Safety of Elderly Fallers

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Safety of elderly fallers:
Identifying associated risk factors for 30-day unplanned readmissions using a clinical data warehouse

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ABSTRACT

Background Hospital readmissions are a major problem in the elderly as they are frequent, costly, and life-threatening. Falls among older adults are the leading cause of injury, deaths and emergency department visits for trauma.

Objective The main objective was to determine risk factors associated with a 30-day readmission after index hospital admission for Fall Related Injuries (FRI).

Methods A retrospective nested case-control study was conducted. Data from elderly patients initially hospitalized for FRI in 2019, in 11 of the Greater Paris University Hospitals and discharged home, were retrieved from the clinical data warehouse. Cases were admission of elderly patients who subsequently experienced a readmission within 30 days after discharge from the index admission. Controls were admission of elderly patients who were not readmitted to hospital.

Results Among 670 eligible index admissions, 127 (18.9%) were followed by readmission within 30 days after discharge. After multivariate analysis, men gender (OR = 2.29, 95% CI = 1.45-3.61), abnormal concentration of C-reactive protein and anaemia (OR = 2.22, 95% CI = 1.28 - 3.85; OR = 1.85, 95% CI = 1.11 - 3.11 respectively) were associated with a higher risk of readmission. Oppositely, having a traumatic injury at index admission decreased this risk (OR = 0.47, CI95% = 0.28 - 0.81).

Conclusion Reducing early unplanned readmission is crucial, especially in elderly patients susceptible to falls. Our results indicate that the probability of unplanned readmission is higher for patients with specific characteristics that should be taken into consideration in interventions designed to reduce this burden.

INTRODUCTION

Hospital readmissions are defined as patient admissions within a specified time frame following discharge from index hospital admission. Hospital readmission rate within 30 days of discharge from an index admission serves as a key indicator for measuring the quality of patient health care and is adopted by major healthcare stakeholders nationally and internationally (1).

Readmissions increase patient morbidity and mortality particularly among the elderly, and result in a huge financial burden on healthcare. In 2011, there were approximately 3.3 million readmissions in the United States (US), contributing to $41.3 billion in total hospital costs (2,3). Finally, readmissions constitute a substantial burden for health care systems with incidences as high as 15.5 to 19.6 % (4,5).

The reasons which account for hospital readmission are multifactorial, it is obvious that they result from factors related to comorbidities (*e.g.* natural progression of the diseases), factors related to the patient (social and family environment or treatment adherence), or a combination of all of these (6). Several studies have demonstrated links between hospital readmissions and specific diseases or comorbidities (7–11), medications (12–14), male gender (15), older age (7), education level (11), living conditions (16) and poor overall condition of the patient (17). Nevertheless, from 9% to 48% of all readmissions could be considered as avoidable because they were associated with indicators of substandard care during the index admission such as poor resolution of the main clinical problem, unstable therapy at discharge, or inadequate post discharge care (18).

People aged 65 years or over accounted for 20% of the French population in 2019, and 9.5% were over 75 years old (19). Older adults have a greater risk of being admitted to hospital than any other age group and FRIs account for many of these hospital admissions. The incidence and prevalence of falls and related hospital admissions are indeed significantly higher among elderly patients: about 32-42% of people aged 70 and over fall each year and 85% of all emergency visits for home and leisure injuries are due to a fall in victims aged 65 years and over. Hospitalization of elderly patients, especially those admitted for FRIs is associated with an increased risk of functional worsening, loss of independence, overall deterioration and also a high rate of hospital readmission (20,21).

Defining factors associated with hospital readmission is important in order to identify higher risk patients. Accurate information on index admission diagnosis, therapeutics and laboratory

tests associated with readmission is required to effectively design a preventive strategy to reduce readmission rates and improve the health care system.

The main objective of our study was to identify risk factors associated with unplanned hospital readmission within 30 days after discharge. We thus conducted a nested case-control study using the Clinical Data Warehouse (CDW) of the Greater Paris University Hospitals (AP-HP) among elderly patients initially admitted for FRIs (e.g. fracture or injuries). Our secondary objectives were to assess the rate of unplanned readmission within 30 days after discharge and their time of occurrence, to determine the number of hospital readmissions per patient, to describe and to compare the characteristics of cases of unplanned readmission within 30 days after discharge and controls.

METHODS

This study is presented according to the REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement (22).

Study design and setting

An observational retrospective nested case-control study within a cohort of patients admitted to the Greater Paris University Hospitals (AP-HP) was conducted from January 1st to December 31st, 2019 using the Clinical Data Warehouse (CDW) of AP-HP. The CDW collects data on more than 11 million patients from the 39 institutions of AP-HP. In addition to demographic data, the warehouse can contain medico-administrative data pertaining to the PMSI (*medicalized information system program*), diagnoses, procedures, biology and imaging results and medical reports associated with hospital admissions, including emergency department data. Among the 39 institutions of AP-HP, only 11 had computerized drug prescriptions that can be extracted. Thus, for this study, we extracted data of all admissions of elderly patients initially admitted with a diagnosis of fall-related injuries in one of these 11 institutions.

