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Impact of delirium on short-term outcomes in hip fracture patients under a program of approach to delirium

Rafael Bielza,[1,2] Francisco Zambrana,[2,3] Eva Fernández de la Puente,[4] Jorge Sanjurjo,[2,5] Cristina Andreu,[6] Israel J. Thuissard[6] and Jorge Gómez Cerezo[2,7]

[1]Department of Geriatric Medicine, Hospital Universitario Infanta Sofía, Madrid, Spain
[2]Clinical Department, School of Health Sciences, Universidad Europea, Madrid, Spain
[3]Department of Oncology, Hospital Universitario Infanta Sofía, Madrid, Spain
[4]Department of Geriatric Medicine, Hospital Central de la Cruz Roja, Madrid, Spain
[5]Department of Orthopedics, Hospital Universitario Infanta Sofía, Madrid, Spain
[6]School of Doctoral Studies & Research, Universidad Europea, Madrid, Spain
[7]Department of Internal Medicine, Hospital Universitario Infanta Sofía, Madrid, Spain

Correspondence
Rafael Bielza MD PhD, Department of Geriatric Medicine, Hospital, Universitario Infanta Sofía. Paseo de Europa 37, San Sebastián de los Reyes 28007, Spain.
Email: rafabielza@hotmail.com

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Aim: We aimed to investigate the impact of delirium on short-term outcomes in hip fracture patients. Special attention was given to patients with delirium and dementia.

Methods: A prospective observational cohort study was carried out in hip fracture patients aged ≥70 years who were admitted to a hospital unit where a multicomponents approach to delirium is established for all patients. Our population was split into delirium (n = 212) and non-delirium cohort (n = 171) according to the Confusion Assessment Method. Patients with a previous diagnosis of dementia in an outpatient appointment were also assessed within the delirium cohort. The utility of the rehabilitation was measured with the Absolute Functional Gain index.

Results: A total of 383 patients were entered into the study. The median age was 86 years, and most patients were women (78.8%). Delirium patients were older, presented a lower previous Barthel Index (BI), had higher rates of dementia and came more frequently from nursing homes. Comparative analysis did not show differences in mortality, complications, length of stay or walking ability between the cohorts. However, lower BI on discharge, lower Absolute Functional Gain and the presence of nosocomial infections were found more frequently in the delirium cohort. In multivariate analysis, only the BI on discharge (P = 0.010) was lower in delirium patients. Within the delirium cohort, those suffering from dementia had worse BI on discharge (P = 0.017) and lower Absolute Functional Gain (P = 0.019).

Conclusions: Delirium was not associated with mortality, walking ability, length of stay and clinical complications in hip fracture patients. BI on discharge was the only short-term outcome affected. In the delirium cohort, those suffering from dementia showed worse rehabilitation results. **Geriatr Gerontol Int 2020; 20: 130–137**.

Keywords: delirium, dementia, orthopedics.

Introduction

Delirium affects 28–61% of hip fracture (HF) patients, and is associated with poor outcomes in the acute phase, such as longer length of stay, greater rate of institutional placement, worse functional recovery and higher costs.[1] This syndrome is characterized by a change in mental status with attention and awareness deficits, loss of cognitive and perceptive functions, and alterations in the sleep cycle.[2] The most widely used instrument for identification of delirium is the Confusion Assessment Method (CAM) with sensitivity of 94%, specificity of 89% and high interrater reliability.[3]

Given the consequences of delirium and its high prevalence in HF patients, the identification of people at risk of developing delirium, and the implementation of strategies to reduce and prevent its morbidity are highly desirable.[3] Comprehensive geriatric care reduces the incidence of perioperative delirium, but there is limited evidence showing whether these approaches have an impact on short-term outcomes, such as clinical complications, length of stay or functional recovery.[1,4,5]

Dementia, functional decline, vision impairment, history of alcohol abuse and advanced age are the leading factors associated with delirium that have been recognized on admission in both medical and non-cardiac surgery populations. Comorbidity burden and the presence of stroke or depression are also associated with an increased risk for developing delirium in all patient populations.[3,6] Similarly, dementia is one of the strongest risk factors contributing to delirium, but the effects of dementia on outcomes after delirium have been hardly described in older HF patients.[7]

In the present prospective study, we analyzed the impact of delirium on short-term outcomes in HF patients admitted to an orthogeriatric share care unit where a protocol of approach to delirium was implemented. Special attention was given to patients with delirium and dementia.

