European Journal of Internal Medicine xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

European Journal of Internal Medicine

journal homepage: www.elsevier.com/locate/ejim

Original Article

Readmission to hospital of medical patients – A cohort study

Mette Gothardt Rasmussen [a,b,*], Pernille Ravn [a,c], Stig Molsted [b], Lise Tarnow [b,d], Susanne Rosthøj [e]

[a] Faculty of Health and Medical Science, University of Copenhagen, Copenhagen, Denmark
[b] Department of Clinical Research, Nordsjællands Hospital, Hillerød, Denmark
[c] Department of Medicine, Herlev Gentofte Hospital, Gentofte, Denmark
[d] Department of Biomedicine, Health, Aarhus University, Aarhus, Denmark
[e] Section of Biostatistics, Institute of Public Health, University of Copenhagen, Copenhagen, Denmark

ARTICLE INFO

Article history:
Received 19 April 2017
Received in revised form 29 June 2017
Accepted 3 July 2017
Available online xxxx

Keywords:
Patient readmission
Internal medicine
Aged
Epidemiology
Comorbidity

ABSTRACT

Introduction: The incidence of acute readmissions is higher among elderly medical patients than in the general population. Risk factor identification is needed in order to prevent readmissions.
Objective: To estimate the incidence of acute readmissions among medical patients ≥65 years discharged from departments of internal medicine and to identify risk factors associated with readmissions.
Material and methods: We included patients discharged between 1st of January 2011 and 1st of December 2014 and collected data regarding primary diagnosis and comorbidities. The primary outcome was acute readmission within 30 days of discharge. We determined risk factors using a multivariable Cox proportional hazards model.
Results: Out of 21,634 discharged patients, 3432 (15.9%) patients had an acute readmission. Risk factors were: age per decade (HR: 1.06, 95%CI: 1.02–1.11), male sex (HR: 1.07, 95%CI: 1.00–1.15), receiving home care service (personal care) (HR: 1.33, 95%CI: 1.15–1.55), nursing home residency (HR: 1.30, 95%CI: 1.14–1.48), a previous admission within six months (HR: 1.59, 95%CI: 1.48–1.72), increased length of index admission (HR: 1.14, 95%CI: 1.11–1.17), and moderate or high level of comorbidities (HR: 1.22, 95%CI: 1.13–1.32, HR: 1.52, 95%CI: 1.38–1.67, respectively).
Conclusion: Around one in six patients had an acute readmission and we identified several risk factors. The risk factors a previous hospital admission within six months, a long or very long length of index admission and a high level of comorbidities were strong risk factors for an acute readmission.

1. Introduction

A readmission is often considered an adverse event with consequences for the patient, the relatives and for the healthcare system in general [1]. Identification of risk factors associated with readmissions may be useful in order to detect high-risk patients and plan interventional programs with the purpose of decreasing the incidence of avoidable readmissions.

In 2013 the incidence of acute admissions in Denmark were around 1.2 million (21%) out of a population of 5.6 million citizens [2,3]. Around 84,000 (7%) were readmitted within 30 days of discharge [3]. The incidence of acute readmissions among elderly medical patients is higher than in the general population and varies between hospitals and geographical areas [1]. European studies have reported incidences of acute readmissions within 30 days of discharge among elderly medical patients ranging from 11% to 22% [4,5,6,7]. Several risk factors associated with acute readmissions have been identified, e.g. male sex, comorbidities, previous hospital admission within six months, length of first hospital stay, functional disability, nursing home residency, and biomarkers [4,8].

To our knowledge the incidence and characteristics of readmitted elderly medical patients have not yet been studied in populations in Northern Europe. Several European studies have investigated characteristics of elderly readmitted medical patients but due to differences in settings, study methodology and healthcare systems these studies are not directly transferable to populations in Northern Europe [4,7,9].

The objective of this register-based cohort study was to estimate the incidence of acute readmissions among Danish elderly medical patients discharged from departments of internal medicine in a specific region and in addition to identify risk factors associated with an acute readmission.

2. Material and methods

2.1. Study design, setting and participants

This is a register-based cohort study and it was reported according to Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) initiative for cohort studies [10].

* Corresponding author at: Department of Pulmonary and Infectious Diseases, Nordsjællands Hospital, Dyrehavevej 29, DK-3400 Hillerød, Denmark.
E-mail address: mette.gothardt.rasmussen@regionh.dk (M.G. Rasmussen).

http://dx.doi.org/10.1016/j.ejim.2017.07.008
0953-6205/

The public healthcare system in Denmark provides feeless, tax-paid treatment for medical care, hospitalisations, and homecare services uniformly for all Danish citizens without additional charge. The majority of the Danish population therefore uses the public healthcare system in Denmark. Hospitals in Denmark are organised in five regions and the present study took place at public hospitals in North Zealand in the northern part of the Capital region serving around 310,000 citizens.

We included all patients ≥65 years holding a civil registry number and discharged (after an inpatient admission) from departments of internal medicine at hospitals in North Zealand between 1st of January 2011 and 1st of December 2014 regardless of diagnosis. Outpatients and emergency department visits without inpatient admissions were excluded from the study. Patients with a planned admission within 30 days of discharge were excluded.

