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ORIGINAL ARTICLE

The orthogeriatric comanagement improves clinical outcomes of hip fracture in older adults

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Abstract

Summary Treatment of older adults with hip fracture is a healthcare challenge. Orthogeriatric comanagement that is an integrated model of care with shared responsibility improves time to surgery and reduces the length of hospital stay and mortality compared with orthopedic care with geriatric consultation service and usual orthopedic care, respectively.

Introduction Treatment of fractures in older adults is a clinical challenge due partly to the presence of comorbidity and polypharmacy. The goal of orthogeriatric models of care is to improve clinical outcomes among older people with hip fractures. We compare clinical outcomes of persons with hip fracture cared according to orthogeriatric comanagement (OGC), orthopedic team with the support of a geriatric consultant service (GCS), and usual orthopedic care (UOC).

Methods This is a single-center, pre-post intervention observational study with two parallel arms, OGC and GCS, and a retrospective control arm. Hip fracture patients admitted to the trauma ward were assigned by the orthopedic surgeon to the OGC ($n = 112$) or GCS ($n = 108$) group. The intervention groups were compared each with others and both with the retrospective control group ($n = 210$) of older adults with hip fracture. Several clinical indicators are considered, including time to surgery, length of stay, in-hospital, and 1-year mortality.

Results Patients in the OGC (OR 2.62; CI 95% 1.40–4.91) but not those in the GCS (OR 0.74; CI 95% 0.38–1.47) showed a higher probability of undergoing surgery within 48 h compared with those in the UOC. Moreover, the OGC (β, − 1.08; SE, 0.54, $p = 0.045$) but not the GCS (β, − 0.79; SE, 0.53, $p = 0.148$) was inversely associated with LOS. Ultimately, patients in the OGC (OR 0.31; CI 95 % 0.10–0.96) but not those in the GCS (OR 0.37; CI 95% 0.10–1.38) experienced a significantly lower 1-year mortality rate compared with those in the UOC. All analyses were independent of several confounders.

Conclusions Older adults with hip fracture taken in care by the OGC showed better clinical indicators, including time to surgery, length of stay and mortality, than those managed by geriatric consultant service or usual orthopedic care.

Keywords Hip fracture · Orthogeriatric · Outcomes · Models of care · Mortality

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Introduction

Hip fracture is a catastrophic event with substantial impact on the health, wellbeing, and independence of older persons and their families [1, 2]. Since 1980, in Western populations, the age-specific incidence rates of hip fracture have reached a plateau or tended to decrease, but the number of hip fractures is increasing due to the aging population, their elevated risk of falling, and high prevalence of osteoporosis. Therefore, hip fracture is a major healthcare concern with estimations rising from 1.66 million in 2000 to 6.26 by 2050, worldwide [3, 4].

Hip fracture is an acute stress challenging the resilience of older persons, already weakened because of aging, comorbidities, polypharmacy, and disability. Hip fracture patients

resemble the frailest patient phenotype, with increased vulnerability, higher risk of complications, and fatal adverse events. These features represent difficulties of the orthopedic surgeons, which demand multiple medical consultations to manage patients' frailty, extending length of stay (LOS), delaying surgery, and ultimately increasing mortality [5–7]. In addition, comorbidities, clinical complications, and LOS are the main correlates of in-hospital charges [8]. Hospital costs account for 44–57% of the total economic burden of hip fracture in the USA [9]. Worldwide, direct and indirect costs associated with hip fractures impact substantially on healthcare services.

The aim of multidisciplinary management and treatment approaches is to improve outcomes among hip fracture patients. Orthogeriatric comanagement (OGC) may be a strategy for managing the frailty of hip fracture patients, improving their outcomes and reducing the economic healthcare burden [10]. In different countries, several orthogeriatric care models have been implemented, with the main difference depending on which specialist takes the responsibility for patients [11]. A systematic literature review grouped orthogeriatric care into four treatment models, but could not identify the best one. The multidisciplinary integrated care models are indisputably superior compared with orthopedic usual management, but it is difficult to draw firm conclusions about the advantages of OGC over geriatric consultation service (GCS) [12, 13]. By showing improved clinical outcomes and better functional recovery compared with other care models, OGC may add quality-adjusted life years and may achieve higher levels of patient and provider satisfaction [14, 15]. By shortening LOS and reducing readmission rates and mortality, OGC may generate substantial in-hospital financial savings and better allocation of resources compared with the usual orthopedic care [12, 16, 17]. To date, Middelton et al. showed improvements of 30-day mortality and performance indicators by changing hip fracture service from a geriatric consultation to an integrated orthogeriatric model of care using a pre-post observational study [18]. Given the uncertainties about the best model of care and the scanty data about quality indicators achieved by integrated orthogeriatric and geriatric consultation models of care, we further investigate the clinical outcomes associated with orthogeriatric comanagement (OGC), geriatric consultation service (GCS), and traditional orthopedic care (UOC) among hip fracture hospitalized older patients during the acute phase.

