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## Original article

## Risk factors for hospital readmission of elderly patients

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## ABSTRACT

**Background:** The aim of this study was to identify which factors were associated with a risk of hospital readmission within 3 months after discharge of a sample of elderly patients admitted to internal medicine and geriatric wards.

**Methods:** Of the 1178 patients aged 65 years or more and discharged from one of the 66 wards of the 'Registry Politerapie SIMI (REPOSI)' during 2010, 766 were followed up by phone interview 3 months after discharge and were included in this analysis. Univariate and multivariate logistic regression models were used to evaluate the association of several variables with rehospitalization within 3 months from discharge.

**Results:** Nineteen percent of patients were readmitted at least once within 3 months after discharge. By univariate analysis in-hospital clinical adverse events (AEs), a previous hospital admission, number of diagnoses and drugs, comorbidity and severity index (according to Cumulative Illness Rating Scale-CIRS), vascular and liver diseases with a level of impairment at discharge of 3 or more at CIRS were significantly associated with risk of readmission. Multivariate logistic regression analysis showed that only AEs during hospitalization, previous hospital admission, and vascular and liver diseases were significantly associated with the likelihood of readmission.

**Conclusions:** The results demonstrate the need for increased medical attention towards elderly patients discharged from hospital with characteristics such as AEs during the hospitalization, previous admission, vascular and liver diseases.

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## 1. Introduction

Hospital readmission within a short time from discharge is a common occurrence in the daily practice of internal medicine wards [1,2]. Some studies documented that the decrease in the rate of readmission is important in order to improve quality of care and reduce costs [3,4]. Different rates of readmissions have been found between hospitals and geographical areas [5,6] and several risk factors and combinations thereof have been proposed in order to identify

patients at risk to be rehospitalized [7–9]. In the last few years, due to cost containment physicians are often prompted to minimize the length of hospital stay. Shortening of hospitalization length is a factor often associated to a higher risk of readmission [10], with the paradoxical effects of decreasing the quality of care and increasing secondary expenses due to the incomplete patient recovery. For this reason it has been suggested that high and rising readmission rates may be “the price of early discharge” [11]. Older people are at increased risk of hospital readmissions, so that a number of studies have chosen to study the risk factors of hospital readmission in the elderly [9]. For instance, Silverstein et al. conducted a retrospective cohort study of people aged 65 or older using administrative data of seven acute care hospitals in order to develop predictors of 30-day readmission [7], but fewer studies focused their attention on predictors of later hospital readmission in the elderly [12]. The aim of this study was to analyze which factors are associated with an increased

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<sup>1</sup> REPOSI denotes Registry of Polytherapies SIMI (Società Italiana di Medicina Interna).

risk of readmissions within 3 months of the index date of discharge of a cohort of 65 years or older patients evaluated in the frame of the network of Italian internal medicine and geriatric wards participating in 2010 in the Registro Politerapie SIMI (REPOSI).

## 2. Methods

### 2.1. Study setting, design and patient population

This study was conducted in 66 hospital wards representative of the Italian internal and geriatric medicine wards, participating in the 'Registro Politerapie SIMI' (REPOSI). The REPOSI is a collaborative and independent study of the Italian Society of Internal Medicine (SIMI) and the Mario Negri Institute of Pharmacological Research. The design was described in details elsewhere [13]. In brief, patients aged 65 years or older consecutively admitted to hospital during four periods that lasted four weeks and separated each from the other for three months, were enrolled in the study. A standardized web-based case report form was filled in by the attending physicians, including socio-demographic factors, clinical parameters, diagnoses and medications prescribed at both hospital admission and discharge, adverse events (AEs) during hospitalization, comorbidity according to the Cumulative Illness Rating Scale (CIRS) [14], performance in basic activities of daily living according to Barthel index scale [15], cognitive status according to the Short Blessed Test [16] and presence of depression using Geriatric Depression Scale [17]. Follow-up, addressed to the patient or his relative and performed 3 months after hospital discharge by physician telephone interview, collected data on mortality, new diagnoses, new hospital admission, drug regimen, AEs and Barthel index. All the collected data were checked by a central monitoring institution (the Mario Negri Institute for Pharmacological Research, Milan). The study was approved by the Ethical Committee of the IRCCS Cà Granda Maggiore Policlinico Hospital Foundation, Milan.

