



**Surgical treatment reduces in-hospital mortality after hip fracture: retrospective analysis using the Japanese Diagnosis Procedure Combination database**

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1 Shoda et al.

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7 **Surgical treatment reduces in-hospital mortality after hip fracture: retrospective**

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9 **analysis using the Japanese Diagnosis Procedure Combination database**

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Shoda et al.

## Abstract

**Objective:** To identify risk factors for in-hospital mortality in patients with hip fractures using the Japanese Diagnosis Procedure Combination (DPC) nationwide administrative claims database.

**Design:** Retrospective observational study.

**Setting:** Hospitals adopting the DPC system during 2007–2009.

**Participants:** We extracted a total of 80,800 eligible patients aged  $\geq 60$  years old with a single hip fracture (ICD-10 codes: S72.0 and S72.1). The DPC database includes patients treated between July and December each year.

**Main outcome measures:** In-hospital mortality after hip fracture.

**Results:** The overall in-hospital mortality rate after hip fractures was 3.3%. Multivariate analysis indicated that in-hospital mortality was significantly associated with male gender (odds ratio [OR] 2.12; 95% confidence interval [CI] 1.94 to 2.31), advancing age and number of comorbidities. Significantly higher mortality was observed in those treated conservatively (OR 4.25; 95% CI 3.92 to 4.61). Surgical delays of 5 days or more were significantly associated with higher rates of in-hospital mortality (OR 1.34; 95% CI 1.20 to 1.50).

**Conclusions:** In patients with hip fractures, surgical treatment was associated with

Shoda et al.

lower rates of in-hospital mortality.

What is already known on this topic

Hip fracture is a serious problem in an aging society and associated with high mortality.

Previous studies have shown several factors that may be associated with the increased mortality after hip fracture.

What this study adds

In-hospital mortality was significantly associated with male gender, advancing age and number of comorbidities. Significantly higher mortality was observed in those treated conservatively. Surgical delays of 5 days or more were significantly associated with higher rates of in-hospital mortality.

Shoda et al.

## INTRODUCTION

Hip fracture is a serious injury related to bone fragility caused by osteoporosis, and it has emerged as a public health burden in an aging society such as that of Japan.<sup>1-5</sup> It is estimated that the number of hip fractures worldwide will rise from 1.7 million in 1990 to 6.3 million in 2050.<sup>6</sup> Recent studies have reported an increased incidence of hip fractures in Japan<sup>3 5</sup> although the incidence is decreasing in some Western countries.<sup>7 8</sup> Hip fracture leads to impaired function, loss of independence and increased mortality of the patients. It has been reported that the increased mortality after hip fracture is associated with many factors such as increasing age, comorbidity and pre-fracture functional disability of the patients.<sup>9-12</sup> Hip fractures are usually treated by orthopaedic surgical procedures such as hemiarthroplasty or internal fixation, and several studies have shown that early surgery is associated with lower rates of mortality,<sup>13-16</sup> while other studies exhibited no benefit of early surgery in reducing mortality or improving functional recovery.<sup>17 18</sup> Conservative treatment is often chosen for patients with severe comorbidities. However, it is not clear whether conservative treatment is actually superior in reducing mortality compared with surgical treatment in high risk patients. In this study, we investigated the in-hospital mortality rate of hip fracture patients using data from the Japanese Diagnosis Procedure Combination (DPC) nationwide

1 Shoda et al.

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6 administrative claims database, and compared mortality following hip fractures between  
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9 groups treated surgically or conservatively.  
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## 15 **METHODS**

### 16 **DPC database**

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20 The DPC database is a diagnosis-dominant case-mix system administered by the  
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24 Ministry of Health, Labour and Welfare of Japan, and linked with a lump-sum payment  
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28 system.<sup>19</sup> All 82 university teaching hospitals in Japan are obliged to adopt the DPC  
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32 system, while adoption by community hospitals is voluntary. A comprehensive survey  
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36 of the DPC hospitals is conducted between July 1 and December 31 each year by the  
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40 DPC Research Group, funded by the Japanese government. Detailed patient data, as  
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44 well as administrative claims data, are collected for all the inpatients discharged from  
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48 the participating hospitals between July 1 and December 31 each year. The number of  
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52 participating hospitals increased to 818 with 2.57 million patients in 2009, which  
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56 represented approximately 40% of all the in-patient admissions to acute care hospitals  
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60 in Japan. Hospitals send all the anonymised data for each month to the DPC Research  
Group for compilation in the database server in the Department of Health Management  
and Policy, The University of Tokyo.

Shoda et al.

The database includes the following data: hospital location; patients' age and sex; diagnoses, comorbidities at admission, and complications after admission, recorded in accordance with the International Classification of Diseases, 10th Revision (ICD-10) codes and text data in the Japanese language; procedures coded with the Japanese original K codes; comorbidities at admission; complications after admission coded with the ICD-10 codes; in-hospital mortality; length of stay; and hospital charges.

This study was based on a secondary analysis of the administrative claims data. The requirement for informed consent was waived because of the anonymous nature of the data. Study approval was obtained from the Institutional Review Board at the University of Occupational and Environmental Health.

### Data compilation

We retrospectively collected data of patients coded S72.0 (fracture of the neck of the femur) and S72.1 (perthrochanteric fracture) between 2007 and 2009 from the DPC database. Exclusion criteria were as follows: age < 60 years; patients with open fractures or multiple fractures; and incomplete data. We extracted data on age, sex, method of treatment (surgical or conservative), number of acute beds and in-hospital mortality. From the comorbidities at admission, we collected data on seven factors:

Shoda et al.

malignancy, diabetes mellitus, cardiovascular disease, cerebrovascular disease, lung disease, renal failure, hepatic failure.

### Statistical analysis

The Chi-squared test was used for univariate comparisons of the surgical and conservative treatment groups. Multivariate logistic regression analysis was performed to analyse the confounding effects of various factors on in-hospital mortality. Odds ratios (OR) and 95% confidence intervals (CI) were determined. The OR of in-hospital mortality in conservatively treated patients was analysed in subgroups of patients stratified according to number of comorbidities or age. In addition, the effect of surgical delays in surgically treated patients was analysed. A p-value <0.05 was considered significant. All the statistical analyses were performed using SPSS Statistics ver. 19.0 (IBM SPSS Inc.; Chicago, IL, US).

## RESULTS

### Patient background

Data of 94,139 patients with hip fractures were extracted based on ICD-10 codes. We excluded 8,956 patients with open fractures or multiple fractures, 496 patients with



Shoda et al.

incomplete data and 3887 patients aged <60 years. Finally, 80,800 eligible patients were included in the analysis.

Table 1 presents the patient characteristics. Overall, 79.1% were females. The mean (standard deviation) age was 82.8 (8.3) years. The patients were categorised into the following four age groups: 60–69 (n=5,523), 70–79 (n=18,618), 80–89 (n=37,362), and  $\geq 90$  (n=19,297). Approximately 83% (n=66,893) of patients underwent surgical treatment, while 17% (n=13,907) were treated conservatively. Hospital size was categorised into four groups according to the number of acute beds:  $\leq 199$  (13.9%), 200–399 (40.4%), 400–599 (28.6%), and  $\geq 600$  (15.0%). The proportion of patients with comorbidities at admission was as follows: malignancy (5.7%), diabetes mellitus (13.4%), cardiovascular disease (7.6%), cerebrovascular disease (8.0%), lung disease (6.4%), renal failure (4.4%) and hepatic failure (0.8%).

### Univariate analysis of in-hospital mortality

Table 2 shows the factors associated with in-hospital mortality according to the univariate analysis. The overall in-hospital mortality rate was 3.3% (n=2,681) with the average length of stay of 38 days. Male gender, advancing age, conservative treatment and smaller hospital size were significantly associated with higher mortality. As for

Shoda et al.

comorbidities, patients with malignancy, lung disease, renal failure and hepatic failure at admission exhibited higher mortality rates. In contrast, diabetes mellitus, cardiovascular disease or cerebrovascular disease did not significantly affect the mortality of the patients. The number of comorbidities at admission was positively related to the mortality rate.

