30-day and one-year readmission rate in 11,270 patients with surgical treatment for proximal femoral fractures across Austria

Correspondence should be sent to P. Puchwein paul.puchwein@medunigraz.at

Cite this article:
Bone Jt Open 2024;5(4):
294–303.

DOI: 10.1302/2633-1462.54.BJO-2024-0002.R1

M. A. Smolle,[1,2] S. F. Fischerauer,[1] I. Vukic,[3] L. Leitner,[1] P. Puchwein,[1] H. Widhalm,[4] A. Leithner,[1] P. Sadoghi[1]

[1]Department of Orthopaedics and Trauma, Medical University of Graz, Graz, Austria
[2]Department of Orthopaedics, Balgrist University Hospital, Zurich, Switzerland
[3]Federal Ministry of Social Affairs, Health, Care and Consumer Protection, Vienna, Austria
[4]Department of Orthopedics and Trauma Surgery, Medical University of Vienna, Vienna, Austria

Aims

Patients with proximal femoral fractures (PFFs) are often multimorbid, thus unplanned readmissions following surgery are common. We therefore aimed to analyze 30-day and one-year readmission rates, reasons for, and factors associated with, readmission risk in a cohort of patients with surgically treated PFFs across Austria.

Methods

Data from 11,270 patients with PFFs, treated surgically (osteosyntheses, n = 6,435; endoprostheses, n = 4,835) at Austrian hospitals within a one-year period (January to December 2021) was retrieved from the Leistungsorientierte Krankenanstaltenfinanzierung (Achievement-Oriented Hospital Financing). The 30-day and one-year readmission rates were reported. Readmission risk for any complication, as well as general medicine-, internal medicine-, and surgery/injury-associated complications, and factors associated with readmissions, were investigated.

Results

The 30-day and one-year readmission rates due to any complication were 15% and 47%, respectively. The 30-day readmission rate (p = 0.001) was higher in endoprosthesis than osteosynthesis patients; this was not the case for the one-year readmission rate (p = 0.138). Internal medicine- (n = 2,273 (20%)) and surgery/injury-associated complications (n = 1,612 (14%)) were the most common reason for one-year readmission. Regardless of the surgical procedure, male sex was significantly associated with higher readmission risk due to any, as well as internal medicine-associated, complication. Advanced age was significantly associated with higher readmission risk after osteosynthesis. In both cohorts, treatment at mid-sized hospitals was significantly associated with lower readmission risk due to any complication, while prolonged length of stay was associated with higher one-year readmission risks due to any complication, as well as internal-medicine associated complications.

Conclusion

Future health policy decisions in Austria should focus on optimization of perioperative and post-discharge management of this vulnerable patient population.

Take home message

- In 11,270 patients treated surgically for proximal femoral fractures across Austria within a one-year period, overall 30-day and one-year hospital readmission rates amounted to 15% (n = 1,720), and 47% (n = 5,324), respectively.

Bone & Joint Open

- Readmission rates were higher in patients with endoprostheses compared to those with osteosyntheses.
- The most common reason for unplanned readmission was due to internal medicine-associated complications.
- Consequently, future health policy decisions should aim at optimizing perioperative and post-discharge management of this vulnerable patient population, to eventually reduce readmission rate.

Introduction

The incidence of proximal femoral fractures (PFFs) is increasing worldwide.[1,2] The majority of patients with PFFs present with additional comorbidities.[3-5] These patients are at high risk for development of complications, such as urinary tract infection, heart failure, renal insufficiency, deep vein thrombosis, and pneumonia, leading to unplanned readmissions following hospital discharge.[6-8] In order to improve patient care and reduce the logistical, as well as financial burden to healthcare systems, it is important to analyze the factors associated with readmission due to complications developing after surgery for PFFs, together with reasons for readmission.[8,9]

However, readmission rates may vary depending on healthcare systems, with differences in health insurance, accessibility to healthcare facilities, and provision and financing of medical treatments, as well as post-discharge care, contributing to the risk. The Austrian healthcare system is one of the most expensive in the European Union, with roughly USAD $5,138 spent on health per capita in 2015.[10] Structural specifics of the system include a high density of practising physicians and easy access to any level of the healthcare system, as well as mandatory health insurance for every inhabitant that covers all required treatments.[10] Unsurprisingly, Austria therefore has the second highest hospital discharge rate within the European Union.[10]

Moreover, similar to other western countries, the Austrian population is ageing: in 2023, 20% of inhabitants were aged 65 years or older, compared to 16% in 2001.[11] Therefore, the rate of frailty fractures, including those of the proximal femur, is expected to increase, further intensifying the logistical and financial burden on the Austrian healthcare system.[12] In this respect, analysis of readmission rates and causes in surgically treated patients with PFFs may inform future healthcare policies towards improved management of this vulnerable patient population.

Therefore, we aimed to 1) assess the 30-day and one-year unplanned readmission risk due to complications in patients following osteosynthesis or endoprosthetic arthroplasty for PFFs across Austria; 2) analyze causes of readmission; and 3) investigate associations between demographic factors and hospital size on readmission rates.

Methods

Patients with a diagnosis of PFF (i.e. per-/inter-/subtrochanteric or femoral neck fracture) undergoing surgery between January and December 2021 at Austrian hospitals were potentially eligible. For this purpose, patient data were retrieved from the Leistungsorientierte Krankenanstaltenfinanzierung (Achievement-Oriented Hospital Financing). Variables obtained included date of hospital admission for fracture (in months and years), size of the hospital where the fracture was treated (defined by number of endoprosthetic arthroplasties and osteosyntheses annually performed), patient age at diagnosis of fracture, side of surgery (left/right), type of surgery (according to the "Leistungskatalog" (catalogue of benefits)), length of in-hospital stay (LOS) upon first surgery (in days), date of readmission for complications (in months and years), and cause of readmission (ICD-10-based; Supplementary Table i).[13]

