

# Assessment of Mortality Risk in Elderly Patients After Proximal Femoral Fracture

JENNIFER M.T.A. MEESSEN, PHD; SALVATORE PISANI, MD; MARIA L. GAMBINO, MD;  
DOMENICO BONARRIGO, MD; NATASJA M. VAN SCHOOR, PHD; STEFANIA FOZZATO, MD;  
PAOLO CHERUBINO, MD; MICHELE F. SURACE, MD

## abstract

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Mortality after hip fracture is a major problem in the Western world, but its mechanisms remain uncertain. This study assessed the 2-year mortality rate after hip fracture in elderly patients by including hospital factors (eg, intervention type, surgical delay), underlying health conditions, and, for a subset, lifestyle factors (eg, body mass index, smoking, alcohol). A total of 828 patients (183 men) 70 to 99 years old experiencing a hip fracture in 2009 in the province of Varese were included in the study. The risk factors for death were assessed through Kaplan-Meier analysis and Cox proportional hazards analysis. Hip fracture incidence per 1000 persons was higher in women (8.4 vs 3.7 in men) and in elderly patients (12.4 for 85-99 years vs 4.4 for 70-84 years). The mortality rate after 1, 6, 12, and 24 months was 4.7%, 16%, 20.7%, and 30.4%, respectively. For the province of Varese, sex (hazard ratio, 0.39 for women), age group (hazard ratio, 2.2 for 85-99 years), and Charlson Comorbidity Index score (hazard ratio, 2.06 for score greater than 1) were found to be statistically significant. The 2-year mortality rate in hip fractures is associated with sex, age, and comorbidities. Male sex, age older than 85 years, and Charlson Comorbidity Index score greater than 1 are associated with a higher risk. Surgical delay was significant in the Kaplan-Meier survival time analysis but not in the Cox hazard analysis, suggesting that early surgery reduces risk in patients with numerous comorbidities.

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*The authors are from Vrije Universiteit (JMTAM), Amsterdam, The Netherlands; Osservatorio Epidemiologico (SP, MLG, DB), Azienda Sanitaria Locale, Varese, Italy; the EMGO Institute for Health and Care Research (NMv), VU University Medical Center, Amsterdam, The Netherlands; and the Department of Biotechnologies and Life Sciences (SF, PC, MFS), University of Insubria, Varese, Italy.*

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*Correspondence should be addressed to: Michele F. Surace, MD, Department of Biotechnologies and Life Sciences, University of Insubria, viale Borri 57, Varese, Italy (mfsurace@yahoo.com).*

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**H**ip fractures are a major health problem in Western countries.<sup>1</sup> At the age of 65, the prevalence of hip fractures is 1.6%; this increases to 8.9% for individuals older than 90 and varies widely between countries, with the highest rates in Scandinavia.<sup>2,3</sup> With a higher incidence in elderly patients and an aging population, the burden of hip fractures on society will increase even more in the near future.<sup>4-7</sup> One-year mortality rates after experiencing a hip fracture are 12% to 36%, with the highest rates reported in the first month after fracture.<sup>4,8-11</sup> Several studies were performed regarding risk factors associated with higher mortality levels in elderly patients sustaining hip fractures and showed that although white women older than 65 years have the highest risk of hip fracture, mortality rates are highest in men.<sup>8,9,12-15</sup>

The influence of comorbidities on a patient's chances of survival has been proven to be significant. Liver, cardiovascular, and respiratory diseases affect mortality rate.<sup>9,12,14,15</sup> In addition, comorbidities increase the incidence of postoperative complications that are proven to reduce survival rates.<sup>8,15</sup> Unfortunately, none of these studies gave a conclusive explanation for the excessive mortality rate in elderly patients after a hip fracture.

The purpose of this study was to assess the effects of hospital (fracture therapy and surgical delay) and underlying health (prior comorbidities) factors on mortality after hip fracture.