Inclusion and exclusion criteria

Patients were included in the study if they were aged 75 years and more, admitted to one of the 11 hospitals of the study, with a diagnosis of FRI according to the International Classification of Diseases, 10th Revision (ICD-10) and discharged home.

Exclusion criteria were: patients who died during the hospital stay or within 30 days after discharge, outpatients and patients who attended the emergency department without

admission, during this period. Deaths after discharge were checked in the French national open dataset of death records (23).

Cases and controls definition

Cases were admissions of elderly patients susceptible to falls who experienced an unplanned readmission within 30 days after discharge. Controls were admissions of elderly patients susceptible to falls not readmitted within 30 days.

A readmission could also be considered as case if it was for FRI with discharge home and was followed by subsequent admission within 30 days. However, readmission will be considered as a control if it was for FRI with discharge home and was not followed by subsequent admission, or followed by subsequent admission later than 30 days (figure 1 in the supplementary files).

This approach is in line with the methodology of the Agency for Healthcare Research and Quality and the benchmark study of readmission rates by Jencks *et al*. (4).

Variables

The primary outcome of this study was the risk factors for hospital readmission within 30 days after discharge from index admission for FRI.

Data were extracted at the index admission, the analyzed variables included: demographic characteristics (age, gender) , admission characteristics (entry mode, length of stay and previous hospital admission in the 6 months prior to the index admission), therapeutic characteristics (prescribed drugs were grouped according to the anatomical, pharmacological or chemical level of the Anatomical Therapeutic Classification (ATC) according to the significance of the clinical interpretation, number of drugs, number of pharmacological classes, polymedication (more than 5 drugs), presence of Potentially Inappropriate Medication (PIM) defined by Beers criteria (24)), diagnosis characteristics (according to the ICD-10, number of comorbidities and Charlson index based on the algorithm developed by Quan *et al.* (25)). Laboratory test results were also analyzed (electrolytes, blood count, leukocyte formula, lymphocyte populations, CRP, uremia, glomerular filtration rate, proteinemia), according to the significance of the clinical interpretation, some of these variables were categorized according to normal clinical rates.

Statistical analysis

A descriptive analysis of the study population (cases and controls) was performed. Baseline characteristics were described by the usual parameters: mean and standard deviation for continuous variables; numbers and percentages for qualitative variables. The median and the

interquartile range were used to describe the time to readmission. A Kaplan Meier survival curve was also used to describe readmission time within 30 days of discharge.

We used a t-test to compare means for quantitative variables and Chi-squared test to compare the percentages of qualitative variables between cases and controls. The variables with a difference between groups ($p \leq 0.1$) or widely described in the literature were included in the multivariate analysis. A collinearity diagnosis and a correlation matrix were made to determine the correlations between selected variables. If two variables were correlated, we decided to remove the variable with the highest p-value. Multivariate logistic regression models, providing Odds-Ratio (OR) and 95% Confidence Intervals (95% CI) were used to assess the association between unplanned readmission within 30 days and potential risk factors while adjusting relevant influencing factors (backward elimination). All p values <0.05 were taken as statistically significant.

We carried out a sensitivity analysis which consisted in comparing ORs obtained in full case analysis and after imputation of missing data, to ensure that the missing data did not affect our risk estimate.

All statistical analyzes were performed using SAS Institute, version 9.4, North Carolina, USA.

RESULTS

Participants

From January 1st to December 31st, 2019 a total of 1,397 admissions of elderly patients (≥ 75 years or over), initially admitted for FRI in one of the 11 AP-HP hospitals of the study were included. Among them, 670 admissions have met our definition of index admission. A total of 127 index admissions were followed by a readmission within 30 days after discharge and classified as cases. Whereas, 543 index admissions were not followed by a readmission within 30 days after discharge and were classified as controls (figure 1). The 30-day readmission rate was, therefore, 18.9%.

A total of 579 patients met our inclusion criteria: 113 were readmitted to the hospital within 30 days of discharge from index admission and 503 patients were not readmitted. Among readmitted patients, 103 (91.1%) patients had one readmission; 8 (7.1%) patients had two readmissions and 2 (1.8%) patients had four readmissions. The 30-day readmission rate was therefore 17.8%. The median time to readmission was 7 days (Interquartile Range: 2-18) (figure 2).