Reasons for readmission were grouped into internal medicine-associated (ICD-10 codes A00-B99, C00-C97, D50-D89, E00-E99, I00-I99, J00-J99, K00-K93, R09-R99; Supplementary Table i), general medicine-related (ICD-10 codes F00-F99, G00-G99, H99-H59, H60-H95, L00-L99, M00-M99, N00-N99, Q00-Q99, U00-U49, Z00-Z99; Supplementary Table i), and surgery- and injury-associated (ICD-10 code S00-T98 ; Supplementary Table i). From the latter group, implant-associated complications were additionally analyzed separately (ICD-10 codes T84.0, T84.1, T84.2, T84.3, T84.4, T84.5, T84.6, T84.7, T84.8, T84.9; Supplementary Table i). Hospital size was divided into five categories: annual numbers of endoprosthetic arthroplasties and osteosyntheses ≤ 250 (group A), between 251 and 500 (group B), between 501 and 750 (group C), between 751 and 1,000 (group D), and ≥ 1,001 (group E). Patient age at surgery was categorized into four groups: < 55 years, 55 to 64 years, 65 to 74 years, and ≥ 75 years. Surgical procedures were divided into osteosyntheses (usually intramedullary fixation) and endoprostheses, with the latter group both containing hip hemiarthroplasties and total hip arthroplasties. All patients were followed up for 12 months, or until readmission for complications. Of note, detailed in-hospital information such as the surgeon's experience level, American Society of Anesthesiologists (ASA) grade,[14] surgical time, or (in the case of endoprosthetic arthroplasty) cementing technique, as well as information on discharge destination (e.g. home care, rehabilitation facility) could not be ascertained. Prior to the study initiation and data receipt, its intended purpose had been reviewed and approved by the Federal Ministry; therefore, no specific ethical approval or patient informed consent were required.

Statistical analysis

Means are provided with standard deviations (SDs) and medians with interquartile ranges (IQRs). Normality of continuous data was assessed with Shapiro-Wilk test. Differences in normally and non-normally distributed independent variables were analyzed with independent-samples *t*-tests and Mann-Whitney U tests, respectively. Chi-squared or Fisher's exact test were used to assess differences in binary and categorical data. Time elapsed from discharge from hospital to readmission due to any complication, as well as due to general medicine-, internal medicine-, and surgery/injury-associated complications was documented in days, with all patients without any event being censored after 12 months. The 30-day and one-year all-cause readmission risk, as well as readmission risk due to general medicine-, internal medicine-, surgery/injury-, and implant-associated complications was investigated separately for patients with osteosynthesis and endoprosthetic arthroplasty using multivariate logistic regression models. Variables included in the fully adjusted models were sex, patient age (four categories), hospital size (five categories), and LOS. Odds ratios (ORs) are provided with corresponding 95% confidence

intervals (CIs). Subgroup analyses including patients aged 55 years and above only (n = 10,869) were additionally performed, as well as subgroup analyses comparing patients with THA to those with hip hemiarthroplasty for PFF. A p-value < 0.05 was considered statistically significant. All statistical analyses were performed with Stata v. 16.1 for Mac (StataCorp, USA).

Results

Participants

Altogether, data of 11,270 patients with surgically treated pertrochanteric (n = 5,299) or femoral neck fractures (n = 5,971) at Austrian hospitals within a one-year period were analyzed. Of these, 6,435 (57%) had undergone osteosynthesis, and 4,835 (43%) endoprosthetic arthroplasty, either as hip hemiarthroplasty (n = 3,687) or THA (n = 1,148). The majority of patients were female (67%; n = 7,525), and most patients were among the age group ≥ 75 years (75%; n = 8,397). Further demographic data on the entire cohort, as well as for patients with osteosyntheses and endoprostheses, are outlined in Table I. Median time to readmission for any complication was 2.4 months (IQR 0.7 to 5.9), and significantly longer in patients with osteosyntheses (median 2.5 months (IQR 0.7 to 6.0) compared to those with endoprostheses (median 2.3 months (IQR 0.6 to 5.8); p = 0.008, Mann-Whitney U test).

Median LOS was 11 days (IQR 7 to 15), and significantly longer in patients with endoprosthetic arthroplasty (median 11 days (IQR 8 to 16) in comparison to osteosynthesis (median ten days (IQR 7 to 15); p < 0.001, Mann-Whitney U test). The vast majority of patients with endoprosthetic arthroplasty had underlying femoral neck fractures (99%; n = 4,835), while most patients with osteosynthesis had presented with pertrochanteric fractures (82%; n = 5,244; p < 0.001, chi-squared test). A slight male predominance was found in patients receiving hip hemiarthroplasties or THAs as compared with osteosyntheses (34% vs 32%; p = 0.038, chi-squared test). Rather, osteosyntheses had been performed in younger age groups (p < 0.001, chi-squared test). Furthermore, hospital size differed between patients undergoing osteosynthesis and endoprosthetic arthroplasty (p = 0.015, chi-squared test; Table I). Intriguingly, patients undergoing ORIF were more often treated at category E (very large-sized) hospitals compared to patients with endoprosthetic arthroplasty (Table I). Specific reasons for one-year readmission (as defined by ICD-10 codes), separated by osteosynthesis and endoprosthesis, are depicted in Figure 1.

30-day and one-year readmission rate in osteosynthesis and endoprosthesis patients

For the entire cohort, 30-day and one-year readmission rate due to any complication was equivalent to 15% and 47%, respectively (Table II). At 30 days, patients with endoprostheses presented with significantly higher readmission rates than those with osteosynthesis (30 days: 17% vs 14%; p = 0.001, chi-squared test), while no significant difference was present at one year (48% vs 47%; p = 0.138, chi-squared test; Table II). Likewise, in the subgroup analysis only involving patients aged ≥ 55 years, 30-day readmission rates due to any complication were higher in endoprosthesis patients (n = 4,772) compared to osteosynthesis patients (n = 6,097; 17% vs 15%; p = 0.014, chi-squared test), but comparable at one year (48% vs 47%; p = 0.451, chi-squared test).

