of linked administrative databases brought several strengths to our study. First, linkage could be performed more easily than surveys and chart reviews. Second, completeness of linkage is greater than by manual methods. Third, the use of administrative databases allowed us to study a very large cohort of patients. More generally, record linkage offers the potential of turning routinely collected data (as part of the prospective payment system) into information on outcome measurement and pathway of care.

Nevertheless, our study has several limitations. First, several factors potentially associated with patients readmission could not be measured in our administrative databases, including the timing to surgery [26], the prefracture mobility [22] and the functional status after the surgery [27]. Second, the presence of comorbidities at the index stay was identified through additional diagnoses codes which could suffer from misclassification.

Lastly, we found an in-hospital mortality rate of 5% which is at the lower limit of those reported in the literature [3, 11, 28], and the mortality rate during the index stay and identified readmission was 9% (519/5, 982). We obviously underestimated the overall 1-year mortality rate. In fact, we could not assess the mortality of patients without readmissions. The connection to national mortality databases is mandatory for a correct estimation of 12-month mortality.

The risk of readmission is high after surgery for HF in older patients. Half of these readmissions were found related to the index surgical stay and a great majority of these occurred early post-discharge from the surgery. Surgical conditions caused near 50% of all related readmissions. Further improvement in orthopedic-geriatric co-care of patients with HF may impact outcomes after surgery and bring significant decrease in readmission rates.

Key points

- In a large-scale retrospective cohort study of French elderly patients surgically treated for hip fracture, one-third of patients had at least one readmission within a year.
- Of these, 974 (53%) were related to the index stay. Surgical complications led to 47% of related readmissions.
- 78% of related FRs occurred within 3 months post-discharge from the surgery while the monthly rate of unrelated FRs was stable over the 12 months following the index discharge.

Conflicts of interest

J.H. was responsible for the concept and the design of the study. M.R. and T.B. acquired the data, which were analysed and interpreted by A.T., L.T., J.H., M.R., T.B.. A.T. drafted the manuscript. L.T., J.H., and G.C. provided substantial input to the first draft. All authors reviewed the manuscript.

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Received 24 February 2009; accepted in revised form 29 April 2009