Characteristics of the study population

Patients mean age was 86.1 (±6.0) years; 62.1% were women and 66.6% came directly from home. For diagnosis characteristics, the mean number of comorbidities was 6.7 (±3.5) and the mean of Charlson index was 1.4 (±1.5). The mean number of prescribed drugs was 8.9 (±3.3) and 84.0% of patients were polymedicated (> 5 drugs); 33.6% of patients were initially admitted with a tendency to fall (table 1).

Comparison of case and control characteristics

We compared demographic, therapeutic, diagnosis, laboratory tests results and admission characteristics between cases and controls in order to select the variables for the multivariate analysis. Table 2 shows the characteristics that have a difference ($p \leq 0.1$) or widely described in the literature comparing cases and controls (the other variables are presented in table S1 in the supplementary files). There were missing data for 53 (7.9%) admission regarding therapeutic characteristics, 45 (6.7%) regarding hemoglobin concentration and 96 (14%) regarding C-reactive protein (CRP) laboratory tests.

Bivariate analysis shows differences between cases and controls. The rate of readmission for men was higher in cases (52.8% vs. 34.4%; P=0.0001). For therapeutic characteristics, cases were significantly more exposed to antiarrhythmics, antigout drugs, antiepileptics, anxiolytics, hypnotics, sedatives, systemic corticosteroids, diuretics and benign prostate hyperplasia drugs than controls. The number of pharmacological classes and PIM was higher in cases compared to controls. Cases were more likely to have been diagnosed with anaemia (25.2% *vs.* 18.4%; P= 0.0837), a malignant tumor (19.7% *vs.* 11.2%; P=0.0104), other heart disease (43.3% *vs*. 35.4; P=0.0946), a higher Charlson index (1.6 ± 1.7 *vs.* 1.4 ± 1.5; P=0.0861) on index admission, less likely to have a traumatic injury (28.3% *vs*. 40.3%; P=0.0123) than controls. Furthermore, cases were more likely to have an abnormal concentration of CRP and hemoglobin, and a previous hospital admission. The length of stay was higher in controls than in cases (24.7±29.7 *vs* 18.7 ± 27.2; P=0.0385).

Multivariate analysis

The variables in the bivariate analysis did not show any collinearity or correlation, therefore, they were all included in the multivariate analysis. We performed our multivariate analysis on cases and controls with complete data (105 cases and 459 controls).

In this final logistic regression model (table 3), male gender, abnormal concentration of CRP, anaemia, and traumatic injury were still significantly associated with hospital readmission ($p< 0.05$), after adjustment for use of anxiolytics, hypnotics and sedatives, systemic corticosteroids, length of stay and previous hospital admission. Therefore, men had a higher readmission risk (OR = 2.29, 95%CI = 1.45-3.61). Having an abnormal concentration of CRP and anaemia at the index admission increased the readmission risk (OR = 2.22, 95%CI = 1.28 - 3.85; OR = 1.85, 95%CI = 1.11 - 3.11, respectively). On the contrary, having a traumatic injury at the index admission decreased the readmission risk (OR = 0.47, IC95% = 0.28 - 0.81).

Sensitivity analysis

We performed a multiple imputation of missing data to ensure that the missing data did not affect our risk estimate. Tables S2, S3 and S4 in the supplementary files show the results of our sensitivity analysis. Male gender, abnormal concentration of CRP and anaemia were still significantly associated with hospital readmission after adjustment for use of anxiolytics, hypnotics and sedatives, systemic corticosteroids, traumatic injury and previous hospital admission (OR = 2.14, 95%CI = 1.42 - 3.22; OR = 1.83, 95%CI = 1.08 - 3.09; OR=1.67, 95%CI = 1.03 - 2.71, respectively). Comparison of the ORs of the final models (with and without imputation) showed no difference. In the final model with imputation, the length of stay was significantly associated with the readmission risk (OR = 0.98; 95%CI = 0.97 – 0.99): having a longer length of stay decreases the readmission risk.

DISCUSSION

In this observational retrospective case-control study conducted using the AP-HP clinical data warehouse, among elderly patients aged 75 years or older initially hospitalized for FRI (*e.g.* fractures, injury), the rate of all-cause hospital readmission within 30 days from index admission discharge was 18.9%. This finding is close to that of the French advisory council for the future of health insurance regarding readmission, which was 17.5% (26). Likewise, our readmission rate is also close to that generally reported in the literature, which varies from 14 to 20% according to differences in methodology (*e.g.*, definition of unplanned readmission) and study population (*e.g.* older people, heart failure,…) (4,5,27–29).

