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ORIGINAL ARTICLE

Length of hospital stay after hip fracture surgery and 1-year mortality

J. Yoo[1] · J.S. Lee[2] · S. Kim[1] · B.S. Kim[1] · H. Choi[1] · D.Y. Song[3] · W.B. Kim[4] · C.W. Won[1]

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Abstract

Summary There is ongoing effort to discharge patients early after hip fracture surgery to reduce the medical and economic burden. We tried to find whether there is any related side effect, and discovered that early discharge, especially before 10 days after surgery, is associated with higher mortality.

Introduction The aim of this study was to analyze the association between the length of hospital stay after hip fracture and 1-year mortality in older adults aged ≥ 65 years old.

Methods We conducted a retrospective cohort study using the Korean National Health Insurance Service data to identify patients who were discharged after hip fracture surgery from 2007 to 2009 among 487,460 older adults of age ≥ 65 years. The lengths of stay involving hip fracture surgery were categorized at 10-day interval, and analyzed in relation to 1-year mortality from the date of hospital discharge.

Results A total of 4213 patients were discharged after hip fracture surgery, of whom 604 (14.3%) died within 1 year of discharge. The average length of stay was 30.7 days (standard deviation 24.5 days). The 1-year mortality was the highest for the length of stay ≤ 10 days group at 21.7%, followed by 15.2%, 14.3%, 13.3%, and 12.4% for > 40, 21–30, 31–40, and 11–20 days groups, respectively (p value 0.05). On Cox proportional hazard regression, the adjusted hazard ratio for length of stay ≤ 10 days group was 1.56 (95% confidence interval 1.14–2.12) against the reference group (11–20 days), while other groups did not show statistical significance. Higher risk of death was associated with increasing age, male gender, Charlson comorbidity index ≥3, subtrochanteric fracture, and discharge to tertiary care hospitals and long-term care hospitals.

Conclusion Older adults discharged within 10 days of hospital admission for hip fracture surgery have higher 1-year mortality after discharge.

Keywords Frail elderly · Healthcare administrative claims · Hip fractures · Mortality

Introduction

Hip fracture is one of the most debilitating conditions in older adults and has high mortality, morbidity, and economic burden [1]. The excess mortality may last up to 5 years and more, but the most profound effect of hip fracture on mortality is usually short-lived, and devastating, 1-year mortality ranging from 8.4 to 36% [2–6]. The quality of life falls substantially even after treatment, and only 41 to 67% of patients regain their pre-fracture ambulatory ability in 1 year [7–9]. Although the incidence of hip fracture is decreasing, probably due to advancement in medical care of osteoporosis, the total number of hip fractures is projected to keep increasing and surpass 6 million by year 2050, worldwide [10, 11]. This discrepancy seems inevitable considering the global increase in the older adult

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✉ C.W. Won
chunwon62@naver.com

[1] Department of Family Medicine, College of Medicine, Kyung Hee University, 23 Kyungheedae-ro, Dongdaemun-gu, Seoul, South Korea

[2] Clinical Research Center, Asan Medical Center, 88, 43-gil Olympic-ro, Songpa-gu, Seoul, South Korea

[3] Elderly Frailty Research Center, Kyung Hee University, 23 Kyungheedae-ro, Dongdaemun-gu, Seoul, South Korea

[4] Department of Medicine, Graduate School, Kyung Hee University, 23 Kyungheedae-ro, Dongdaemun-gu, Seoul, South Korea

population. The number of people aged 65 years and over was 8.5% in 2015, and is expected to reach 12.0% by 2030, and 16.7% by 2050 [12]. Most older adults fracture their hips from falls, and approximately 30% of community-dwelling older adults experience falls every year [13, 14]. Older adults are more prone to hip fracture due to increasing prevalence of osteoporosis with age, especially after menopause in older women, and are also more likely to experience fall-related injuries from dizziness, decreased sense of balance, slower reaction to falling, and medical side effects [15].

Hip fracture requires relatively long time for recovery and rehabilitation, resulting in burdensome medical expenditure. Hip fracture accounts for only 14% of all osteoporotic fractures, but requires 72% of the total cost expenditure, and is projected to cost over 18.2 billion dollars by 2025 in the USA [16]. Prolonged length of stay (LOS) has direct impact on personal and social medical costs as well as increased rate of healthcare-associated infections, and there have been continuous efforts to reduce the LOS [17, 18]. The LOS is closely related to the postoperative clinical condition of each patient, and has been regarded more as an outcome of surgery than a possible risk factor that may affect the prognosis. However, the ongoing efforts to discharge patients sooner after hip fracture surgery may deprive them of optimal care, and requisite rehabilitation for functional recovery. The consequence may be more serious in older adults who often have multiple comorbidities and do not have enough support for rehabilitation after discharge from medical facilities.

