

ORIGINAL ARTICLE

Time from admission to surgery in Polish patients with hip fractures: temporal trends in the last decade and association with duration of hospitalization and in-hospital mortality

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healthcare, hip fractures, patient outcome assessment, quality indicators

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ABSTRACT

INTRODUCTION Hip fracture is an important cause of morbidity and mortality among elderly patients worldwide. It poses a particular challenge for healthcare systems with limited financial and human resources.

OBJECTIVES The aim of the study was to assess factors associated with the length of hospital stay and in-hospital mortality, focusing on the time from admission to surgery. The secondary goal was to assess temporal trends in the intervals of admission to surgery between 2010 and 2011 and in 2019.

PATIENTS AND METHODS This was a cross-sectional study enrolling patients aged 65 years or older who underwent surgery for hip fracture between January 2010 and October 2011 in 12 Polish hospitals. Demographic and clinical data, dates of hospital admission and surgery as well as information about in-hospital death were gathered. We additionally searched the databases of the same 12 hospitals for patients hospitalized due to hip fracture between January and June 2019 and recorded the dates of admission and surgery.

RESULTS We included 381 patients who underwent surgery in 2010 and 2011 and 761 patients hospitalized in 2019. In a multivariable analysis, including age, sex, and diagnosis of dementia, we observed association between time from admission to surgery and higher in-hospital mortality and longer hospital stay. There was a decrease in proportion of patients undergoing surgery within 2 days from admission (52.8% vs 44.3%; $P = 0.007$) between 2010 to 2011 and in 2019.

CONCLUSIONS In-hospital mortality and length of hospitalization were associated with time from admission to surgery in patients undergoing surgery for hip fracture. We observed an alarming trend towards an increase in the admission–surgery interval.

INTRODUCTION Hip fractures are an important cause of morbidity, mortality, and emergency surgeries among geriatric patients in the developed countries and their incidence is projected to triple by 2050.^{1,2} This condition leads to a significant functional impairment and therefore decreases patient quality of life and is a burden for

healthcare systems.^{3,4} Advanced age, lower body-mass index, tendency for falls, and physical inactivity are well-established risk factors for hip fractures.⁵ Mortality in this population is affected by several factors (male sex, dementia, and history of cardiovascular disease) according to the recently published meta-analysis.⁶

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WHAT'S NEW?

Hip fractures remain one of the most important challenges for contemporary medicine. According to current guidelines, prompt surgery is a crucial factor in improvement of patient outcomes. In this study, we showed that both length of hospital stay and mortality were affected by time passing from admission to surgery, independent of patients' age, sex, and diagnosis of dementia. Moreover, we assessed temporal trends between years 2010 and 2011, and in 2019 in terms of the interval between admission and procedure for hip fracture. Alarming, the analysis showed a decrease in the proportion of patients undergoing surgery within 2 days from admission. What is more, the absolute value of this important healthcare quality measure would put Poland in one of the last places in Europe. These results should not only cause unease among the Polish healthcare providers, but also trigger prompt action to reverse this negative trend.

Hip fractures pose a serious challenge for the Polish healthcare system with estimated age-standardized rate of 181/100 000, putting Poland on the 44th place out of 63 countries analyzed in a study by Kanis et al.⁷ Unfortunately, observed trends suggest that the hip fracture rate in the Polish population will continuously rise to reach approximately 470/100 000 in the next 30 years.⁸ The Polish healthcare system is particularly vulnerable to an increase in the number of procedures due to limited workforce and financial resources.

Early surgery after hip fracture is considered one of the most important factors influencing patient outcomes, based on the results of several observational studies.⁹ This is reflected in practice guidelines which recommend performing surgery on the day of, or the day after, the admission.¹⁰ Percentage of patients operated for hip fracture within 2 days varies significantly in Europe and ranges from 96% in Norway and Denmark to 46% in Latvia. Unfortunately, similar data on surgery timing in the Polish population are missing in the recent Organization for Economic Co-operation and Development (OECD) report.¹¹

In this cross-sectional study, we aimed to assess factors associated with in-hospital mortality and hospitalization length among Polish patients who suffered hip fracture. Our secondary aim was to assess the temporal changes in quality of care, reflected by time from admission to surgery, in this population.

