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Mortality after hip fracture in the elderly: The role of a multidisciplinary approach and time to surgery in a retrospective observational study on 23,973 patients

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ABSTRACT

Background: Since most hip fractures occur in fragile patients, an important step forward in the treatment may be a co-managed, multidisciplinary treatment approach with orthopaedic surgeons and geriatricians. This multidisciplinary care model (MCM) is implemented in some Tuscan hospitals, while in hospitals with the usual care model (UCM) medical consultation is required only as deemed necessary by the admitting surgeon.
The primary aim of this study was to assess the effect of the MCM on 30-day mortality, compared with the UCM.
Methods: A retrospective study was conducted on patients with main diagnosis of hip fracture, as reported in the hospital admission discharge reports, aged 65 years and older, who underwent surgery in Tuscan hospitals from 2010 to 2013. A multilevel logistic regression model was performed to assess the effect of the MCM vs the UCM. The Charlson Comorbidity Index (CCI) was used as a proxy for case mix complexity.
Results: 23,973 patients were included: 23% men and 77% women; the mean age was 83.5 years. The multilevel analysis showed that mortality was significantly higher in the UCM, after adjusting for gender, age, comorbidity and timing of surgery (OR = 1.32; 95% CI 1.09–1.59; $p = 0.004$). Surgical delay was not significantly associated with higher mortality rates.
Conclusions: A co-managed approach to hip fracture, with orthopaedic surgeons and geriatricians, offers a multidisciplinary pathway for the elderly and leads to a reduction in mortality after hip fracture surgery.

1. Introduction

Hip fractures are a growing public health issue and one of the most serious injuries affecting elderly people. The incidence of hip fracture increases with age and it is already the second most frequent cause of hospitalisation in elderly people (Wilkins, 1999; Kates, Mendelson, & Friedman, 2010). The number of hip fractures is huge in Europe, with more than 500,000 fractures per year (Dettoni, Peveraro, & Dettoni, 2012). An Italian study conducted in 2006 reported that the incidence rate of hip fractures in Italy was about 1.4 fractures/1000 inhabitants/year, and ranged from 6.5 to 7.5/1000 individuals aged over 65 (Laforgia, Maggi, Bianchi, Crepaldi, & Marzari, 2006).

Mortality after hip fracture surgery is higher compared with that observed in sex- and-age matched general population; it remains higher in the first year after fracture with an estimated mortality range between 14% and 36% in different studies. (Haentjens et al., 2010; Gdalevich, Cohen, Yosef, & Tauber, 2004; Zuckerman, 1996).

International Guidelines for hip fracture care suggest that patients should undergo surgery within 24–48 h of hospital admission [NICE Clinical Guidelines No. 124. The Management of Hip Fracture in Adults. London: Royal College of Physicians, 2011]; however, the role of surgical delay in mortality remains unclear

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(Gdalevich et al., 2004; Haentjens et al., 2010; Simunovic, Devereaux, & Bhandari, 2011). In recent studies a shorter time to surgery has been associated with a lower complication rate and shorter length of stay, while the association between time of surgery and mortality is controversial (Librero et al., 2012). Anyway, a surgery delay due to clinical reasons is sometimes necessary to evaluate and stabilise patients with significant comorbidities. Since most hip fractures occur in frail older patients, a co-managed care performed by orthopaedic surgeons and geriatricians may constitute an important step forward in the treatment of this condition (Biber et al., 2013; Flikweert et al., 2014).

Geriatricians may be able to identify and reduce the risk of functional decline, long-term care needs and death, thus improving outcomes for elderly patients undergoing hip fracture surgery (Friedman, Mendelson, Kates, & Bingham, 2009). This model differs from the usual management of hip fracture, where medical consultation is required only as deemed necessary by the admitting surgeon (Della Rocca et al., 2013).

An orthogeriatric approach has been implemented in some Tuscan hospitals in different time frames between 2006 and 2009. So, the primary aim of this study was to investigate whether the implementation of a co-managed care model can significantly reduce 30-day mortality rate. This study assessed the independent contribution of the model of care to patients' mortality, after adjustment for baseline differences in patients' characteristics. The role of time to surgery on 30-day mortality was also examined.

2. Materials and methods

2.1. Data source

This study was conducted in accordance with the Helsinki Declaration.