Therefore, we aimed to analyze the association between the length of hospital stay after hip fracture and 1-year mortality in older adults aged 65 years and older using the Korean national claims data in order to propose the optimal LOS after hip fracture surgery.

Methods

Data source

We used the claims database provided by the Korean National Health Insurance Service (NHIS) from 2002 to 2013. The NHIS is the sole national insurance service that covers the whole Korean population and provides representative sample databases with a substantial volume of information that does not require privacy regulation for researches [19]. The NHIS-Senior (2002~2013) is a subset of the data on adults aged 60 years and older and contains information on socioeconomic demographics, disability state, death, medical treatments, health check-ups, medical facility statuses, and long-term care services. The NHIS-SC is composed of a random sample of 558,147 older adults, approximately 10% of 5.5 million people aged 60 years and older at the end of 2002.

Study sample selection

Out of 487,460 people aged 65 years and older in 2007, 7331 patients were charged with diagnostic codes for hip fracture between January 1, 2007 and December 31, 2009. Among them, only 5120 patients received surgery for hip fracture. We limited the target patients to those who had both the diagnostic code and the procedure code for hip fracture in order to ensure the patients newly had and were treated for hip fracture. Both main and subsidiary diagnoses were allowed for the ICD-10 (International Classification of Diseases 10th Revision) codes for hip fracture (S720, S721, and S722). The applied surgical codes were N0711, N0715, N0731, N0305, N0601, N0991, N0641, or N0981. There could be multiple types of fracture and surgeries performed in one patient, and multiple codes were gathered for each category, if any. There were 794 patients who received prior hip fracture surgery within 5 years of the corresponding event and were excluded in order to rule out reoperation, and to eliminate the accumulative effects of previous hip fracture on mortality [2, 3]. In order to determine the mortality after hospital discharge, 113 patients who died during hospital stay after surgery were excluded from analyses. A total of 4213 patients who were discharged after hip fracture surgery were analyzed. Figure 1 illustrates the details of the inclusion flow.

Covariates of interest

The NHIS-SC provides the projected level of income based on the insurance fee of the patient, and the socioeconomic status was categorized as upper 30%, middle 31~70%, and lower 30% based on the given data. The impact of various comorbidities on mortality was managed using the Charlson comorbidity index [20]. The Charlson comorbidity index is the sum of different weights of 17 categories of comorbidities with varying disease burden, and is used to predict 1-year mortality. The ICD-10 codes for the involved comorbidities were identified using Quan's codes which have been validated in a number of studies [21]. The codes for AIDS (Acquired Immune Deficiency Syndrome) are masked as sensitive information in the data, and were not included in the analysis. History of osteoporotic fracture of the spine (ICD-10 S220, S221, S320, S327, and S328), distal radius (ICD-10 S525, S526), and proximal humerus (ICD-10 S422) within 5 years prior to hip fracture was identified to analyze possible additive effects of previous osteoporotic fracture on mortality. Multiple responses were allowed for comorbidities, fracture type, and surgery type, as there may be more than one of each. The number of days taken from the date of admission to the date of surgery was identified using the date of insurance claims. Information regarding admission to another medical facility or re-admission to the surgical hospital within 3 days after discharge was obtained to identify the discharge disposition. The