Readmission rates due to general medicine- and internal medicine-associated complications at either timepoint were comparable between both groups (all p > 0.05, chi-squared tests) and also in the subgroup analysis excluding patients aged < 55 years (all p > 0.05, chi-squared test). Notably, 30-day readmission rates due to surgery/injury-associated complications were significantly higher in patients with endoprostheses (7%) compared to those with osteosynthesis (6%; p = 0.008, chi-squared test), whereas one-year readmission rates were again comparable (14% vs 15%; p = 0.529; chi-squared test; Table II). Similar results were observed in the subgroup analysis involving patients aged ≥ 55 years only (30 days: 7% (endoprosthesis) vs 6% (osteosynthesis), p = 0.030, chi-squared test; one year: 14% (endoprosthesis) vs 15% (osteosynthesis), p = 0.527, chi-squared test). The discrepancy at 30days was attributable to a higher number of implant-associated complications (endoprosthesis vs osteosynthesis 1% vs 0.7%; p = 0.001, chi-squared test), and specifically implant-associated infections (endoprosthesis vs osteosynthesis: 1% vs 0.2%; p < 0.001, chi-squared test; Table II) in patients with endoprosthesis. Related to this, one-year readmission rate due to implant-associated infections was also higher in endoprosthesis patients (1%) than osteosynthesis patients (0.3%; p < 0.001, chi-squared test). Comparable findings were again made in the subgroup of patients aged ≥ 55 years (endoprosthesis vs osteosynthesis, implant-associated infections at 30 days: 0.7% vs 0.2%, p < 0.001, chi-squared test; at one year: 1% vs 0.3%, p < 0.001, chi-squared test).

Interestingly, a second subgroup analysis comparing patients with THA (n = 1,148) to those with hip hemiarthroplasty (n = 3,687) for PFF revealed a significantly higher 30-day and one-year all-cause readmission rate (30 days: 13% vs 18%, p < 0.001, chi-squared test; one year: 43% vs 50%; p < 0.001, chi-squared test) for the latter cohort. This was attributable to higher readmission rates due to internal medicine-associated complications at both timepoints for patients with hip hemiarthroplasty (30 days: 8% vs 4%, p < 0.001, chi-squared test; one year: 22% vs 15%; p < 0.001, chi-squared test), while readmission rates due to general medicine- and surgery/injury-associated complications, as well as detailed implant-associated complications (i.e. mechanical complications, implant-associated infections, other implant-associated complications), were comparable (all p > 0.05, chi-squared test).

Male patients are at higher risk for 30-day and one-year readmission due to any complication, as well as internal medicine-associated complications

At 30 days and one year, male sex was significantly associated with higher readmission risk due to any complication, both in patients with osteosynthesis (30 days - OR 1.35 (95% CI 1.17 to 1.57); p < 0.001, logistic regression; one year - OR 1.18 (95% CI 1.06 to 1.31); p = 0.003, logistic regression; Table III) and endoprosthetic arthroplasty (30 days - OR 1.38 (95% CI 1.18 to 1.61); p < 0.001, logistic regression; one year - OR 1.36 (95% CI 1.21 to 1.54); p < 0.001, logistic regression; Table III). This effect was independent from age, hospital size, or LOS. Similar findings were made in the subgroup excluding patients aged < 55 years (Supplementary Table ii). Upon detailed analysis of

Table I. Demographic data of patients with proximal femoral fractures, treated with osteosynthesis or endoprostheses.

Variable	All patients (n = 11,270)	Osteosynthesis (n = 6,435)	Endoprosthesis (n = 4,835)	p-value
Age group, yrs, n (%)				< 0.001†
< 55	401 (4)	338 (5)	63 (1)	
55 to 64	813 (7)	524 (8)	289 (6)	
65 to 74	1,659 (15)	877 (14)	782 (16)	
≥ 75	8,397 (74)	4,696 (73)	3,701 (77)	
Male sex, n (%)	3,745 (33)	2,087 (32)	1,658 (34)	0.038†
Fracture type, n (%)				< 0.001†
Pertrochanteric	5,299 (47)	5,244 (82)	55 (1)	
Femoral neck	5,971 (53)	1,191 (18)	4,780 (99)	
Surgical side (right), n (%)	5,645 (50)	3,272 (51)	2,373 (49)	0.063†
Hospital category (surgeries per year), n (%)*				0.015†
A (0 to 250)	801 (7)	453 (7)	348 (7)	
B (251 to 500)	2,712 (24)	1,519 (24)	1,193 (25)	
C (501 to 750)	3,249 (29)	1,832 (29)	1,417 (29)	
D (751 to 1,000)	2,222 (20)	1,252 (19)	970 (20)	
E (> 1,001)	2,286 (20)	1,379 (21)	907 (19)	
LOS (days)				< 0.001‡
Median (IQR)	11 (7 to 15)	10 (7 to 15)	11 (8 to 16)	
Mean (SD)	13.5 (10.2)	12.9 (9.8)	14.2 (10.7)	

*Endoprosthetic arthroplasties and osteosyntheses.
†Chi-squared test.
‡Mann-Whitney U test.
IQR, interquartile range; LOS, length of stay; SD, standard deviation.

reason for readmission, male sex was significantly associated with higher 30-day and one-year readmission risk owing to internal medicine-associated complications, regardless of the surgical procedure (Supplementary Tables iii and iv). On the other hand, patient sex was neither significantly associated with altered risk for readmissions due to general medicine-associated complications, nor due to surgery/injury-related complications at either timepoint following osteosynthesis or endoprosthesis (Supplementary Tables iii and iv), except for male sex being associated with higher one-year readmission risk for general medicine-associated complications in the endoprosthesis cohort (OR 1.33 (95% CI 1.12 to 1.57); p = 0.001, logistic regression; Supplementary Table iv).

Older patients with osteosynthesis are at higher risk for 30-day and one-year readmission

At both timepoints, advanced patient age was significantly associated with higher readmission risk due to any complication in osteosynthesis patients (all p < 0.05, except for age group ≥ 55 to ≤ 64 years at one year, p = 0.056, logistic regression; Table III). This observation was independent from patient sex, LOS, and hospital size. For endoprosthesis patients, no such association was found for 30-day readmission risk, whereas at least very old patient age (i.e. aged ≥ 75 years) was associated with higher one-year readmission risk (OR 1.69 (95% CI 1.01 to 2.84); p = 0.046, logistic regression; Table III). In the subgroup analysis excluding patients aged < 55 years, comparable findings were made (Supplementary Table ii).

With regard to 30-day and one-year readmission risk due to internal medicine-, general medicine-, and surgery/injury-related complications, advanced patient age showed a significant positive association in osteosynthesis patients (except for surgery/injury-associated complications at one year, p > 0.05, logistic regression; Supplementary Table iii). However, no such association was found for patients with endoprosthetic arthroplasty (Supplementary Table iv).