PATIENTS AND METHODS **Design, setting, and population of the study** The study was a part of a DUQuE (Deepening our Understanding of Quality Improvement in Europe) project—an international multilevel cross-sectional study, designed to assess relationship between quality management and patient outcomes in the European Union.¹² This substudy included patients undergoing hip fracture surgery between January 2010 and October 2011 in 12 teaching and nonteaching hospitals in Poland. In accordance with the study

protocol, each center was obliged to stop recruitment after enrolling 35 patients.

The inclusion criteria were: 1) age 65 years or older; 2) diagnosis of hip fracture; 3) surgery for hip fracture during index hospitalization.

Exclusion criteria was transfer from a different hospital for treatment after the initial diagnosis.

Additionally, in order to assess temporal changes in clinical practice, we searched databases of participating hospitals for patients admitted between January and June 2019 for hip fracture using the *International Classification of Diseases, Ninth Revision (ICD-9)* and *International Statistical Classification of Diseases, Tenth Revision (ICD-10)* codes (8200–1, 8202–3, 8208–9 and S72.0, S72.1, S72.2 respectively) in order to assess the time from hospital admission to surgery.

The protocol complied with the Declaration of Helsinki and its amendments. Signing of the written informed consent to participate in the study was not required. The DUQuE project was approved by the bioethics committee at the Health Department of the Government of Catalonia. The approval of local bioethical committees was not required.

Data collection The research staff gathered demographic (sex, age) and clinical data (history of hypertension, coronary artery disease, congestive heart failure, diabetes mellitus, kidney disease, liver disease, chronic obstructive pulmonary disease or asthma, dyslipidemia, peripheral artery disease and dementia) based on interviews with the patients, family members, and available medical records. Additionally, dates of fracture, admission, surgery and discharge or in-hospital death were collected. In case of patients hospitalized in 2019, only dates of birth, admission, and surgery were recorded.

Statistical analysis Categorical variables were presented as counts (percentage) and compared using the χ^2 test, while continuous variables were presented as mean (SD) or median (interquartile range) and compared using the *t* test or the Mann–Whitney test depending on their distribution. A multivariable analysis was performed in the entire study group using logistic regression to assess association between in-hospital mortality and time from admission to surgery, adjusted for age, sex, and diagnosis of dementia, while linear regression was performed in order to evaluate the relation between length of hospital stay and time from admission to surgery, adjusted for age, sex, and diagnosis of dementia. Variables other than time from admission to surgery (age, sex, dementia) were selected based on available literature, reviewers' comments, and authors' knowledge. Assumptions of normality of residuals and homoscedasticity were evaluated and multicollinearity was assessed using the variance inflation factors. This was a complete-case analysis. Statistical analyses were performed with RStudio, packages *rms* and *ggplot2* (RStudio, PBC, Boston, Massachusetts, United States).

TABLE 1 Study group characteristics

Characteristics	Total (n = 381)	Survivors (n = 295)	Nonsurvivors (n = 86)	P value
Demographic				
Age, y, median (IQR)	80.3 (75.6–85.7)	80.5 (75.7–85.4)	79.9 (74.6–86.4)	0.43
Male sex	109 (28.6)	79 (26.8)	30 (34.9)	0.14
Comorbidities				
Coronary artery disease	58 (15.2)	43 (18.5)	15 (27.3)	0.15
Chronic heart failure	110 (28.9)	86 (35.3)	24 (43.6)	0.24
Hypertension	221 (58)	175 (64.1)	46 (65.7)	0.8
COPD/asthma	36 (9.4)	29 (11.9)	7 (12.3)	0.93
Chronic kidney disease	14 (3.7)	10 (3.9)	4 (5.7)	0.49
Dementia	66 (17.3)	42 (19.1)	24 (35.8)	0.004
Diabetes mellitus	116 (30.4)	86 (29.2)	30 (34.9)	0.31
Time intervals				
Fracture to surgery, d, median (IQR)	3 (1–5)	2 (1–5)	5 (3–8)	<0.001
Admission to surgery, d, median (IQR)	2 (1–4)	2 (1–3)	4 (3–7)	<0.001
Surgery time, min, median (IQR)	63 (50–90)	60 (50–90)	70 (50–95)	0.17
Hospitalization time, d, median (IQR)	11 (9–14)	11 (9–13)	12 (7–19)	0.4

Data are presented as number (percentage) of patients unless otherwise indicated.