### **Multivariate analysis of in-hospital mortality**

Table 3 shows the adjusted OR and 95% CI for in-hospital mortality as determined by multivariate analysis. Consistent with the univariate analysis, the in-hospital mortality was significantly associated with male gender (OR 2.12 compared with female gender;  $p < 0.001$ ), advancing age (OR 1.57 in the 70–79 years age group, 2.28 in the 80–89 years group and 3.51 in the  $\geq 90$  years group compared with the 60–69 years age group,  $p < 0.001$ ), conservative treatment (OR 4.25 compared with the surgical treatment group,  $p < 0.001$ ), and number of comorbidities (OR 2.50 in patients with one comorbidity and 3.79 in those with two or more comorbidities as compared with no comorbidity,  $p < 0.001$ ). There was no association with hospital size. We then stratified the patients into the following three groups according to the number of comorbidities: no comorbidity ( $n=51,544$ ), one comorbidity ( $n=22,170$ ), and two or more comorbidities

1 Shoda et al.

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6 (n=7,086). Regardless of the number of comorbidities, conservative treatment was  
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9 significantly associated with higher mortality compared with surgical treatment (fig 1A).  
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12 In addition, patients with conservative treatment exhibited higher mortality even the  
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15 patients were stratified according to age (fig 1B).  
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18 We finally analysed the effect of surgical delays on in-hospital mortality in patients  
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21 treated surgically. Delays to surgery of 5 days or longer after admission were  
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24 significantly associated with a higher rate of in-hospital mortality (OR 1.34; 95% CI  
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27 1.20 to 1.50), while there was no significant difference in mortality among patients  
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30 undergoing surgery within 4 days.  
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### 33 34 35 **DISCUSSION**

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38 Previous studies have reported that 3.6% to 6.0% of patients with hip fractures die  
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41 during hospitalisation,<sup>9 20</sup> and that the 1-year mortality rate is between 10.1% and  
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44 27.3%.<sup>12 21</sup> The reasons for the high mortality rate after hip fracture have been  
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47 extensively studied. Frost et al. recently reported that men had a 2.4 times higher risk of  
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50 in-hospital death compared with women, and advancing age increased the risk by 2.06  
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53 times for every 10-year increase in age.<sup>9</sup> Maggi et al. reported that 6-month mortality  
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56 was positively associated with increasing age, comorbidity, pre-fracture functional  
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Shoda et al.

disability and having surgery more than 48 hours after admission.<sup>22</sup> Hu et al. identified the following 12 preoperative predictors of postoperative mortality in hip fracture patients through systematic review: advanced age, male gender, nursing home or facility residence, poor preoperative walking capacity, poor activities of daily living, higher ASA (American Society of Anesthesiologists) grading, poor mental state, multiple comorbidities, dementia or cognitive impairment, diabetes, cancer and cardiac disease.<sup>10</sup>

In this study, we investigated the in-hospital mortality rate after hip fractures using the Japanese DPC administrative claims database. The DPC database is equivalent in several ways to the Nationwide Inpatient Sample database in the United States, but there is an advantage of the DPC database whereby complications occurring after admission are clearly differentiated with comorbidities that were already present at admission.

In our study, 83% of the patients underwent surgery and 17% were treated conservatively, which were similar rates to previous studies. Among them, 3.3% of patients died during the hospitalisation. The overall mortality rate was slightly lower than that in previous reports. In multivariate analysis, we found that male gender, advancing age and number of comorbidities were positively and independently associated with the mortality, which is consistent with previous studies. The size of hospital as determined by the number of acute beds had no significant relationship with

1 Shoda et al.

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6 in-hospital mortality in our study. This result may suggest that high risk patients are not  
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9 necessarily treated at large hospitals. Schilling et al. reported that decreased  
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12 hospital-wide nurse staffing levels are associated with increased in-hospital mortality  
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15 among patients with hip fracture.<sup>20</sup> In contrast, Browne et al. reported that hospital  
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18 volume is not associated with decreased mortality in the treatment of hip fractures.<sup>23</sup>  
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21 There are various scales to represent hospital quality, so more studies may be needed to  
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24 clarify the relationship between hospital quality and hip fracture mortality.  
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27 Interestingly, conservative treatment was an independent risk factor for in-hospital  
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29 mortality. The analysis indicated that this did not arise because of patients with higher  
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32 risks being more likely to undergo conservative treatment, because patients treated  
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35 conservatively exhibited more than four times higher risk for mortality even after  
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38 stratification according to the number of comorbidities or age. The exact reason for the  
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41 higher mortality in conservatively treated patients is unclear, but the patients treated  
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44 surgically can start rehabilitation earlier, and therefore avoid the complications caused  
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47 by long-term bed rest such as bedsores, venous thromboembolism, atelectasis and  
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50 hypostatic pneumonia.  
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54 We found that surgical delays of 5 days or more were significantly associated with  
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57 higher rates of in-hospital mortality, which was consistent with the recent prospective  
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1 Shoda et al.

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6 cohort study by Vidan et al., showing that surgical delays longer than 5 days were

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9 associated with higher mortality and medical complication rates.<sup>15</sup>

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12 Our study has several limitations. First, this is a retrospective observational study.

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15 Thus, patient allocation was non-randomised and the cohort of patients we used did not

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18 constitute random sampling. Consequently, our results are potentially biased due to

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21 unmeasured confounders. Second, the DPC adopting hospitals are generally of large

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24 size although the DPC database covered more than 40% of all inpatient admissions in

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27 Japan. Third, this database is for administrative claims, so recorded diagnoses may be

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30 less well validated than in planned prospective surveys. Finally, this database includes

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33 information only during the hospitalisation, and we were unable to determine the

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36 condition of patients before admission or after discharge. Despite these limitations, our

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39 study provides helpful information about the risk factors of in-hospital mortality for

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42 treatment decision-making in patients with hip fractures.

## 43 44 45 46 47 **CONCLUSION**

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50 This study has shown that timely surgical treatment in patients with hip fractures was

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53 associated with lower rates of in-hospital mortality.

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## 8 **Acknowledgement**

9 **Contributors:** NS, HY, HH and ST designed the study, analysed and interpreted the  
10 data, and drafted the manuscript. YK contributed to the study design, analysis and  
11 interpretation of the data. SM interpreted the data and made significant contributions to  
12 drafts of the manuscript. All authors had full access to all data (including statistical  
13 reports and tables) in the study and take responsibility for the integrity of the data and  
14 the accuracy of the data analysis. SN, HY and ST are guarantors.  
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50 **Competing interests:** None declared.  
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53 **Ethical approval:** Not needed  
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Shoda et al.

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Shoda et al.

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Shoda et al.

**Figure legends**

Table 1 Patient characteristics

Table 2 Risk factors for in-hospital mortality (univariate analysis)

Table 3 Risk factors for in-hospital mortality (multivariate analysis)

Fig 1 Odds ratios of in-hospital mortality and 95% confidence intervals in hip fracture patients treated conservatively. **A.** Patients were stratified into three groups according to the number of comorbidities. **B.** Patients were stratified into four groups according to age.

Shoda et al.

Table 1 Patient characteristics

	n	(%)
<b>Gender</b>		
Females	63,920	(79.1)
Males	16,880	(20.9)
<b>Age</b>		
60–69	5,523	(6.8)
70–79	18,618	(23.0)
80–89	37,362	(46.2)
≥90	19,297	(23.9)
<b>Treatment</b>		
Surgical	66,893	(82.8)
Conservative	13,907	(17.2)
<b>Hospital size (number of acute beds)</b>		
≤199	11,243	(13.9)
200–399	32,613	(40.4)
400–599	23,125	(28.6)
≥600	12,099	(15.0)
<b>Comorbidities</b>		
Malignancy	4,753	(5.7)
Diabetes mellitus	10,795	(13.4)
Cardiovascular disease	6,147	(7.6)
Cerebrovascular disease	6,438	(8.0)
Lung disease	5,179	(6.4)
Renal failure	3,554	(4.4)
Hepatic failure	646	(0.8)
<b>Number of comorbidities</b>		
0	51,544	(63.8)
1	22,170	(27.4)
≥2	7,086	(8.8)

Shoda et al.