However, previous studies specifically conducted on patients admitted following injury have shown lower rates. Osler *et al.* have shown that 6.7% of patients admitted for traumatic injury were readmitted within 30 days (30), this low rate could be explained by the fact that their

study population consists of non-elderly adults. These patients may not have multiple comorbidities and might be in a better health than our patients. Furthermore, Strosberg *et al.* have also shown a lower readmission rate (8.4%) among older trauma patients (31). However, this result was obtained for adults aged 45 years and older discharged after index admission to several destinations (home, rehabilitation facilities and extended care facilities). It seems that methodological differences do not allow for direct comparisons between our readmission rate identified here and in these studies.

Our study showed that male gender, abnormal concentration of CRP and anaemia at index admission were independently associated with increased risk of 30-day hospital readmission. On the contrary, a traumatic injury at the index admission was associated with decreased risk of early hospital readmission, and that after adjustment for use of anxiolytics, hypnotics and sedatives, systemic corticosteroids, history of hospital admission and length of stay.

These findings are broadly consistent with other observations. Several studies indeed found that male gender was significantly associated with a higher risk of hospital readmission (15,32), moreover, previous studies conducted in the US have shown that in a population of patients initially hospitalized for a hip fracture which is a diagnosis often associated with a fall, men were more likely to be readmitted within 30 days after discharge than women (33,34). This finding can be explained by the fact that frailty is more common among older men than women (35). There are also gender related differences in quality of hospital care and in the utilization of health care services: women have greater medical care service utilization and are more likely to seek health care for prevention and illness. In addition, hospitalized men are more likely to be referred for invasive procedures than women, which results in a higher readmission rate (36). This result suggests that clinicians should consider gender in discharge planning and for the entire episode of care for the population.

Another risk factor for early hospital readmission was an abnormal CRP concentration. This result is consistent with other studies that have found that a high plasma CRP at discharge was an independent predictor of subsequent unplanned readmission (37,38). CRP is a marker of ongoing inflammation linked to the systemic inflammatory response. This finding may indicate that there was residual organ dysfunction, nosocomial infection and/or an inflammatory process after discharge from index admission resulting in subsequent readmission. Assessment of the evolution of CRP concentrations during hospitalization could be a useful tool in discharge decision-making. It may provide additional information regarding the resolution of the critical illness and the development of infections.

We also found that anaemia was independently associated with increased early hospital readmission. This is not surprising since a lot of studies have shown that anaemia is much more common in hospitalized geriatric patients (39) and linked with increased hospital readmission (40). However, in our study, anaemia and abnormal CRP concentration were correlated, suggesting that anaemia could be due to another factor (e.g. malnutrition, bleeding…). As the cause of anaemia is often multifactorial, it is important for clinicians to understand the underlying causes and contributing factors when deciding on the most appropriate care for newly admitted patients.

Only one protective factor was identified in our study: a traumatic injury was associated with decreased risk of early hospital readmission. A recent study by Morris *et al.* have shown a similar result, they found that hospitalization after traumatic injury was associated with a decreased risk of early readmission (OR = 0.37, p = 0.004) (41). This finding may be explained by the fact that trauma patients are very vulnerable and they may benefit from a specific health care coordination to prevent hospital readmission and special attention paid to home support.

Several studies have been carried out among elderly patients to assess the unplanned hospital readmission rate and to identify the associated risk factors. In this study, we focused on elderly patients susceptible to falls regarding the need for effective interventions to reduce readmission rate among this specific population and to decrease functional worsening and loss of independence, risks that were widely described. We found a common profile of risk factors among elderly patients susceptible to falls and the general population of older patients. Furthermore, the risk factors that we have identified are close to frailty risk factors in elderly patients, in particular, increased mean levels of C-reactive protein and anaemia (42). Our findings confirm the frailty of elderly patients who are susceptible to fall and the results of other studies that defined frailty as a stronger predictor of readmission in older trauma patients (43). Likewise, Hatcher *et al.* have already shown that after an index admission for trauma related injury, frail elderly patients were more likely to be readmitted compared with non-frail (OR, 2.26; 95% CI, 1.39-3.66; P = 0.001) (44).

This study had some limitations. First, among the 39 institutions of the AP-HP, at the time of the study only 11 had computerized drug prescription system and we did not consider readmission to other hospitals or institutions, and this could lead to a classification bias and underestimating of readmission rate. Indeed, controls might have been readmitted to another hospital after discharge. However, based on previous studies, 91.1% of readmissions were in the same hospital and only 8.9% in another hospital (45). Secondly, there were some missing

data regarding therapeutic characteristics and laboratory test results. Missing data can create potential selection bias and may have generated false-positive results. Hence, we performed a multiple imputation of missing data to ensure that they did not affect our risk estimate. The two multivariate models (before and after imputation) produced a very similar result for risk factors associated with 30-day hospital readmission. Thirdly, in our study, we did not include information on patient abilities to perform everyday routine tasks or other measurements of physical functioning. This ability can be a marker of frailty and enhance the risk of hospital readmission. However, we included a large number of other relevant data including patient therapeutics, laboratory tests, and admission characteristics which enabled us to test several potential factors of hospital readmission.