Abbreviations: COPD, chronic obstructive pulmonary disease; IQR, interquartile range

RESULTS Clinical characteristics of the study group in 2010–2011

The study group consisted of 381 patients who underwent surgery for hip fracture. The median age was 80.3 (75.6–85.7) years and 109 study participants (28.6%) were men. We observed high prevalence of hypertension (58%), diabetes (30.4%), and chronic heart failure (28.9%). Patients who died (86; 22.6%) during hospitalization had significantly higher prevalence of dementia (35.8% vs 19.1%; $P = 0.004$), longer fracture to surgery time (5 vs 2 days; $P < 0.001$), and admission to surgery time (4 vs 2 days; $P < 0.001$) compared with survivors. In the study group, 201 patients (52.8%) underwent surgery within 2 days from admission. Detailed information can be found in [TABLE 1](#) and [FIGURE 1](#).

Multivariable analysis Multivariable analyses showed that time from admission to surgery was associated with in-hospital mortality (odds ratio, 2.567; 95% CI, 1.811–3.762; $P < 0.001$) and duration of hospitalization (odds ratio, 0.575; 95% CI, 0.502–0.649; $P < 0.001$). Presented effects are for the square root of time from admission to surgery. All results were adjusted for age, sex and diagnosis of dementia. Odds ratios with 95% CI and β -coefficients with 95% CI are presented in [TABLE 2](#) and [TABLE 3](#), respectively.

Time from admission to surgery in 2019 We identified 761 patients at a median (IQR) age of 83 (75–87) years hospitalized in 2019, who underwent the surgical procedure for hip fracture. The median (IQR) time from admission to surgery was 3 (1–5) days. Among them, 337 patients (44.3%) were operated within 2 days from admission.

Assessment of temporal changes between 2010 and 2011 and in 2019 showed a significant increase in time from admission to surgery (2 vs 3 days; $P = 0.002$) and decrease in proportion of patients undergoing surgery within 2 days from admission (52.8% vs 44.3%; $P = 0.007$). Patients hospitalized in 2019 were significantly older compared with those undergoing surgery in 2010 and 2011 (83 vs 80.3; $P = 0.007$).

DISCUSSION In this cross-sectional study based on the Polish population of patients aged 65 years or older who underwent surgery for hip fracture, we observed that both mortality and length of hospital stay are associated with time interval between admission to the hospital and surgery. Moreover, we observed a decrease in the proportion of patients undergoing surgery within 2 days from admission between 2011 and 2019.

The Polish population of patients with hip fracture is comparable with these in studies performed in other countries; patients are usually elderly women with significant comorbidities.⁷ An analysis of baseline clinical and demographic differences between survivors and nonsurvivors showed higher prevalence of dementia among the latter, which corroborates data from several previous reports.^{13,14}

The most crucial factor influencing mortality after hip surgery was time between hospital admission and surgery. This association was confirmed in both univariable and multivariable analysis which included age, sex, and diagnosis of dementia. There are numerous observational studies showing positive impact of early surgery on outcomes of patients with hip fracture, and therefore, guidelines suggest performing surgery not

TABLE 2 Multivariable analysis of association between mortality and admission–surgery time, adjusted for sex, age, and diagnosis of dementia

Factor	OR	95% CI	P value
Admission–surgery time ^a	2.567	1.811–3.762	<0.001
Age ^a	1.061	0.601–2.006	0.839
Sex ^b	0.970	0.499–1.937	0.929
Dementia	1.522	0.737–3.053	0.244

a Continuous variables were square root transformed in the process of model development.

b Male sex was used as a comparator.