Prolonged LOS is associated with readmission risk

Regardless of the surgical procedure, prolonged LOS was independently associated with increased one-year readmission risk due to any complication (osteosynthesis: p < 0.001; endoprosthesis: p = 0.002; both based on logistic regression; Table III). This finding was confirmed in the subgroup analysis excluding patients aged< 55 years (Supplementary Table ii). For osteosynthesis patients, prolonged LOS also associated with higher 30-day readmission risk (OR 1.00 (95% CI 1.00 to 1.01); p = 0.042, logistic regression; Table III),

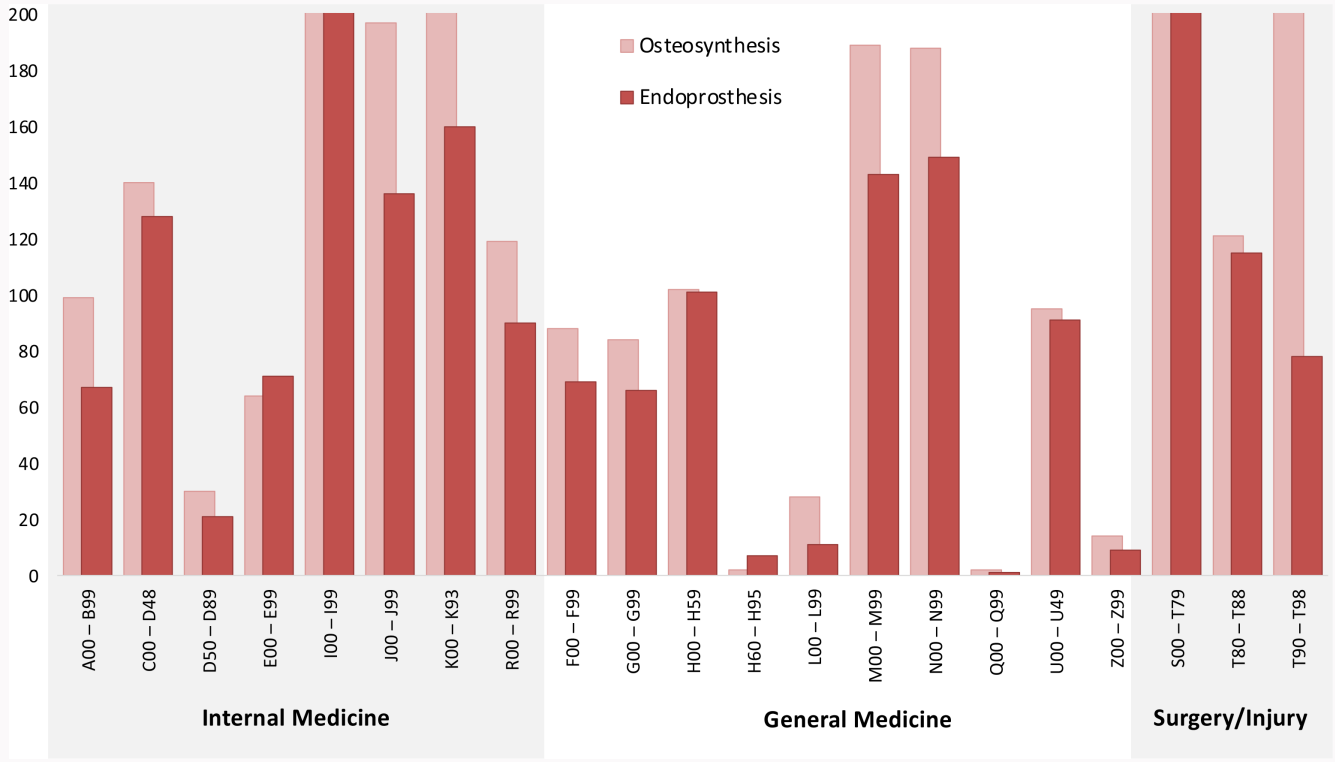

Fig. 1
Specific reasons for one-year readmissions according to International Classification of Diseases (ICD)-10 codes for osteosynthesis and endoprosthesis patients. A detailed description of conditions defined by given ICD-10 codes is provided in Supplementary Table i.

which was not the case in the subgroup analysis excluding patients aged < 55 years (OR 1.01 (95% CI 0.99 to 1.01); p = 0.062, logistic regression; Supplementary Table ii). Furthermore, prolonged LOS was significantly associated with higher readmission risk due to internal medicine-related complications at both timepoints in osteosynthesis patients (Supplementary Table iii), and with one-year readmission risk in endoprosthesis patients (Supplementary Table iv). Intriguingly, one-year readmission risk due to surgery/injury-associated complications was negatively associated with prolonged LOS in endoprosthesis patients (OR 0.99 (95% CI 0.98 to 0.99); p = 0.015, logistic regression; Supplementary Table iv). There was no significant association between LOS and readmission risk due to general medicine-associated complications at 30 days or one year, regardless of the surgical procedure.

Treatment at mid- to large-sized compared to very small-sized hospitals associates with lower readmission risk

Surgery at category D hospitals was significantly associated with lower readmission risk due to any complication in osteosynthesis patients as compared to treatment at category A hospitals (Table III). In patients with endoprosthetic arthroplasty, surgery at both category C and D hospitals was significantly associated with lower 30-day readmission risk (Table III), with the significant association prevailing at one year for treatment at category C hospitals (Table III). Comparable results were obtained in the subgroup analysis including patients aged 55 years and above (Supplementary Table ii).

When looking at specific reasons for readmission, in both osteosynthesis and endoprosthesis patients, treatment at mid-sized hospitals (depending on the timepoint, either category C or D) showed a significant association with lower 30-day or one-year readmission risk due to surgery/injury-associated complications (Supplementary Table iii, Supplementary Table iv). Furthermore, treatment at category E hospitals was significantly associated with higher 30-day readmission risk due to general medicine-associated complications in endoprosthesis patients (Supplementary Table iv), but not osteosynthesis patients (Supplementary Table iii).