Finally, the strength of this study is its focus on risk factors at discharge after index admission. Index admission is considered as the care phase where interventions to reduce readmission would have been most effective (46), thus allowing better intervention and facilitating the implementation of the interventions.

Interestingly, even if our results may not be generalizable to the entire population of elderly patients susceptible to falls, the use of the clinical data warehouse enabled us to study a substantial diversity of patient profiles and thus reflects an accurate representation of this population.

CONCLUSION

Early hospital readmission in elderly patients remains a major health care problem in many countries, leading to potentially serious consequences, especially in elderly admitted for FRI, presumably because of the frailty of this population. Prevention calls for the identification of risk factors to target interventions for high-risk patients. Our study shows for the first time, in older patients susceptible to falls, that the probability of unplanned readmission is higher for patients with specific characteristics (men, anaemia and abnormal concentration of CRP). The implementation of a specific post discharge programme for these patients is now crucial to reduce early hospital readmission.

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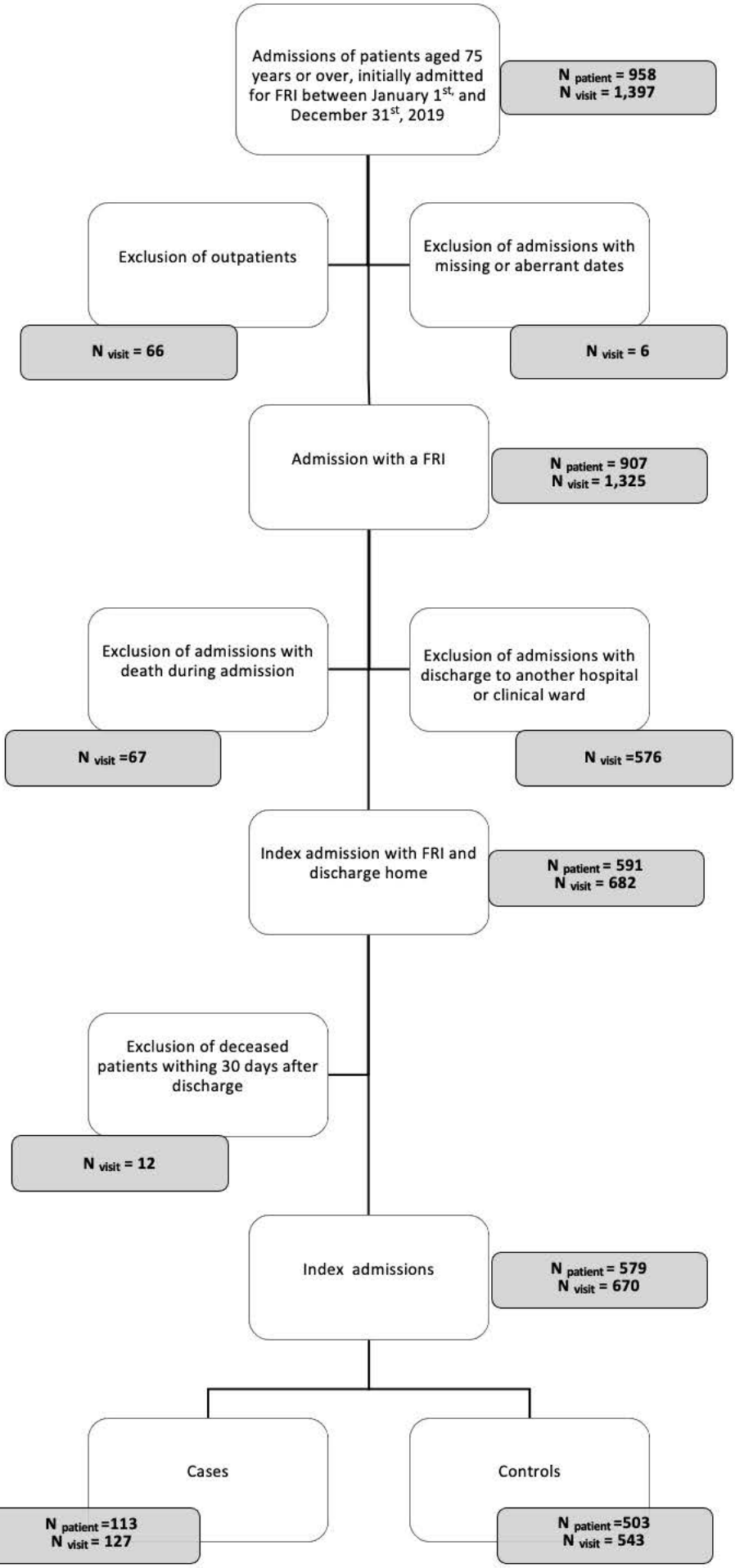
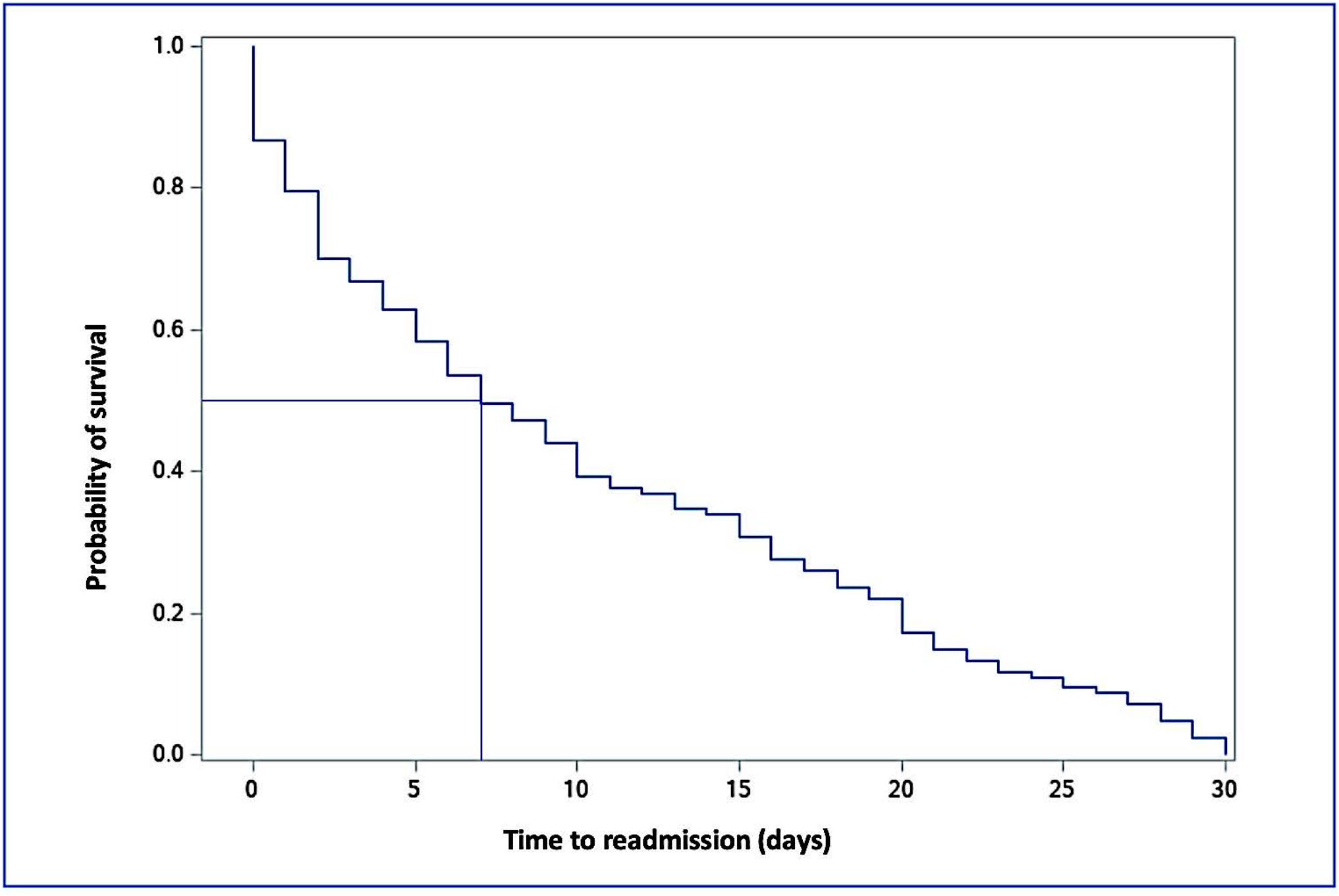
FIGURES LEGEND:

Figure 1 : Flow diagram of patient selection process

Figure 2: Kaplan Meier survival curve with median time to readmission


Admissions of patients aged 75 years or over, initially admitted for FRI between January 1st, and December 31st, 2019
N patient = 958
N visit = 1,397
Exclusion of outpatients
N visit = 66
Exclusion of admissions with missing or aberrant dates
N visit = 6
Admission with a FRI
N patient = 907
N visit = 1,325
Exclusion of admissions with death during admission
N visit =67
Exclusion of admissions with discharge to another hospital or clinical ward
N visit =576
Index admission with FRI and discharge home
N patient = 591
N visit = 682
Exclusion of deceased patients withing 30 days after discharge
N visit = 12
Index admissions
N patient = 579
N visit = 670
Cases
N patient =113
N visit = 127
Controls
N patient =503
N visit = 543


1.0
0.8
0.6
0.4
0.2
0.0
Probability of survival
0
5
10
15
20
25
30
Time to readmission (days)

The RECORD statement – checklist of items, extended from the STROBE statement, that should be reported in observational studies using routinely collected health data.