## MATERIALS AND METHODS

Patient records from the SDO database—Provincia di Varese, which comprises all discharge records of the residents of the province of Varese, Italy (population, 868,777), were retrospectively evaluated. This database was linked to individual records of mortality. The clinical records of 184 individuals (37 men) treated at Circolo Hospital in Varese were reviewed to verify the correspondence of some variables, such as

sex, date of intake, and time in the hospital.

### Inclusion and Exclusion Criteria

Patients between 70 and 99 years old with ICD-9 codes 820.0 through 820.9 (diagnoses of femoral fracture) as a primary diagnosis were included. The study included all patients admitted to the hospital with a hip fracture in 2009. Patients who experienced a previous fracture of the hip (either the same or contralateral side) in the past 2 years and patients diagnosed with a malignant tumor in the past 2 years were excluded. Patients admitted to the hospital with multiple traumas were also excluded (patients with diagnosis-related groups 484 through 487). The exclusion criteria were based on the criteria used by the Italian Ministry of Health for its National Health Survey.

The study cohort included 183 (22%) men and 645 (78%) women with a mean age of 83.3±6.2 years. Less than 1% (n=4) of the patients were lost due to moving out of the province of Varese.

### Outcome Measure and Risk Factors

The primary outcome measure of the study was the cumulative mortality and proportional survival at 1, 6, 12, and 24 months after fracture, stratified over different risk factors. The following risk factors were included:

*Age.* There is substantial evidence to prove the relationship between age and risk of hip fracture. Older age increases the incidence of sustaining a hip fracture and its associated mortality.<sup>9,16</sup>

*Sex.* It has been extensively proven that women have a higher risk of developing a hip fracture, although mortality rates are higher in men. The mechanisms behind this phenomenon are not yet clear.<sup>8,9,13-15</sup>

*Marital Status.* It is well known that marriage has a beneficial effect on health. Marriage influences individuals to become more cautious about their health, and it improves overall mental and physical health.<sup>17-20</sup> Multiple studies have prov-

en that marriage is associated with a lower incidence of hip fractures.<sup>2,21</sup> The influence of marriage on mortality after hip fracture has not been extensively studied.

*Number of Comorbidities.* Each patient's number of comorbidities was taken from the patient's records of the previous 2 years. Only the comorbidities recommended by the Italian Ministry of Health were included: diabetes mellitus, obesity, blood diseases, dementia, Parkinson's disease, hemiplegia or other paralyzes, heart conditions, hypertension, cerebrovascular diseases, vascular diseases, chronic obstructive pulmonary disease, chronic nephropathy, chronic diseases, rheumatoid arthritis, and osteoporosis.<sup>22</sup>

After considering the absolute number of comorbidities, the Charlson Comorbidity Index score was calculated for each patient. This score takes into account the weight of a disease on the person's health and may be a more appropriate measure of personal comorbidities.<sup>23</sup>

*Type of Intervention.* To investigate whether there was a difference in mortality between the most common interventions, 3 groups were included in the analysis: (1) those who received ICD-9 code 7935 (internal fixation of the femur); (2) those who received ICD-9 code 8152 (partial substitution of the hip); and (3) those who received other interventions.

*Total Hospital Stay.* In the United States during the year 2003, average hospital stay after fracturing the hip was 7 days.<sup>24</sup> This was counted from the day of admission to the day of discharge.

*Hospital of Admission.* To investigate any bias caused by the hospital performing treatment, the hospital of admission was included in the analysis. The hospitals were divided into the following groups: north (Varese and Cittiglio), southeast (Busto Arsizio, Tradate, and Saronno), and southwest (Gallarate and Angera).

Considering that all inhabitants of the province of Varese were included in the study, some may have been admitted to hospitals outside the province or to private

clinics. For this reason, a group comprising other clinics was created.