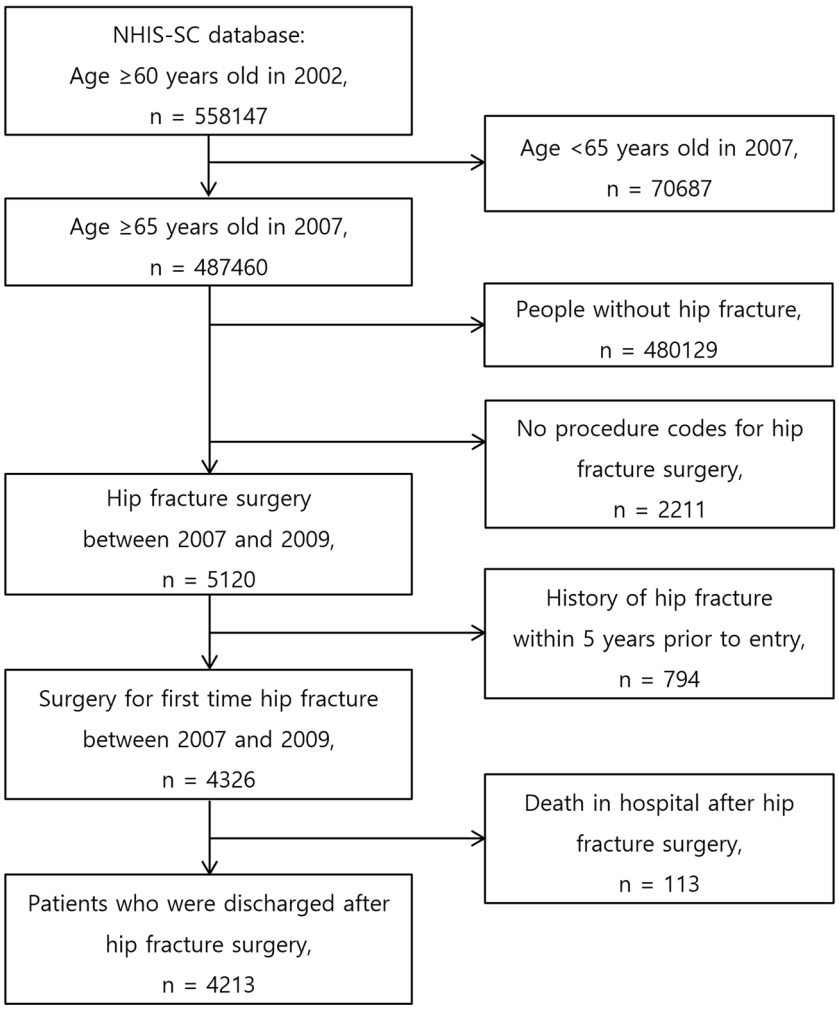

Fig. 1 Subject selection flow chart. NHIS-SC, National Health Insurance Service-Senior Cohort

disposition of patients without any medical facility admission was regarded as non-medical disposition including home and nursing homes that are not covered by health insurance.

Statistical analysis

The primary outcome was all-cause mortality within 1 year from the date of hospital discharge. The association between the risk of death and different LOS was analyzed; the LOS being categorized as ≤ 10 days, 11–20 days, 21–30 days, 31–40 days, and > 40 days. We assessed the differences between continuous variables using ANOVA, and the differences between categorical variables using chi-square test or Fisher's exact test. The risk of death for all-cause mortality by different LOS was estimated by the Kaplan-Meier product limit method with log-rank tests to stratify the LOS. We used Cox proportional hazard regression to obtain the risk of death using univariate analysis, and multivariate analysis with all involved variables.

We further identified the causes of death within 1 year of discharge using the death certificate data in the national death registry. Common causes, except malignancy, were divided into seven categories, and we used Cox proportional hazard regression to perform multivariate analysis with regard to LOS using all involved variables.

All statistical analyses were conducted using SAS version 9.3 (SAS Institute Inc., Cary, NC, USA).

Results

A total of 604 (14.3%) out of 4213 patients died within 1 year of discharge from the hospitals where they received surgery. The average LOS was 30.7 days (standard deviation [S.D.] 24.5 days), and 309, 1159, 1234, 682, and 829 patients stayed in the hospital for ≤ 10, 11–20, 21–30, 31–40, and > 40 days, respectively. In comparison, the mean LOS of 113 patients who expired in the hospital was 34 days (S.D. 26 days), and the median LOS was 28 days (interquartile range 16–45 days). Table 1 shows the characteristics of patients across different LOS. Most patients received surgery within 1 day of hospital

admission. Patients operated in secondary and primary care hospitals were discharged earlier than patients in tertiary care hospitals. Charlson comorbidity index (CCI) increased with longer LOS, except for the LOS ≤ 10 days group. Shorter LOS was associated with femoral neck fracture among fracture types, and open reduction with closed pinning, and closed reduction among surgery types. Approximately 86.6% of patients went home or to other non-medical dispositions after discharge, but only 76.1% of patients in the LOS ≤ 10 days group were discharged to non-medical dispositions, and 23.9% were discharged to or re-admitted to medical facilities.

The risk of death by different LOS using the Kaplan-Meier analysis is presented in Fig. 2 based on the cumulative mortality at 3, 6, and 12 months. The 1-year mortality was the highest for the LOS ≤ 10 days group at 21.7%, followed by > 40 days group 15.2%, 21–30 days group 14.3%, 31–40 days group 13.3%, and 11–20 days group 12.4% (p value 0.005). The cumulative mortality of LOS ≤ 10 days group was 10.4%, 15.5%, and 21.7%, at 3, 6, and 12 months after discharge, respectively, and was significantly higher than the rest of the groups throughout 1 year of follow-up. The risk of death by LOS was of reverse J shape and did not show linear relationship when LOS was analyzed as a continuous variable.