Methods

Study design and sample

This is a pre-post observational study evaluating the impact on health outcomes of hip fracture patients between two different models of geriatric involvement, i.e., orthogeriatric comanagement (OGC) and geriatric consultation service (GCS), compared with usual orthopedic care (UOC) model. Eligible persons were 65 years or older, hospitalized because of a proximal native or low-impact femur fracture. Patients with peri-prosthetic, cancer-related, multiple trauma and inherited bone disorder fractures were excluded. The intervention consisted of implementation of an OGC and a GCS that took place from September 1st, 2011, to February 28th, 2012. In the 6-months after the implementation of OGC and GCS models, data were prospectively gathered from participants consecutively admitted to the Trauma and Orthopedic Ward from March 1st to August 31st, 2012. As informed consent was obtained, participants were randomly assigned to OGC or GCS by orthopedic resident on call, in collaboration with the orthopedic surgeon in charge, using the coin-flipping procedure. The attribution to OGC or CGS was performed as soon as the patients arrived at the ward by the orthopedic surgeon before comprehensive assessment, thus limiting biases of the assignment to groups due to the characteristics of the patients. The traditional orthopedic control group was obtained from the database of hospital records by looking at patients consecutively admitted to the same ward from March 1st to August 31st, 2011. During this period, patients were admitted to the orthopedic ward under the care of an orthopedic surgical team, who were responsible and decided for their care by themselves or asking specialist consultations. The study was conducted at the "Santa Maria Misericordia" hospital, University of Perugia. This is a teaching hospital meeting the acute care needs of almost 900,000 inhabitants of the Umbria region of Italy, where one in four persons (24%) is over 65 years. Our trauma unit treats between 500 and 600 hip fractures annually. According to consensus, prosthetic replacement is the main surgical indication for medial fracture and osteosynthesis for lateral femur fracture. During the entire period of the study, the availability of the surgical theater, professionals involved in the care of hip fracture patients, and beds for rehabilitation settings remained unchanged; patients with hip fracture were not prioritized and neither hip fracture programs were activated at national, regional, and local healthcare services. The study was conducted in accordance with the declaration of Helsinki and approval was obtained from the ethics committee of the regional healthcare system with registration number 2257/14.

Orthogeriatric comanagement

Patients assigned to OGC group had an orthopedic surgeon and a geriatrician who, with a nurse, performed daily rounds from Monday to Saturday. The appointed geriatricians usually were rapidly notified of participants assigned to OGC; they took care of patients at the earliest from admission and during the entire hospital stay. Orthopedic surgeons changed weekly due to their high turnover rate. Geriatric and orthopedic care providers shared responsibility for patients' care throughout their entire in-hospital stay. They evaluated and defined patients' priorities, i.e., surgical and/or medical, and treated them according to a

standardized comprehensive geriatric assessment and multidisciplinary management. The traumatologist decided on the suitability of the surgical treatment, technique to use, and when progressive weight bearing could begin. The geriatrician managed comorbidities and polypharmacy to make patients clinically stable and ready for surgery, to reduce peri-operative complications and promote early functional recovery. The geriatrician wrote daily notes about medically indicated orders in patients' charts and coordinated additional medical or surgical consultations as required. Both traumatologist and geriatrician shared surgical and clinical information at the daily briefing with anaesthesiologists in the pre-operative phase in order to decide the trauma list, while in the early post-operative phase, they started rehabilitation and discharge planning with physical therapists and nurses, respectively. The geriatrician was not available at weekends or public holidays, when the traumatologists were on-call. In our study, OGC was completely dedicated to the management of persons with hip fractures in their acute phase. Such a model was developed based on the reorganization of existing local staff and resources.

Geriatric consultation service

Patients assigned to the GCS were mainly under the management of the traumatologists who decided upon the need for any geriatric consultation during the hospital stay according to their perception of patients' clinical conditions. There were neither standard clinical pathways nor a multidisciplinary treatment plan. Referrals for medical problems were made to the GCS through a formal request of a consultation. The GCS consisted of two geriatricians skilled in the care of hip fracture persons. They worked in the geriatric acute ward of the hospital, the same one of the geriatricians involved in OGC. The geriatric consultant team assured patients' evaluation within 8 h from the request and provided assessment, interventions, and orders for patients' care by written notes in the charts. Traumatologists took responsibility for the management of patients' medical and surgical problems throughout the entire hospital stay.

Participants' characteristics and study outcomes

Reviewing the medical charts, we gathered information on administrative data, demographics, clinical characteristics, including biochemical and diagnostic tests, drug treatments, RBC transfusions, medical complications and consultations, ASA and Charlson comorbidity score [19], pain, fluid, nutritional and early rehabilitative management, cognitive performance, and functional status before admission, when available. Functional status before admission was investigated using the Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL) scales [20]. For the purpose of the study, participants were classified as having the highest ADL independence if they were able to conduct at least five basic ADLs (i.e., bathing, dressing, using the toilet, getting from bed to chair, continence, and eating). The highest independence in IADL was classified for a men if able in at least four IADLs (i.e., ability to use telephone, shopping, food preparation, housekeeping, laundry, mode of transportation, responsibility for own medication, and ability to handle finances), and for a women if able in at least five IADLs. In-hospital complications were defined as organ or system complication affecting the diagnosis, the management, or the treatment of patients, including acute coronary syndrome, arrhythmia, syncope, pulmonary embolism, stroke, MI, pneumonia, gastrointestinal bleeding or other major bleeding, congestive heart failure, respiratory failure, acute renal failure, delirium, bed sore, urinary tract infection, deep venous thrombosis, wound infection, dysphagia, uncontrolled pain, vomiting, hypotension, and electrolyte imbalance. In-hospital complications were assessed at the time of hospital discharge from the acute ward. Time to surgery was the time, in hours, from admission to starting operation in the surgical theater. Length of stay was the time, in days, from admission to discharge. Drug prescriptions for secondary prevention of fragility fracture, i.e., specific drug plus calcium and vitamin D supplementation, were recorded. Vital status at 1 year from discharge and date of death was obtained by searching the regional health registry.

Statistical analysis of data

Baseline characteristics of participants (Table 1) and clinical indicators (Table 2) are presented as means and standard deviations if continuous variables, and as proportions and percentages if categorical variables. Differences between groups were tested using the Bonferroni post hoc ANOVA test or the Fisher and Mantel-Haenszel chi-square, as appropriate. The relationship between models of care and 1-year mortality was investigated using cumulative survival analysis and plotted using the Kaplan-Meier curves (Fig. 1). The relationship between care models and main clinical indicators, i.e., time to surgery, length of stay, and mortality, was evaluated using multivariate regression models (Tables 3). A logistic or GLM procedure was used as appropriate. All analyses were performed with the SAS statistical package, version 9.3 (SAS Institute, Cary, NC). A two-tailed p value < 0.05 and 95% confidence interval (CI) were used to indicate statistical significance.