### 2.2. Outcomes

The primary outcome of this study was patient hospital readmission within 3 months after discharge from the first admission (index hospitalization). Rehospitalization rate was calculated only for patients whose case report form was filled in the section relative to the 3 months follow-up. The variables analyzed were: demographic data (age, sex, education, marital status, body mass index, and lifestyle habits), clinical variables (length of stay and previous hospital admission in the 6 months before the index admission, number of diagnoses and drugs at discharge, cognitive status [Short Blessed Test-SBT], depression status [Geriatric Depression scale-GDS]), and functional variables such as ability in basic activities of daily living [Barthel index]). Comorbidity and severity indexes, according to the Cumulative Illness Rating Scale (CIRS), were calculated [14]. CIRS comorbidity index was computed by counting the number of items for which moderate to severe illness was reported (scores of 3, 4 or 5), while overall illness severity was represented by the mean of the 13 CIRS items [14]. The effect of the most common diseases at discharge on readmission was also analyzed. A long length of hospital stay was defined as a stay longer than the 90th percentile of the distribution of all patients' hospital stays [12]. To study the association between AEs and readmission, the diagnoses were grouped according to the chapters of International Classification of Disease, Ninth Revision (ICD-9).

### 2.3. Statistical analysis

Association between rehospitalization and socio-demographic variables, clinical characteristics and diseases at discharge was studied using univariate logistic regression and reporting Odds Ratios (ORs) with 95% confidence intervals (95%CI). A series of gerarchical models was performed to study the association of selected variables

with the presence of rehospitalization. The models studied the association of demographic variables (age and sex) alone, adding then a measure of comorbidity (CIRS severity index) or clinical conditions (AEs during index hospitalization/previous hospitalization) and them together. The last model included previous selected variables, with severity of comorbidity replaced by presence of at least moderate vascular or liver disease (the two classes of diseases significantly associated with readmission in the univariate analysis). Selection of variables to be included in the multivariate model was based on statistical and clinical significance. All statistical calculations were performed with the software JMP Pro 10 (SAS Institute Inc.).

## 3. Results

Of the 1380 enrolled patients, a total of 1178 (85%) were discharged alive from the participating wards. The 3 month follow-up information was obtained from 832 (70%) of them. During the 3 months of follow-up, 66 (7.9%) patients died, thus 766 patients were ultimately included in the analysis: 145 of them (19%) were readmitted at least once within 3 months from the index date of discharge (rehospitalized group), the remaining 621 patients were the non-rehospitalized group (Fig. 1). Among the rehospitalized group, 63 (43.4%) patients were readmitted within 1 month (18 of them in the first group). Of the 766 elderly followed up females were 55.2% and 51.5% in the rehospitalized and non-rehospitalized groups, and the mean age was  $77.8 (\pm 7.6)$  and  $78.7 (\pm 7.2)$  years respectively. The mean length of hospital stay was  $11.4 (\pm 8.9)$  and  $10.2 (\pm 7.9)$  days for rehospitalized and non-rehospitalized groups.

Table 1 shows the socio-demographic and clinical characteristics of rehospitalized and non-rehospitalized groups and factors associated with readmission. By univariate analysis (Table 1), the occurrence of AEs during hospitalization, any previous hospital admission within 6 months before the index hospitalization, number of diagnosis, number of drugs, CIRS severity index, CIRS comorbidity index, and vascular and liver diseases with a level of impairment at discharge of 3 or more at CIRS were significantly associated with an increased risk of readmission, while the length of hospital stay was not. Among AEs, diagnoses included in the chapter 9 of ICD-9 (digestive system diseases) ( $OR = 3.2$ ,  $95\%CI = 1.49-6.87$ ;  $p = 0.004$ ) and those in the chapter 17 (injury and poisoning diseases) ( $OR = 5.3$ ,  $95\%CI = 1.60-17.67$ ;  $p = 0.008$ ) were significantly associated to readmission. In the multivariate logistic regression analyses (Table 2), after adjustment for factors which were statistically significantly associated at univariate analysis, only AEs during hospitalization, previous hospital admission, and vascular and liver diseases were still significantly associated with the risk of