Table 2 shows the risk of death for the involved variables calculated using Cox proportional hazard regression. The adjusted hazard ratio for LOS ≤ 10 days group was 1.56 with 95% confidence interval (CI) 1.14–2.12 against LOS 11–20 days reference group, while other LOS groups did not show statistical significance. Higher risk of death was associated with increasing age, male gender, Charlson comorbidity index 3 and higher, subtrochanteric fracture, and discharge to tertiary care hospitals and long-term care hospitals. Surgery type of open reduction with closed pinning had significantly lower mortality.

We further performed a sensitivity analysis on patients who were not re-admitted or transferred to another hospital, in order to verify the effects of LOS on 1-year mortality of patients who were discharged home or to other non-medical facilities. The sensitivity analysis thus performed produced similar results; the adjusted hazard ratio of the shortest LOS group being 1.92 (95% CI 1.36–2.72), which was slightly higher than that of the whole group (Supplementary Table 1).

The multivariate analysis of cause-specific mortality by different lengths of study is presented in Table 3. Of 604 deaths, infection, diabetes, any heart disease, cerebrovascular disease, pneumonia, chronic pulmonary disease, and hip fracture and other osteoporotic fractures accounted for 12 (2%), 38 (6.3%), 66 (10.9%), 48 (7.9%), 25 (4.1%), 29 (4.8%), and 102 (16.9%) deaths, respectively. Seven patients (1.2%) had missing values, and 69 (11.5%) patients had codes for symptoms, signs, and findings as the cause of death which could not be evaluated as specific causes. Pneumonia better accounted for mortality in the LOS ≤ 10 days group (hazard ratio 5.71, 95% CI 1.33–24.48) than other groups, and hip fracture and other osteoporotic fractures better accounted for mortality in the LOS > 40 days group than other groups.

Discussion

This study of the nationwide sample cohort revealed that the length of hospital stay 10 days and less is associated with increased 1-year mortality after discharge from surgical hospitals in older adults. Our results implicate that early discharge after hip fracture surgery may increase the risk of death in older adults and may require more thorough screening of the patient's overall status before discharge. The structure of the healthcare system is also an important factor of discharge plans. Therefore, adapting the results of our study must accompany careful consideration of the healthcare system.

There were several differences between the patients discharged within 10 days and the patients discharged afterwards. Compared to the groups discharged past 10 days, the early discharge group had higher rate of surgery in secondary and primary care surgical hospitals; more femoral neck fracture and less pertrochanteric fracture; more open reduction with closed pinning and closed reduction, and less hemiarthroplasty; and higher rate of disposition to secondary and tertiary care hospitals. The level of surgical hospital and type of fracture or surgery could not explain the difference in mortality based on our data. The only factor of significance was the disposition after discharge. The rate of discharge to tertiary care facilities was 10.7% for the early discharge group which is comparable to 3.8–5.3% for other LOS groups. Compared to non-medical dispositions, the adjusted hazard ratio of discharge to tertiary care hospitals was 1.68 (95% CI 1.23–2.29). Poor postoperative condition due to surgical failure or serious complications that cannot be addressed in the surgical hospital is a possible explanation for discharge to a higher-level hospital. Therefore, it is a plausible hypothesis that patients admitted to tertiary hospitals after discharge were transferred to another facility that can provide better care for the patients than the surgical hospital, and not discharged upon completion of treatment. This is reinforced by the fact that the only statistically significant cause-specific mortality for the early discharge group was pneumonia in our study, which is a common postoperative complication of hip fracture [22].

A sensitivity analysis was further performed to address these concerns regarding re-admission and discharge to higher-level hospitals for grave postoperative conditions. However, the analysis with only patients discharged home or to other non-medical facilities where expert rehabilitation is very limited revealed similar results overall. In fact, the risk of death within 1 year of hospital discharge was slightly higher after removing the group in question (adjusted hazard ratio 1.92 vs. 1.56). Therefore, the

Table 1 Characteristics of the study cohort by different lengths of hospital stay