Table 2 Risk factors for in-hospital mortality (univariate analysis)

	n	(%)	p-value
<b>Total</b>	2681	(3.3)	
<b>Gender</b>			
Females	1677	(2.6)	<0.001
Males	1004	(5.9)	
<b>Age</b>			
60–69	97	(1.8)	<0.001
70–79	488	(2.6)	
80–89	1223	(3.3)	
≥90	873	(4.5)	
<b>Treatment</b>			
Surgical	1372	(2.1)	<0.001
Conservative	1309	(9.4)	
<b>Hospital size (number of acute beds)</b>			
≤199	454	(4.0)	<0.001
200–399	1080	(3.3)	
400–599	672	(2.9)	
≥600	412	(3.4)	
<b>Comorbidities</b>			
Malignancy	669	(14.6)	<0.001
Diabetes mellitus	365	(3.4)	0.694
Cardiovascular disease	198	(3.2)	0.659
Cerebrovascular disease	215	(3.3)	0.920
Lung disease	516	(10.0)	<0.001
Renal failure	305	(8.6)	<0.001
Hepatic failure	126	(19.5)	<0.001
<b>Number of comorbidities</b>			
0	968	(1.9)	<0.001
1	1139	(5.1)	
≥2	574	(8.1)	

Shoda et al.

Table 3 Risk factors for in-hospital mortality (multivariate analysis)

		Odds ratio	95% confidence interval	p-value
<b>Gender</b>				
	Females	reference		
	Males	2.12	1.94 to 2.31	<0.001
<b>Age</b>				
	60–69	reference		
	70–79	1.57	1.25 to 1.96	<0.001
	80–89	2.28	1.84 to 2.82	<0.001
	≥90	3.51	2.83 to 4.37	<0.001
<b>Treatment</b>				
	Surgical	reference		
	Conservative	4.25	3.92 to 4.61	<0.001
<b>Hospital size (number of acute beds)</b>				
	≤199	reference		
	200–399	0.99	0.88 to 1.11	0.814
	400–599	0.88	0.77 to 1.00	0.043
	≥600	0.93	0.81 to 1.07	0.304
<b>Number of comorbidities</b>				
	0	reference		
	1	2.50	2.28 to 2.74	<0.001
	≥2	3.79	3.38 to 4.24	<0.001

Shoda et al.

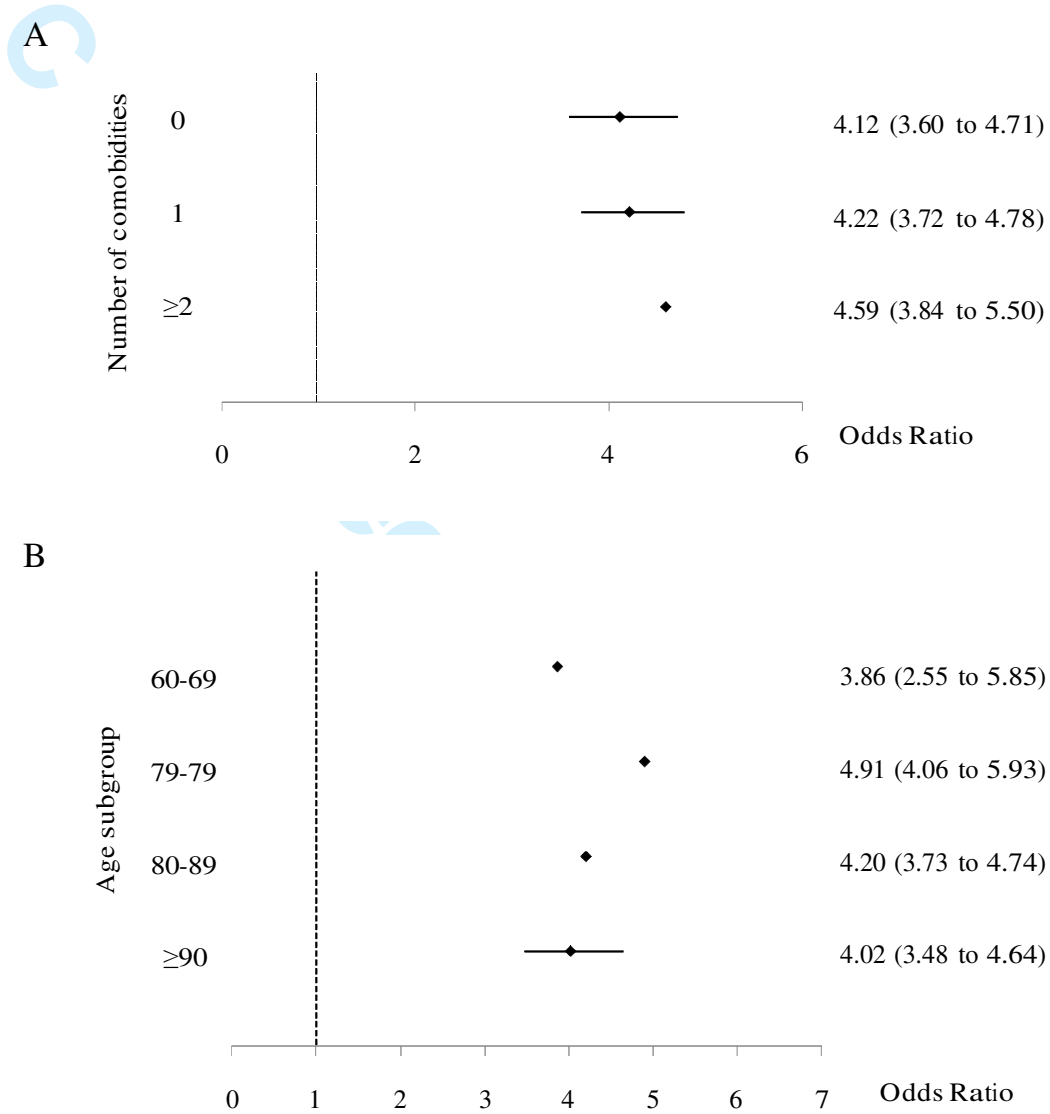


Fig 1



**Risk factors affecting in-hospital mortality after hip fracture: retrospective analysis using the Japanese Diagnosis Procedure Combination database**

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6 **Risk factors affecting in-hospital mortality after hip fracture: retrospective**  
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9 **analysis using the Japanese Diagnosis Procedure Combination database**  
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Shoda et al.

## Article Summary

### Article focus

- Hip fracture leads to impaired function, loss of independence and increased mortality of the patients.
- The aim of this study is to identify risk factors for in-hospital mortality in patients with hip fractures

### Key messages

- Using the Japanese Diagnosis Procedure Combination (DPC) nationwide administrative claims database, we analysed 80,800 hip fracture patients in total.
- The overall in-hospital mortality rate was 3.3%, and the in-hospital mortality was significantly associated with male gender (OR 2.12 compared with female gender;  $p < 0.001$ ), advancing age (OR 1.57 in the 70–79 years age group, 2.28 in the 80–89 years group and 3.51 in the  $\geq 90$  years group compared with the 60–69 years age group,  $p < 0.001$ ), conservative treatment (OR 4.25 compared with the surgical treatment group,  $p < 0.001$ ), and number of comorbidities (OR 2.50 in patients with one comorbidity and 3.79 in those with two or more comorbidities as compared with no comorbidity,  $p < 0.001$ ). W
- The proportion of patients with delay to surgery of 5 days or longer was 53.6%, and

Shoda et al.

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6 the delay was significantly associated with a higher rate of in-hospital mortality (OR  
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9 1.34; 95% CI 1.20 to 1.50), while there was no significant difference in mortality  
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12 among patients undergoing surgery within 4 days.

### 13 14 15 **Strengths and limitations of this study**

- 16  
17  
18 ■ We analysed a large number of patients using the Japanese DPC administrative  
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claims database, which included approximately 40% of all the in-patient admissions  
to acute care hospitals in Japan.
- Complications occurring after admission are clearly differentiated with  
comorbidities that were already present at admission.
- This is a retrospective observational study, and the database includes information  
only during the hospitalisation.

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6 **Abstract**  
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8 **Objective:** To identify risk factors for in-hospital mortality in patients with hip fractures  
9 using the Japanese Diagnosis Procedure Combination (DPC) nationwide administrative  
10 claims database.  
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16 **Design:** Retrospective observational study.  
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18 **Setting:** Hospitals adopting the DPC system during 2007–2009.  
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20 **Participants:** We extracted a total of 80,800 eligible patients aged  $\geq 60$  years old with a  
21 single hip fracture (ICD-10 codes: S72.0 and S72.1). The DPC database includes  
22 patients treated between July and December each year.  
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32 **Main outcome measures:** In-hospital mortality after hip fracture.  
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34 **Results:** The overall in-hospital mortality rate after hip fractures was 3.3%. Multivariate  
35 analysis indicated that in-hospital mortality was significantly associated with male  
36 gender (odds ratio [OR] 2.12; 95% confidence interval [CI] 1.94 to 2.31), advancing age  
37 and number of comorbidities. Significantly higher mortality was observed in those  
38 treated conservatively (OR 4.25; 95% CI 3.92 to 4.61). Surgical delays of 5 days or  
39 more were significantly associated with higher rates of in-hospital mortality (OR 1.34;  
40 95% CI 1.20 to 1.50).  
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55 **Conclusions:** In patients with hip fractures, male gender, advancing age, high number  
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*Shoda et al.*

of comorbidities and the surgical delay of 5 days or more were associated with higher rates of in-hospital mortality.

