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Pressure ulcers are associated with six month mortality in elderly patients with hip fracture managed in orthogeriatric care pathway.

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**Running headline:** Pressure ulcer and hip fracture

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## Abstract

**Introduction:** Pressure ulcers (PUs) in hip fracture patients are frequent and associated with a poor outcome. An orthogeriatric management, recommended by international guidelines in hip fracture patients and including PU prevention and treatment, could influence causes and consequences of PU. However, remaining factors associated with PU occurrence and prognostic value of PU in hip fracture patients managed in an orthogeriatric care pathway remain unknown.

**Methods:** From June 2009 to April 2015, all consecutive patients with hip fracture admitted to an Unit for Post-Operative Geriatric Care were evaluated for eligibility. Patients were included if their primary presentation was due to hip fracture and if they were  $\geq 70$  years of age. Patients were excluded in presence of pathological fracture or if they were already hospitalized at the time of the fracture. In our unit, orthogeriatric principles are implemented, including a multicomponent intervention to improve PU prevention and management. Patients were followed until 6 months after discharge.

**Results:** 567 patients were included, with an overall 14,4 % 6-month mortality (95% CI: 11.6-17.8%). Of these, 67 patients (12 %) experienced at least one PU. Despite orthogeriatric management, PUs were significantly associated with a low albumin level (RR 0.90, 95% CI:0.84-0.96;  $p=0.003$ ) and history of atrial fibrillation (RR 1.91, 95% CI:1.05-3.46,  $p=0.033$ ), coronary artery disease (RR 2.16, 95% CI:1.17-3.99;  $p=0.014$ ) and diabetes (RR 2.33, 95% CI:1.14-4.75;  $p=0.02$ ). A PU was associated with 6 month mortality (RR 2.38, 95% CI: 1.31-4.32,  $p=0.044$ ).

**Conclusion:** In elderly patients with hip fracture managed in an orthogeriatric care pathway, PU remained associated with poorly modifiable risk factors and long term mortality.

**Keywords:** hip fracture, elderly, pressure ulcers, orthogeriatric

## Introduction

Hip fractures are a leading cause of mortality and disability among older people. Worldwide 1.6 million patients suffer from hip fracture every year [1]. The number of hip fractures is expected to rise to over 6 million by the year 2050 [2]. Even if the hip fracture incidence decreased over time, the lifetime risk of a hip fracture has not decreased because of the increase of life expectancy [3]. Overall, the survival rate after a hip fracture has not improved since 1998 [4]. Elderly mortality after hip fracture remains high ranging from 14,9% to 25,6% for women to 25,4% to 36,4% for men at 6 months in elderly and in elderly in nursing home respectively [4]. Despite all mechanisms associated with hip fracture prognosis in this emergency setting being currently incompletely known [5], comorbidities represent a more important prognostic factor than the fracture itself [6], justifying a multi-disciplinary approach for the prevention and management of complications [7].

Pressure ulcers (PUs) are a common complication of decubitus in elderly patients, associated with a poor prognosis and increased risk of death [8]. Pressure ulcers are associated with increased length of hospital stay, costs, shorter life expectancy and worse quality of life [9]. Overall prevalence of PUs decreases but PUs still affects 8,9% to 12.3% of hospitalized patients, particularly elderly patients with numerous risk factors including immobility [8, 10]. Hip fracture patients are at high risk of PUs because of a long resting period before, during and after surgery and the presence of other PU risk factors such as incontinence and poor nutritional status [11]. Approximately one-third of hip fracture patient develop PU, with a higher rate in acute setting [6, 12]. In particular, PUs are associated with one year mortality in hip fracture patients [13].

According to orthogeriatrics concept [14, 15], an appropriate clinical intervention is recommended for patient receiving surgery with high risk of developing PUs [16]. In a previous study, we have shown a significant reduction in the number of pressure ulcers (9 %

versus 33%) after hip fracture in patients treated in a dedicated post-operative geriatric unit, compared with usual care, together with improvement of morbidity and 6-month mortality [17].

Finally, PUs in hip fracture patients are frequent and serious, but consequences of early orthogeriatrics management on PUs outcome and prognosis remain unknown. The purpose of this study was to determine the prognostic value of PUs in elderly hip fracture patients managed in a dedicated post-operative geriatric care unit.