Results

Baseline characteristics

Baseline characteristics of 430 participants grouped by OGC ($n = 112$), GCS ($n = 108$), and UOC ($n = 210$) are presented in Table 1. Overall, participants were more likely to be women (78.6% vs 74.1% vs 73.8%, $p = 0.616$), with mean age over 80 years (83.3 ± 7.1 vs 82.4 ± 7.6 vs 85.0 ± 7.0, $p = 0.005$),

Table 1 Baseline characteristics of the participants grouped by orthogeriatric comanagement, geriatric consultation service, and orthopedic usual care

Characteristic	Orthogeriatric comanagement ($N = 112$)	Geriatric consultation service ($N = 108$)	Orthopedic usual care ($N = 210$)	p value
Women, *N* (%)	88 (78.6)	80 (74.1)	155 (73.8)	0.616
Age, years, M ± SD	83.3 ± 7.1	82.4 ± 7.6	85.0 ± 7.0[c]	0.005
Type of fracture, *N* (%)				
- Medial	43 (38.4)[a]	59 (55.1)[c]	79 (37.6)	0.01
- Lateral	67 (59.8)[a]	48 (44.4)[c]	122 (58.1)	
- Sub-trochanteric	2 (1.8)	1 (0.9)	9 (4.3)	
Place of residence before admission, *N* (%)				
- Home	104 (92.9)[b]	102 (94.4)[c]	73 (34.8)	< 0.001
- Nursing home	2 (1.8)	3 (2.8)	2 (1.0)	
- Unknown	6 (5.4)	3 (2.8)	135 (64.3)[cb]	
Fall, *N* (%)				
- Accidental or medical cause	104 (92.9)[b]	107 (99.1)[ca]	141 (67.1)	< 0.001
- Unknown	8 (7.2)[a]	1 (0.9)	69 (32.9)[cb]	
Coexisting diseases, M ± SD	4.4 ± 2.2[b]	4.2 ± 2.0[c]	2.2 ± 1.8	< 0.001
Hypertension, *N* (%)	65 (58.0)	60 (55.6)	107 (50.9)	0.443
Dementia, *N* (%)	25 (22.3)[b]	18 (16.7)	24 (11.4)	0.035
Ischemic heart disease and heart failure, *N* (%)	29 (25.9)	25 (23.2)	36 (17.3)	0.163
Depression, *N* (%)	35 (31.3)[b]	29 (26.9)[c]	19 (9.1)	<0.001
Diabetes, *N* (%)	18 (16.1)	20 (18.5)	31 (14.76)	0.688
Medications at admission, M ± SD	4.4 ± 2.8	4.8 ± 3.2	4.0 ± 2.6	0.07
Antiplatelet at admission, *N* (%)	36 (32.1)	38 (35.2)	55 (29.0)	0.528
Anticoagulant at admission, *N* (%)	16 (14.3)	12 (11.1)	18 (9.5)	0.440
Charlson comorbidity index, M ± SD	2.6 ± 2.1[ab]	2.0 ± 1.4	1.3 ± 1.3	< 0.001
Charlson comorbidity index ≥ 4, *N* (%)	34 (30.3)[b]	21 (19.4)[c]	13 (6.2)	< 0.001
ASA score, M ± SD	3.0 ± 0.6	3.0 ± 0.7	3.1 ± 0.7	0.58
ASA score ≥ 4, *N* (%)	17 (15.2)	23 (21.3)	41 (19.5)	0.48

M ± SD, mean + standard deviation; *N (%)*, number percent

p value for difference between groups are determined by chi-square or ANOVA test as appropriate

[a] *p* value < 0.05 for the difference between orthogeriatric comanagement and consultant geriatric service

[b] *p* value < 0.05 for the difference between orthogeriatric comanagement and usual care

[c] *p* value < 0.05 for the difference between consultant geriatric service and usual care

mainly affected by lateral hip fracture (59.8% vs 44.4% vs 58.1%, $p = 0.01$) and living at home (92.9% vs 94.4% vs 34.8%) before fracture. In the OGC group, 43% and 33% of participants were almost independent in ADL and IADL, respectively (data not shown). Lateral fractures outnumbered medial fractures among participants belonging OGC (59.8% vs 38.4%; $p = 0.02$) and UOC (58.1% vs 37.6%; $p = 0.01$), while medial fractures overcome the later ones in the GCS (44.4% vs 55.1%; $p = 0.01$). An accidental domestic fall was the main cause of hip fracture. Participants belonging to the UOC group had registered in the medical chart a lower number of diseases (2.2 ± 1.8) compared with those in OGC and in GCS (4.4 ± 2.8 and 4.8 ± 3.2, $p = < 0.001$), respectively. Independent of the care group, participants reported a similar number of ongoing medications (4.4 ± 2.8 vs 4.8 ± 3.2 vs 4.0 ± 2.6, $p = 0.07$). Overall, the most frequent diseases were hypertension (67.4%), depression (22.4%), ischemic chronic disease and heart failure (22.1%), dementia (16.8%), and arrhythmia (16.5%), with prevalence rates decreasing from the comanagement to the geriatric consultation service and the UOC group. As expected, the Charlson index score and the distribution of patients with Charlson index score ≥ 4 resemble the comorbidity distribution, with highest values among patients belonging to OGC and lowest values among those in UOC (Table 1). There was no difference between groups regarding ASA score.