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Shoda et al.

## INTRODUCTION

Hip fracture is a serious injury related to bone fragility caused by osteoporosis, and it has emerged as a public health burden in an aging society such as that of Japan.<sup>1-5</sup> It is estimated that the number of hip fractures worldwide will rise from 1.7 million in 1990 to 6.3 million in 2050.<sup>6</sup> Recent studies have reported an increased incidence of hip fractures in Japan<sup>3,5</sup> although the incidence is decreasing in some Western countries.<sup>7,8</sup> Hip fracture leads to impaired function, loss of independence and increased mortality of the patients. It has been reported that the increased mortality after hip fracture is associated with many factors such as increasing age, comorbidity and pre-fracture functional disability of the patients.<sup>9-12</sup> Hip fractures are usually treated by orthopaedic surgical procedures such as hemiarthroplasty or internal fixation, and several studies have shown that early surgery is associated with lower rates of mortality,<sup>13-16</sup> while other studies exhibited no benefit of early surgery in reducing mortality or improving functional recovery.<sup>17,18</sup> Conservative treatment is often chosen for patients with severe comorbidities. However, it is not clear whether conservative treatment is actually superior in reducing mortality compared with surgical treatment in high risk patients. In this study, we investigated the in-hospital mortality rate of hip fracture patients using data from the Japanese Diagnosis Procedure Combination (DPC) nationwide

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6 administrative claims database, and compared mortality following hip fractures between  
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9 groups treated surgically or conservatively.

## 10 11 12 13 14 **METHODS**

### 15 16 17 **DPC database**

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20 The DPC database is a diagnosis-dominant case-mix system administered by the  
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23 Ministry of Health, Labour and Welfare of Japan, and linked with a lump-sum payment  
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25  
26 system.<sup>19</sup> All 82 university teaching hospitals in Japan are obliged to adopt the DPC  
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29 system, while adoption by community hospitals is voluntary. A comprehensive survey  
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32 of the DPC hospitals is conducted between July 1 and December 31 each year by the  
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35 DPC Research Group, funded by the Japanese government. Detailed patient data, as  
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37  
38 well as administrative claims data, are collected for all the inpatients discharged from  
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40  
41 the participating hospitals between July 1 and December 31 each year. The number of  
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44 participating hospitals increased to 818 with 2.57 million patients in 2009, which  
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46  
47 represented approximately 40% of all the in-patient admissions to acute care hospitals  
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50 in Japan. Hospitals send all the anonymised data for each month to the DPC Research  
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52  
53 Group for compilation in the database server in the Department of Health Management  
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56 and Policy, The University of Tokyo.

1 *Shoda et al.*  
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6 The database includes the following data: hospital location; patients' age and sex;  
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8 diagnoses, comorbidities at admission, and complications after admission, recorded in  
9 accordance with the International Classification of Diseases, 10th Revision (ICD-10)  
10 codes and text data in the Japanese language; procedures coded with the Japanese  
11 original K codes; comorbidities at admission; complications after admission coded with  
12 the ICD-10 codes; in-hospital mortality; length of stay; and hospital charges.  
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23 This study was based on a secondary analysis of the administrative claims data. The  
24 requirement for informed consent was waived because of the anonymous nature of the  
25 data. Study approval was obtained from the Institutional Review Board at the University  
26 of Occupational and Environmental Health.  
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### 38 **Data compilation**

39 We retrospectively collected data of patients coded S72.0 (fracture of the neck of the  
40 femur) and S72.1 (peritrochanteric fracture) between 2007 and 2009 from the DPC  
41 database. Exclusion criteria were as follows: age < 60 years; patients with open  
42 fractures or multiple fractures; and incomplete data. We extracted data on age, sex,  
43 method of treatment (surgical or conservative), number of acute beds and in-hospital  
44 mortality. From the comorbidities at admission, we collected data on seven factors:  
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6 malignancy, diabetes mellitus, cardiovascular disease, cerebrovascular disease, lung  
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9 disease, renal failure, hepatic failure.

### 14 **Statistical analysis**

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17 The Chi-squared test was used for univariate comparisons of the surgical and  
18  
19 conservative treatment groups. Multivariate logistic regression analysis was performed  
20  
21 to analyse the confounding effects of various factors on in-hospital mortality. Odds  
22  
23 ratios (OR) and 95% confidence intervals (CI) were determined. The OR of in-hospital  
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25 mortality in conservatively treated patients was analysed in subgroups of patients  
26  
27 stratified according to number of comorbidities or age. In addition, the effect of surgical  
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29 delays in surgically treated patients was analysed. A p-value <0.05 was considered  
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31 significant. All the statistical analyses were performed using SPSS Statistics ver. 19.0  
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33 (IBM SPSS Inc.; Chicago, IL, US).  
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47 **Data sharing statement:** No additional data are available.  
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## 52 **RESULTS**

### 53 **Patient background**

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6 Data of 94,139 patients with hip fractures were extracted based on ICD-10 codes. We  
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8  
9 excluded 8,956 patients with open fractures or multiple fractures, 496 patients with  
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12 incomplete data and 3887 patients aged <60 years. Finally, 80,800 eligible patients were  
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15 included in the analysis.

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17  
18 Table 1 presents the patient characteristics. Overall, 79.1% were females. The mean  
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20 (standard deviation) age was 82.8 (8.3) years. The patients were categorised into the  
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22  
23 following four age groups: 60–69 (n=5,523), 70–79 (n=18,618), 80–89 (n=37,362), and  
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25  
26  $\geq 90$  (n=19,297). Approximately 83% (n=66,893) of patients underwent surgical  
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29 treatment, while 17% (n=13,907) were treated conservatively. Hospital size was  
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32 categorised into four groups according to the number of acute beds:  $\leq 199$  (13.9%),  
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35 200–399 (40.4%), 400–599 (28.6%), and  $\geq 600$  (15.0%). The proportion of patients with  
36  
37  
38 comorbidities at admission was as follows: malignancy (5.7%), diabetes mellitus  
39  
40  
41 (13.4%), cardiovascular disease (7.6%), cerebrovascular disease (8.0%), lung disease  
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44 (6.4%), renal failure (4.4%) and hepatic failure (0.8%).  
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### 50 **Univariate analysis of in-hospital mortality**

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52 Table 2 shows the factors associated with in-hospital mortality according to the  
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55 univariate analysis. The overall in-hospital mortality rate was 3.3% (n=2,681) with the  
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6 average length of stay of 38 days. Male gender, advancing age, conservative treatment  
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8 and smaller hospital size were significantly associated with higher mortality. As for  
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10 comorbidities, patients with malignancy, lung disease, renal failure and hepatic failure at  
11  
12 admission exhibited higher mortality rates. In contrast, diabetes mellitus, cardiovascular  
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14 disease or cerebrovascular disease did not significantly affect the mortality of the  
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16 patients. The number of comorbidities at admission was positively related to the  
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18 mortality rate.  
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### 29 **Multivariate analysis of in-hospital mortality**

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31  
32 Table 3 shows the adjusted OR and 95% CI for in-hospital mortality as determined by  
33  
34 multivariate analysis. Consistent with the univariate analysis, the in-hospital mortality  
35  
36 was significantly associated with male gender (OR 2.12 compared with female gender;  
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38  $p < 0.001$ ), advancing age (OR 1.57 in the 70–79 years age group, 2.28 in the 80–89  
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40 years group and 3.51 in the  $\geq 90$  years group compared with the 60–69 years age group,  
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42  $p < 0.001$ ), conservative treatment (OR 4.25 compared with the surgical treatment group,  
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44  $p < 0.001$ ), and number of comorbidities (OR 2.50 in patients with one comorbidity and  
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46 3.79 in those with two or more comorbidities as compared with no comorbidity,  
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48  $p < 0.001$ ). There was no association with hospital size. We then stratified the patients  
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6 into the following three groups according to the number of comorbidities: no  
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9 comorbidity (n=51,544), one comorbidity (n=22,170), and two or more comorbidities  
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11 (n=7,086). Regardless of the number of comorbidities, conservative treatment was  
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13 significantly associated with higher mortality compared with surgical treatment (fig 1A).  
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15 In addition, patients with conservative treatment exhibited higher mortality even the  
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17 patients were stratified according to age (fig 1B).  
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23 We finally analysed the effect of surgical delays on in-hospital mortality in patients  
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25 treated surgically. The proportion of patients with delay to surgery of 5 days or longer  
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27 was 53.6%, and the delay was significantly associated with a higher rate of in-hospital  
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29 mortality (OR 1.34; 95% CI 1.20 to 1.50), while there was no significant difference in  
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31 mortality among patients undergoing surgery within 4 days.  
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## 41 **DISCUSSION**