Data were obtained from different administrative databases in the Tuscany region: hospital discharge abstract (HDA) which contains up to six diagnoses and clinical procedures (The International Classification of Diseases, 9th Revision, Clinical Modification [ICD-9-CM]) and demographic data, Emergency Department Records (EDR) that collect data on all visits, drug dispensing records coded using Anatomic Therapeutic Chemical (ATC) codes for drug classification (the ATC system is the drug classification system adopted by the World Health Organization) and Inhabitant Registry (IR) with demographic information (birthdate and death date where applicable). All the administrative databases were linked through an anonymous patient identifier.

2.2. Study population

We conducted a retrospective observational study on patients resident in Tuscany, with principal diagnosis of hip fracture (diagnosis code 820.0x – 820.9x), aged 65 years and older, undergoing surgery at regional public hospitals from 1st January 2010 to 31st December 2013. We included in the study the first episode of hospital admission for hip fracture, happening within a 4-day timeframe. The fracture date was defined as the hospital admission date or the access to ED date, where applicable.

Surgery treatment was evaluated during the first hospital admission and during any subsequent ones occurring within 4 days, and was identified using the procedure codes of unilateral or total hip arthroplasty, internal fixation of fracture of trochanteric or subcapital femur, hemiarthroplasty of fracture of subcapital femur, open and closed reduction of fracture of femur with fixation (procedure codes 7855, 7915, 7935, 8151, 8152).

Exclusion criteria were incorrect anonymous patient identifier, multiple significant trauma (DRG 484–487), *peri*-prosthetic fracture around prosthetic joint (996.44), pathologic fracture of neck of femur (733.14), secondary malignant neoplasm of bone and bone marrow (198.5), malignant neoplasm and leukaemia (ICD9CM 140.xx-208.xx) within 2 years, admissions to hospitals with a volume of hip fracture of less than 50 per year.

2.3. Outcome

The outcome was 30-day mortality after hip fracture, defined as the difference between fracture date and death date, as recorded in the IR.

2.4. Patient and treatment characteristics

Three age categories were defined based on the actual age at injury including 60–74 years, 75–84 years and ≥85 years. The three-level Charlson Comorbidity Index (CCI) was used as a proxy for case mix complexity (Deyo, Cherkin, & Ciol, 1992). To assess patients' comorbidities, all diagnoses coded in the hospital discharge records and in those of the previous 5 years were considered. Anticoagulant and antiplatelet therapy was evaluated in the three months before the fracture date as recorded in drug dispensing records (ATC codes B01AA e B01AC).

Time to surgery was defined as the time between fracture date and the day of the surgical procedure and was divided into categories for exploratory analysis: less than 48 h (early surgery) and more than 48 h (late surgery).

2.5. Hospital characteristics

We conducted a survey on hospitals organisational aspects (referred to the whole period 2010–2013), by sending a questionnaire via email to the hospital management staff. So, two different organisational models were identified: the *multidisciplinary care model*, with co-management of geriatricians and orthopaedic surgeons, and the *usual care model*, where geriatricians are consulted for the management of medical conditions and complications as they occur. Length of stay was defined using the HDA.

2.6. Statistical analysis

Descriptive statistics and the univariate test of association were used to evaluate differences in study populations. To account for clustering of patients within hospitals, a multilevel logistic regression model (with a random intercept) was performed to assess the effect of clinical and organisational factors on 30-day mortality, with hospitals as second-level units. The following covariates were considered: time to surgery, patient-related factors (gender, age, CCI) and, at hospital-level, organisational model (multidisciplinary care or usual care). Three- and two-term interactions between CCI, time to surgery and organisational model were also tested.

Analyses were performed using STATA 12 (StataCorp LP 4905 Lakeway Drive College Station, Texas 77845 USA). P value < 0.05 was considered statistically significant.

3. Results

Table 1 shows baseline characteristics of patients with hip fracture, timing of surgery and 30-day mortality rate classified into usual care and multidisciplinary model groups. 35 admissions were excluded because of wrong patient identifier.

23,973 Tuscan patients were included in the study: 5522 men (23%) and 18,451 women (77%). Mean age was 83.5 years (SD 7.1). Almost half of all patients were older than 85 years and only 12% were under 75. About 32% of patients had a CCI ≥1; congestive

Table 1
Characteristics of patients, timing of surgery and mortality in the Usual Care Model (UCM) and in the Multidisciplinary Care Model (MCM).