Clinical indicators

Table 2 reports clinical indicators according to care models. Although there was no difference regarding

Table 2 Clinical indicators grouped by orthogeriatric comanagement, geriatric consultation service, and orthopedic usual care

Outcome	Orthogeriatric comanagement ($N = 112$)	Geriatric consultation service ($N = 108$)	Orthopedic usual care ($N = 210$)	p value
Conservative treatment, N (%)	5 (4.5)	2 (1.9)	14 (6.7)	0.164
Time to surgery, days, M ± SD	3.3 ± 2.1[ab]	4.2 ± 2.3	4.5 ± 3.8	0.034
Time to surgery ≤ 48 h, N (%)	47 (42.0)[ab]	19 (17.6)	58 (27.6)[c]	< 0.001
In-hospital complications, M ± SD	1.9 ± 1.7	2.0 ± 1.3	1.8 ± 1.8	0.496
In-hospital complications, N (%)	85 (20.8)[b]	99 (24.2)	159 (38.8)	0.020
Consultations, M ± SD	1.2 ± 1.6[b]	1.6 ± 2.1	1.9 ± 2.2	0.01
RBC transfusion, M ± SD	1.8 ± 1.8	1.5 ± 1.4[c]	2.2 ± 1.8	0.004
Length of stay, days, M ± SD	8.2 ± 3.3[b]	8.7 ± 3.0	9.5 ± 4.8	0.02
Persons discharged 7 days from admission, N (%)	55 (50.0)[b]	41 (38.3)	73 (36)	0.04
Hb > 11 at discharge	29 (26.4)[ba]	16 (15.0)	28 (15.2)	0.034
Anti-fracture drug prescription at discharge, N (%)	60 (54.6)[ba]	39 (36.5)	63 (30.9)	< 0.001
In-hospital mortality, N (%)	2 (1.8)[b]	1 (0.9)[c]	7 (3.3)	< 0.001
1-year mortality, N (%)	16 (14.8)	13 (12.3)[c]	46 (23.1)	0.037

M ± SD, mean + standard deviation; *N (%)*, number percent

p value for the difference between groups are determined by chi-square or ANOVA test as appropriate

[a] p value < 0.05 for the difference between orthogeriatric comanagement and consultant geriatric service

[b] p value < 0.05 for the difference between orthogeriatric comanagement and usual care

[c] p value < 0.05 for the difference between consultant geriatric service and usual care

conservative non-surgical treatments between groups ($p = 0.164$), the proportion of patients who underwent surgery within 48 h was significantly higher in OGC as compared with GCS and UOC ($p = < 0.001$). Given the unbalanced distribution of types of fractures between groups, time to surgery appeared shorter among patients with medial as compared with lateral femur fracture (3.7 ± 2.5 and 4.4 ± 3.4, respectively; $p = 0.02$). However, the association between the type of fractures and time to surgery promptly disappeared after controlling for ASA score or drug treatments at admission in the multivariate analysis (data not shown). Patients in OGC (OR 2.62; CI 95% 1.40–4.91) but not those in GCS (OR 0.74; CI 95% 0.38–1.47) showed a higher probability of undergoing surgery within 48 h compared with those in UOC independent of confounders, including age, gender, coexisting diseases and drugs, ongoing anticoagulant and antiplatelets at admission, type of fracture, ASA score, and day of the week at admission (Table 3). The fully adjusted model fitted in the entire sample of patients belonging to OGC and GCS confirmed the higher probability of the OGC to provide early surgery (OR 3.32; CI 95% 1.66–6.63) compared with GCS.

The LOS differs among groups (OGC, 8.2 ± 3.3; GCS, 8.7 ± 3.0; UOC, 9.5 ± 4.8 days, $p = 0.02$), with OGC showing the lowest LOS compared with UOC (Table 2). Moreover, OGC (β, − 1.08; SE, 0.54, $p = 0.045$) but not GCS (β, − 0.79; SE, 0.53, $p = 0.148$) was inversely associated with LOS independent of several confounders, i.e., age, gender, coexisting diseases and drugs, ongoing anticoagulant and antiplatelets at admission, type of fracture, ASA score, complications, consultations, dementia, and RBC transfusions (Table 3). One in two patients belonging to OGC was discharged within 7 days from admission as compared with 38.3% of those in GCS and 36.0% of those in UOC ($p = 0.04$).

The mean number of in-hospital complications was almost superimposed among groups ($p = 0.496$). OGC was associated with the lowest proportion of patients who experienced complications during hospital stay while the highest percentage was found among those in UOC (20.8% vs 38.8%, $p = 0.02$). Consistently, OGC reduced the specialist consultations compared with GCS ($p = 0.016$) and UOC ($p = 0.01$), respectively (Table 2). Similarly, the lowest consumption of RBC transfusions appeared in GCS (1.5 ± 1.4), with the tendency to be higher in OGC (1.8 ± 1.8) as compared with UOC (2.2 ± 1.8). At discharge, a higher percentage of patients in OGC had hemoglobin > 11 g/dl ($p = 0.003$) and received drug prescription for secondary fracture prevention ($p = < 0.0001$) compared with both the GCS and UOC groups.

Patients' in-hospital mortality was lower in OGC (1.8%) and GCS (0.9%) compared with UOC (3.3%) ($p = < 0.0001$), while 1-year mortality was similar between OGC (16.4%) and GCS (13.1%), but lower than UOC (23.1) ($p = 0.037$) (Table 2). The survival curves are presented in Fig. 1. Panel A shows lower mortality among hip fracture patients managed with the involvement of a geriatrician, including both OGC and GCS, compared with those receiving UOC (Log-rank test 6.653; $p = 0.010$). In panel B, patients receiving hospital care according to OGC and