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43 Previous studies have reported that 3.6% to 6.0% of patients with hip fractures die  
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45 during hospitalisation,<sup>9 20</sup> and that the 1-year mortality rate is between 10.1% and  
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47 27.3%.<sup>12 21</sup> The reasons for the high mortality rate after hip fracture have been  
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49 extensively studied. Frost et al. recently reported that men had a 2.4 times higher risk of  
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51 in-hospital death compared with women, and advancing age increased the risk by 2.06  
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6 times for every 10-year increase in age.<sup>9</sup> Maggi et al. reported that 6-month mortality  
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9 was positively associated with increasing age, comorbidity, pre-fracture functional  
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12 disability and having surgery more than 48 hours after admission.<sup>22</sup> Hu et al. identified  
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15 the following 12 preoperative predictors of postoperative mortality in hip fracture  
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18 patients through systematic review: advanced age, male gender, nursing home or facility  
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21 residence, poor preoperative walking capacity, poor activities of daily living, higher  
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24 ASA (American Society of Anesthesiologists) grading, poor mental state, multiple  
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27 comorbidities, dementia or cognitive impairment, diabetes, cancer and cardiac disease.<sup>10</sup>  
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29  
30 In this study, we investigated the in-hospital mortality rate after hip fractures using  
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32 the Japanese DPC administrative claims database. The DPC database is equivalent in  
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35 several ways to the Nationwide Inpatient Sample database in the United States, but there  
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38 is an advantage of the DPC database whereby complications occurring after admission  
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41 are clearly differentiated with comorbidities that were already present at admission.  
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44 In our study, 83% of the patients underwent surgery and 17% were treated  
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47 conservatively, which were similar rates to previous studies<sup>21</sup>. The proportion of  
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50 conservative treatment was higher than that in the Western countries, which may be due  
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53 to the insurance system in Japan, which allows patients a longer hospital stay.  
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56 Overall, 3.3% of patients died during the hospitalisation. The mortality rate was  
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6 slightly lower than that in previous reports. In multivariate analysis, we found that male  
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9 gender, advancing age and number of comorbidities were positively and independently  
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12 associated with the mortality, which is consistent with previous studies. The size of  
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15 hospital as determined by the number of acute beds had no significant relationship with  
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18 in-hospital mortality in our study. This result may suggest that high risk patients are not  
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21 necessarily treated at large hospitals. Schilling et al. reported that decreased  
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24 hospital-wide nurse staffing levels are associated with increased in-hospital mortality  
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27 among patients with hip fracture.<sup>20</sup> In contrast, Browne et al. reported that hospital  
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30 volume is not associated with decreased mortality in the treatment of hip fractures.<sup>23</sup>  
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32 There are various scales to represent hospital quality, so more studies may be needed to  
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35 clarify the relationship between hospital quality and hip fracture mortality.  
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38 Interestingly, conservative treatment was an independent risk factor for in-hospital  
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41 mortality. The analysis indicated that this did not arise because of patients with higher  
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44 risks being more likely to undergo conservative treatment, because patients treated  
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47 conservatively exhibited more than four times higher risk for mortality even after  
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50 stratification according to the number of comorbidities or age. The exact reason for the  
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53 higher mortality in conservatively treated patients is unclear, but the patients treated  
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56 surgically can start rehabilitation earlier, and therefore avoid the complications caused  
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6 by long-term bed rest such as bedsores, venous thromboembolism, atelectasis and  
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9 hypostatic pneumonia.

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11 We found that surgical delays of 5 days or more were significantly associated with  
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13 higher rates of in-hospital mortality, which was consistent with the recent prospective  
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15 cohort study by Vidan et al., showing that surgical delays longer than 5 days were  
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17 associated with higher mortality and medical complication rates.<sup>15</sup>  
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23 Our study has several limitations. First, this is a retrospective observational study.  
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25 Thus, patient allocation was non-randomised and the cohort of patients we used did not  
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27 constitute random sampling. Consequently, our results are potentially biased due to  
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29 unmeasured confounders. Second, the DPC adopting hospitals are generally of large  
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31 size although the DPC database covered more than 40% of all inpatient admissions in  
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33 Japan. Third, this database is for administrative claims, so recorded diagnoses may be  
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35 less well validated than in planned prospective surveys. Finally, this database includes  
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37 information only during the hospitalisation, and we were unable to determine the  
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39 condition of patients before admission or after discharge. Despite these limitations, our  
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41 study provides helpful information about the risk factors of in-hospital mortality for  
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43 treatment decision-making in patients with hip fractures.  
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## 6 **CONCLUSION**

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9 This study has shown that male gender, advancing age, high number of comorbidities  
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11 and surgical delay were associated with higher rates of in-hospital mortality in patients  
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13 with hip fractures.  
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## 20 **Acknowledgement**

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22  
23 **Contributors:** NS, HY, HH and ST designed the study, analysed and interpreted the  
24  
25 data, and drafted the manuscript. YK contributed to the study design, analysis and  
26  
27 interpretation of the data. SM interpreted the data and made significant contributions to  
28  
29 drafts of the manuscript. All authors had full access to all data (including statistical  
30  
31 reports and tables) in the study and take responsibility for the integrity of the data and  
32  
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50 involved in the design, conduct or interpretation of the study, or in the writing of the  
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*Shoda et al.*

submitted work.

**Competing interests:** None declared.

**Ethical approval:** Not needed

For peer review only

Shoda et al.

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Shoda et al.

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1 *Shoda et al.*

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6 **Figure legends**

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9 **Fig 1** Odds ratios of in-hospital mortality and 95% confidence intervals in hip fracture  
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11 patients treated conservatively. **A.** Patients were stratified into three groups according to  
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13 the number of comorbidities. **B.** Patients were stratified into four groups according to  
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15 age.  
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Shoda et al.

Table 1 Patient characteristics

	n	(%)
<b>Gender</b>		
Females	63,920	(79.1)
Males	16,880	(20.9)
<b>Age</b>		
60–69	5,523	(6.8)
70–79	18,618	(23.0)
80–89	37,362	(46.2)
≥90	19,297	(23.9)
<b>Treatment</b>		
Surgical	66,893	(82.8)
Conservative	13,907	(17.2)
<b>Hospital size (number of acute beds)</b>		
≤199	11,243	(13.9)
200–399	32,613	(40.4)
400–599	23,125	(28.6)
≥600	12,099	(15.0)
<b>Comorbidities</b>		
Malignancy	4,753	(5.7)
Diabetes mellitus	10,795	(13.4)
Cardiovascular disease	6,147	(7.6)
Cerebrovascular disease	6,438	(8.0)
Lung disease	5,179	(6.4)
Renal failure	3,554	(4.4)
Hepatic failure	646	(0.8)
<b>Number of comorbidities</b>		
0	51,544	(63.8)
1	22,170	(27.4)
≥2	7,086	(8.8)

Shoda et al.