		Overall patients	UCM n (%)	MCM n (%)	*p-value*
		23,973 (100)	14,924 (62.3%)	9049 (37.7%)	–
Sex	male	5522 (23.0)	3391 (22.7)	2131 (23.5)	0.14
	female	18451 (77.0)	11533 (77.3)	6918 (76.5)	
Age	65–74	2900 (12.1)	1796 (12.1)	1104 (12.2)	0.65
	75–84	9473 (39.5)	5931 (39.7)	354.2 (39.1)	
	85+	11600 (48.4)	7197 (48.2)	4403 (48.7)	
CCI[#]	0	16,310 (68.1)	10,337 (69.3)	5973 (66.0)	0.000
	1	3820 (15.9)	2268 (15.2)	1552 (17.2)	
	2+	3843 (16.0)	2319 (15.5)	1524 (16.8)	
Early surgery	no	9659 (40.3)	5496 (36.8)	4163 (46)	0.000
	yes	14,314 (59.7)	9428 (63.2)	4886 (54)	
30-day mortality	no	23,029 (96.1)	14,288 (95.7)	8741 (96.6)	<0.001
	yes	944 (3.9)	636 (4.3)	308 (3.4)	

[#] Charlson Comorbidity Index.

heart failure (CHF) and chronic obstructive pulmonary disease (COPD) were present in 7% of patients, diabetes in 9%, dementia in 5%, cerebrovascular disease in 10%, myocardial infarction (AMI) in 4%, anticoagulation therapy in more than 40%.

There were 8 Tuscan hospitals with multidisciplinary care (25.8%), and 23 with the usual care model (74.2%); the model of care was the same for the period 2010–2013. 14,924 patients (62.3%) were in hospitals with usual care and 9049 (37.7%) in hospitals with multidisciplinary care. While the percentage of patients with a CCI of 1 or 2+ was significantly higher in the multidisciplinary care model, there were no differences regarding sex and age.

Surgery was performed within 48 h in 59.7% of cases, with a proportion of early surgery increasing from 2010 to 2013 (from 50% to 67%). Early surgery was more frequently performed in hospitals with the usual care model. Mean length of stay was 12.6 days (SD 6.6) in MCM and 10.3 days (SD 5.8) in UCM.

Of all patients, 944 died within 30 days (about 4%); mortality was higher in males (OR = 2.5), increased with age (75–84 years OR = 2.3, 85+ years OR = 3.7), in patients with comorbidity (CCI 1 OR = 2.0, CCI 2 + OR = 3.0) and anticoagulation treatment (OR = 1.2).

The multidisciplinary care model had significantly lower mortality rates than the usual care model (Table 1). There was no significant difference in mortality rates between early and late surgery (3.9% vs 4.1%, $p = 0.43$).

As shown in Table 2, the multilevel analysis confirmed that there was a positive association between male gender and the 30-day rate of mortality, and that the risk of death rises with increasing age and CCI. The analysis also confirmed that surgical delay is not associated with significantly higher mortality rates. When considering the interaction between CCI and time of surgery, patients with CCI of 2 or more undergoing early surgery had a significant higher risk of 30-day mortality than those undergoing late surgery.

The analysis also confirmed that mortality risk is higher in the usual care model than in the multidisciplinary model, even after adjusting for sex, age, comorbidity and timing of surgery, with an OR of 1.32 (95% CI 1.09–1.59; $p = 0.004$).

We also evaluated the interaction between timing of surgery, CCI and organisational models (Fig. 1).

Only interaction between timing of surgery and CCI was significant, showing that mortality in patients with CCI of 2 or more was higher when undergoing early surgery.

4. Discussion

This study analyses association between different perioperative pathways for hip fracture patients, time to surgery and 30-day mortality.

As expected, higher mortality rates was associated with age, the male sex and comorbidity, confirming previously published results (Roche, Wenn, Sahota, & Moran, 2005; Frost, Nguyen, Eisman, Nguyen, & Black, 2011).

Our study shows a significant reduction in 30-day mortality for patients treated in hospitals with a multidisciplinary approach. The literature reports that a co-managed multidisciplinary approach to hip fracture, offering an organised pathway for elderly patients, is effective for the management of this condition (Biber et al., 2013; Boddaert et al., 2014; Della Rocca et al., 2013; Friedman et al., 2009; Gregersen, Mørch, Damsgaard, & Hougaard, 2012; Rostagno, Cartei, Landi, Gensini, & Buzzi, 2013). To date, however, as also testified in different studies, the impact of the implementation of this model on mortality is still a matter of discussion

Table 2
Multilevel logistic regression of 30-day mortality after hip surgery (n = 23973).[a]