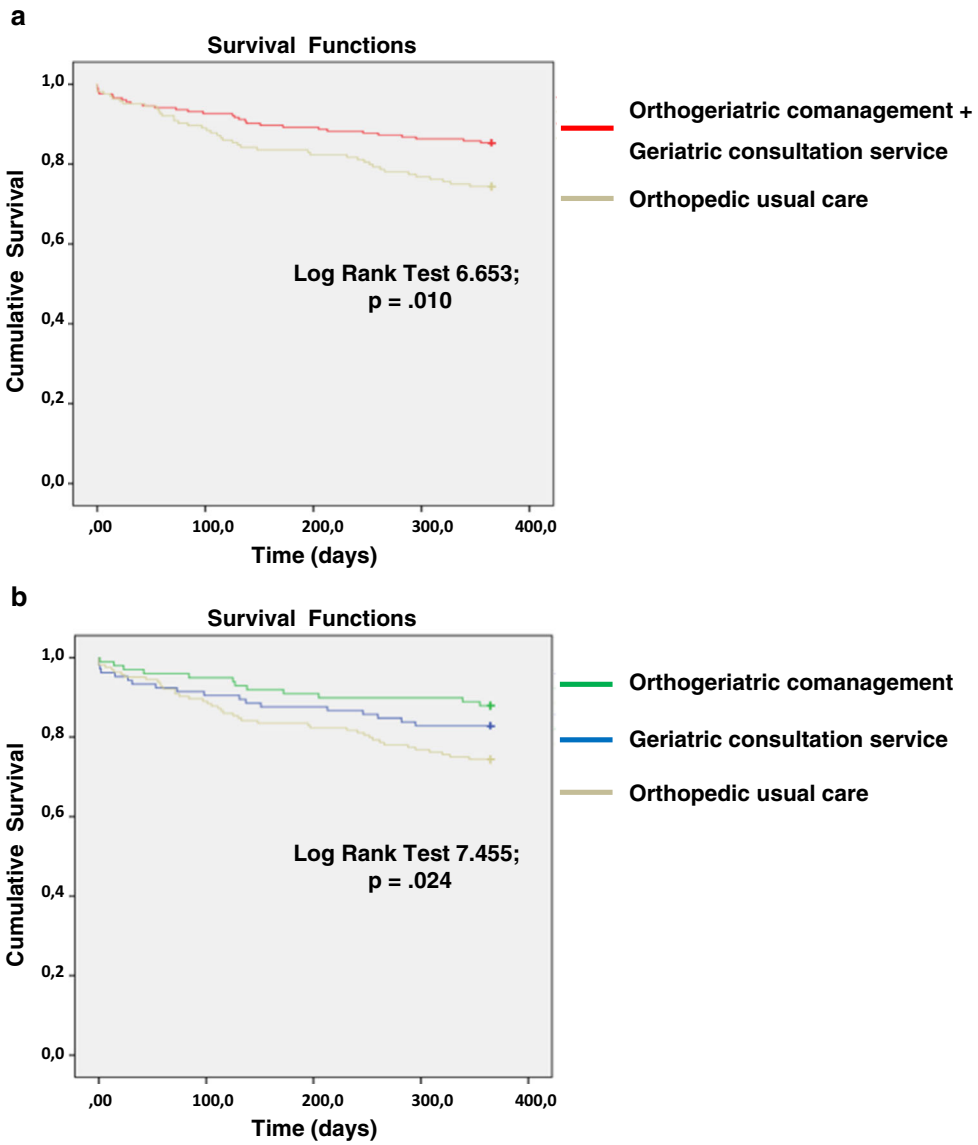

Fig. 1 Cumulated survival as calculated by Kaplan-Meier curves over 1 year following hip fracture treatment

GCS experienced both lower mortality compared with those belonging to the UOC (Log-rank test 7.455; $p = 0.024$).

After adjustments for confounders, including age, gender, coexisting diseases, and drugs, ongoing anticoagulant and anti-platelets at admission, type of fracture, ASA score, in-hospital complications and RBC transfusions, discharge within 7 days, and the presence of urinary catheter, patients in OGC (OR 0.31; CI 95% 0.10–0.96) but not those in GCS (OR 0.37; CI 95% 0.10–1.38) experienced a significantly lower 1-year mortality compared with those in UOC (Table 3).

Discussion

This study directly compares the two accepted models of orthogeriatric care, likely OGC and GCS, in a prospective manner, and both models with UOC using a pre-post approach in the same hospital. Older adults with hip fractures managed according to OGC experience better outcomes as regards time to surgery, LOS, and mortality compared with UOC. These findings were not confirmed for GCS compared with UOC. Furthermore, OGC was superior to GCS in shortening time to surgery in a direct comparison.

To the best of our knowledge, this study is the first to directly compare two currently accepted models of orthogeriatric care using the head-to-head approach in a real-world clinical setting, and both models with historical usual orthopedic care model. The main findings of the study add to the literature by supporting the implementation of an integrated orthogeriatric model of care.

Table 3 Multivariate analysis of the association between models of care and the length of stay, time to surgery < 48 h, and 1-year mortality

Variable	Time to surgery < 48 h		Length of stay day		Mortality 1 year	
Models of care	OR (CI 95%)	*p*	β ± SE	*p*	OR (CI 95%)	*p*
- Orthogeriatric Comanagement	2.62 (1.40–4.91)	0.003	− 1.08 ± 0. 54	0.045	0.31 (0.10–0.96)	0.041
- Geriatric consultation service	0.74 (0.38–1.47)	0.395	− 0.79 ± 0.53	0.148	0.37 (0.10–1.38)	0.138
- Orthopedic usual care	REF		REF		REF	
Age	0.98 (0.94–1.01)	0.185	0.04 ± 0.03	0.210	1.10 (1.02–1.19)	0.010
Women	1.49 (0.80–2.75)	0.207	− 1.07 ± 0.48	0.026	0.17 (0.07–0.42)	< 0.001
Coexisting diseases	0.91 (0.76–1.08)	0.271	0.14 ± 0.13	0.301	1.15 (0.88–1.49)	0.308

Independent of other confounders including type of fracture, dementia, depression, drugs, including anticoagulant and antiplatelets at admission, ASA score, day of week at admission, in-hospital complications, consultations, RBC transfusions, and urinary catheter at discharge

Our results are consistent with those by Middleton showing that orthogeriatric care significantly improves 30-day mortality and performance indicators, including LOS and time to surgery, compared with a geriatric consultation model [18]. In both cases, study results refer to acute hip fracture inpatient management, with the exclusion of sub-acute or community-based rehabilitation programs, and they were obtained in a single-center setting.