Characteristics		Total (%)	Length of stay (number (%))					*p* value
			≤ 10	11–20	21–30	31–40	> 40	
Age	Total (Mean ± SD)		79.2 ± 7.9	78.9 ± 6.8	78.9 ± 6.9	78.8 ± 6.8	78.6 ± 6.8	0.73
	65~69	418 (9.9)	38 (12.3)	110 (9.5)	117 (9.5)	67 (9.8)	86 (10.4)	0.462
	70~74	815 (19.3)	57 (18.4)	222 (19.2)	250 (20.3)	131 (19.2)	155 (18.7)	
	75~79	1027 (24.4)	64 (20.7)	291 (25.1)	296 (24.0)	173 (25.4)	203 (24.5)	
	80~84	991 (23.5)	69 (22.3)	257 (22.2)	288 (23.3)	162 (23.8)	215 (25.9)	
	85~89	700 (16.6)	55 (17.8)	217 (18.7)	196 (15.9)	108 (15.8)	124 (15.0)	
	≥ 90	262 (6.2)	26 (8.4)	62 (5.3)	87 (7.1)	41 (6.0)	46 (5.5)	
Sex	Male	1034 (24.5)	85 (27.5)	305 (26.3)	300 (24.3)	158 (23.2)	186 (22.4)	0.188
	Female	3179 (75.5)	224 (72.5)	854 (73.7)	934 (75.7)	524 (76.8)	643 (77.6)	
Socioeconomic status	High	1786 (42.4)	132 (42.7)	499 (43.1)	528 (42.8)	300 (44.0)	327 (39.4)	0.036
	Middle	962 (22.8)	66 (21.4)	286 (24.7)	289 (23.4)	152 (22.3)	169 (20.4)	
	Low	1465 (34.8)	111 (35.9)	374 (32.3)	417 (33.8)	230 (33.7)	333 (40.2)	
Level of surgical hospital	Tertiary care hospital	2765 (65.6)	164 (53.1)	732 (63.2)	836 (67.7)	446 (65.4)	587 (70.8)	< 0.001
	Secondary care hospital	1310 (31.1)	115 (37.2)	387 (33.4)	364 (29.5)	215 (31.5)	229 (27.6)	
	Primary care hospital	138 (3.3)	30 (9.7)	40 (3.5)	34 (2.8)	21 (3.1)	13 (1.6)	
Charlson comorbidity index	Total (Mean ± SD)		2.8 ± 2.2	2.6 ± 1.9	2.9 ± 1.9	3.1 ± 2.0	3.0 ± 2.0	< 0.001
	0	431 (10.2)	50 (16.2)	139 (12.0)	112 (9.1)	57 (8.4)	73 (8.8)	< 0.001
	1	704 (16.7)	51 (16.5)	230 (19.8)	203 (16.5)	98 (14.4)	122 (14.7)	
	2	907 (21.5)	57 (18.4)	260 (22.4)	264 (21.4)	145 (21.3)	181 (21.8)	
	3	754 (17.9)	47 (15.2)	210 (18.1)	218 (17.7)	131 (19.2)	148 (17.9)	
	4	574 (13.6)	40 (12.9)	136 (11.7)	188 (15.2)	99 (14.5)	111 (13.4)	
	5 or more	843 (20.0)	64 (20.7)	184 (15.9)	249 (20.2)	152 (22.3)	194 (23.4)	
Combination of fracture	Hip fracture alone	3821 (90.7)	283 (91.6)	1050 (90.6)	1123 (91.0)	623 (91.3)	742 (89.5)	0.703
	Hip fracture with previous osteoporotic fracture(s)	392 (9.3)	26 (8.4)	109 (9.4)	111 (9.0)	59 (8.7)	87 (10.5)	
Fracture type	Femoral neck fracture	2295 (54.5)	181 (58.6)	668 (57.6)	682 (55.3)	356 (52.2)	408 (49.2)	0.001
	Pertrochanteric fracture	1894 (45.0)	123 (39.8)	489 (42.2)	545 (44.2)	321 (47.1)	416 (50.2)	0.002
	Subtrochanteric fracture	99 (2.4)	8 (2.6)	18 (1.6)	25 (2.0)	22 (3.2)	26 (3.1)	0.079
Surgery type	Total hip arthroplasty	137 (3.3)	9 (2.9)	43 (3.7)	43 (3.5)	17 (2.5)	25 (3.0)	0.645
	Hemiarthroplasty of hip	2082 (49.4)	107 (34.6)	588 (50.7)	681 (55.2)	329 (48.2)	377 (45.5)	< 0.001
	Open reduction	1822 (43.3)	126 (40.8)	496 (42.8)	483 (39.1)	313 (45.9)	404 (48.7)	< 0.001
	Open reduction with closed pinning	114 (2.7)	20 (6.5)	24 (2.1)	23 (1.9)	22 (3.2)	25 (3.0)	< 0.001
	Closed reduction	148 (3.5)	48 (15.5)	24 (2.1)	18 (1.5)	22 (3.2)	36 (4.3)	< 0.001
	Others	12 (0.3)	0 (0.0)	1 (0.1)	5 (0.4)	2 (0.3)	4 (0.5)	0.392
Time from admission to surgery (days)	< 1	4178 (99.2)	302 (97.7)	1152 (99.4)	1224 (99.2)	677 (99.3)	823 (99.3)	0.071
	≥ 1	35 (0.8)	7 (2.3)	7 (0.6)	10 (0.8)	5 (0.7)	6 (0.7)	
Discharge disposition	Non-medical disposition[a]	3648 (86.6)	235 (76.1)	999 (86.2)	1104 (89.5)	590 (86.5)	720 (86.9)	< 0.001
	Tertiary care hospital	208 (4.9)	33 (10.7)	57 (4.9)	47 (3.8)	36 (5.3)	35 (4.2)	
	Secondary care hospital	168 (4.0)	32 (10.4)	44 (3.8)	33 (2.7)	25 (3.7)	34 (4.1)	
	Long-term care hospital	162 (3.9)	8 (2.6)	45 (3.9)	44 (3.6)	30 (4.4)	35 (4.2)	
	Other hospitals[b]	27 (0.6)	1 (0.3)	14 (1.2)	6 (0.5)	1 (0.1)	5 (0.6)	