Discussion

Herein, we discovered that 30-day and one-year unplanned all-cause readmission rate in patients with osteosynthesis or endoprosthetic arthroplasty due to proximal femoral fractures amounted to 15% and 47%, respectively. The 30-day readmission rate was higher in patients undergoing endoprosthetic arthroplasty, owing to a large number of readmissions due to implant-associated complications, particularly implant-associated infections. Male sex associated with higher readmission risk due to any complication, as well as internal medicine-related complications at both timepoints, irrespective of the surgical procedure. Advanced patient age was significantly associated with higher readmission risk in patients with osteosynthesis, but only to a small extent in those with endoprosthetic arthroplasty. Treatment at mid-sized hospitals was significantly associated with lower all-cause readmission risk. Moreover, prolonged LOS upon surgery for PFF was significantly associated with higher one-year readmission risk due to any complication, both in osteosynthesis and endoprosthesis patients. Notably, all these findings were confirmed in a subgroup analysis excluding patients aged < 55 years.

Table II. 30-day and one-year readmissions due to general medicine-, internal medicine-, or surgery/injury-associated complications, divided by osteosyntheses and endoprostheses.

Readmission, n (%)	All patients (n = 11,270)	Osteosynthesis (n = 6,435)	Endoprosthesis (n = 4,835)	p-value*
30 days				
Internal medicine	691 (6)	371 (6)	320 (7)	0.062
General medicine	356 (3)	199 (3)	157 (3)	0.642
Surgery/injury	673 (6)	351 (6)	322 (7)	0.008
Injury	540 (5)	296 (5)	244 (5)	0.272
Surgery	29 (0.3)	13 (0.2)	16 (0.3)	0.181
Implant	104 (0.9)	42 (0.7)	62 (1)	0.001
Mechanical	43 (0.4)	24 (0.4)	19 (0.4)	0.865
Implant-associated infection	46 (0.4)	11 (0.2)	35 (0.7)	< 0.001
Other	15 (0.1)	7 (0.1)	8 (0.2)	0.414
Overall	1,720 (15)	921 (14)	799 (17)	0.001
1 year				
Internal medicine	2,273 (20)	1,277 (20)	996 (21)	0.323
General medicine	1,439 (13)	792 (12)	647 (13)	0.091
Surgery/injury	1,612 (14)	932 (15)	680 (14)	0.529
Injury	1,376 (12)	811 (13)	565 (12)	0.141
Surgery	44 (0.4)	23 (0.4)	21 (0.4)	0.517
Implant	192 (2)	98 (2)	94 (2)	0.087
Mechanical	110 (1)	72 (1)	38 (1)	0.075
Implant-associated infection	66 (0.6)	18 (0.3)	48 (1)	< 0.001
Other	16 (0.1)	8 (0.1)	8 (0.2)	0.566
Overall	5,324 (47)	3,001 (47)	2,323 (48)	0.138

*Chi-squared test, comparing osteosynthesis with endoprosthesis.
IQR, interquartile range; SD, standard deviation.

Similar to other studies on patients with PFFs, we observed a female predominance.[15–21] With a mean of 13.5 days, LOS was longer than reported in other cohorts, ranging between a mean of 2.5 days[17] and 8.9 days.[15,16,18–20] This is most likely attributable to peculiarities of the Austrian healthcare system as already outlined above, with a combination of a strong inpatient sector and a less well developed secondary care facilities eventually reducing the pressure for (early) patient discharge or transfer to remobilization facilities.[10] At 30 days, our overall readmission rate was equivalent to 15%, and significantly higher in patients with endoprosthetic arthroplasty (17%) than osteosynthesis (14%). Slightly lower 30-day readmission rates have been reported by Martin et al[8] in 17,765 patients (8%) and by Kates et al[15] in 1,081 patients (12%) from the USA. Similarly, reported 30-day readmission rates by Buecking et al[17] in 402 patients from Germany (12%), and by Khan et al[3] in 467 patients from the UK (12%) are lower than in our cohort. Also, our observed one-year overall readmission rate of 47% is slightly higher than in a nationwide study across the USA,[22] but comparable to findings reported in a cohort study from Taiwan.[23] In light of this, routine orthogeriatric screening upon admission of patients with a PFF, as for example widely implemented in the UK, may help to reduce readmission rates in Austria.[24]

In line with previous observations,[8,9,17,19] the most common cause for readmission in our study was due to internal medicine-associated complications. Furthermore, implant-associated infections were the most frequent reason for readmission due to implant-related complications in patients with endoprosthetic arthroplasty, mirroring findings in the literature.[25,26] Of note, the subgroup analysis comparing patients with THA to those with hip hemiarthroplasty revealed that the latter cohort was at significantly higher risk for 30-day and one-year readmission, largely attributable to internal medicine-associated complications. Moreover, male sex was not only associated with higher readmission risk for internal medicine-related complication, but also all-cause readmission risk at 30 days and one year in both cohorts. Similar findings have been reported in other studies on patients with PFFs undergoing surgical therapy.[15,17,18,23] As male patients usually present with more comorbidities than female patients of a similar age,[27] these findings appear unsurprising.

Table III. Factors influencing readmission for any complication at 30 days and one year in osteosynthesis and endoprosthesis patients.

Readmission timepoint	Osteosynthesis (n = 6,435)			Endoprosthesis (n = 4,835)		
30 days	**OR**	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**
Age group, yrs (< 55 ref.)	(ref.)			(ref.)		
55 to 64	1.91	1.04 to 3.51	0.036	1.12	0.50 to 2.54	0.780
65 to 74	3.29	1.88 to 5.75	< 0.001	1.23	0.57 to 2.67	0.595
≥ 75	4.41	2.60 to 7.50	< 0.001	1.59	0.75 to 3.36	0.228
Male sex	1.35	1.17 to 1.57	< 0.001	1.38	1.18 to 1.61	< 0.001
Hospital category (surgeries per year)* (A (0 to 250) ref.)	(ref.)			(ref.)		
B (251 to 500)	0.96	0.72 to 1.30	0.774	0.81	0.60 to 1.10	0.172
C (501 to 750)	0.85	0.64 to 1.13	0.271	0.71	0.53 to 0.97	0.029
D (751 to 1,000)	0.66	0.49 to 0.90	0.008	0.65	0.47 to 0.89	0.008
E (> 1,001)	1.01	0.76 to 1.36	0.992	1.13	0.83 to 1.55	0.428
LOS, days	1.00	1.00 to 1.01	0.042	1.00	0.99 to 1.01	0.755
1 year						
Age group, yrs (< 55 ref.)	(ref.)			(ref.)		
55 to 64	1.33	0.99 to 1.77	0.056	1.32	0.75 to 2.31	0.339
65 to 74	2.13	1.63 to 2.78	< 0.001	1.39	0.82 to 2.36	0.226
≥ 75	1.95	1.53 to 2.49	< 0.001	1.69	1.01 to 2.84	0.046
Male sex	1.18	1.06 to 1.31	0.003	1.36	1.21 to 1.54	< 0.001
Hospital category (surgeries per year)* (A (0 to 250) ref.)	(ref.)			(ref.)		
B (251 to 500)	1.02	0.83 to 1.26	0.849	0.82	0.65 to 1.04	0.107
C (501 to 750)	0.88	0.72 to 1.09	0.240	0.74	0.58 to 0.93	0.011
D (751 to 1,000)	0.79	0.63 to 0.98	0.030	0.79	0.62 to 1.01	0.064
E (> 1,001)	1.02	0.83 to 1.27	0.826	1.07	0.84 to 1.38	0.574
LOS, days	1.01	1.01 to 10.2	< 0.001	1.01	1.00 to 1.01	0.002