Our results support results from previous studies showing that OGC is more successful than usual care in reducing time to surgery, LOS, and 1-year mortality [15, 21–25], as well as in-hospital mortality and major medical complications [26, 27]. We are not able to compare data concerning rehospitalization rates [17].

Our OGC resembles the most sophisticated care model. The orthopedic surgeon and geriatrician manage patients by integrating competence and sharing responsibilities on daily ward rounds, from admission until discharge [11, 12, 28]. The continuity of care assured by geriatricians assigned to the orthopedic ward improved patients' assessment and management, thus endorsing the increased benefits of coresponsibility for care compared with traumatologist's responsibility and explaining the better outcomes of OGC, but not that of GCS, compared with UOC [27, 29, 30]. Like previous studies, geriatricians involved in GCS were skilled in the care of older people with hip fracture. However, in clinical practice, they usually gave advice on medical problems only when the traumatologist considered them relevant, without any prevention of geriatric syndromes. GCS therefore failed to generate beneficial effects on the majority of quality clinical care indicators. Our findings on GCS are similar to those obtained in care models where geriatricians held once or twice weekly rounds, and took patients in care in the pre- or post-operative surgical phase [31–33].

Time to surgery is among the most investigated parameters in hip fracture patients due to its undisputed influence on mortality. In our study, time to surgery was slightly lower than that observed by Vidan [26] and Gonzales-Montalvo [21], but higher than in other studies [30]. It is strongly influenced by several modifiable system variables, including the availability of theater, drug treatments, and weekday admission [34]. Our relatively longer time to surgery may be partly related to such aspects. Additionally, the proportion of patients undergoing surgery within 48 h was almost comparable to the Italian mean and to that described in similar models. Patients in OGC experienced a twofold higher probability of undergoing surgery within 48 h compared with those in UOC, but the probability became even threefold higher when compared with those in GCS. Whether shorter time to surgery positively affects clinical outcomes needs to be formally investigated. We merely observed a correlation between shorter time to surgery and lower incidence of complications and shorter LOS.

There is a great variability of LOS among studies, from 6.6 to 36.8 days depending on the local organization of healthcare systems and program typology, which may or not include the rehabilitation phase [8, 14, 35–38]. Comparing the LOS related to similar orthogeriatric models may lead to false conclusions when they work in different countries. Therefore, we propose using the percentage of patients discharged within 7 days as a quality indicator. Such an indicator may reflect the efficiency of the orthogeriatric team in improving the quality of clinical care offered to patients, ameliorating the processes involved to achieve such care, and ultimately, optimizing the use of resources.

As regards in-hospital mortality among patients in OGC, it was almost higher than 0.6% showed by Vidan and 1.6% reported by Friedman but lower than most studies [24, 37, 39, 40]. Similarly, 1-year mortality resembles that from Vidan [26] but was lower than that reported by Barone [41] and Suhm [42]. Moreover, the protective effect of OGC against 1-year mortality was independent of comorbidity, dementia, depression, and ASA score. Although 1-year mortality among patients in GCS was similar to Shyu [43] and Adunsky [44], we failed to demonstrate an impact of consultant service on such a parameter. Based on data gathered during the entire in-hospital stay, we also found that OGC reduces clinical complications and consultations by other specialists,

improves the rate of discharge of patients with better clinical conditions, for instance having more acceptable hemoglobin levels and being prescribed with drugs for secondary fracture prevention. As previous authors suggested, the main correlate of a successful orthogeriatric model is the equal and full responsibility of orthopedic surgeons and geriatricians in taking care and following patients' surgical and medical problems. However, an essential cornerstone of OGC is the comprehensive geriatric assessment that improves knowledge of the patients' pre-fracture health status and social-environmental features of the living place [45]. We speculate that the length of time by which patients receive comprehensive geriatric assessment may influence time to surgery due to its strict correlation with time of qualification for surgical list. During weekdays, geriatricians made effort to assess and treat patients in OGC group as soon as possible from admission in order to get patients qualified for surgery and scheduled in the list. In GCS and UOC groups, this step depends on the perception by the traumatologist of patient's clinical conditions and his/her decision upon the need for geriatric or other specialist consultations. In case of frail and complex patients, the length of time to obtain patients qualified for surgery and scheduled in the list may be longer in GCS and UOC than in OGC. Whether time for patient's comprehensive geriatric assessment impacts time to surgery and clinical outcomes needs to be formally investigated. Ultimately, we did not find signal for independent association between type of fracture and time to surgery, LOS, complications, and mortality.

We acknowledge that the study has several limitations. This is a pre-post observational study conducted in the same ward. As the traumatologist on call had visited the patient, he/she assigned by chance the patient to the OGC or GCS group with a basic randomized design, being aware of the differences between intervention groups. Of course, this is bias and we strongly believe it may underestimate the efficacy of the OGC compared GCS. As regards the higher probability of OGC to assure surgery within 48 h compared with other models, we recognize that it might be affected by the fact that the surgeons were not blinded to the patients' assignment and probably more confident to schedule patients assigned to OGC than those belonging to UOC or GCS. These limitations do not hamper the contribution of the body of evidence of our results.

The orthopedic surgeon conducted daily rounds with geriatricians or without them, depending on the type of intervention patients were assigned to. These aspects possibly influenced the clinical judgment of the traumatologists. Traumatologists involved in clinical care had higher turnover, while geriatricians mainly assured the continuity of care during the hospital stay. Then, patients' characteristics and medical diagnosis in UOC were identified by looking at clinical charts, thus depending on the clinical assessment carried out by the traumatologists. As shown by Friedman [23], we found that patients in OGC and GCS were affected by more coexisting diseases and had higher comorbidity index than in UOC. This discrepancy between UOC and groups involving a geriatric management may reflect the under-recognition of pathological conditions when a CGA is not used, even if patients report a similar number of total and specific ongoing drugs. This hypothesis is supported by the diminishing prevalence of comorbidities and geriatric diseases, including dementia, depression, and heart disease, moving from comanagement to consultant and to traditional care model. Although the limitations with the retrospective collection of data in the pre-intervention observational phase of the study, this approach was also feasible for reducing bias due to comparisons with different orthopedic teams and healthcare system organization. Ultimately, we acknowledge that during the pre-post intervention phases of the study, changing may have been occurred over time potentially influencing the outcome much more than intervention. Therefore, using administrative data, we investigated the differences over time in the rate of hip fracture admission, the availability of orthopedic surgeons, anaesthesiologists, or surgical theaters and we excluded changes occurring during the phases of the study. The economic advantages already showed and prompted the implementation of OCG models [16, 17] and OGC was developed by means of the reorganization of existing local staff and resources, differently allocated among medical and surgical settings.