		Odds Ratio	*p-value*	95% C.I.
Sex	male	1		
	female	0.42	<0.001	0.37–0.48
Age	65–74	1		
	75–84	1.70	<0.001	1.24–2.34
	85+	3.82	<0.001	2.80–5.17
Early surgery	no	1		
	yes	0.88	0.22	0.73–1.08
Charlson Comorbidity Index	0	1		
	1	1.88	<0.001	1.46–2.43
	2+	2.20	<0.001	1.73–2.80
Early surgery *CCI	<48h*CCI 1	1.04	0.84	0.73–1.47
	<48h*CCI 2+	1.54	0.007	1.12–2.10
Multidisciplinary care model	yes	1		
	no	1.32	0.004	1.09–1.59

[a] Wald chi2 (9): 532.26 ($p < 0.001$); AUC(c): 71,4%; AIC: 7423.476; BIC 7512.408.

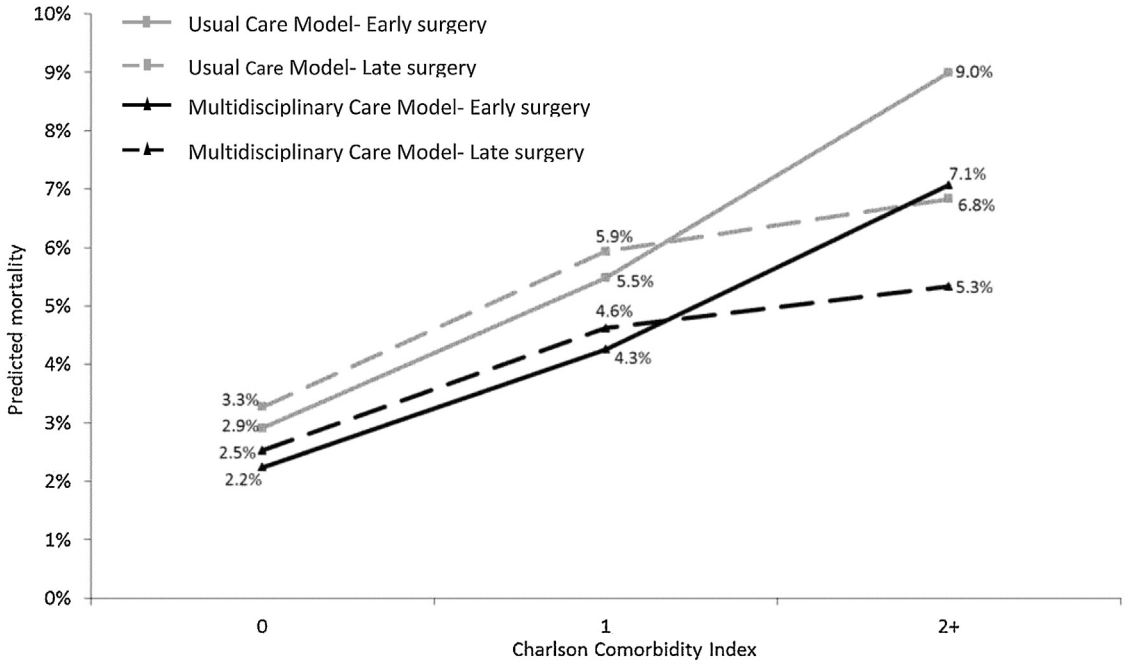

Fig. 1. Predicted mortality (%): timing of surgery and Charlson Comorbidity Index in Multidisciplinary Care Model and Usual Care Model.

(Boddaert et al., 2014; Gregersen et al., 2012; Lynch, Tower, & Venturato, 2015).

In our study, early surgery does not affect mortality; as there was no statistically significant difference in mortality between early and late surgery and in patients with complex needs, it seems to be associated with an increase in mortality. Evidence appears unclear in the medical literature and the association between delay to surgery and perioperative mortality is still a questionable issue. Time to hip fracture surgery has in fact been studied extensively, with some authors reporting a decrease in mortality following early surgical intervention (Bottle & Aylin, 2006; Carretta et al., 2011; Simunovic et al., 2010), and others instead showing no benefit of early surgery (Holt, Smith, Finlayson, Gregori, & Duncan, 2008; Khan, Kalra, Khanna, Parker, & Thiruvengada, 2009; Majumdar et al., 2006; Sund & Liski, 2005). An update to the NICE clinical guidelines reports results of a recent systematic review and *meta*-analysis (2012) that investigated the association between mortality and delayed surgery after hip fracture among elderly patients: the authors affirmed that confounders such as comorbidity or cognitive impairment were frequently not checked for in the studies included and that this, together with the observational design of the evidence, limited firm conclusions. It was also reported that healthier patients may have been more likely to be operated earlier, and that some patients were excluded because of medical conditions, which may have introduced bias. However, the conclusions of the review that early surgery seems to be associated with a lower overall mortality risk are consistent with the recommendation in NICE guidelines to perform surgery on the day of or day after hospital admission (Hip fracture: Evidence Update, 2013). A very important and frequent consideration in treating elderly and frail patients with hip fracture is the potential benefit of correcting major comorbidities before surgery to influence survival (Belmont et al., 2014; Holt, Smith, McKeown, & Duncan, 2010); this approach is supported by geriatricians who sustain that delay may be necessary for stabilising patients with comorbidities (Moja et al., 2012).