Methods

Ethical considerations

The study was carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans. The study was approved by the Research Commission of our institution on 20 December 2012, before the recruitment period started. Each patient gave informed consent. Patients, or a proxy in the case of patients with cognitive impairment, signed the written informed consent during the initial assessment.

Study design and population

A prospective cohort study was carried out in the orthogeriatric service of the Hospital Universitario Infanta Sofía (Madrid, Spain), a public university hospital located in the north of Madrid (Spain), which covers a population of 306 000 people. An average of 200 HF patients attend every year. Patients were admitted to the orthopedic ward, where the orthopedic surgeon and the geriatrician share the responsibility for the care.[8] Both specialists carry out daily joint rounds along with nurses, and each specialist writes orders and communicates with the patient and care team. Interdisciplinary weekly meetings among the whole staff (social workers, orthopedic surgeons, rehabilitation specialists, geriatricians and nurses) allow scheduling rehabilitation, and a surgical and the discharge date.[9]

We split the population into delirium and non-delirium cohorts, according to the CAM criteria, as mentioned below. The primary aim of the study was to assess the differences in Absolute Functional Gain (AFG) after HF surgery between patients with and without delirium. AFG was considered as Barthel index (BI) on discharge minus BI on admission.[10] Power calculation was carried out before the recruitment period started. According to prior research, we considered as clinically relevant when a difference of 5 points in AFG between cohorts was obtained.[11] Previous data of our unit showed a standard deviation of the AFG of 12.5. As a result, a random sample of at least 90 patients per cohort was calculated to detect a mean difference of 5 points in AFG per group, taking into consideration a 95% confidence level, 80% statistical power and a 15% follow-up loss.

Patients aged ≥70 years undergoing HF surgery admitted to the orthogeriatric service from January 2013 to December 2014 were included in the study.

Program of approach to delirium

The initial evaluation was carried out during the 24 h after admission or within 72 h if the patient was admitted during the weekend. All HF patients admitted to the unit underwent the program of approach to delirium, which included:

- Prevention. Previous pharmacological treatments were reviewed, focusing specifically on medications that might have cumulative anticholinergic burden.[12] According to the Hospital Elder Life Program, the staff of the orthogeriatric department approached patients aiming to prevent known factors contributing to delirium, such as sleep deprivation, immobility, visual or hearing impairment and dehydration.[13] Pain was monitored and regular non-opioid agents were administered from admission. Paracetamol every 8 h plus metamizol every 8 h (both intravenously) were administered from admission as per protocol. Tramadol or morphine were used as rescue medication for breakthrough pain. Regarding anesthetic management, spinal anesthesia was recommended for all patients unless contraindicated, and perioperative peripheral nerve blockade was considered as part of multimodal pain relief for HF patients.
- The CAM was applied for screening and assessment.[14] The CAM is based on four features: (i) acute onset and fluctuating course; (ii) inattention; (iii) disorganized thinking; and (iv) altered level of consciousness. The diagnosis of delirium by CAM requires the presence of features (i) and (ii), and either (iii) or (iv). To detect delirium episodes occurring during periods when the members of the geriatrics staff were not available, medical records were reviewed in a structured way. The diagnosis of delirium was considered if any of the following is present: low level of consciousness, hyperalertness, lethargy, inattention, agitation or increased use of neuroleptic drugs.
- Management of the episode was undertaken preferably with non-pharmacological interventions. When medications were necessary, preferably low doses of oral quetiapine were administered.
- Rehabilitation protocol. All HF patients received physical therapy adapted to their needs, from the day after surgery until discharge, in daily sessions of 30 min each, from Monday to Friday.