In conclusion, our findings support the advantages of the orthogeriatric comanagement for the care of older adults with hip fracture during the acute hospital phase compared with both geriatric consultant and usual orthopedic models. Further research is needed to strengthen the advantages of the orthogeriatric comanagement of older adults with hip fracture.

Compliance with ethical standards

The study was conducted in accordance with the declaration of Helsinki and approval was obtained from the ethics committee of the regional healthcare system with registration number 2257/14.

Conflicts of interest None.

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References

1. Abrahamsen B, van Staa T, Ariely R, Olson M, Cooper C (2009) Excess mortality following hip fracture: a systematic epidemiological review. Osteoporos Int 20(10):1633–1650
2. Dyer SM, Crotty M, Fairhall N, Magaziner J, Beaupre LA, Cameron ID, Sherrington C, Fragility fracture network (FFN) rehabilitation research special interest group (2016) A critical review of the long-term disability outcomes following hip fracture. BMC Geriatr 16:158

3. Cooper C, Cole ZA, Holroyd CR, Earl SC, Harvey NC, Dennison EM, Melton LJ, Cummings SR, Kanis JA, IOF CSA Working Group on Fracture Epidemiology (2011) Secular trends in the incidence of hip and other osteoporotic fractures. Osteoporos Int 22: 1277–1288
4. Piscitelli P, Iolascon G, Argentiero A et al (2012) Incidence and costs of hip fractures vs strokes and acute myocardial infarction in Italy: comparative analysis based on national hospitalization records. Clin Interv Aging 7:575–583
5. Marcantonio ER, Flacker JM, Michaels M, Resnick NM (2000) Delirium is independently associated with poor functional recovery after hip fracture. 48:618–624
6. Simunovic N, Devereaux PJ, Sprague S, Guyatt GH, Schemitsch E, Debeer J, Bhandari M (2010) Effect of early surgery after hip fracture on mortality and complications: systematic review and meta-analysis. CMAJ 182:1609–1616
7. Uzoigwe CE, Burnand HG, Cheesman CL, Aghedo DO, Faizi M, Middleton RG (2013) Early and ultra-early surgery in hip fracture patients improves survival. Injury 44:726–729
8. Khasraghi FA, Lee EJ, Christmas C, Wenz JF (2003) The economic impact of medical complications in geriatric patients with hip fracture. Orthopedics 26:49–53
9. Burge R, Dawson-Hughes B, Solomon DH, Wong JB, King A, Tosteson A (2007) Incidence and economic burden of osteoporosis-related fractures in the United States, 2005-2025. J Bone Miner Res 22:465–475
10. Grigoryan KV, Javedan H, Rudolph JL (2014) Orthogeriatric care models and outcomes in hip fracture patients: a systematic review and meta-analysis. J Orthop Trauma 28:e49–e55
11. Giusti A, Barone A, Razzano M, Pioli G (2011) Optimal setting and care organization in the management of older adults with hip fracture. Eur J Phys Rehabil Med 47:281–296
12. Kammerlander C, Roth T, Friedman SM, Suhm N, Luger TJ, Kammerlander-Knauer U, Krappinger D, Blauth M (2010) Orthogeriatric service-a literature review comparing different models. Osteoporos Int 21:S637–S646
13. Handoll HH, Cameron ID, Mak JC, Finnegan TP (2009) Multidisciplinary rehabilitation for older people with hip fractures. Cochrane Database Syst Rev 7(4):Cd007125
14. Friedman SM, Mendelson DA, Kates SL, RM MC (2008) Geriatric co-management of proximal femur fractures: total quality management and protocol-driven care result in better outcomes for a frail patient population. J Am Geriatr Soc 56:1349–1356
15. Prestmo A, Hagen G, Sletvold O, Helbostad JL, Thingstad P, Taraldsen K, Lydersen S, Halsteinli V, Saltnes T, Lamb SE, Johnsen LG, Saltvedt I (2015) Comprehensive geriatric care for patients with hip fractures: a prospective, randomised, controlled trial. Lancet 385:1623–1633
16. Ginsberg G, Adunsky A, Rasooly I (2013) A cost-utility analysis of a comprehensive orthogeriatric care for hip fracture patients, compared with standard of care treatment. Hip Int 23:570–575
17. Miura LN, Di Piero AR, Homer LD (2009) Effects of a geriatrician-led hip fracture program: improvements in clinical and economic outcomes. J Am Geriatr Soc 57:159–167
18. Middleton M, Wan B, da Assunçao R (2017) Improving hip fracture outcomes with integrated orthogeriatric care: a comparison between two accepted orthogeriatric models. Age Ageing 46:465–470
19. Charlson ME, Pompei P, Ales KL, MacKenzie CR (1987) A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis 40:373–383
20. Katz S, Ford AB, Moskovitz RW, Jackson BA, Jaffe MW (1963) Studies of illness in the aged. The index of ADL: a standardized measure of biological and psychosocial function. JAMA 185:914–919
21. González-Montalvo JI, Alarcón T, Mauleón JL, Gil-Garay E, Gotor P, Martín-Vega A (2010) The orthogeriatric unit for acute patients: a new model of care that improves efficiency in the management of patients with hip fracture. Hip Int 20:229–235
22. Gupta A (2014) The effectiveness of geriatrician-led comprehensive hip fracture collaborative care in a new acute hip unit based in a general hospital setting in the UK. A. J R Coll Physicians Edinb 44: 20–26
23. Friedman SM, Mendelson DA, Bingham KW, Kates SL (2009) Impact of a co-managed geriatric fracture center on short-term hip fracture outcomes. Arch Intern Med 169:1712–1717
24. Gregersen M, Mørch MM, Hougaard K, Damsgaard EM (2012) Geriatric intervention in elderly patients with hip fracture in an orthopedic ward. J Inj Violence Res 4:45–51
25. Swanson CE, Day GA, Yelland CE, Broome JR, Massey L, Richardson HR, Dimitri K, Marsh A (1998) The management of elderly patients with femoral fractures. A randomised controlled trial of early intervention versus standard care. Med J Aust 169: 515–518
26. Vidán M, Serra JA, Moreno C, Riquelme G, Ortiz J (2005) Efficacy of a comprehensive geriatric intervention in older patients hospitalized for hip fracture: a randomized, controlled trial. J Am Geriatr Soc 53:1476–1482
27. Khasraghi FA, Christmas C, Lee EJ, Mears SC, Wenz JF Sr (2005) Effectiveness of a multidisciplinary team approach to hip fracture management. J Surg Orthop Adv 14:27–31
28. Chong CP, Savige J, Lim WK (2009) Orthopaedic-geriatric models of care and their effectiveness. Australas J Ageing 28:171–176
29. Liem IS, Kammerlander C, Suhm N, Blauth M, Roth T, Gosch M, Hoang-Kim A, Mendelson D, Zuckerman J, Leung F, Burton J, Moran C, Parker M, Giusti A, Pioli G, Goldhahn J, Kates SL, Investigation performed with the assistance of the AOTrauma Network (2013) Identifying a standard set of outcome parameters for the evaluation of orthogeriatric co-management for hip fractures. Injury 44:1403–1412
30. Khan R, Fernandez C, Kashifl F, Shedden R, Diggory P (2002) Combined orthogeriatric care in the management of hip fractures: a prospective study. Ann R Coll Surg Engl 84:122–124
31. Gilchrist WJ, Newman RJ, Hamblen DL, Williams BO (1988) Prospective randomised study of an orthopaedic geriatric inpatient service. BMJ 297:1116–1118
32. Naglie G, Tansey C, Kirkland JL, Ogilvie-Harris DJ, Detsky AS, Etchells E, Tomlinson G, O'Rourke K, Goldlist B (2002) Interdisciplinary inpatient care for elderly people with hip fracture: a randomized controlled trial. CMAJ 167:25–32
33. Kennie DC, Reid J, Richardson IR, Kiamari AA, Kelt C (1988) Effectiveness of geriatric rehabilitative care after fractures of the proximal femur in elderly women: a randomised clinical trial. BMJ 297:1083–1086
34. Mendelson DA, Friedman SM (2014) Principles of comanagement and the geriatric fracture center. Clin Geriatr Med 30:183–189
35. Ventura C, Trombetti S, Pioli G, Belotti LM, De Palma R (2014) Impact of multidisciplinary hip fracture program on timing of surgery in the elderly patients. Osteoporos Int 25:2591–2597
36. Ho WW, Kwan Dai DL, Liu KW, Chow KM, Lau E, Woo J, Leung KS (2009) To investigate the effect and cost-effectiveness of implementing an orthogeriatric intervention for elderly patients with acute hip fracture: the experience in Hong Kong. J Am Geriatr Soc 57:2153–2154
37. Sirois MJ, Côté M, Pelet S (2009) The burden of hospitalized hip fractures: patterns of admissions in a level I trauma center over 20 years. J Trauma 66:1402–1410
38. Hagino H, Endo N, Harada A, Iwamoto J, Mashiba T, Mori S, Ohtori S, Sakai A, Takada J, Yamamoto T (2017) Survey of hip fractures in Japan: recent trends in prevalence and treatment. J Orthop Sci 22:909–914