Length of stay seems to be longer in the multidisciplinary care model, while other studies reported a shorter length of stay (Biber et al., 2013; Friedman et al., 2009; Lau, Fang, & Leung, 2013). Two recent *meta*-analyses and systematic review revealed heterogeneous results regarding length of hospital stay, which may be caused by differences in different features of local structures (Grigoryan, Javedan, & Rudolph, 2014; Buecking et al., 2013). Moreover, an integrated and patient-centred approach probably leads to longer average hospital stays. In addition to this, in our study, in Tuscan hospitals with a multidisciplinary approach, patients who underwent surgery had a higher CCI than patients in the traditional care model, so they probably required previous assessment and management of comorbidity, influencing the timing of surgery.

Our study is strengthened by the large number of people involved, with 23,973 Tuscan patients included and information collected on all individuals, more than many other studies found in the literature. We can therefore consider this sample representative of the Regional situation.

This study has some limitations. Firstly, a retrospective cohort study depends on quality of administrative data. In addition to this, we did not investigate fundamental aspects justifying the use of early surgery, such as pain control, complications, length of stay and economic outcomes (Orosz et al., 2004; Simunovic et al., 2010).

Preoperative patients' characteristics were adjusted to assess the independent contribution of the model of care to the outcome of interest. However, it is still possible that differences may be due to features other than the model of care, such as other patient aspects, surgical approach or complications, which were not collected in this study.

This study focuses on 30-day mortality. Even if this outcome is important in evaluating the quality of care, it would also be important to assess more long-term outcomes, such as functional status and type of residence at 12 months (Friedman et al., 2009). The retrospective nature of the study did not allow follow-up of the outcomes after discharge, such as return to autonomy in basic day-to-day activities, which is important following a hip fracture. Lastly, our results may in part be attributable to specific characteristics of the Tuscan healthcare system and may not be applicable to regions or countries with different health systems.

5. Conclusion

The implementation of a co-managed model of care for elderly patients with hip fracture, based on a multidisciplinary geriatric and orthopaedic surgical intervention, seems to reduce 30-day mortality after surgery. Further studies are needed to evaluate whether adopting a co-managed approach would also help to improve other outcomes for older people with associated comorbidities, such as reducing complications and functional decline, which often occur in hip fracture patients. It would also be important to determine whether this model can be replicated in other settings to assess the generalizability of our results. The role of early surgery on 30-day mortality seems to be tightly bound to patients' pre-existing clinical conditions, and efforts to perform early surgery may be hindered by the lack of an integrated clinical approach aimed at stabilising more complex patients. In fact, early surgery does not seem to improve survival in our study, especially in patients with more than one comorbidity, regardless of the hospital care model, but it is not clear whether this is attributable to previous health conditions, which can influence the final outcome. Further studies, with different study designs, are needed to confirm or refuse our conclusions on 30-day mortality, particularly as regards more complex patients undergoing early surgery. This seems to be a very interesting field of research, which deserves to be explored.

Conflict of interest

All authors confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

Contributors

All authors contributed to the conception and design of the study, interpreted the data and drafted the article. Study conception and design: Silvia Forni, Francesca Pieralli, Alessandro Sergi, Chiara Lorini, Guglielmo Bonaccorsi, Andrea Vannucci. Acquisition of data: Francesca Pieralli, Alessandro Sergi. Analysis of the data: Silvia Forni, Francesca Pieralli, Alessandro Sergi and interpretation of data: Silvia Forni, Francesca Pieralli, Alessandro Sergi, Chiara Lorini, Guglielmo Bonaccorsi, Andrea Vannucci.

All authors gave final approval of the version to be published, and agree to be accountable for all aspects of the work.

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