We considered the diagnosis of dementia when it was previously carried out in an outpatient appointment. The definition of dementia that was used is based on previous population-based studies.[15] Dementia was graded according to the Red Cross Mental Scale,[16] as follows: cognitively normal (0), mild cognitive impairment,[1,2] mild-to-moderate dementia,[3] moderate to severe dementia[4] and severe dementia.[5]

Variables and data collection

To evaluate functional status before the fracture (pre-fracture) and on discharge, walking ability and activities of daily living (ADL) were assessed. Patients' walking ability was classified by the Red Cross Physical Scale[16] into able to walk independently (0–2), able to walk with the assistance of other persons[3,4] and unable to walk.[5] The ability to carry out the ADL was classified according to the usual cut-off points of the BI.[17] The utility of the rehabilitation was measured with the differences on AFG.[10] Complementary to AFG, we considered a Relative Functional Gain (RFG) >0.5 as a measurement of the effectiveness of rehabilitation. RFG was calculated as BI on discharge minus BI on admission/prior BI minus BI

on admission.[10] To assess morbi-mortality, we recorded in-hospital mortality, length of stay (in days) and clinical complications (Table 1). To investigate risk factors for delirium, we also included age (in years), sex, dementia, comorbidity according to the Charlson Comorbidity Index,[18] American Society of Anesthesiologists classification,[19] pre-fracture functional status, anemia on admission according to World Health Organization criteria,[20] residence before admission and type of fracture (whether subcapital or per-subtrochanteric).

Statistical analysis

We described baseline characteristics of the sample and presented them as mean values with standard deviation or median value with interquartile interval for continuous variables according to parametric tests results, and absolute and relative frequencies for categorical variables. Baseline characteristics of study cohorts were compared using the χ^2-test or the Fisher's exact test when appropriate for qualitative variables, and non-parametric Mann–Whitney *U*-tests for quantitative variables. Differences were considered significant with a probability >95% ($P < 0.05$). Univariate analyses were carried out to determine the effect of delirium on short-term outcomes (BI, AFG, walking ability, length of stay, clinical complications and mortality). Lineal regression analyses were applied for short-term outcomes significantly different between cohorts (BI and AFG). BI and AFG regression models were adjusted for age, sex, type of fracture, anemia, previous BI, length of stay and clinical complications. To identify variables independently related to the occurrence of delirium, only those variables with a significance level of $P < 0.100$ (delirium *vs* non-delirium) in the univariate analysis (age, dementia, previous BI, RFG, residence before admission) were subsequently included in the binary logistic regression multivariate models (backward stepwise method). Finally, univariate analyses were carried out to evaluate whether dementia negatively affects AFG, functional status on discharge, in-hospital mortality, length of stay or complications in the delirium cohort. Within the delirium cohort, binary logistic and lineal regressions models were built to assess the effect of dementia on walking ability, BI and AFG.

All data analysis was carried out using SPSS version 21.0 (IBM Corporation, Armonk, NY, USA).

Results

A total of 383 patients were enrolled in the study during the research period (flow chart in Table S1). These patients were very elderly (86 years [82–90 years]) and mostly women (78.8%, $n = 302$). Regarding pre-fracture functional status, slight disability for the ADL (BI of 65–100) was present in 58.2% ($n = 223$). A total of 47.2% ($n = 182$) of patients were living in nursing homes, and the majority suffered from extracapsular HF (64.5%, $n = 247$). On discharge, patients showed severe disability (BI 33 [18.5–48.5]), with a median AFG of 17^{6-28} and a RFG >0.5 was obtained in 23.8% of the patients (Table 1).