	Item No.	STROBE items	Location in manuscript where items are reported	RECORD items	Location in manuscript where items are reported
Title and abstract					
	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found	1	RECORD 1.1: The type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included. RECORD 1.2: If applicable, the geographic region and timeframe within which the study took place should be reported in the title or abstract. RECORD 1.3: If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract.	1
Introduction					
Background rationale	2	Explain the scientific background and rationale for the investigation being reported	2		2
Objectives	3	State specific objectives, including any prespecified hypotheses	3		3
Methods					
Study Design	4	Present key elements of study design early in the paper	3		3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	3		3

Participants	6	*(a) Cohort study* - Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study* - Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study* - Give the eligibility criteria, and the sources and methods of selection of participants *(b) Cohort study* - For matched studies, give matching criteria and number of exposed and unexposed *Case-control study* - For matched studies, give matching criteria and the number of controls per case	3-4	RECORD 6.1: The methods of study population selection (such as codes or algorithms used to identify subjects) should be listed in detail. If this is not possible, an explanation should be provided. RECORD 6.2: Any validation studies of the codes or algorithms used to select the population should be referenced. If validation was conducted for this study and not published elsewhere, detailed methods and results should be provided. RECORD 6.3: If the study involved linkage of databases, consider use of a flow diagram or other graphical display to demonstrate the data linkage process, including the number of individuals with linked data at each stage.	3-4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.	4	RECORD 7.1: A complete list of codes and algorithms used to classify exposures, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided.	4
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4		4

Bias	9	Describe any efforts to address potential sources of bias	4		4
Study size	10	Explain how the study size was arrived at			
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	4-5		4-5
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) *Cohort study* - If applicable, explain how loss to follow-up was addressed *Case-control study* - If applicable, explain how matching of cases and controls was addressed *Cross-sectional study* - If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses	4-5		4-5
Data access and cleaning methods		..		RECORD 12.1: Authors should describe the extent to which the investigators had access to the database population used to create the study population.	3-4

				RECORD 12.2: Authors should provide information on the data cleaning methods used in the study.	
Linkage		..		RECORD 12.3: State whether the study included person-level, institutional-level, or other data linkage across two or more databases. The methods of linkage and methods of linkage quality evaluation should be provided.	4
Results					
Participants	13	(a) Report the numbers of individuals at each stage of the study (*e.g.*, numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed) (b) Give reasons for non-participation at each stage. (c) Consider use of a flow diagram		RECORD 13.1: Describe in detail the selection of the persons included in the study (*i.e.,* study population selection) including filtering based on data quality, data availability and linkage. The selection of included persons can be described in the text and/or by means of the study flow diagram.	5
Descriptive data	14	(a) Give characteristics of study participants (*e.g.*, demographic, clinical, social) and information on exposures and potential confounders (b) Indicate the number of participants with missing data for each variable of interest (c) *Cohort study* - summarise follow-up time (*e.g.*, average and total amount)	Table 1		Table 1
Outcome data	15	*Cohort study* - Report numbers of outcome events or summary measures over time *Case-control study* - Report numbers in each exposure	7		7

		category, or summary measures of exposure *Cross-sectional study* - Report numbers of outcome events or summary measures			
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Table 3		Table 3
Other analyses	17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	9-10		9-10
Discussion					
Key results	18	Summarise key results with reference to study objectives	10		10
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	12	RECORD 19.1: Discuss the implications of using data that were not created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over time, as they pertain to the study being reported.	12
Interpretation	20	Give a cautious overall interpretation of results considering objectives,	11-12		11-12

		limitations, multiplicity of analyses, results from similar studies, and other relevant evidence			
Generalisability	21	Discuss the generalisability (external validity) of the study results	13		13
Other Information					
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Supplemtentary Data		Supplementary Data
Accessibility of protocol, raw data, and programming code		..		RECORD 22.1: Authors should provide information on how to access any supplemental information such as the study protocol, raw data, or programming code.	Upon request

*Reference: Benchimol EI, Smeeth L, Guttmann A, Harron K, Moher D, Petersen I, Sørensen HT, von Elm E, Langan SM, the RECORD Working Committee. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement. *PLoS Medicine* 2015; in press.