**Surgical Delay.** Surgical delay is defined as the time from hospital admission to surgery. Current British guidelines dictate that patients preferably be operated on within 24 hours of trauma; however, due to an unstable patient condition or a hospital-specific work arrangement, this is not always possible.<sup>25</sup>

There is no conclusive answer regarding if and how surgical delay could influence mortality after hip fracture. Some studies found evidence of a negative effect, whereas others reported an increase in mortality for delays longer than 4 days or showed no significant effect.<sup>26-31</sup>

Orosz et al<sup>32</sup> reported that surgical delay is not related to a higher mortality rate but is related to more complications. The comprehensive literature review by Leung et al<sup>28</sup> showed that although there is no conclusive evidence of the effect of surgical delay on mortality rate, there is evidence that early surgery improves a patient's scoring on other variables, such as morbidity, hospital stay, and pain.

**Statistical Analysis**

The data were assessed for normal variation. Each variable was tested for significant differences between the patients who died within 24 months and those who survived. Categorical variables were assessed with a chi-square test, and continuous variables were assessed with a Student's *t* test.

To test variables for differences in survival time and to construct survival curves, the Kaplan-Meier method was used. A log rank test separately assessed the significance of the differences found in survival time for each variable.

The variables found to have significant differences in survival time were used in a multivariate Cox proportional hazards backward regression model. This analysis gave the hazard ratio for each variable adjusted for the other variables in the model and showed whether the included variables

were predictors of patient survival. Data were analyzed using SPSS for Windows version 19 statistical software (SPSS Inc, Chicago, Illinois).

**RESULTS**

Cross-verification of the tested variables in a subset of clinical records at Circolo Hospital in Varese (sex, date of intake, and hospital stay) showed a complete overlap between the information in the clinical files and the digital databases.

The incidence of hip fracture varied greatly among groups. The overall incidence was 6.6 per 1000 individuals. For the younger group (74-84 years), the incidence was 4.4 per 1000, whereas for the older group (85-99 years), it increased to 17.4 per 1000. Hip fractures were more frequent in men, with an incidence of 3.7 per 1000 vs 8.4 per 1000 in women. The incidence was calculated using the number of residents in the area 70 to 99 years old (N=126,344). A detailed overview of the variables is shown in **Table 1**.

For the hospital of admission,

Table 1

**Patient Characteristics**

Characteristic	Survived <sup>a</sup>	Died <sup>a</sup>	P
Hospital, No. (%)			
Southeast	179 (72.5)	68 (27.5)	.01
North	221 (69.5)	97 (30.5)	
Southwest	127 (63.5)	73 (36.5)	
Other clinics	53 (84.2)	10 (15.8)	
Sex, No. (%)			
Male	90 (49)	93 (51)	<.001
Female	490 (76)	155 (24)	
Mean age, y	82.4±5.9	85.5±6.1	<.001
Age range, No. (%)			
70-84 y	365 (78)	104 (22)	<.001
85-99 y	215 (60)	144 (40)	
Civil state, No. (%)			
Married	150 (65.8)	78 (34.2)	.24
Living alone	364 (71.9)	142 (28.1)	
Unknown	66 (70.2)	28 (29.8)	
Mean time to surgery, d	2.67±2.37	3±2.54	.09
Surgical delay, No. (%)			
<48 h	330 (73.6)	118 (26.4)	.01
>48 h	250 (65.8)	130 (34.2)	
Mean hospital stay, d	12.7±7.27	13.63±9.78	.18
Mean No. of patients with comorbidities <sup>b</sup>	1.17±1.55	1.91±2.05	<.001
Comorbidities, No. (%)			
0	250 (77.4)	73 (22.6)	<.001
1	173 (73.9)	61 (26.1)	
>1	157 (57.9)	114 (42.1)	
Mean Charlson Index Score	1.17±1.62	1.96±2.16	<.001
Charlson group, No. (%)			
0	261 (77.9)	72 (22.1)	<.001
1	167 (72.9)	62 (27.1)	
>1	152 (57.6)	112 (42.4)	
Intervention, No. (%)			
ICD-9 code 7935	235 (66.9)	116 (33.1)	.01
ICD-9 code 8152	224 (71.1)	91 (28.9)	
Other	116 (80)	29 (20)	
Mean No. of hospital admissions <sup>b</sup>	0.62±1.19	0.87±1.53	.02

<sup>a</sup>First 2 years after fracture.

<sup>b</sup>In the past 2 years.