*Endoprosthetic arthroplasties and osteosyntheses.
CI, confidence interval; LOS, length of stay; OR, odds ratio.

Evidently, advanced patient age also correlates with presence of comorbidities.[28] Thus, readmission risk owing to general medicine- and internal medicine-related complications may increase in older patients with PFFs. In this respect, however, discrepant findings have been reported in the literature. One study discovered no association between age and readmission rate in patients treated surgically for PFFs,[17] while others reported a significant one.[15,18,23] Herein, advanced age significantly and independently was associated with higher readmission risk due to any complication, as well as internal medicine-, general medicine-, and surgery/injury-related complications in osteosynthesis patients (except for readmission risk due to surgery/injury-associated complications at one year). In patients with endoprosthetic arthroplasty, only very old patient age (i.e. aged ≥ 75 years) was associated with higher one-year all-cause readmission risk. Of note, similar findings were obtained when excluding patients aged < 55 years, who can be considered as being more fit and healthy than geriatric patients with PFF.

One may argue that treatment of patients with PFFs at category E (high-volume) hospitals results in a reduced readmission rate. Intriguingly, our data revealed that surgical treatment at category C and D (mid-sized) hospitals was generally associated with a lower readmission risk than surgery at category A and B (very small-sized) hospitals. This association was likewise observed in osteosynthesis and endoprosthesis patients. Furthermore, treatment at category D (mid-sized) hospitals was significantly associated with lower 30-day or one-year readmission risk owing to surgery/injury-associated complications. Notably, endoprosthetic arthroplasty at category E (very large-sized) hospitals was significantly associated with higher 30-day readmission risk due to general medicine-related complications. Overall, our findings point towards a reduced readmission risk for any complication, as well as for surgery/injury-related complications in patients treated at category C and D (mid-sized) hospitals compared to category A and B (very small-sized) hospitals, while treatment at category E (high-volume) centres

appears to have no protective effect. This observation may be explained by the fact that patients with complex medical histories are more likely to be admitted to very large-sized centres with high expertise, as they are at higher risk for development of postoperative complications.

Finally, prolonged LOS for primary treatment is known for its negative impact on unplanned hospital readmission risk in different patient populations.[23,29–31] In the present study, prolonged LOS significantly associated with increased all-cause one-year readmission risk in both osteosynthesis and endoprosthesis patients. This is unsurprising, given that extended LOS upon primary surgery for PFF most likely reflects a more complex perioperative management and potential surgical delay due to prevailing comorbidities.[5]

Thus, future structural changes of the Austrian healthcare system should focus on optimizing perioperative management of patients with PFFs by reducing pre- as well as post-surgical stay, eventually incorporating orthogeriatric screening as standard, and expanding the secondary healthcare sector.

The uniform availability of investigated parameters in a large patient cohort can be regarded as a strength of the current study, especially when comparing our patient number of 11,270 to studies involving < 500,[3,17] < 5,000,[15,16,20,32] or < 10,000 patients with PFFs.[18] Only studies using nationwide databases such as the American College of Surgeons National Surgical Quality Improvement Programme (NSQIP),[8] Medicare,[22] or Danish Multidisciplinary Hip Fracture Registry (DMHFR)[21] included more patients than we did.

Apart from these strengths, some limitations have to be considered. First, the lack of additional potentially relevant information such as patient comorbidities, sub-differentiation into per-, inter-, or subtrochanteric PFF, surgical time, cemented versus uncemented implants (although international trends to use cemented systems in the case of PFF are usually followed in Austria),[33] ASA grade, BMI, or discharge destination constitutes a major limitation. Although these factors may have affected readmission risk in the present cohort, the focus was to assess not only all-cause readmission risk, but also reasons for readmission in detail, aiming at providing new insights to eventually inform future health policy decisions. Second, based on the structure of data available, we were unable to differentiate between pre-surgery and post-surgery in-hospital stay as well as potentially associated reasons. Therefore, we can only extrapolate that prolonged LOS was also in part influenced by a surgical delay, which per se negatively affects outcome. Nevertheless, in Austria, government-based recommendations advise operating on patients with PFF within 48 hours from admission.[34] In addition, there are no incentives or regulations in Austria compared to other countries in favour of shortened hospital stay. Third, patient death was not analyzed as a secondary endpoint. However, as already outlined above, the focus of this study was on investigation of readmission rates together with reasons for readmission, rather than evaluation of patient mortality. Further, hospital size was determined based on cumulative number of osteosyntheses and endoprostheses performed, therefore one has to consider a potential uneven case load distribution depending on each hospital's focus and expertise. Related to this, the eventual impact of surgeons' experience level on readmission risk could not be assessed, as this information was unavailable. Next, the study population also included patients aged < 55 years, who may present with differing risk profiles compared to older individuals. Therefore, subgroup analyses were carried out excluding patients diagnosed with PFFs below the age of 55 years, yielding similar results to the ones obtained in the entire cohort. In addition, a clear connection between surgery for PFF and complications necessitating hospital readmission, especially for those readmissions taking place several weeks following discharge, can only be assumed. Moreover, owing to limited event numbers, individual reasons leading to readmission, apart from differentiation into general medicine-, internal medicine-, and surgery/injury-associated complications, were not considered in the statistical models for 30-day and one-year readmission risk. In this context, numbers on specific reasons for readmission are altogether rather low, and therefore the practical relevance of observed statistically significant differences has to be interpreted cautiously.