[a] Non-medical disposition includes home and other non-medical facilities such as nursing homes

[b] Other hospitals include primary care hospitals, public care clinics, and oriental hospitals. Twenty-five patients were discharged to primary care hospitals, and one patient each was discharged to a public care clinic and an oriental hospital

concern with regard to 1-year mortality being raised by re-admission or transfer to higher level hospitals could be eliminated.

The average LOS varies widely among different countries from 5.6 to 45 days [23–28]. The mean LOS in this study was 30.8 days. This wide variation may be

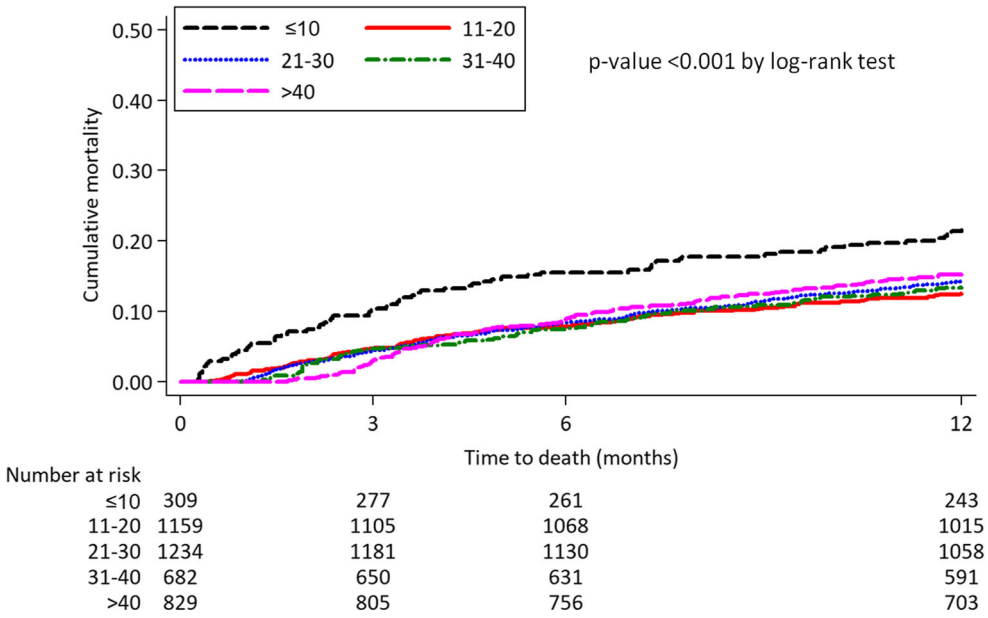

Fig. 2 Kaplan-Meier curve for mortality by different lengths of stay

explained by differences in healthcare systems. Most of previous studies refer to the LOS in the initial institution where the patients received surgery for hip fracture. However, different healthcare systems provide different perioperative settings of care. Countries including the USA, the UK, and Australia have tiered healthcare setting, so that patients are discharged from surgical hospitals to post-acute or subacute care facilities, and then to intermediate or long-term care facilities from which the patients are finally discharged home or to other non-medical facilities. Others, including Korea and Japan, provide most of postoperative care and rehabilitation in the surgical hospitals, and discharge patients home or to other non-medical facilities [8, 27].

Recent retrospective cohort studies in Sweden and the USA reported the effects of the LOS on 30-day mortality after hospital discharge with conflicting results. While Nordström et al. reported that earlier discharge was associated with an increased risk of death after discharge for LOS below 10 days in Sweden (recent mean LOS 11.6 days), Nikkel et al. reported that decreased LOS was associated with reduced rates of early mortality in a cohort in the USA (recent average LOS 5.6 days) [23, 24]. This contrasting result arises from differences in healthcare systems [23, 29]. In addition to the report of Nikkel et al. that 12.9% of the patients were discharged to their homes, Bentler et al. reported that 14% of patients were discharged to their homes, 26% to inpatient rehabilitation centers, and 58% to nursing facilities in the USA [23, 30]. In Sweden, 31.1% went home while 61.8% were discharged to short- and long-term nursing homes after a mean LOS of 13.0 days [31]. In contrast, Shin et al. reported that the rate of patients discharged home after hip fracture surgery in Korea was 45.4%, which is far higher than the rates reported in the USA or Sweden [32]. Furthermore, another study from Sweden reports that while the mean acute care hospital LOS in Sweden was 11.3 (S.D. 6.6) days, the total LOS inclusive of stays in nursing homes was 27.9 (S.D. 30.9) days which comes close to the mean LOS of our study [29].