Table 2

**Time of Death**

Characteristic	No.	No. (%)			
		<1 mo	<6 mo	<12 mo	<24 mo
Total	828	39 (4.7)	124 (15.0)	171 (20.7)	252 (30.4)
Sex					
Male	183	21 (11.4)	54 (29.5)	68 (37.1)	93 (50.8)
Female	645	19 (2.9)	70 (10.8)	103 (15.9)	159 (24.7)
Age, y					
70-84	467	17 (3.6)	50 (10.7)	67 (14.3)	106 (22.7)
85-99	359	22 (5.8)	74 (20.6)	104 (29.0)	146 (40.7)

a significant difference was only found between the southwest hospitals and the other clinics (such as private clinics or hospitals outside the province of Varese). In the hospitals within the province of Varese, no significant difference was found.

For surgical delay, the average number of days patients waited for their intervention was 2.67 for surviving patients and 3 for deceased patients. This was not significantly different. However, when the patients were divided into those who waited less than 48 hours and those who waited more than 48 hours, a significant difference was found.

The number of comorbidities was significantly higher in deceased patients than in surviving patients. Charlson Comorbidity Index scores were similar to the absolute number of comorbidities, and there was a significant effect to be found here. When the 2 measurement scales (ie, Charlson Comorbidity Index and absolute number) were compared, no statistically significant difference was found ( $P=.798$ ). Therefore, only the Charlson Comorbidity Index was used to assess each patient's underlying health.

Average age of deceased patients and surviving patients after 2 years differed significantly, with deceased patients being older than survivors. This significant

effect was also demonstrated by dividing the patients into 2 groups (70-84 years and 85-99 years).

The type of intervention showed a significant difference in mortality between patients receiving ICD-9 code 7935 or other interventions. There was no significant difference between patients receiving ICD-9 code 7935 and 8152.

The number of prior admissions in the past 2 years differed significantly between the 2 groups: 0.62 times for surviving patients and 0.87 times for deceased patients.

At 1 month after admission, 39 (4.7%) patients had died; after 6 months, this number increased to 124 (15%). Twelve months after fracturing the hip, 171 (20.7%) patients had died; at 2 years after the incident, 252 (30.4%) had died (Table 2). Two-year mortality was higher for men and at an older age.

**Survival Time Analysis**

Kaplan-Meier survival graphs were constructed and log rank analyses were performed to analyze the effect of the tested variable on survival time. These analyses showed that the difference in survival time was significant only for sex, age (70-84 years or 85-99 years), surgical delay, and Charlson Comorbidity Index (divided into 3 groups: 0, 1, or greater than 1).

Kaplan-Meier curve stratified for sex showed that the cumulative chance of survival for women (0.76), who had an average of 620 days of survival, was higher than that for men (0.492), who had an average of 472 days of survival (log rank analysis,  $P<.001$ ) (Figure 1).

Kaplan-Meier curve stratified for age group showed that the cumulative chance of survival for the younger group (70-84 years) was 0.778, with an average survival of 630 days. The older group (85-99) lived an average of another 532 days and had a cumulative chance of survival of 0.599. The difference between the 2 groups was significant ( $P<.001$ ) (Figure 2).

Charlson Comorbidity Index score was shown to be significantly different between those with a score of 0 and those with a score greater than 1 ( $P<.001$ ). There was no significant difference between patients with a Charlson Comorbidity Index score of 0 and those with a score of 1. These 2 groups had an average survival time of 634 and 598 days, respectively, whereas those with a score of greater than 1 had a mean survival of 520 days (Figure 3).

For surgical delay, 2 groups were formed: less than 48 hours of delay and more than 48 hours of delay. Mean survival was 610 days for the first group and 562 days for the second group. The cumulative chance of survival was 0.737 for the patients operated on within 48 hours and 0.658 for those waiting longer. This difference was significant ( $P=.01$ ) (Figure 4).