## Methods

The study was approved by our hospital ethics committee (CPP Ile de France VI, Paris, France); waived informed consent was authorized since the study was observational. The database was declared to the French National Commission on Computing and Liberty (CNIL, Paris, France). This cohort has been used in previous studies [17]. This study was carried out in a ten-bed perioperative geriatric unit and in a tertiary teaching hospital. Acquisition of data was prospective but this study should be considered as retrospective since the design was performed later. Nevertheless, the statistical plan of the study was decided before the analysis.

## Patients

In June 2009, we created a geriatric unit (Unit for Post-Operative Geriatric Care, UPOG) devoted to the post-operative care of elderly patients with hip fracture [17].

In this geriatric dedicated unit, knowledge of PUs risk factors to define better prevention of pressure ulcers is provided. The medical and paramedical staff is focused on comorbidities management and rehabilitation, and was formed to the importance of controlling PUs risk factors to limit their development. To that goal, all patients were provided with air-filled mattresses to prevent or treat pressure ulcers. This was in agreement with initial Braden scale evaluations, showing that all patients were at high risk of PU. Furthermore, systematic malnutrition detection was performed according to weight and albumin level, as well as swallowing disorders in order to adapt nutrition in conjunction with a nutritionist. Clinical management was focused on early mobilization, including chair sitting in the 3 hours following operating room exit. Installation to bed and chair was reviewed with an occupational therapist.

From June 2009 to April 2015 (i.e. 71 months), all consecutive patients with hip fracture admitted to the UPOG were evaluated for eligibility. Patients were included if their primary presentation was due to hip fracture and if they were  $\geq 70$  years of age. Patients were excluded if it was a pathological fracture or if they were already hospitalized at the time of the fracture.

#### Data Collection

Data were prospectively entered in a dedicated research database. The following variables were collected: age, sex, home or nursing home living conditions, previous medical history, and type of fracture. The Cumulative Illness Rating Scale (CIRS) was determined. Functional status was evaluated with the Activities of Daily Living (ADL) scale and the Instrumental Activities of Daily Living (IADL) scale.

#### Outcome and Follow-up

The primary end point was 6-month mortality. Patients were followed from hospital admission until death or 6 months after surgery. Surviving patients or their family were seen in routine consultation, or contacted and interviewed by telephone. Missing patients were tracked through health care providers, particularly general practitioners, or any identified acquaintances. Secondary end points were in-hospital mortality and 30-day mortality since this end-point has been widely used in perioperative studies, length of stay (LOS) in acute care facilities, and main complications including admission into ICU, as previously described [23].

#### Data Analysis

The sample size was based on all available patients and thus no a priori power calculation was conducted. Data are presented as mean + SD, median [25-75 interquartile] for non-Gaussian variables, or number (percentages). Comparison between patients with and without pressure

ulcer was performed using the unpaired Student t test, Mann-Whitney test, Chi square test, Fisher's exact method, when appropriate.

A logistic model using all variables available at admission was developed to determine variables associated with the occurrence of a pressure ulcer, excluding patients who already had pressure ulcer at the admission. The odds ratios and their 95% CI were calculated.

Survival was estimated by the Kaplan-Meier method and differences were assessed by the log-rank test. Since we previously observed that three variables (age, sex, CIRS) were associated with 6-month mortality [17], we tested the impact of pressure ulcer by calculating the hazard ratio and its 95 percent confidence interval (CI) in association with these prognostic variables.

All P values are two-tailed, and  $P < 0.05$  was considered to denote significant differences.

Statistical analyses were carried out using NCSS software (Statistical Solutions ltd, Corke, Ireland) and R software (version 2.15) (<http://www.r-project.org>)



## Results

Over the study period, 585 patients with hip fracture were admitted. Among them, 18 patients were excluded for pathological fracture (n=5) or because they were already hospitalized (n=13) at the time of the fracture. Finally, 567 patients were addressed to our ED and UPOG and included in the study. Two (0.4 %) patients were lost on follow-up and 56 (10%) patients were followed less than 6 months.