Incidence and risk factors for delirium on admission

New episodes of delirium during hospitalization occurred in 55.3% of the patients. As compared with non-delirium patients, patients developing delirium were older, more likely previously diagnosed with dementia and had a worse BI on admission. This group also had less antiplatelet treatment and came more frequently from nursing homes (Table 2).

Table 1 Demographic and clinical characteristics of patients undergoing hip fracture surgery

Age (years)	86 (82–90)
Sex	
Female	302 (78.8)
Charlson Comorbidity Index >2	159 (41.5)
Pre-fracture functional status	
Walking ability	
Walked without help	207 (54.0)
Walked with help	148 (38.7)
Unable to walk	28 (7.3)
Barthel Index	
Slight disability	223 (58.2)
Moderate disability	70 (18.3)
Severe disability	90 (23.5)
Previous cognitive status	
Dementia (RCM >2)	114 (29.8)
Type of fracture	
Per-subtrochanteric	247 (64.5)
Subcapital	136 (35.5)
Residence before admission	
Nursing home	182 (47.2)
Previous anticoagulant treatment	69 (18.2)
Previous antiplatelet treatment	138 (36.3)
Anesthetic risk	
ASA >II	325 (84.9)
Hemoglobin on admission (g/dL)	12.6 (11.6–13.6)
Hospital stay (days)	
Time from admission to surgery	4 (2.5–5.5)
Time from surgery to discharge	7 (5–9)
Total hospital stay	11 (9–13)
Delirium	212 (55.3)
Functional status on discharge	
Walking ability	
Walked without help	8 (2.1)
Walked with help	320 (83.6)
Unable to walk	53 (13.8)
Barthel Index	33 (18.5–48.5)
Absolute functional gain†	17 (6–28)
Relative functional gain >0.5‡	91 (23.8)
Clinical complications	154 (40.2)
Cerebral complications	12 (3.1)
Cardiac complications	47 (12.3)
Thrombo-embolic complications	7 (1.8)
Nosocomial infection	77 (20.1)
Pressure ulcer	1 (0.2)
Hydroelectrolitic disorders	59 (15.5)
Gastrointestinal complications	12 (3.1)
Hemoglobin at discharge (g/dL)	10.2 (9.5–10.9)
Transfused patients	210 (54.8)
Transfusion rate (units per patient)	2 (1.5–2.5)
Discharge from acute hospital	
Nursing home	168 (43.9)
Own home	96 (25.1)
Subacute units	104 (27.1)
Died (in-hospital mortality)	15 (3.9)
Type of anesthesia	
Intradural anesthesia	318 (83)
General anesthesia	65 (17)

Results are expressed as *n* (%) or median (Q3–Q1). †Absolute functional gain, Barthel Index at discharge – Barthel index on admission.

‡*Relative functional gain:* $\frac{\text{Barthel index at discarche – Barthel index on admission}}{\text{Prior Barthel index - Barthel index on admission}}$

ASA, American Society of Anesthesiologists Classification; RCM, Red Cross Mental Scale.

Table 2 Baseline characteristics and outcomes in delirium and non-delirium cohorts