**Proportional Hazards Analysis**

Multivariate Cox hazards analysis was performed using the variables that were found to be significant in the Kaplan-Meier analysis. Hazard ratio for sex, calculated with men as a reference, was 0.39 (95% confidence interval [CI], 0.299-0.512). Hazard ratio for age group, calculated with the younger group as a reference, was 2.20 (95% CI, 1.679-2.852). Hazard ratio for Charlson Comorbidity Index score, calculated with 0 comorbidities as a reference, was 1.23 for a score

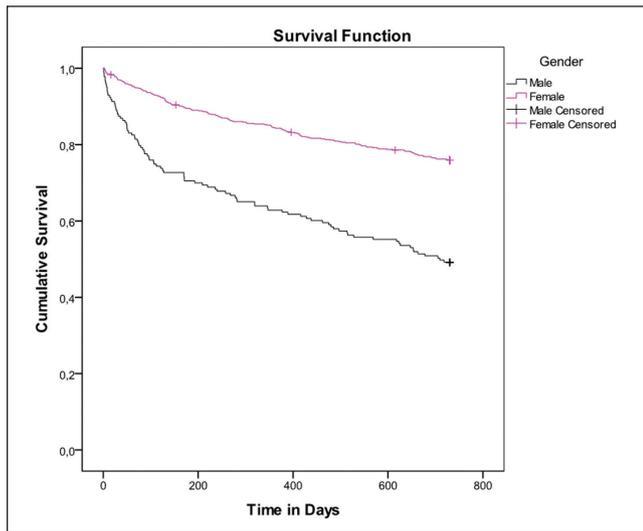


Figure 1: Survival curve for sex.

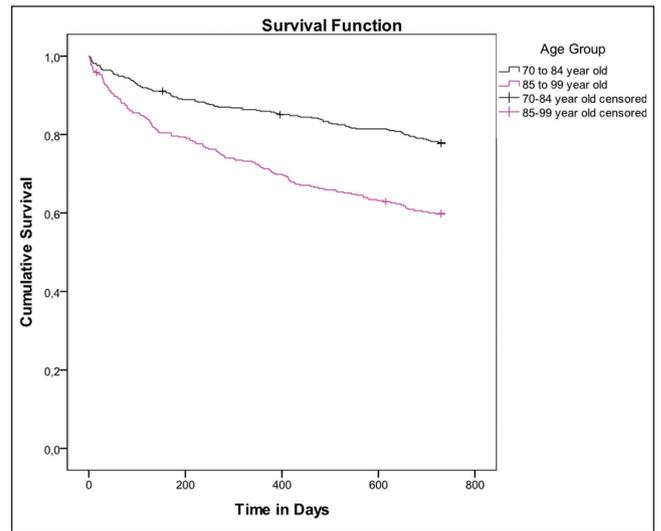


Figure 2: Survival curve for age group.

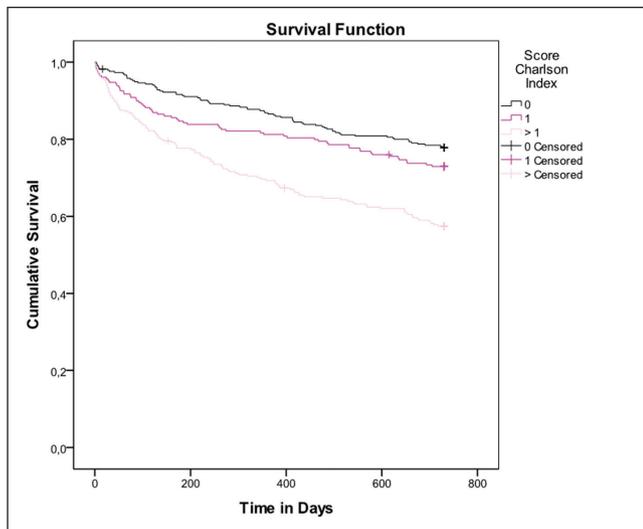


Figure 3: Survival curve for Charlson Comorbidity Index.