Baseline characteristics of the cohort are shown in Table 1. Sixty-seven (11.8%, 95% CI 8.3-13.5%) patients experienced pressure ulcer. The main localization was the heel (n=40, 60%) and the sacrum (n=26, 39%). Four patients had a pressure ulcer at admission in ED whereas it appeared later in the 63 other patients. Forty-three patients (64%) had 1 ulcer, 19 (28%) 2 ulcers, and 5 (7%) more than 2 ulcers. The severity of the pressure ulcer was grade 1 in 23 (34%) patients, grade 2 in 33 (49%) patients and grade 3 in 6 (9%) patients and grade 4 in the remaining 5 (7%) patients. The median delay from hospital admission to pressure ulcer was 5 days [25-75 interquartile 3-8].

Using a multivariable logistic model, we determined that 4 variables were significantly associated with the occurrence of a pressure ulcer: a low serum albumin level, chronic atrial fibrillation, coronary artery disease, and diabetes (Table 2).

The 30-day mortality was 4.1 % (95% CI: 2.7-6.3%) and the 6-month mortality was 14.4 % (95% CI: 11.6-17.8%). Table 2 shows the complications and mortality in the Control and pressure ulcer group. During the follow up period, survival rate significantly decreased in the pressure ulcer group (71%, 95% CI 60-83%) as compared to the control group (90%, 95%CI 87-93%) (Logrank test=17.2, P<0.001) (Fig). When taking into account age, sex, and co-morbidities (using the CIRS), this difference remained significant. The risk ratio of death at 6 month associated with pressure ulcer was 2.38 (95% CI: 1.31-4.32%, P=0.044).

## Discussion

To our knowledge, this is the first study in a dedicated geriatric post-operative unit, focusing on PU in elderly patients with hip fracture with a detailed description of multimorbidity, complications and medical procedures performed to avoid PU occurrence. Despite a PU targeted intervention including prevention and treatment, 12 % of patients experienced one or more PU, with a median occurrence of 5 days after hospital admission. Furthermore, survival rate was significantly lower in the PU group, and PUs were significantly associated with a low albumin level, history of atrial fibrillation coronary artery disease and diabetes.

Incidence of PU in elderly patients admitted with hip fracture greatly varies according to countries, type of unit and length of stay, length of follow-up, and stage of PU ( $\geq$  stage 2), making comparison between studies difficult. It varies from 2%, in a younger population (mean age 74.5 year old [18]), to 3.7 % but with uncompleted data for PU (7% of patients) [19], to 36% [12]. Using a common methodological approach between units, we previously reported a 33% prevalence of PU in a standard orthopedic care pathway, and observed a 9 % prevalence in our dedicated geriatric pathway [17]. As reported here, we used, inside a dedicated unit allowing an early geriatric intervention, a procedure with early surgery and mobilization, nutritional support and systematic air mattresses. Some of these factors were previously reported as effective for PU prevention, such as orthogeriatric, in a model of daily geriatric intervention in an orthopedic ward [20], time to surgery [21] and use of dedicated support to prevent or limit the severity of pressure ulcers occurrence [22]. Nutritional supplementation is still a matter of debate in PU prevention [23], but oral supplementation in hip fracture patients was associated with a lower rate of complications and deaths [24]. Taken together, our study suggests that a dedicated pathway centered around a geriatric perioperative unit allows a multilayer intervention, may be associated with a low prevalence

of PU. However, this study was not interventional and this result should be confirmed by a randomized study including a multilayer intervention including all validated factors.