	Patients undergoing hip fracture (n = 383)		
	Non-delirium (n = 171)	Delirium (n = 212)	P-value
Baseline characteristics of delirium and non-delirium patients			
Age (years)	85 (79.5–90.5)	87 (83.5–90.5)	0.007
Sex			
Male	32 (18.7)	49 (23.1)	
Female	139 (71.3)	163 (76.9)	0.295
Charlson Comorbidity Index >2	69 (40.4)	90 (42.5)	0.678
Prefracture functional status			
Able to walk (with or without aid)	157 (91.8)	198 (91.8)	0.554
Unable to walk	14 (8.2)	14 (8,2)	
Previous Barthel Index	88 (69–100)	61 (38.1–83.8)	<0.001
Barthel Index on admission	10 (2–18)	10 (5–15)	<0.001
Previous cognitive status			
Non dementia (RCM ≤2)	145 (84.7)	124 (58.5)	
Dementia (RCM ≥3)	26 (25.3)	88 (41.5)	<0.001
Residence before admission			
Nursing home	56 (32.8)	126 (59.4)	
Own home	115 (67.2)	86 (40.6)	<0.001
Anemia on admission	72	80	0.385
Previous anticoagulant treatment	58 (33.9)	80 (37.7)	0.439
Previous antiplatelet treatment	40 (23.4)	29 (13.7)	0.001
Type of fracture			
Per-subtrochanteric	115 (67.2)	132 (62.3)	
Subcapital	56 (22.8)	80 (37.7)	0.311
Type of anesthesia			
Intradural anesthesia	135 (78.9)	183 (86.3)	
General anesthesia	36 (21.1)	29 (13.7)	0.056
Anesthetic risk			
ASA I–II	30 (17.5)	28 (13.2)	0.239
ASA >II	141 (82.5)	184 (76.8)	
Short-term outcomes in delirium and non-delirium patients			
Functional status on discharge			
Walking ability			
Unable to walk	14 (8.2)	14 (6.6)	
Able to walk (with or without aid)	157 (91.8)	198 (93.4)	0.847
Barthel Index	40 (25–55)	26 (14.1–37.9)	<0.001
Absolute functional gain[†]	22 (19–35)	13 (4.1–21.9)	<0.001
Relative functional gain >0.5[‡]	51 (29.8)	40 (18.87)	0.012
Hospital stay (days)			
Time from admission to surgery	4.0 (2.5–5.5)	4 (3–5)	0.048
Time from surgery to discharge	7 (5.5–8.5)	7 (5–9)	0.965
Total hospital stay	10 (7.5–12.5)	11 (8.5–13.5)	0.151
Clinical complications	62 (36.3)	92 (43.4)	0.157
Nosocomial infections	22 (12.9)	55 (25.9)	0.002
In-hospital mortality	8 (4.6)	7 (3.3)	0.490

Results are expressed as n (%) or median (Q3–Q1). [†]Absolute functional gain, Barthel Index at discharge – Barthel Index on admission. [‡]Relative functional gain: Barthel Index at discharge – Barthel Index on admission / prior Barthel Index – Barthel Index on admission. ASA, American Society of Anesthesiologists Classification; RCM, Red Cross Mental Scale.

According to the multivariate logistic regression analysis dementia (OR 2.2, 95% CI 1.216–3.899; P = 0.009), a lower previous BI (OR 0.988, 95% CI 0.978–0.998; P = 0.017) and came from a nursing home (OR 1.754, 95% CI 1.080–2.849; P = 0.023) were all found to be risk factors for developing delirium (Fig. 1).

Impact of delirium on short-term outcomes

Comparative analysis showed significant differences in AFG and BI on discharge between delirium and non-delirium patients. A significantly higher proportion of nosocomial infections was registered in patients with delirium, but we did not find differences

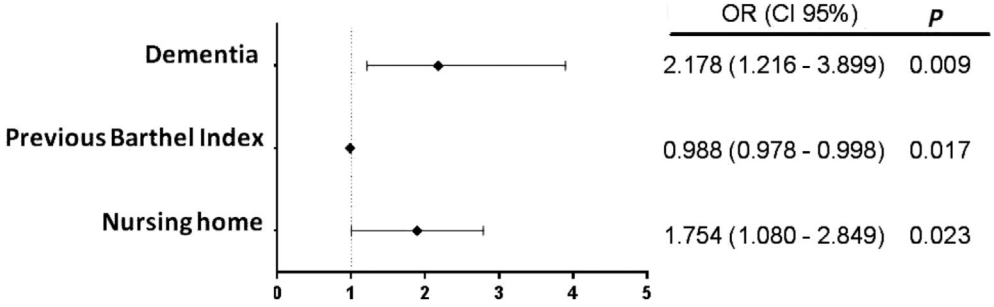

Figure 1 Risk factors for delirium according to the multivariate logistic regression analysis.