According to this cross-sectional study analyzing patients treated surgically for proximal femoral fractures within one year across Austria, male sex is associated with higher 30-day and one-year readmission risk, regardless of the surgical procedure performed. Prolonged LOS is associated with increased readmission risk, while treatment at mid-sized hospitals appears to be negatively associated with readmission risk. Considering that the most frequent reason for readmission was due to internal medicine-related complications, optimization of perioperative and post-discharge management in this vulnerable patient population, as already implemented in other countries as the UK, should be one target of future health policy decisions in Austria.

Supplementary material

Tables depicting International Classification of Diseases-10 codes used to identify reason for readmission within one year from surgery for per- and subtrochanteric fractures; subgroup analyses excluding patients aged 55 years and below, investigating factors associated with readmission for any complication at 30 days and one year; analyses on factors influencing readmission for complications in osteosynthesis patients; and statistical analyses on the influence of parameters on readmission for complications in endoprosthesis patients.

References

1. **Veronese N**, **Maggi S**. Epidemiology and social costs of hip fracture. *Injury*. 2018;49(8):1458–1460.
2. **Gullberg B**, **Johnell O**, **Kanis JA**. World-wide projections for hip fracture. *Osteoporos Int*. 1997;7(5):407–413.
3. **Khan MA**, **Hossain FS**, **Dashti Z**, **Muthukumar N**. Causes and predictors of early re-admission after surgery for a fracture of the hip. *J Bone Joint Surg Br*. 2012;94-B(5):690–697.
4. **Pedersen AB**, **Ehrenstein V**, **Szépligeti SK**, **et al**. Thirty-five-year trends in first-time hospitalization for hip fracture, 1-year mortality, and the prognostic impact of comorbidity: a Danish nationwide cohort study, 1980-2014. *Epidemiology*. 2017;28(6):898–905.
5. **Schrøder CK**, **Hjelholt TJ**, **Møller H**, **Madsen M**, **Pedersen AB**, **Kristensen PK**. Comorbidity and quality of in-hospital care for hip fracture patients. *J Am Med Dir Assoc*. 2022;23(4):671–677.
6. **Gadgaard NR**, **Varnum C**, **Nelissen RGHH**, **Vandenbroucke-Grauls C**, **Sørensen HT**, **Pedersen AB**. Comorbidity and risk of infection among patients with hip fracture: a Danish population-based cohort study. *Osteoporos Int*. 2023;34(10):1739–1749.

7. **Folbert EC**, **Hegeman JH**, **Gierveld R**, **et al**. Complications during hospitalization and risk factors in elderly patients with hip fracture following integrated orthogeriatric treatment. *Arch Orthop Trauma Surg*. 2017;137(4):507–515.
8. **Martin CT**, **Gao Y**, **Pugely AJ**. Incidence and risk factors for 30-day readmissions after hip fracture surgery. *Iowa Orthop J*. 2016;36:155–160.
9. **Sarimo S**, **Pajulammi H**, **Jämsen E**. Process-related predictors of readmissions and mortality following hip fracture surgery: a population-based analysis. *Eur Geriatr Med*. 2020;11(4):613–622.
10. **Bachner F**, **Bobek J**, **Habimana K**, **et al**. Austria: health system review. *Health Syst Transit*. 2018;20(3):1–254.
11. **No authors listed**. Population by age/sex. Statistics Austria. 2023. https://www.statistik.at/en/statistics/population-and-society/population/population-stock/population-by-age-/sex (date last accessed 26 March 2024).
12. **Muschitz C**, **Hummer M**, **Grillari J**, **et al**. Epidemiology and economic burden of fragility fractures in Austria. *Osteoporos Int*. 2022;33(3):637–647.
13. **No authors listed**. International statistical classification of diseases and related health problems: tenth revision. World Health Organization. 2004. https://iris.who.int/handle/10665/42980 (date last accessed 26 March 2024).
14. **Saklad M**. Grading of patients for surgical procedures. *Anesthesiol*. 1941;2(3):281–284.
15. **Kates SL**, **Behrend C**, **Mendelson DA**, **Cram P**, **Friedman SM**. Hospital readmission after hip fracture. *Arch Orthop Trauma Surg*. 2015;135(3):329–337.
16. **Crijns TJ**, **Caton T**, **Teunis T**, **et al**. Longer length of stay increases 1-year readmission rate in patients undergoing hip fracture surgery. *Arch Bone Jt Surg*. 2018;6(6):492–500.
17. **Buecking B**, **Eschbach D**, **Koutras C**, **et al**. Re-admission to Level 2 unit after hip-fracture surgery - risk factors, reasons and outcome. *Injury*. 2013;44(12):1919–1925.
18. **Basques BA**, **Bohl DD**, **Golinvaux NS**, **Samuel AM**, **Grauer JG**. General versus spinal anaesthesia for patients aged 70 years and older with a fracture of the hip. *Bone Joint J*. 2015;97-B(5):689–695.
19. **Lizaur-Utrilla A**, **Serna-Berna R**, **Lopez-Prats FA**, **Gil-Guillen V**. Early rehospitalization after hip fracture in elderly patients: risk factors and prognosis. *Arch Orthop Trauma Surg*. 2015;135(12):1663–1667.
20. **Pinto AFD**, **Teatini CM**, **Avelar N de**, **Leopoldino AAO**, **Moura ICG**. Factors associated with readmission within 30 days after discharge and in-hospital mortality after proximal femoral fracture surgery in the elderly: retrospective cohort. *Rev Bras Ortop (Sao Paulo)*. 2023;58(2):222–230.
21. **Schrøder CK**, **Hjelholt TJ**, **Møller H**, **Madsen M**, **Pedersen AB**, **Kristensen PK**. Comorbidity and quality of in-hospital care for hip fracture patients. *J Am Med Dir Assoc*. 2022;23(4):671–677.
22. **Riester MR**, **Beaudoin FL**, **Joshi R**, **et al**. Evaluation of post-acute care and one-year outcomes among Medicare beneficiaries with hip fractures: a retrospective cohort study. *BMC Med*. 2023;21(1):232.
23. **Lee T-C**, **Ho P-S**, **Lin H-T**, **Ho M-L**, **Huang H-T**, **Chang J-K**. One-year readmission risk and mortality after hip fracture surgery: a national population-based study in Taiwan. *Aging Dis*. 2017;8(4):402–409.
24. **No authors listed**. Royal College of Physicians, 15 years of quality improvement: the 2023 national hip fracture database report on 2022. 2023. https://www.nhfd.co.uk/2023report (date last accessed 26 March 2024).
25. **Gallardo-Calero I**, **Larrainzar-Coghen T**, **Rodriguez-Pardo D**, **et al**. Increased infection risk after hip hemiarthroplasty in institutionalized patients with proximal femur fracture. *Injury*. 2016;47(4):872–876.
26. **Guren E**, **Figved W**, **Frihagen F**, **Watne LO**, **Westberg M**. Prosthetic joint infection-a devastating complication of hemiarthroplasty for hip fracture. *Acta Orthop*. 2017;88(4):383–389.
27. **L Riska BS**, **Forsén L**, **Omsland TK**, **Søgaard AJ**, **Meyer HE**, **Holvik K**. Does the association of comorbidity with 1-year mortality after hip fracture differ according to gender? The Norwegian Epidemiologic Osteoporosis Studies (NOREPOS). *J Am Geriatr Soc*. 2018;66(3):553–558.
28. **Barnett K**, **Mercer SW**, **Norbury M**, **Watt G**, **Wyke S**, **Guthrie B**. Epidemiology of multimorbidity and implications for health care, research, and medical education: a cross-sectional study. *Lancet*. 2012;380(9836):37–43.
29. **Morcos MW**, **Nowak L**, **Schemitsch E**. Delayed discharge after total hip arthroplasty is associated with an increased risk of complications. *Can J Surg*. 2022;65(5):E593–E598.
30. **Ansari SF**, **Yan H**, **Zou J**, **Worth RM**, **Barbaro NM**. Hospital length of stay and readmission rate for neurosurgical patients. *Neurosurgery*. 2018;82(2):173–181.
31. **Tahiri Y**, **Fischer JP**, **Wink JD**, **et al**. Analysis of risk factors associated with 30-day readmissions following pediatric plastic surgery: a review of 5376 procedures. *Plast Reconstr Surg*. 2015;135(2):521–529.
32. **Long Y**, **Wang T**, **Xu X**, **et al**. Risk factors and outcomes of extended length of stay in older adults with intertrochanteric fracture surgery: a retrospective cohort study of 2132 patients. *J Clin Med*. 2022;11(24):24.
33. **Fernandez MA**, **Achten J**, **Parsons N**, **et al**. Cemented or uncemented hemiarthroplasty for intracapsular hip fracture. *N Engl J Med*. 2022;386(6):521–530.
34. **No authors listed**. (Clinical path: Treatment of fractures near the hip in patients who were previously orally anticoagulated) (Version 2020). Bundesministerium, 2020. https://www.sozialministerium.at/Themen/Gesundheit/Gesundheitssystem/Gesundheitssystem-und-Qualitaetssicherung/Qualitaetsstandards/Klinischer-Pfad--Behandlung-hueftnaher-Frakturen-bei-zuvor-oral-antikoagulierten-Patientinnen-und-Patienten.html (date last accessed 26 March 2024). (Website in German).