Table 2 Risk factors for in-hospital mortality (univariate analysis)

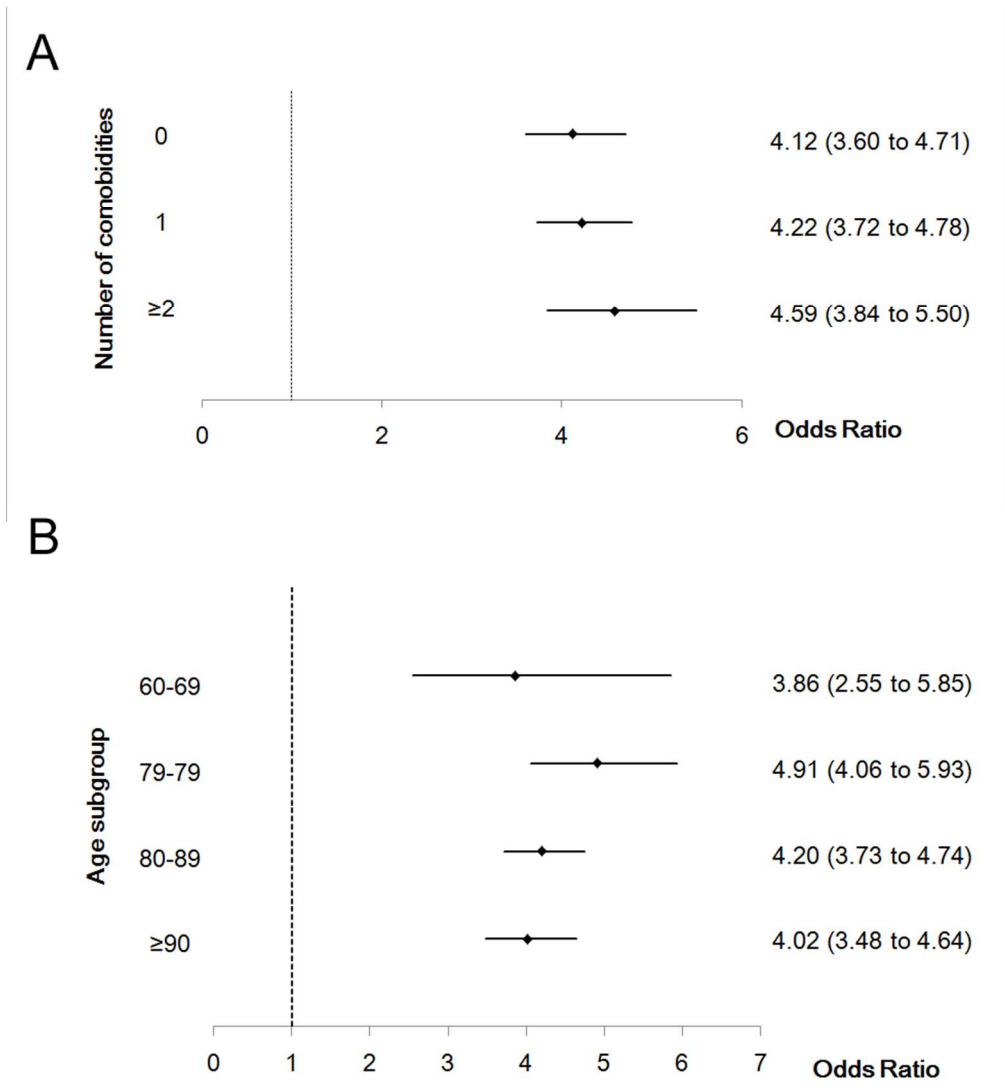
	In-hospital mortality		
	n	(%)	p-value
<b>Total</b>	2681	(3.3)	
<b>Gender</b>			
Females	1677	(2.6)	<0.001
Males	1004	(5.9)	
<b>Age</b>			
60–69	97	(1.8)	<0.001
70–79	488	(2.6)	
80–89	1223	(3.3)	
≥90	873	(4.5)	
<b>Treatment</b>			
Surgical	1372	(2.1)	<0.001
Conservative	1309	(9.4)	
<b>Hospital size (number of acute beds)</b>			
≤199	454	(4.0)	<0.001
200–399	1080	(3.3)	
400–599	672	(2.9)	
≥600	412	(3.4)	
<b>Comorbidities</b>			
Malignancy	669	(14.6)	<0.001
Diabetes mellitus	365	(3.4)	0.694
Cardiovascular disease	198	(3.2)	0.659
Cerebrovascular disease	215	(3.3)	0.920
Lung disease	516	(10.0)	<0.001
Renal failure	305	(8.6)	<0.001
Hepatic failure	126	(19.5)	<0.001
<b>Number of comorbidities</b>			
0	968	(1.9)	<0.001
1	1139	(5.1)	
≥2	574	(8.1)	

Shoda et al.

Table 3 Risk factors for in-hospital mortality (multivariate analysis)

	Odds ratio	95% confidence interval	p-value
<b>Gender</b>			
Females	reference		
Males	2.12	1.94 to 2.31	<0.001
<b>Age</b>			
60–69	reference		
70–79	1.57	1.25 to 1.96	<0.001
80–89	2.28	1.84 to 2.82	<0.001
≥90	3.51	2.83 to 4.37	<0.001
<b>Treatment</b>			
Surgical	reference		
Conservative	4.25	3.92 to 4.61	<0.001
<b>Hospital size (number of acute beds)</b>			
≤199	reference		
200–399	0.99	0.88 to 1.11	0.814
400–599	0.88	0.77 to 1.00	0.043
≥600	0.93	0.81 to 1.07	0.304
<b>Number of comorbidities</b>			
0	reference		
1	2.50	2.28 to 2.74	<0.001
≥2	3.79	3.38 to 4.24	<0.001

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**Risk factors affecting in-hospital mortality after hip fracture: retrospective**

**analysis using the Japanese Diagnosis Procedure Combination database**

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## Article Summary

### Article focus

■ Hip fracture leads to impaired function, loss of independence and increased mortality of the patients.

■ The aim of this study is to identify risk factors for in-hospital mortality in patients with hip fractures

### Key messages

■ Using the Japanese Diagnosis Procedure Combination (DPC) nationwide administrative claims database, we analysed 80,800 hip fracture patients in total.

■ The overall in-hospital mortality rate was 3.3%, and the in-hospital mortality was significantly associated with male gender (OR 2.12 compared with female gender;  $p < 0.001$ ), advancing age (OR 1.57 in the 70–79 years age group, 2.28 in the 80–89 years group and 3.51 in the  $\geq 90$  years group compared with the 60–69 years age group,  $p < 0.001$ ), conservative treatment (OR 4.25 compared with the surgical treatment group,  $p < 0.001$ ), and number of comorbidities (OR 2.50 in patients with one comorbidity and 3.79 in those with two or more comorbidities as compared with no comorbidity,  $p < 0.001$ ). W

■ The proportion of patients with delay to surgery of 5 days or longer was 53.6%, and

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6 the delay was significantly associated with a higher rate of in-hospital mortality (OR  
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9 1.34; 95% CI 1.20 to 1.50), while there was no significant difference in mortality  
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12 among patients undergoing surgery within 4 days.

### 13 14 15 **Strengths and limitations of this study**

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17 ■ We analysed a large number of patients using the Japanese DPC administrative  
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claims database, which included approximately 40% of all the in-patient admissions  
to acute care hospitals in Japan.
- Complications occurring after admission are clearly differentiated with  
comorbidities that were already present at admission.
- This is a retrospective observational study, and the database includes information  
only during the hospitalisation.

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6 **Abstract**

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9 **Objective:** To identify risk factors for in-hospital mortality in patients with hip fractures  
10 using the Japanese Diagnosis Procedure Combination (DPC) nationwide administrative  
11 claims database.  
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17 **Design:** Retrospective observational study.

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20 **Setting:** Hospitals adopting the DPC system during 2007–2009.

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23 **Participants:** We extracted a total of 80,800 eligible patients aged  $\geq 60$  years old with a  
24 single hip fracture (ICD-10 codes: S72.0 and S72.1). The DPC database includes  
25 patients treated between July and December each year.  
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31 **Main outcome measures:** In-hospital mortality after hip fracture.

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34 **Results:** The overall in-hospital mortality rate after hip fractures was 3.3%. Multivariate  
35 analysis indicated that in-hospital mortality was significantly associated with male  
36 gender (odds ratio [OR] 2.12; 95% confidence interval [CI] 1.94 to 2.31), advancing age  
37 and number of comorbidities. Significantly higher mortality was observed in those  
38 treated conservatively (OR 4.25; 95% CI 3.92 to 4.61). Surgical delays of 5 days or  
39 more were significantly associated with higher rates of in-hospital mortality (OR 1.34;  
40 95% CI 1.20 to 1.50).  
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55 **Conclusions:** In patients with hip fractures, male gender, advancing age, high number  
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of comorbidities and the surgical delay of 5 days or more were associated with higher rates of in-hospital mortality.