This phenomenon of similar total length of institutional stay is well reinforced by studies from the UK and Australia. The mean LOS of 16, 12, and 18 days in the surgical hospitals amounted to 22, 33, and 35 days when combining LOS in post-acute care facilities and rehabilitation facilities in England, Northern Ireland, and Wales, respectively [33]. Also, Ireland et al. reported the mean total LOS as 30.8 days in Australia, with 43% of the period attributable to acute fracture management (13.4 days), 37% to rehabilitation, and 20% to management of contingent conditions [25]. Therefore, reports from different countries regarding LOS need to be interpreted with regard to the type of healthcare system so as to identify whether the studied LOS represents the surgical LOS only or the total LOS before patients are discharged to non-medical dispositions.

An important strength of this study is the use of national claims data. Korea has one unified national health insurance service which covers most of the national population, and the NHIS-SC data is representative of all strata of the elderly population living in Korea. The use of claims data in conjunction with national death registry allowed minimal loss to follow-up. Also, we endeavored to discriminate the cumulative effects of previous hip fractures on mortality by excluding all patients with prior hip fracture surgery within 5 years of the study initiation. Lastly, this is the first

Table 2 Hazard ratios (95% confidence interval) for risk of death after hospital discharge

Characteristics		Unadjusted	Adjusted[a]
Length of stay	≤ 10	1.87 (1.40–2.50)	1.56 (1.14–2.12)
	11–20	Ref	Ref
	21–30	1.15 (0.92–1.43)	1.12 (0.90–1.40)
	31–40	1.07 (0.82–1.39)	1.03 (0.79–1.34)
	> 40	1.22 (0.96–1.56)	1.19 (0.93–1.51)
Age group	65~69	Ref	Ref
	70~74	1.54 (1.00–2.39)	1.47 (0.95–2.27)
	75~79	1.81 (1.19–2.75)	1.82 (1.20–2.77)
	80~84	2.65 (1.76–3.98)	2.80 (1.86–4.22)
	85~89	3.54 (2.35–5.34)	4.02 (2.66–6.08)
	≥ 90	4.95 (3.18–7.69)	6.38 (4.08–9.96)
Sex	Male	1.40 (1.18–1.67)	1.68 (1.41–2.01)
	Female	Ref	Ref
Socioeconomic status	High	Ref	Ref
	Middle	0.98 (0.79–1.21)	1.06 (0.86–1.31)
	Low	1.06 (0.89–1.27)	1.09 (0.91–1.31)
Level of surgical hospital	Tertiary care hospital	Ref	Ref
	Secondary care hospital	1.00 (0.84–1.18)	1.06 (0.88–1.27)
	Primary care hospital	1.02 (0.65–1.60)	0.94 (0.58–1.52)
Charlson comorbidity index	0	Ref	Ref
	1	0.68 (0.46–0.99)	0.71 (0.49–1.04)
	2	1.03 (0.74–1.44)	1.11 (0.79–1.55)
	3	1.51 (1.09–2.08)	1.65 (1.19–2.29)
	4	1.46 (1.04–2.05)	1.59 (1.13–2.25)
	≥ 5	1.65 (1.20–2.26)	1.95 (1.41–2.69)
Combination of fracture	Hip fracture alone	Ref	Ref
	Hip fracture with previous osteoporotic fracture(s)	1.17 (0.90–1.52)	1.19 (0.92–1.55)
Fracture type	Femoral neck fracture	0.92 (0.78–1.07)	1.53 (0.91–2.56)
	Pertrochanteric fracture	1.10 (0.94–1.30)	1.54 (0.92–2.56)
	Subtrochanteric fracture	1.34 (0.84–2.14)	2.07 (1.15–3.74)
Surgery type	Total hip arthroplasty	1.07 (0.69–1. 66)	0.81 (0.38–1.72)
	Hemiarthroplasty of hip	1.00 (0.85–1.17)	0.57 (0.30–1.08)
	Open reduction	0.95 (0.81–1.12)	0.56 (0.30–1.04)
	Open reduction with closed pinning	0.47 (0.23–0.94)	0.32 (0.13–0.77)
	Closed reduction	1.86 (1.32–2.60)	1.16 (0.68–1.98)
	Others	0.27 (0.02–4.29)	0.20 (0.01–3.45)
Time from admission to surgery (days)	< 1	Ref	Ref
	≥ 1	0.97 (0.40–2.34)	1.04 (0.45–2.44)
Discharge disposition	Non-medical disposition[b]	Ref	Ref
	Tertiary care hospital	1.76 (1.30–2.38)	1.68 (1.23–2.29)
	Secondary care hospital	1.24 (0.84–1.83)	1.11 (0.75–1.66)
	Long-term care hospital	1.56 (1.10–2.23)	1.48 (1.04–2.12)
	Other hospitals[c]	1.39 (0.57–3.34)	1.99 (0.84–4.71)