Table 3 Regression analysis of variables affecting Barthel Index on discharge, absolute functional gain and relative functional gain >0.5

Variable	Barthel Index on discharge	Absolute functional gain[†]	Relative functional gain >0.5[‡]
	Outcomes (multivariate linear regression, B (95% CI)		Multivariate logistic regression, OR (95% CI)
Male sex	4.228 (0.944–7.513); $P = 0.012$	4.326 (0.792–7.860); $P = 0.017$	1.695 (0.884–3.249); $P = 0.112$
Age	−0.255 (−0.473 to −0.037); $P = 0.022$	− 0.184 (−0.418 to 0.050); $P = 0.124$	0.956 (0.919–0.995); $P = 0.027$
Type of fracture (Per-subtrochanteric)	0.358 (−2.426 to 3.142); $P = 0.800$	1.936 (−1.059 to 4.932); $P = 0.204$	1.774 (1.067–2.952); $P = 0.027$
Anemia	−0.199 (−2.426 to 3.142); $P = 0.889$	−0.718 (−3.716 to 2.281); $P = 0.638$	0.773 (0.455–1.313); $P = 0.341$
Clinical complications	−4.504 (−7.354 to −1.655); $P = 0.002$	− 4.555 (−7.621 to −1.489); $P = 0.004$	0.692 (0.404–1.186); $P = 0.181$
Length of stay	0.511 (0.188–0.835); $P = 0.002$	0.489 (0.141–0.837); $P = 0.006$	1.045 (0.985–1.108); $P = 0.144$
Previous Barthel Index	0.486 (0.437–0.536); $P < 0.001$	0.304 (0.251–0.357); $P < 0.001$	1.007 (0.998–1.017); $P = 0.144$
Delirium	−3.698 (−6.507 to −0.889); $P = 0.010$	−2.238 (−5.260 to 0,784); $P = 0.146$	0.641 (0.381–1.080); $P = 0.095$
Charlson Comorbidity Index ≥3	1.324 (−1.406 to 4.054); $P = 0.341$	2,391 (−0.546 to 5.328); $P = 0.110$	1.181 (0.710–1.962); $P = 0.522$

[†]Absolute functional gain, Barthel Index at discharge – Barthel Index on admission. [‡]Relative functional gain: Barthel Index at discharge – Barthel Index on admission / prior Barthel Index – Barthel Index on admission.

between the two cohorts in the rates of other complications, such as in-hospital mortality or length of stay (Table 2).

Multivariate analyses confirmed that delirium did not have a significant effect on AFG or RFG. In contrast, BI on discharge (b = −3.698, 95% CI −6.507 to −0.889; $P = 0.010$) was found to be significantly lower in patients with delirium (Table 3).

Patients with delirium undergoing HF surgery: Non-dementia versus dementia cohorts

Of the 212 patients with delirium, 88 (41.9%) had dementia. On admission, dementia patients were more frequently living in nursing homes and presented lower previous BI. On discharge, dementia patients showed worse functional status in terms of BI and walking ability, as compared with the non-dementia cohort. Furthermore, lower AFG and lower length of stay were found in the dementia group. However, there were no differences in the preoperative period, clinical complications, nosocomial infections or in-hospital mortality between these two cohorts (Table 4).

Multivariate analysis confirmed that within the delirium cohort, those suffering from dementia had a significantly lower BI on discharge (b = −5.129, 95% CI −8.777 to −1.480; $P = 0.006$), showed lower AFG (b = − 4.477, 95% CI −0.728 to −8.226; $P = 0.019$) and less frequently obtained a RFG >0.5 (b = −1.016, 95% CI 0.140–0.935; $P = 0.036$). On the contrary, dementia did not have any association with other outcomes variables (Fig. S1).