2.2. Primary outcome

The primary outcome was acute readmission within 30 days of discharge to any hospital in Denmark regardless of diagnosis and only the first readmission of every patient were included in the analysis. The follow-up period was 30 days to the end of December 2014.

2.3. Data collection

All citizens in Denmark have a unique civil registry number, which identifies the individual in different national registers. The hospitals provide information about admissions to the Danish National Patient Registry (DNPR), which enables information about all admissions to Danish hospitals including e.g. date of admission, diagnosis and comorbidities according to the International Classification of Diseases. The 10th edition of International Classification of Diseases (ICD-10) has been used in Denmark since 1994.

Using the DNPR we identified all patients with a contact to hospitals in North Zealand in the study period and included patients according to our inclusion and exclusion criteria. The first hospital stay within the study period was used for the index admission of each patient. For all included patients we collected baseline data from the DNPR and the Register for Elderly People Receiving Social Benefits on the day of index admission regarding: age, sex, municipality, nursing home residency, receiving homecare services (personal care and/or practical help for e.g. laundry, vacuuming), and date of admission.

The main reason for a patient's hospital admission is the primary diagnosis assigned at discharge according to World Health Organization and Danish guidelines [11,12]. We therefore collected data at discharge of index admission from the DNPR regarding date of discharge, primary diagnosis for index admission, comorbidities, and death during index admission.

Comorbidities were identified using Charlson's Comorbidity Index (CCI). Charlson's Comorbidity Index is a weighted index of comorbidities that takes the severity of a disease into account and the index score is based on the condition's correlation with mortality [13]. The index includes 19 comorbidities based on the ICD-10 codes. We identified comorbidities based on DNRP data in accordance with a previous study by Thygesen et al. [14]. We calculated a CCI score for each patient and stratified the scores into three levels: low (CCI score = 0), moderate (CCI score = 1–2) and high (CCI score ≥ 3). To minimise the risk of underreporting of chronic diseases we used data for each patient from all admissions 10 years preceding the index admission. We registered home care service as 'yes' or 'no' registered at the month of index admission. Nursing home residency was registered as 'yes' or 'no' at the year of index admission as no exact date was available for relocation to nursing home. In the case a patient was registered as both receiving home care services and nursing home residency at the same year we registered the patient as 'receiving home care service' to avoid double registration. We described the distribution of primary diagnosis for index admission in diagnostic groups based on the ICD-10 chapters and in accordance with a previous study by Vest-Hansen et al. [15]. We used the three most common diagnostic groups and pooled the other groups into a single category 'Other'. Coding diagnoses based on DNPR have been shown to have a low risk of information bias [14,16]. For each patient we determined length of index admission and we identified weekend discharges, i.e. discharges on a Saturday or Sunday. For patients included in the study we captured information about admissions preceding the index admission and we registered if a patient had an admission to any Danish hospital six months before index admission.

After index admission we collected data regarding readmission or death during follow-up. Readmission during follow-up was identified using DNPR and death by using the Danish Register of Cause of Death.

2.4. Statistical analysis

The primary outcome was treated as a survival outcome, time to readmission, with artificial censoring of patients 30 days after discharge. The basic underlying time scale was defined as the number of days since discharge. Death before readmission was considered a competing risk. Cumulative incidences were determined using the Aalen-Johansen estimator [17]. In the analysis of risk factors associated with readmission, univariable and multivariable Cox proportional hazard regression was applied [18]. In these analyses, patients dying without readmission were censored at the time point of death. The explanatory variables were: age, sex, municipality, home care services, nursing home residency, previous hospital admission, length of index admission, weekend discharge, primary diagnosis, and level of CCI score. The linearity of quantitative explanatory variables was assessed by including the quadratic of the variable. Due to a right skewed distribution and a nonlinear effect, the variable 'length of index admission' was transformed by the logarithm with base 2. The proportional hazards assumption was assessed by the Kolmogorov-type supremum test [19]. Due to the large sample size the proportional hazards assumption was violated for the most of the explanatory variables and therefore the hazard ratios have to be interpreted as average effect over time.

Statistical analyses were performed using the SAS software version 9.4 and R version 3.3.1.

2.5. Ethical approval

This study was based on register databases with no discomfort for the involved participants and an approval from the ethical committee was not required. The Danish Data Protection Agency approved the study (record no.: 2012-58-0004).

3. Results

We identified 22,577 patients ≥65 years admitted to departments of internal medicine at hospitals in North Zealand in the study period and 22,111 patients were discharged alive. Patients with a planned admission within 30 days of discharge ($n = 477$) were excluded leaving 21,634 patients in the study. Two hundred six (1.0%) patients died during follow-up and 17,996 (83.2%) patients did not have a readmission (see Fig. 1).

3.1. Patient characteristics

Patient characteristics are presented in Table 1.

The age was similar between the readmitted and not-readmitted patients whereas the patients who died during follow-up were older. The risk of readmission was greater for men compared to women. Among patients living in a nursing home residency and patients with a previous hospital admission 21.7% and 23.7% respectively, were readmitted. The median length of index admission was longer for readmitted patients and for patients that died during follow-up compared to patients

Please cite this article as: Rasmussen MG, et al, Readmission to hospital of medical patients – A cohort study, Eur J Intern Med (2017), http://dx.doi.org/10.1016/j.ejim.2017.07.008