Abbreviations: OR, odds ratio

TABLE 3 Multivariable analysis of association between hospitalization length^a and admission–surgery time, adjusted for sex, age, and diagnosis of dementia

Factor	β -coefficient	95% CI	P value
Admission–surgery time ^a	0.575	0.502–0.649	<0.001
Age ^a	–0.008	–0.145 to 0.130	0.911
Sex ^b	0.087	–0.067 to 0.240	0.267
Dementia	0.154	–0.012 to 0.320	0.068

a Continuous variables were square root transformed in the process of model development.

b Male sex was used as a comparator.

later than on the next day after admission.¹⁵ Due to observational design of the studies, the quality of evidence remains low; however, the results of the first randomized controlled trial concerning this topic (Hip Fracture Accelerated Surgical Treatment And Care Track; HIP ATTACK; ClinicalTrials.gov identifier, NCT02027896) with almost 3000 enrolled patients have just been published.^{16–18} The study showed that accelerated surgery (goal time to procedure was 6 hours) compared with standard care did not result in an improvement in mortality and other major complications at 90 days after procedure. Mortality in the HIP-ATTACK trial was twice lower (9% in the interventional group, 10% in the standard care group, 22.6% in our study). However, importantly, the median time from the diagnosis to surgery was much shorter (6 hours in the interventional group and 24 hours in the standard care group) compared with median admission to surgery time accounting to 2 days in our study group.

Our study revealed some disturbing data regarding the quality of care provided by the Polish healthcare system. Only around 50% of hip fracture patients underwent surgery within 2 days of hospital admission, which would place Poland in one of the last positions in the aforementioned OECD report.¹¹ Obviously, only a nationwide study could provide reliable data on the actual situation; however, we believe that hitherto acquired results are already alarming enough and thus require a closer investigation. The results of our secondary analysis, showing a positive association between admission to surgery time and longer hospital stay, should grant this issue even

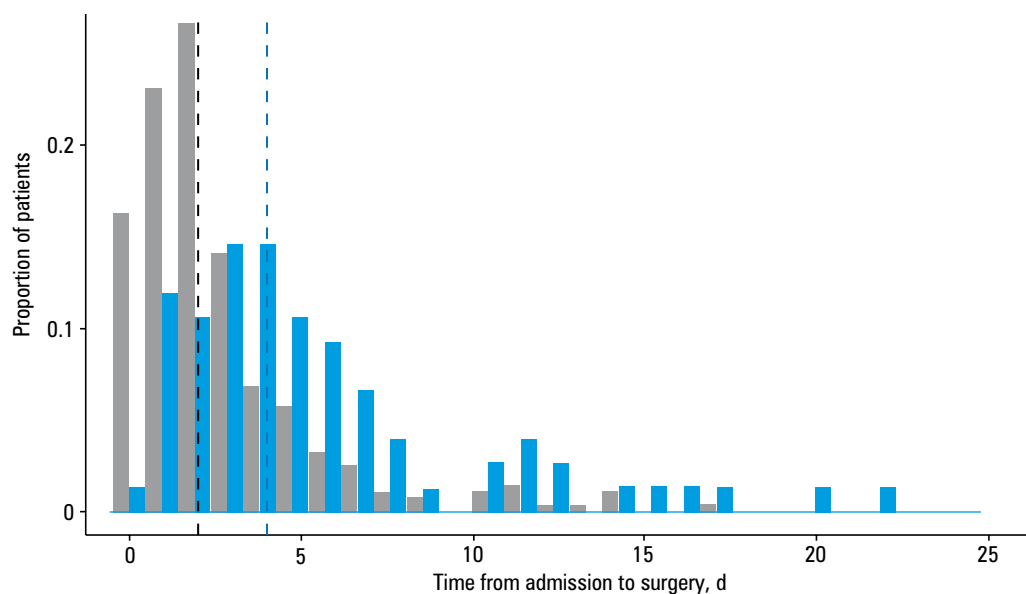
higher priority. Prolonged hospital stay is known not only to increase the risk of complications, for example, hospital-acquired infections and delirium, but also to markedly increase the cost of medical care, which is of particularly great importance in the limited-resource healthcare environment.¹⁹