Pressure ulcers are associated with functional outcome [25] and mortality [26] in hip fracture. In our study, PUs were also associated with long-term mortality, and PU risk factors were represented by nutritional (low serum albumin) and vascular (atrial fibrillation, coronary artery disease and diabetes) conditions. Malnutrition and diabetes are well known PU risk factors [27]. Delay to surgery is also associated with PU [20, 27, 28, 29], and a delay >48h was more frequent in the PU group. However, delay to surgery was no more significant in multivariate analysis in our study. In an emergency surgery such as a hip fracture, vascular risk factors may become overriding, because they can be triggered by dehydration, or perioperative hemodynamic instability and anemia, in agreement with the lower hemoglobin level observed in the PU group of our study. Moreover, the importance of vascular risk factors could explain the timing of appearance of PU, which mainly occurred in the first five days after admission. This suggests that the first days, including admission, could be decisive and require an optimization of hemodynamic filling and anemia management, from emergency department, to operating room and geriatric department. In addition, a multilayer and multispecialist intervention may be necessary, beginning from the arrival to the emergency department (air mattresses, correct management of hydration and blood requirements), to the operating room (shortest time to surgery, air mattresses, strict monitoring of hemodynamic and hemoglobin parameters) and until orthogeriatric (shortest time to walking, air mattresses, multimorbidity management) and rehabilitation admissions. The benefit of nutritional support, early transfer to orthogeriatric unit and early mobilization should also be implemented but is still a matter of debate.

Multimorbidity was associated with 6 months mortality in our study, as represented by CIRS score. Previous studies have also documented that co-morbidities such as malnutrition, renal failure, pneumonia, pre-existing malignancy, previous myocardial infarction, cerebrovascular disease and pressure ulcers [13], or total number number of comorbidities [30] were independently associated with a greater risk of mortality. The previous observation of age and sex (male) as independent factors associated with mortality were not confirmed in our study [13}. Taken together, and considering one of the geriatrics expertises as multimorbidity management in the field of acute care, these data highlight the need of geriatric involvement in perioperative care.

Our study has several limitations. First, it was an observational study and should be considered as retrospective despite acquisition of data wich was prospective. Besides, we did not evaluate the benefit of our systematic intervention, including orthogeriatrics, systematic air mattresses, nutrition support and short delays, and were unable to compare our results to other models of orthogeriatric reported in the literature. Then, we included all stages of PUs, increasing PU incidence, but this choice was guided by real life conditions analysis. However, our study used a systematic procedure for PUs occurrence, and shows the difficulty of PU prevention in this vulnerable population.

## Conclusion

Despite orthogeriatric management, PUs still represent an independent risk factor for mortality after hip fracture. Admission to a dedicated geriatric unit could decrease occurrence of PU, since it was associated with a low PU incidence, but further studies are required to demonstrate it. There is an urgent need for evaluation of the benefit of such units and way of care to prevent PUs using innovative interventions.

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TABLE 1. Comparison of the Main Characteristics of the Patients (n=567)

	Control (n=500)	Pressure ulcer (n=67)	P value
<b>Age (years)</b>	86 ± 7	87 ± 7	0.58
<b>Men</b>	112 (22%)	22 (33%)	0.16
<b>Women</b>	388 (78%)	45 (67%)	
<b>Living in institution</b>	76 (15%)	13 (19%)	0.36
<b>IADL4</b>	2 [0-4]	1 [0-3]	0.16
<b>ADL6</b>	5 [3-6]	5 [3-6]	0.11
<b>Charlson score</b>	3 [2-4]	4 [2-6]	0.002
<b>Dementia</b>	196 (39%)	29 (43%)	0.59
<b>Diabetes</b>	55 (11%)	14 (21%)	0.02
<b>Hypertension</b>	345 (69%)	48 (72%)	0.48
<b>Cardiac failure</b>	85 (17%)	16 (24%)	0.17
<b>Coronary artery disease</b>	87 (17%)	20 (30%)	0.02
<b>Heart valve disease</b>	43 (9%)	8 (12%)	0.35
<b>Atrial fibrillation</b>	126 (25%)	25 (37%)	0.03
<b>Peripheral vascular disease</b>	32 (6%)	10 (15%)	0.02
<b>Stroke</b>	80 (16%)	16 (24%)	0.11
<b>Hemiplegia/paraplegia</b>	17 (3%)	5 (7%)	0.16
<b>Cancer</b>	105 (21%)	18 (27%)	0.05
<b>Chronic obstructive pulmonary disease</b>	38 (8%)	8 (12%)	0.22
<b>Creatinine (µmol.L<sup>-1</sup>)</b>	73 ± 29	92 ± 77	<0.001
<b>Creatinine clearance (mL.min<sup>-1</sup>)</b>	54 ± 23	48 ± 24	0.06
<b>Creatinine clearance &lt;30 mL.min<sup>-1</sup></b>	61 (12%)	11 (16%)	0.32
<b>CIRS</b>	9 [6-11]	11 [8-14]	<0.001
<b>Albumin (g.L<sup>-1</sup>)</b>	28.9 ± 4.4	27.0 ± 4.3	0.002
<b>Hemoglobin (g.dL<sup>-1</sup>)</b>	12.2 ± 1.6	12.0 ± 1.5	<0.001
<b>Hemoglobin &lt; 10 g.dL<sup>-1</sup></b>	48 (10%)	9 (13%)	0.82
<b>Anemia</b>	234 (47%)	42 (63%)	0.28
<b>Type of fracture</b>			
- Femoral neck fracture	260 (52%)	37 (55)	0.69
- Intertrochanteric fracture	240 (48%)	30 (45)	
<b>Delay to surgery (h)</b>	23 [14-34]	26 [15-48]	0.59
<b>Delay to surgery &gt;48h</b>	71 (14%)	17 (39%)	0.04
<b>Delayed time to support (&gt;1 day)</b>	32 (6%)	6 (9%)	0.43
<b>Delay to admission into UPOG (h)</b>	35 [25-56]	42 [25-72]	0.26
<b>Delay to admission into UPOG &gt;48h</b>	175 (35%)	28 (42%)	0.34