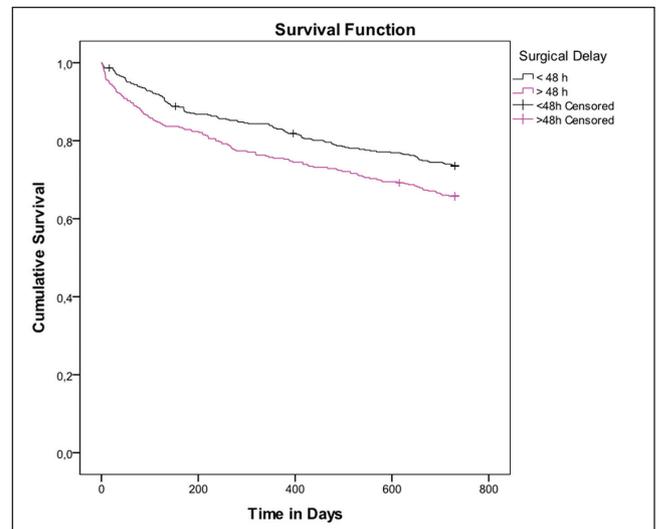


Figure 4: Survival curve for surgical delay.

of 1 (95% CI, 0.874-1.738) and 2.06 for a score greater than 1 (95% CI, 1.523-2.778).

The hazard ratio of 0.39 for sex indicated a protective influence against mortality for women. Being older (85-99 years) also led to a higher risk of mortality (hazard ratio, 2.2) when compared with the younger group (70-84 years).

Comparison of those with a Charlson Comorbidity Index score of 0 with those with a score of 1 led to a hazard ratio of 1.23. This hazard ratio did not differ signif-

icantly from the hazard ratio for those with a Charlson Comorbidity Index score of 0. The hazard ratio was significantly different between those with a Charlson Comorbidity Index score of 0 and those with a score greater than 1 (hazard ratio, 2.06).

### DISCUSSION

In this study, the incidence of hip fracture was more than doubled for women compared with men and was almost 4 times higher in those older than 85 years.

In 2011, the 1-month mortality rate for those in Italy 65 years or older with hip fractures was 5.91%; in the province of Varese it was reported to be 3.31%.<sup>22</sup> The current study showed a mortality rate of 4.7% for those between 70 and 99 years in the Province of Varese in 2009. These data agree with those of a prospective study by Paksima et al<sup>33</sup> in 2008.

Although the incidence of hip fracture was higher for women, the 2-year mortality rate was 50.8% for men, differing significantly from 24.7% for women

( $P < .001$ ); these findings also agree with those of Paksima et al.<sup>33</sup> At 6 months, half of the total patients who would be deceased by 2 years had already died.

Individual Kaplan-Meier analyses for the Provincia database showed that sex, age group, Charlson Comorbidity Index score, surgical delay, number of prior recoveries, and type of intervention had a significant influence on the average survival time of the included patients.

These variables were inserted in a Cox proportional hazards analysis, which concluded that sex (hazard ratio, 0.39 for women), age group (hazard ratio, 2.2 for older age group), and Charlson Comorbidity Index score (hazard ratio, 2.06 for score greater than 1) were statistically significant in influencing the survival time for patients experiencing hip fracture.

Surgical delay was found to be significant in the Kaplan-Meier survival time analysis but not in the Cox hazards analysis; this effect was explained by the Charlson Comorbidity Index score.

One of the main strengths of this study is the large study sample ( $N=828$ ) with a long follow-up time (2 years).

The results are in line with findings in the international scientific literature and the Italian data. This shows that the use of current databases and mortality archives yields results similar to those achieved with ad hoc surveys.

Surgical delay appeared to be longer if patients had more comorbidities. Hospital stay was not independent of surgical delay or comorbidities. Also, the number of men in the study was low.

## CONCLUSION

Two-year mortality after hip fracture is associated with sex, age, and comorbidities. Generally, male sex, age older than 85 years, and Charlson Comorbidity Index score greater than 1 are associated with a higher mortality risk. Surgical delay was found to be significant in the Kaplan-Meier survival time analysis but not in the Cox hazards analysis, likely

indicating that early surgery reduces mortality risk only in patients with numerous associated comorbidities.

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