[a] Adjusted for age, sex, socioeconomic status, level of surgical hospital, Charlson comorbidity index, combination of fracture, fracture type, surgery type, time from admission to surgery, and discharge disposition

[b] Non-medical disposition includes home and other non-medical facilities such as nursing homes

[c] Other hospitals include primary care hospitals, public care clinics, and oriental hospitals. Twenty-five patients were discharged to primary care hospitals, and one patient each was discharged to a public care clinic and an oriental hospital

Table 3 Adjusted hazard ratios for cause-specific mortality by different lengths of study

	LOS (days)[a]				
	≤ 10	11–20	21-30	31–40	> 40
Any infection	2.48 (0.35–17.42)	Ref	1.74 (0.39–7.81)	0.70 (0.08–6.11)	0.19 (0.01–3.64)
Diabetes	1.51 (0.40–5.67)	Ref	1.09 (0.42–2.84)	1.00 (0.32–3.11)	1.77 (0.70–4.46)
Any heart disease	1.71 (0.73–4.02)	Ref	1.01 (0.52–1.94)	0.82 (0.37–1.82)	0.64 (0.29–1.44)
Cerebrovascular disease	0.85 (0.23–3.07)	Ref	0.84 (0.38–1.86)	0.66 (0.24–1.85)	1.47 (0.69–3.16)
Pneumonia	5.71 (1.33–24.48)	Ref	2.27 (0.59–8.67)	0.79 (0.10–6.14)	3.50 (0.90–13.66)
Chronic pulmonary disease	0.42 (0.06–3.22)	Ref	0.70 (0.21–2.28)	2.08 (0.73–5.90)	1.03 (0.33–3.25)
Hip fracture and other osteoporotic fractures	0.93 (0.37–2.32)	Ref	1.23 (0.71–2.15)	1.11 (0.57–2.17)	1.93 (1.11–3.37)

[a] Adjusted for age, sex, socioeconomic status, level of surgical hospital, Charlson comorbidity index, combination of fracture, fracture type, surgery type, time from admission to surgery, and discharge disposition

study to investigate the association between the length of hospital stay and 1-year mortality.

However, important limitations of this study also stem from the use of claims data. The postoperative condition of the patients cannot be ascertained in the NHIS-SC data. This is a grave limitation considering the importance of postoperative condition on the effects of mortality and LOS [34]. Several other factors such as functional status, frailty, albumin level, and residence prior to hospital admission that affect the mortality after surgery also could not be obtained from the data. Medication for osteoporosis may also affect mortality, but could not be simplified for analysis using the claims data with the objective of this study, and was not included in analysis. Also, including all patients with codes for hip fracture as target subjects could include patients who had prior history of hip fracture and were admitted for additional treatment. Therefore, only patients with the codes for both hip fracture and hip fracture surgery were selected to overcome this limitation, leaving out the patients who were managed conservatively.

Early discharge after hip fracture surgery is important considering limited medical resources and increasing elderly population. However, countries worldwide have different healthcare systems, and the preoperative comorbidities, surgical outcomes, and postoperative conditions of each patient differ widely. Therefore, one optimal LOS that suits all is not pragmatic at the moment. A possible alternative may be the development of a scoring system based on relevant demographic characteristics and perioperative conditions as well as functional ability of the patients that can be used to predict prognosis upon discharge.

Conclusion

Discharge from a hospital within 10 days of receiving surgery for hip fracture is associated with increased risk of death within 1 year of discharge in older adults. However, the structure of different healthcare systems must be taken into account when interpreting the results of this study.

Compliance with ethical standards

This study was approved by the Kyung Hee University Hospital Research Ethics Committee (Approval ID: KHUH 2017-01-069).

Conflicts of interest This study used NHIS-Senior data (NHIS-2017-2-328) made by NHIS. Jinho Yoo, Ji Sung Lee, Sunyoung Kim, Byung Sung Kim, Hyunrim Choi, Da Young Song, Won Beom Kim, and Chang Won Won declare no conflict of interest with NHIS.

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