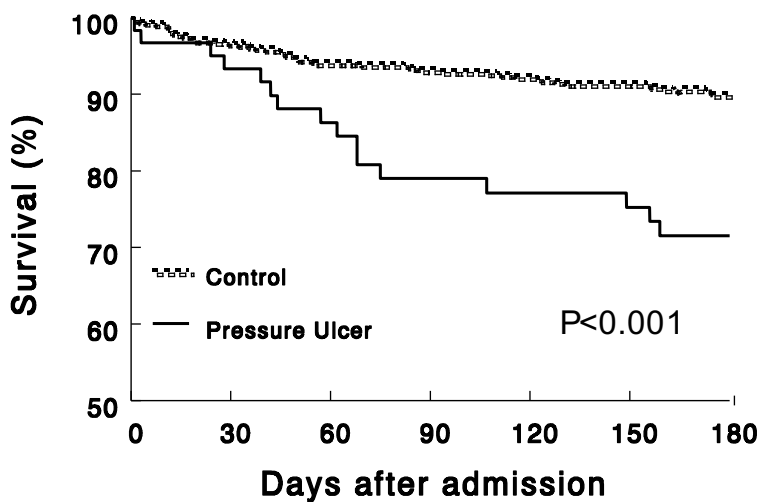
Data are mean ± SD, median [25-75 interquartile], or number (percentage). CIRS: cumulative illness rating scale; IADL4= Instrumental activities of daily living scale; ADL= Activities of daily living scale.

TABLE 2. Multivariable Analysis

Variables		P value
<b>Predicting the Occurrence of Pressure ulcer (n=548*)</b>		
	<b>Odds Ratio [95% CI]</b>	
Albumin (per 1 g.L-1 increase)	0.90 [0.84-0.96]	0.003
Atrial fibrillation	1.91 [1.05-3.46]	0.033
Chronic coronary artery disease	2.16 [1.17-3.99]	0.014
Diabetes	2.33 [1.14-4.75]	0.020
<b>Predicting 6-month mortality (n=565)</b>		
	<b>Risk Ratio [95% CI]</b>	
Age (per 1 year increase)	1.02 [0.98-1.07]	0.25
Sex	1.06 [0.58-1.91]	0.86
CIRS (per 1 point increase)	1.10 [1.05-1.16]	<0.001
Pressure ulcer	2.48 [1.24-4.18]	0.004

CI= 95% confidence interval. \*: only patients who had no pressure ulcer at admission were considered and patients who died were considered.

Figure



Survival curves for mortality in patients with (n=67, solid lines) and without pressure ulcer (n=500, dotted lines). Survival is non-adjusted (panel A) and adjusted (panel B) for age, sex and Cumulative Illness Rating Scale (CIRS) calculated with a Cox regression analysis.