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Shoda et al., Supplementary file

## INTRODUCTION

Hip fracture is a serious injury related to bone fragility caused by osteoporosis, and it has emerged as a public health burden in an aging society such as that of Japan.<sup>1-5</sup> It is estimated that the number of hip fractures worldwide will rise from 1.7 million in 1990 to 6.3 million in 2050.<sup>6</sup> Recent studies have reported an increased incidence of hip fractures in Japan<sup>3,5</sup> although the incidence is decreasing in some Western countries.<sup>7,8</sup> Hip fracture leads to impaired function, loss of independence and increased mortality of the patients. It has been reported that the increased mortality after hip fracture is associated with many factors such as increasing age, comorbidity and pre-fracture functional disability of the patients.<sup>9-12</sup> Hip fractures are usually treated by orthopaedic surgical procedures such as hemiarthroplasty or internal fixation, and several studies have shown that early surgery is associated with lower rates of mortality,<sup>13-16</sup> while other studies exhibited no benefit of early surgery in reducing mortality or improving functional recovery.<sup>17,18</sup> Conservative treatment is often chosen for patients with severe comorbidities. However, it is not clear whether conservative treatment is actually superior in reducing mortality compared with surgical treatment in high risk patients. In this study, we investigated the in-hospital mortality rate of hip fracture patients using data from the Japanese Diagnosis Procedure Combination (DPC) nationwide

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6 administrative claims database, and compared mortality following hip fractures between  
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9 groups treated surgically or conservatively.

## 10 11 12 13 14 **METHODS**

### 15 16 17 **DPC database**

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20 The DPC database is a diagnosis-dominant case-mix system administered by the  
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23 Ministry of Health, Labour and Welfare of Japan, and linked with a lump-sum payment  
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26 system.<sup>19</sup> All 82 university teaching hospitals in Japan are obliged to adopt the DPC  
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29 system, while adoption by community hospitals is voluntary. A comprehensive survey  
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32 of the DPC hospitals is conducted between July 1 and December 31 each year by the  
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35 DPC Research Group, funded by the Japanese government. Detailed patient data, as  
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38 well as administrative claims data, are collected for all the inpatients discharged from  
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41 the participating hospitals between July 1 and December 31 each year. The number of  
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44 participating hospitals increased to 818 with 2.57 million patients in 2009, which  
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47 represented approximately 40% of all the in-patient admissions to acute care hospitals  
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50 in Japan. Hospitals send all the anonymised data for each month to the DPC Research  
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53 Group for compilation in the database server in the Department of Health Management  
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56 and Policy, The University of Tokyo.

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*Shoda et al., Supplementary file*

The database includes the following data: hospital location; patients' age and sex; diagnoses, comorbidities at admission, and complications after admission, recorded in accordance with the International Classification of Diseases, 10th Revision (ICD-10) codes and text data in the Japanese language; procedures coded with the Japanese original K codes; comorbidities at admission; complications after admission coded with the ICD-10 codes; in-hospital mortality; length of stay; and hospital charges.

This study was based on a secondary analysis of the administrative claims data. The requirement for informed consent was waived because of the anonymous nature of the data. Study approval was obtained from the Institutional Review Board at the University of Occupational and Environmental Health.

### **Data compilation**

We retrospectively collected data of patients coded S72.0 (fracture of the neck of the femur) and S72.1 (peritrochanteric fracture) between 2007 and 2009 from the DPC database. Exclusion criteria were as follows: age < 60 years; patients with open fractures or multiple fractures; and incomplete data. We extracted data on age, sex, method of treatment (surgical or conservative), number of acute beds and in-hospital mortality. From the comorbidities at admission, we collected data on seven factors:



1 *Shoda et al., Supplementary file*

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6 malignancy, diabetes mellitus, cardiovascular disease, cerebrovascular disease, lung  
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9 disease, renal failure, hepatic failure.

### 14 **Statistical analysis**

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17 The Chi-squared test was used for univariate comparisons of the surgical and  
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20 conservative treatment groups. Multivariate logistic regression analysis was performed  
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23 to analyse the confounding effects of various factors on in-hospital mortality. Odds  
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26 ratios (OR) and 95% confidence intervals (CI) were determined. The OR of in-hospital  
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29 mortality in conservatively treated patients was analysed in subgroups of patients  
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32 stratified according to number of comorbidities or age. In addition, the effect of surgical  
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35 delays in surgically treated patients was analysed. A p-value <0.05 was considered  
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38 significant. All the statistical analyses were performed using SPSS Statistics ver. 19.0  
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41 (IBM SPSS Inc.; Chicago, IL, US).

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46 **Data sharing statement:** No additional data are available.

## 51 **RESULTS**

### 52 **Patient background**

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6 Data of 94,139 patients with hip fractures were extracted based on ICD-10 codes. We  
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9 excluded 8,956 patients with open fractures or multiple fractures, 496 patients with  
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12 incomplete data and 3887 patients aged <60 years. Finally, 80,800 eligible patients were  
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15 included in the analysis.

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18 Table 1 presents the patient characteristics. Overall, 79.1% were females. The mean  
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20 (standard deviation) age was 82.8 (8.3) years. The patients were categorised into the  
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23 following four age groups: 60–69 (n=5,523), 70–79 (n=18,618), 80–89 (n=37,362), and  
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26  $\geq 90$  (n=19,297). Approximately 83% (n=66,893) of patients underwent surgical  
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29 treatment, while 17% (n=13,907) were treated conservatively. Hospital size was  
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32 categorised into four groups according to the number of acute beds:  $\leq 199$  (13.9%),  
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35 200–399 (40.4%), 400–599 (28.6%), and  $\geq 600$  (15.0%). The proportion of patients with  
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38 comorbidities at admission was as follows: malignancy (5.7%), diabetes mellitus  
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41 (13.4%), cardiovascular disease (7.6%), cerebrovascular disease (8.0%), lung disease  
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44 (6.4%), renal failure (4.4%) and hepatic failure (0.8%).  
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#### 49 **Univariate analysis of in-hospital mortality**

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52 Table 2 shows the factors associated with in-hospital mortality according to the  
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55 univariate analysis. The overall in-hospital mortality rate was 3.3% (n=2,681) with the  
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6 average length of stay of 38 days. Male gender, advancing age, conservative treatment  
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8 and smaller hospital size were significantly associated with higher mortality. As for  
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10 comorbidities, patients with malignancy, lung disease, renal failure and hepatic failure at  
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12 admission exhibited higher mortality rates. In contrast, diabetes mellitus, cardiovascular  
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14 disease or cerebrovascular disease did not significantly affect the mortality of the  
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16 patients. The number of comorbidities at admission was positively related to the  
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18 mortality rate.  
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### 29 **Multivariate analysis of in-hospital mortality**

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32 Table 3 shows the adjusted OR and 95% CI for in-hospital mortality as determined by  
33  
34 multivariate analysis. Consistent with the univariate analysis, the in-hospital mortality  
35  
36 was significantly associated with male gender (OR 2.12 compared with female gender;  
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38  $p < 0.001$ ), advancing age (OR 1.57 in the 70–79 years age group, 2.28 in the 80–89  
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40 years group and 3.51 in the  $\geq 90$  years group compared with the 60–69 years age group,  
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42  $p < 0.001$ ), conservative treatment (OR 4.25 compared with the surgical treatment group,  
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44  $p < 0.001$ ), and number of comorbidities (OR 2.50 in patients with one comorbidity and  
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46 3.79 in those with two or more comorbidities as compared with no comorbidity,  
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48  $p < 0.001$ ). There was no association with hospital size. We then stratified the patients  
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1 *Shoda et al., Supplementary file*

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6 into the following three groups according to the number of comorbidities: no  
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9 comorbidity (n=51,544), one comorbidity (n=22,170), and two or more comorbidities  
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11 (n=7,086). Regardless of the number of comorbidities, conservative treatment was  
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14 significantly associated with higher mortality compared with surgical treatment (fig 1A).  
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17 In addition, patients with conservative treatment exhibited higher mortality even the  
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20 patients were stratified according to age (fig 1B).  
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24 We finally analysed the effect of surgical delays on in-hospital mortality in patients  
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26 treated surgically. The proportion of patients with delay to surgery of 5 days or longer  
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28 was 53.6%, and the delay was significantly associated with a higher rate of in-hospital  
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30 mortality (OR 1.34; 95% CI 1.20 to 1.50), while there was no significant difference in  
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32 mortality among patients undergoing surgery within 4 days.  
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## 40 **DISCUSSION**