Discussion

The rate of new episodes of delirium was 55.3%. Patients developing delirium were older, had worse pre-fracture functional status, presented more prior diagnosis of dementia and came more frequently from nursing homes as compared with the non-delirium population. Dementia, lower previous BI and living in nursing homes before admission were found to be risk factors for delirium in the multivariate analyses. Regarding short-term outcomes, delirium was not associated with clinical complications, length of stay, in-hospital mortality and walking ability or AFG, whereas this syndrome was correlated with lower BI on discharge. Within the group of HF patients with delirium, patients with dementia came more frequently from nursing homes and presented a lower previous BI than patients without dementia. They also showed worse functional status on discharge in terms of BI, AFG and RFG, but dementia did not have any association with the other outcome variables.

The exhaustive assessment of delirium carried out in the orthogeriatric service, the high prevalence of dementia and the high number of patients coming from nursing homes all might have contributed to the high incidence of delirium registered in our cohort, but nevertheless they are in line with other studies.[21,22] Similar to previous reports, we also identified functional impairment on admission and living in nursing homes as risk factors for developing new episodes of delirium in HF patients.[3] In

Table 4 Patients with delirium undergoing hip fracture surgery: Non-dementia versus dementia cohorts

	Patients undergoing hip fracture and delirium (n = 212)		
	Non-dementia (n = 124)	Dementia (n = 88)	P-value
Baseline characteristics of dementia and non dementia patients			
Age (years)	87 (83–91)	87 (83–91)	0.520
Sex			
Male	32 (25.8)	17 (19.3)	
Female	92 (74.2)	71 (80.7)	0.269
Charlson Comorbidity Index >2	46 (37.1)	44 (50)	0.061
Prefracture functional status			
Able to walk (with or without aid)	119 (96)	79 (89.8)	
Unable to walk	5 (4)	9 (10.2)	0.074
Previous Barthel Index	75 (55.5–94.5)	40 (23.9–56.1)	<0.001
Barthel Index on admission	10 (6–14)	5 (2–8)	<0.001
Residence before admission			
Nursing home	56 (32.8)	126 (59.4)	
Own home	115 (67.2)	86 (40.6)	
Anemia on admission	46 (37.1)	34 (38.6)	0.820
Previous anticoagulant treatment	21 (16.9)	8 (9.1)	0.101
Previous antiplatelet treatment	46 (37.1)	34 (38.6)	0.820
Type of fracture			
Per-subtrochanteric	81 (65.3)	51 (58)	0.275
Subcapital	43 (34.7)	37 (42)	
Type of anesthesia			
Intradural anesthesia	106 (85.5)	77 (87.5)	0.674
General anesthesia	18 (14.5)	11 (12.5)	
Anesthetic risk			
ASA I–II	17 (13.7)	11 (12.5)	0.798
ASA >II	107 (86.3)	77 (87.5)	
Short-term outcomes in dementia and non-dementia patients			
Functional status on discharge			
Walking ability			
Unable to walk	12 (9.7)	19 (21.6)	
Able to walk (with or without aid)	112 (90.3)	69 (78.4)	0.016
Barthel Index	34 (23.1–44.9)	16 (7.2–24.7)	<0.001
Absolute functional gain[†]	17.5 (7.6–27.4)	8 (1.6–14.4)	<0.001
Relative functional gain >0.5[‡]	30 (24.2)	10 (11.4)	0.019
Hospital stay (days)			
Time from admission to surgery	4 (2.6–5.4)	4 (3.5–5.5)	0.206
Time from surgery to discharge	7 (5.5–8.5)	6 (4.3–7.7)	0.026
Total hospital stay	11 (8–14)	11 (8.5–13.5)	0.030
Clinical complications	60 (48.4)	32 (36.4)	0.082
Nosocomial infections	35 (28.2)	20 (22.7)	0.368
In-hospital mortality	5 (4)	2 (2.3)	0.702