Author information

M. A. Smolle, MD, Orthopaedic Surgeon,
Department of Orthopaedics and Trauma, Medical University of Graz, Graz, Austria;
Department of Orthopaedics, Balgrist University Hospital, Zurich, Switzerland.

S. F. Fischerauer, MD, PhD, Orthopaedic Surgeon
L. Leitner, MD, PhD, Orthopaedic Surgeon
P. Puchwein, MD, Orthopaedic Surgeon
A. Leithner, MD, Orthopaedic Surgeon
P. Sadoghi, MD, PhD, MBA, Orthopaedic Surgeon
Department of Orthopaedics and Trauma, Medical University of Graz, Graz, Austria.

I. Vukic, MSc, Government Employee, Federal Ministry of Social Affairs, Health, Care and Consumer Protection, Vienna, Austria.

H. Widhalm, MD, Orthopaedic Surgeon, Department of Orthopedics and Trauma Surgery, Medical University of Vienna, Vienna, Austria.

Author contributions

M. A. Smolle: Formal analysis, Investigation, Writing – original draft.
S. F. Fischerauer: Investigation, Validation, Writing – review & editing.
I. Vukic: Data curation, Investigation, Writing – review & editing.
L. Leitner: Supervision, Validation, Writing – review & editing.
P. Puchwein: Project administration, Supervision, Writing – review & editing.
H. Widhalm: Supervision, Validation, Writing – review & editing.
A. Leithner: Resources, Validation, Writing – review & editing.
P. Sadoghi: Project administration, Supervision, Validation, Writing – review & editing.

Funding statement

The authors received no financial or material support for the research, authorship, and/or publication of this article.

ICMJE COI statement

A. Leithner reports institutional educational grants from Johnson & Johnson, Alphamed, Medacta, and Implantec, unrelated to this study. P. Puchwein reports consulting fees from Hofer, I.T.S,

and payment or honoraria for lectures, presentations, speaker bureaus, manuscript writing or educational events from Medacta, I.T.S, Amgen, and Annexa, all of which are unrelated to this study. P. Puchwein also holds a leadership or fiduciary role on ÖGoUT. P. Sadoghi reports royalties or licenses, consulting fees, and support for attending meetings and/or travel from Medacta and DePuy, which are unrelated to this study. P. Sadoghi is an Editorial Board Member of JOA, KSSTA, and *Arthroscopy*. M. A. Smolle reports travel grants from Alphamed, ImplanTec, Implantcast, and PharmarMar, unrelated to this study.

Data sharing

The datasets generated and analyzed in the current study are not publicly available due to data protection regulations. Access to data is limited to the researchers who have obtained permission for data processing. Further inquiries can be made to the corresponding author.

Ethical review statement

Prior to study initiation and data receipt, the intended purpose of the study was reviewed and approved by the Federal Ministry.

Open access funding

The open access fee for this article was self-funded.