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43 Previous studies have reported that 3.6% to 6.0% of patients with hip fractures die  
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45 during hospitalisation,<sup>9 20</sup> and that the 1-year mortality rate is between 10.1% and  
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47 27.3%.<sup>12 21</sup> The reasons for the high mortality rate after hip fracture have been  
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49  
50 extensively studied. Frost et al. recently reported that men had a 2.4 times higher risk of  
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53 in-hospital death compared with women, and advancing age increased the risk by 2.06  
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Shoda et al., Supplementary file

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6 times for every 10-year increase in age.<sup>9</sup> Maggi et al. reported that 6-month mortality  
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9 was positively associated with increasing age, comorbidity, pre-fracture functional  
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12 disability and having surgery more than 48 hours after admission.<sup>22</sup> Hu et al. identified  
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15 the following 12 preoperative predictors of postoperative mortality in hip fracture  
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18 patients through systematic review: advanced age, male gender, nursing home or facility  
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21 residence, poor preoperative walking capacity, poor activities of daily living, higher  
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24 ASA (American Society of Anesthesiologists) grading, poor mental state, multiple  
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27 comorbidities, dementia or cognitive impairment, diabetes, cancer and cardiac disease.<sup>10</sup>  
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30 In this study, we investigated the in-hospital mortality rate after hip fractures using  
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32 the Japanese DPC administrative claims database. The DPC database is equivalent in  
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35 several ways to the Nationwide Inpatient Sample database in the United States, but there  
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38 is an advantage of the DPC database whereby complications occurring after admission  
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41 are clearly differentiated with comorbidities that were already present at admission.  
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44 In our study, 83% of the patients underwent surgery and 17% were treated  
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46 conservatively, which were similar rates to previous studies<sup>21</sup>. The proportion of  
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49 conservative treatment was higher than that in the Western countries, which may be due  
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52 to the insurance system in Japan, which allows patients a longer hospital stay.  
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55 Overall, 3.3% of patients died during the hospitalisation. The mortality rate was  
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6 slightly lower than that in previous reports. In multivariate analysis, we found that male  
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9 gender, advancing age and number of comorbidities were positively and independently  
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12 associated with the mortality, which is consistent with previous studies. The size of  
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15 hospital as determined by the number of acute beds had no significant relationship with  
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18 in-hospital mortality in our study. This result may suggest that high risk patients are not  
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21 necessarily treated at large hospitals. Schilling et al. reported that decreased  
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24 hospital-wide nurse staffing levels are associated with increased in-hospital mortality  
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26 among patients with hip fracture.<sup>20</sup> In contrast, Browne et al. reported that hospital  
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29 volume is not associated with decreased mortality in the treatment of hip fractures.<sup>23</sup>  
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32 There are various scales to represent hospital quality, so more studies may be needed to  
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35 clarify the relationship between hospital quality and hip fracture mortality.  
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38 Interestingly, conservative treatment was an independent risk factor for in-hospital  
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40 mortality. The analysis indicated that this did not arise because of patients with higher  
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42 risks being more likely to undergo conservative treatment, because patients treated  
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44 conservatively exhibited more than four times higher risk for mortality even after  
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47 stratification according to the number of comorbidities or age. The exact reason for the  
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50 higher mortality in conservatively treated patients is unclear, but the patients treated  
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53 surgically can start rehabilitation earlier, and therefore avoid the complications caused  
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6 by long-term bed rest such as bedsores, venous thromboembolism, atelectasis and  
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9 hypostatic pneumonia.

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11 We found that surgical delays of 5 days or more were significantly associated with  
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13 higher rates of in-hospital mortality, which was consistent with the recent prospective  
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15 cohort study by Vidan et al., showing that surgical delays longer than 5 days were  
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17 associated with higher mortality and medical complication rates.<sup>15</sup>  
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23 Our study has several limitations. First, this is a retrospective observational study.  
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25 Thus, patient allocation was non-randomised and the cohort of patients we used did not  
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27 constitute random sampling. Consequently, our results are potentially biased due to  
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29 unmeasured confounders. Second, the DPC adopting hospitals are generally of large  
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31 size although the DPC database covered more than 40% of all inpatient admissions in  
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33 Japan. Third, this database is for administrative claims, so recorded diagnoses may be  
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35 less well validated than in planned prospective surveys. Finally, this database includes  
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37 information only during the hospitalisation, and we were unable to determine the  
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39 condition of patients before admission or after discharge. Despite these limitations, our  
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41 study provides helpful information about the risk factors of in-hospital mortality for  
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43 treatment decision-making in patients with hip fractures.  
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## CONCLUSION

This study has shown that male gender, advancing age, high number of comorbidities and surgical delay were associated with higher rates of in-hospital mortality in patients with hip fractures.

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*Shoda et al., Supplementary file*

submitted work.

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**Ethical approval:** Not needed

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Shoda et al., Supplementary file

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Shoda et al., Supplementary file

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6 **Figure legends**

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9 **Fig 1** Odds ratios of in-hospital mortality and 95% confidence intervals in hip fracture  
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11 patients treated conservatively. **A.** Patients were stratified into three groups according to  
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13 the number of comorbidities. **B.** Patients were stratified into four groups according to  
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18 age.  
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Table 1 Patient characteristics

	n	(%)
<b>Gender</b>		
Females	63,920	(79.1)
Males	16,880	(20.9)
<b>Age</b>		
60–69	5,523	(6.8)
70–79	18,618	(23.0)
80–89	37,362	(46.2)
≥90	19,297	(23.9)
<b>Treatment</b>		
Surgical	66,893	(82.8)
Conservative	13,907	(17.2)
<b>Hospital size (number of acute beds)</b>		
≤199	11,243	(13.9)
200–399	32,613	(40.4)
400–599	23,125	(28.6)
≥600	12,099	(15.0)
<b>Comorbidities</b>		
Malignancy	4,753	(5.7)
Diabetes mellitus	10,795	(13.4)
Cardiovascular disease	6,147	(7.6)
Cerebrovascular disease	6,438	(8.0)
Lung disease	5,179	(6.4)
Renal failure	3,554	(4.4)
Hepatic failure	646	(0.8)
<b>Number of comorbidities</b>		
0	51,544	(63.8)
1	22,170	(27.4)
≥2	7,086	(8.8)

Shoda et al., Supplementary file

Table 2 Risk factors for in-hospital mortality (univariate analysis)

	In-hospital mortality		
	n	(%)	p-value
<b>Total</b>	2681	(3.3)	
<b>Gender</b>			
Females	1677	(2.6)	<0.001
Males	1004	(5.9)	
<b>Age</b>			
60–69	97	(1.8)	<0.001
70–79	488	(2.6)	
80–89	1223	(3.3)	
≥90	873	(4.5)	
<b>Treatment</b>			
Surgical	1372	(2.1)	<0.001
Conservative	1309	(9.4)	
<b>Hospital size (number of acute beds)</b>			
≤199	454	(4.0)	<0.001
200–399	1080	(3.3)	
400–599	672	(2.9)	
≥600	412	(3.4)	
<b>Comorbidities</b>			
Malignancy	669	(14.6)	<0.001
Diabetes mellitus	365	(3.4)	0.694
Cardiovascular disease	198	(3.2)	0.659
Cerebrovascular disease	215	(3.3)	0.920
Lung disease	516	(10.0)	<0.001
Renal failure	305	(8.6)	<0.001
Hepatic failure	126	(19.5)	<0.001
<b>Number of comorbidities</b>			
0	968	(1.9)	<0.001
1	1139	(5.1)	
≥2	574	(8.1)	

Shoda et al., Supplementary file

Table 3 Risk factors for in-hospital mortality (multivariate analysis)

	Odds ratio	95% confidence interval	p-value
<b>Gender</b>			
Females	reference		
Males	2.12	1.94 to 2.31	<0.001
<b>Age</b>			
60–69	reference		
70–79	1.57	1.25 to 1.96	<0.001
80–89	2.28	1.84 to 2.82	<0.001
≥90	3.51	2.83 to 4.37	<0.001
<b>Treatment</b>			
Surgical	reference		
Conservative	4.25	3.92 to 4.61	<0.001
<b>Hospital size (number of acute beds)</b>			
≤199	reference		
200–399	0.99	0.88 to 1.11	0.814
400–599	0.88	0.77 to 1.00	0.043
≥600	0.93	0.81 to 1.07	0.304
<b>Number of comorbidities</b>			
0	reference		
1	2.50	2.28 to 2.74	<0.001
≥2	3.79	3.38 to 4.24	<0.001