Results are expressed as n (%) or median (Q3–Q1). [†]Absolute functional gain, Barthel Index at discharge – Barthel Index on admission. [‡]Relative functional gain: Barthel Index at discharge – Barthel Index on admission / prior Barthel index – Barthel Index on admission. ASA, American Society of Anesthesiologists Classification.

contrast with Sanders *et al.*, comorbidity or American Society of Anesthesiologists classification were not found risk factors for delirium in the present study.[23]

Regarding factors associated with delirium, there were no differences in terms of AFG (primary end-point) and walking ability on discharge between delirium and non-delirium patients. Hence, we can hypothesize that our rehabilitation program might have achieved early mobility in delirium patients, and could be considered a contributor to long-term functional recovery, as previously reported.[24] However, poorer BI observed on discharge might be explained by baseline differences between the BI on admission in delirium and non-delirium patients, as well as by delirium patients recovering walking ability earlier than other ADL. Further investigations are necessary to confirm these results.

Delirium patients did not show significant differences in clinical complications, length of stay, walking ability or in-hospital mortality, as compared with non-delirium patients. In contrast with the present findings, the study by Radinovic *et al.* conducted

within an orthopedic department showed that incident delirium was strongly associated with clinical complications.[25] Interestingly, the study by Lee *et al*. did not find such an association, and they also included a multidisciplinary team approach that involved geriatric consultations.[26] As opposed to a longer length of stay observed in other studies, we achieved an earlier discharge, possibly accounting for the high percentage of HF dementia patients coming from nursing homes.[15] Controversy exists regarding whether delirium is an independent predictor of mortality.[27] However, and in line with our results, a recent meta-analysis showed that delirium was not significantly associated with mortality.[5] According to the current literature and the positive outcomes of our study, involving geriatricians in the implementation of specific strategies for the prevention of delirium in HF patients might reduce adverse outcomes associated with delirium.

Dementia patients usually develop worse early postoperative outcomes, and we expected that patients with delirium and dementia would have even worse outcomes compared with non-demented patients.[28] However, we did not find differences between these cohorts in walking ability, clinical complications, mortality or length of stay. These positive outcomes in the delirium and dementia cohort also support our program of approach to delirium. Regrettably, although motor rehabilitation is a procedural learning and remains intact even in advanced cognitive impairment stages, we did not obtain satisfactory functional recovery outcomes in patients with delirium and dementia.[29] Therefore, it is a challenge for us to implement a better rehabilitation procedure for these specific populations.

There were several limitations in the present study. First, we measured the presence of delirium during the total hospital stay, but not at the onset, which prevented us from knowing the association between delirium and other important precipitant factors. In addition, we did not carry out scales to determine delirium severity and duration. Second, a randomized clinical trial or a quasi-experimental study would have allowed us to establish a direct confirmation of the efficacy of the program. Third, the criteria applied for diagnosing dementia probably prevented us from identifying some individuals with mild dementia. Notwithstanding, the positive outcomes compared with previous studies suggest the utility of the program, and we plan to further implement it in our institution.

In conclusion, despite its high incidence, delirium was not associated with mortality, walking ability, length of stay and clinical complications in older HF patients. BI on discharge was the only short-term outcome that was affected by delirium, whereas we did not find differences in AFG and RFG. In the delirium cohort, those suffering from dementia showed worse rehabilitation results. Finally, dementia, lower previous BI and coming from nursing homes were risk factors for delirium.

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Disclosure statement

The authors declare no conflict of interest.

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Supporting information

Additional supporting information may be found in the online version of this article at the publisher's website:

Table S1. Regression analysis of variables affecting walking ability on discharge, Barthel Index on discharge, absolute functional gain and relative functional gain >0.5 (delirium cohort)
Figure S1. Recruitment flow chart.

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