39. Tarazona-Santabalbina FJ, Belenguer-Varea A, Rovira-Daudi E, Salcedo-Mahiques E, Cuesta-Peredó D, Doménech-Pascual JR, Salvador-Pérez MI, Avellana-Zaragoza JA (2012) Early interdisciplinary hospital intervention for elderly patients with hip fractures : functional outcome and mortality. Clinics 67:547–556
40. Boyd RV, Hawthorne J, Wallace WA, Worlock PH, Compton EH (1983) The Nottingham orthogeriatric unit after 1000 admissions. Injury 15:193–196
41. Barone A, Giusti A, Pizzonia M, Razzano M, Palummeri E, Pioli G (2006) A comprehensive geriatric intervention reduces short- and long-term mortality in older people with hip fracture. J Am Geriatr Soc 54:1145–1147
42. Suhm N, Kaelin R, Studer P, Wang Q, Kressig RW, Rikli D, Jakob M, Pretto M (2014) Orthogeriatric care pathway: a prospective survey of impact on length of stay, mortality and institutionalisation. Arch Orthop Trauma Surg 134:1261–1269
43. Shyu YI, Liang J, Wu CC, Su JY, Cheng HS, Chou SW, Chen MC, Yang CT (2008) Interdisciplinary intervention for hip fracture in older Taiwanese: benefits last for 1 year. J Gerontol A Biol Sci Med Sci 63:92–97
44. Adunsky A, Lerner-Geva L, Blumstein T, Boyko V, Mizrahi E, Arad M (2011) Improved survival of hip fracture patients treated within a comprehensive geriatric hip fracture unit, compared with standard of care treatment. J Am Med Dir Assoc 12:439–444
45. Rubenstein LZ (2004) Jospeph T freeman award lecture: comprehensive geriatric assessment: from miracle to reality. J Gerontol A Biol Sci Med Sci 59:473–477