Table 1: Patient characteristics at index admission

Characteristics	**Admissions (N = 670)**
Age, years, mean ±SD	86.1 ± 6.0
Gender, n (%)	
Female	416 (62.1)
Male	254 (37.9)
Entry mode, n (%)	
Home	446 (66.6)
Other	224 (33.4)
Number of comorbidities, mean ±SD	6.7 ± 3.5
Charlson index, mean ±SD	1.4 ± 1.5
Number of drugs, mean ±SD	8.9 ± 3.3
Polymedication (> 5 drugs), n (%)	563 (84.0)
Fall or an associated diagnosis, n (%)	
Tendency to fall, not elsewhere classified [1]	225 (33.6)
Other and unspecified abnormalities of gait and mobility [2]	131 (19.5)
Difficulty in walking, not elsewhere classified [3]	95 (14.2)
Unspecified fall [4]	64 (9.5)
Fracture of neck of femur [5]	44 (6.6)
Other [6]	111 (16.6)

ICD-10-MC codes: [1]R29.6; [2]R26.8; [3]R26.2; [4]W19.0; [5]S72.00; [6] H82, R42, S00, S40, S50, S60, S70, S7210, S72, S80, S83, W01, W10, W18, W19

Table 2: Comparison of case and control characteristics

Characteristics	Cases (N=127)	Controls (N=543)	p-value*
Demographic characteristics			
Gender, n (%)			
Male	67 (52.8)	187 (34.4)	0.0001
Therapeutic characteristics			
Use of antiarrhythmics, n (%)	23 (20.0)	63 (12.5)	0.0375
Use of antigout drugs, n (%)	14 (12.2)	30 (6.0)	0.0198
Use of antiepileptics, n (%)	25 (21.7)	68 (13.5)	0.0268
Use of anxiolytics, hypnotics and sedatives, n (%)	64 (55.6)	228 (45.4)	0.0474
Use of systemic corticosteroids, n (%)	15 (13.0)	40 (8.0)	0.0849
Use of diuretics, n (%)	60 (52.2)	208 (41.4)	0.0361
Use of benign prostate hyperplasia drugs, n (%)	33 (28.7)	80 (15.9)	0.0014
Number of pharmacological classes, mean ±SD	11.0 ± 4.2	10.3 ± 3.8	0.1015
Number of Potentially Inappropriate Medications (PIM), mean ±SD	1.7 ± 1.4	1.3 ± 0.1	0.1091
Diagnostic characteristics			
Anaemia‡, n (%)	32 (25.2)	100 (18.4)	0.0837
Table 2 (continued)			
Traumatic injury§, n (%)	36 (28.3)	219 (40.3)	0.0123
Malignant tumor¥, n (%)	25 (19.7)	61 (11.2)	0.0104
Other heart disease†, n (%)	55 (43.3)	192 (35.4)	0.0946
Charlson index, mean ±SD	1.6 ± 1.7	1.4 ± 1.5	0.0861
Laboratory analysis characteristics			
Abnormal concentration of CRP, n (%)	87 (80.6)	309 (66.3)	0.0039
Abnormal concentration of hemoglobin, n (%)	82 (67.8)	298 (59.1)	0.0804

Admission characteristics			
Length of stay (days), mean ±SD	18.7 ± 27.2	24.7±29.7	0.0385
Previous hospital admission (6 months before index admission), n (%)	52 (40.9)	166 (30.6)	0.0247

ICD-10-MC codes: ‡ D50 - D64; §S00 - T14; ¥C00 - C97; † I27 - I52
Abnormal concentration of CRP: CRP ≥ 5 mg/L
Abnormal concentration of hemoglobin (Hb): Hb <12 g/dL and Hb >16 g/dL if women; Hb <13 g/dL and Hb >17 g/dL if men
*Missing values were not included in the calculation of the p-value.

Table 3: Multivariable adjusted ORs (95% CIs) for 30-day readmission

Variable	OR	95% CI	p-value
Male	2.29	[1.45 - 3.61]	0.0004*
Use of anxiolytics, hypnotics and sedatives	1.56	[0.99 - 2.47]	0.0542
Use of systemic corticosteroids	1.97	[0.98 - 3.97]	0.0572
Abnormal concentration of CRP	2.22	[1.28 - 3.85]	0.0043*
Anemia‡	1.85	[1.11 - 3.11]	0.0194*
Traumatic injury§	0.47	[0.28 - 0.81]	0.0056*
Length of stay (days)	0.99	[0.98 - 1.00]	0.0711
Previous hospital admission (6 months before index admission)	1.57	[0.99 - 2.51]	0.0563

ICD-10-MC codes: ‡D50 - D64; §S00 - T14
Abnormal concentration of CRP: CRP ≥ 5 mg/L
* P < 0.05: missing values were not included in the calculation of the p-value.

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