This work should urge the officials to establish a national registry of patients with hip fractures. Such registries already exist in countries such as United Kingdom, Australia, New Zealand, Sweden, Norway, Denmark. It would offer a unique opportunity to continuously evaluate the effectiveness of Polish healthcare system in this crucial matter, and therefore could lead to a significant improvement in the quality of care.²⁰ Another important step in the improvement of quality of care in this population should be further development of geriatric orthopedic surgery with a particular focus on interdisciplinary approach to hip fracture patients. This idea encompasses tight cooperation of several specialists (eg, orthopedic surgeon, geriatrician, anesthesiologist, dietician, physiotherapists) aimed at optimization of care in geriatric patients who suffered from hip fracture. It includes multiple elements, for example, precise geriatric assessment, optimization of fitness for surgery, identification of individual goals for rehabilitation, continuous geriatric review, cooperation with other medical services (falls prevention, primary care, social services) and palliative care, if necessary. Such approach proved to be effective in reducing number of complications, shortening hospitalization time, and achievement of walking ability from before the injury.^{21–23}

The additional analysis of differences between years 2010 and 2011 and the first half of 2019 shows some interesting, yet concerning, results. We observed a decrease in the proportion of patients undergoing surgery within 2 days of admission (52.8% vs 44.3%). This discrepancy may be due to differences in the methodology of acquired data (cross-sectional vs retrospective); however, it more probably reflects the decreased accessibility to hip fracture repair surgery. Moreover, observed difference in age could also be associated with increased time from admission to surgery as a result of a possibly higher number of comorbidities, in particular dementia. Another potential explanation would be that some clinicians do not consider hip fracture a medical emergency. Moreover, receiving the decision for anesthesia and surgery takes a long time and leads to delay of the surgery.

We are aware of several limitations of our study. Firstly, due to the relatively low number of patients and events, we were unable to include some other important variables into the model, for example, the study was underpowered to reliably assess the importance of inter-center variability and to evaluate differences in outcomes depending on hospital's reference level. These variables would probably affect described association of time from admission to surgery with in-hospital mortality and duration

FIGURE 1 Histogram of time from admission to surgery in survivors (grey) and nonsurvivors (blue). Dashed lines represent median values for each group.



of hospitalization as higher reference level centers usually have access to more experienced clinicians, better equipment, wider range of specialist consultants, and larger number of intensive care unit beds, which in turn could significantly influence both in-hospital mortality and length of hospital stay. Secondly, lack of post-discharge follow-up deprives us of some potentially interesting observations. Thirdly, data about comorbidities were collected solely on the basis of interviews with patients and families, as well as available medical records, which could lead to some imprecision, particularly in terms of diagnosis of dementia. Also, data on mortality and duration of hospitalization among patients undergoing surgery in 2019 would provide an interesting opportunity to reliably assess recent trends in these crucial outcomes, particularly in the context of potentially significant impact of difference in age between samples from 2010 and 2011, and 2019. Moreover, the retrospective design of the study is inherently associated with some important constraints (eg, lack of information about prehospital functional status and caregiver situation), which could influence the quality of presented data.

In this cross-sectional study, based on the Polish population of patients undergoing hip fracture surgery, around half of patients underwent index procedure later than recommended by clinical guidelines. We confirmed the association between in-hospital mortality, length of hospital stay, and time from admission to surgery. Finally, the analysis of recent trends suggests a decrease in proportion of patients operated within 2 days of hospital admission.

ARTICLE INFORMATION

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CONTRIBUTION STATEMENT HK-W, WS, ZP, BK, RS, GP, JG, and JF designed the study. HK-W, ZP, BK, RS, and GP were involved in data collection. KP, WS, and JF performed statistical analysis. KP, HK-W, WS, ZP, BK, RS, GP,

and JG were involved in literature search. All authors contributed to data interpretation and manuscript preparation.

CONFLICT OF INTEREST None declared.

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