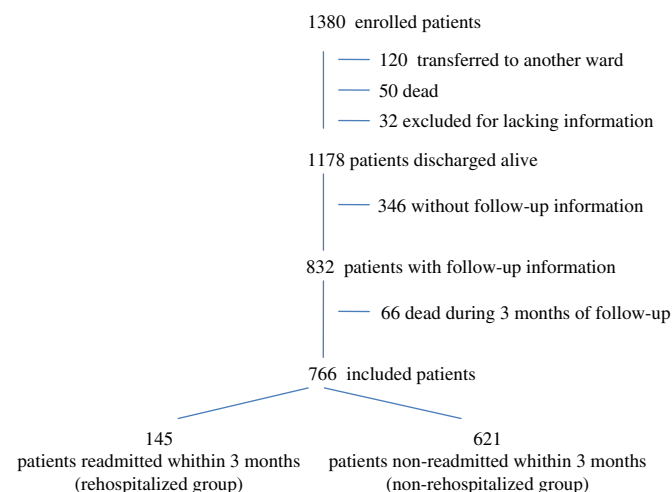


Fig. 1. Flowchart of the study.

**Table 1**

Socio-demographic and clinical characteristics of rehospitalized and not rehospitalized groups and factors associated with readmission in the univariate analysis.

Variables		Re-hospitalization			
		Yes n = 145	No n = 621	OR (95%CI)	P-value
Females, n (%)		80 (55.17)	320 (51.53)	1.16 (0.80–1.66)	0.42
Age (years), mean (SD)		77.83 (7.58)	78.70 (7.22)	0.98 (0.96–1.00)	0.21
Age groups	<85 years	116 (80.00)	497 (80.03)	1.00 (0.62–1.56)	0.99
	>= 85 years	29 (20.00)	124 (19.97)		
Education (years), mean (SD)		7.13 (4.24)	7.23 (4.05)	0.99 (0.37–2.07)	0.80
Marital status, <sup>a</sup> n (%)	Single (unmarried, divorced, separated)	20 (13.89)	54 (8.71)	1	0.13
	Married	69 (47.92)	340 (54.84)	0.54 (0.31–0.99)	
	Widow/er	55 (38.19)	226 (36.45)	0.65 (0.36–1.21)	
Living arrangement, <sup>b</sup> n (%)	Alone	29 (21.01)	154 (25.08)	1	0.26
	With spouse	55 (39.86)	263 (42.83)	1.11 (0.68 – 1.83)	
	With sons	27 (19.57)	86 (14.01)	1.66 (0.92 – 3.00)	
	With spouse and sons	11 (7.97)	62 (10.10)	0.94 (0.42 – 2.00)	
	Other	16 (11.59)	49 (7.98)	1.73 (0.86 – 3.43)	
Caregiver, <sup>c</sup> n (%)		81 (55.86)	324 (52.43)	1.15 (0.80 – 1.65)	0.46
BMI (Body max Index), mean (SD)		26.59 (5.28)	26.42 (5.17)	1.00 (0.97–1.04)	0.72
Adverse clinical events during hospitalization, n (%)		64 (44.14)	184 (29.63)	1.87 (1.30–2.72)	0.001
Previous hospital admission (6 months before index admission) , n (%)		64 (44.14)	170 (27.38)	2.09 (1.44–3.03)	<0.0001
Risk factors	Smoker	16 (11.03)	52 (8.37)	1.36 (0.75–2.45)	0.32
	Drinker <sup>d</sup>	72 (49.66)	268 (43.23)	1.29 (0.90–1.86)	0.16
Number of diagnoses at discharge, mean (SD)		7.04 (3.13)	6.49 (2.85)	1.06 (1.00–1.13)	0.05
Number of drugs at discharge, mean (SD)		6.95 (2.86)	6.10 (2.81)	1.10 (1.04–1.18)	0.002
CIRS—severity index at discharge, mean (SD)		1.74 (0.33)	1.67 (0.30)	2.17 (1.21–3.88)	0.013
CIRS—comorbidity index at discharge, mean (SD)		3.32 (1.85)	2.9 (1.79)	1.13 (1.02–1.25)	0.018
Barthel index at admission, mean (SD)		79.18 (28.05)	82.50 (26.26)	0.99 (0.99–1.00)	0.20
Short Blessed Test at admission, mean (SD)		9.97 (8.24)	9.08 (7.66)	1.01 (0.99–1.03)	0.24
Geriatric Depression Scale at admission, mean (SD)		1.39 (1.24)	1.36 (1.20)	1.02 (0.88–1.19)	0.78
Duration of hospital stay, mean (SD)		11.39 (8.89)	10.15 (7.86)	1.07 (1.00–1.04)	0.12
Cumulative Illness Rating Scale (CIRS) at discharge—level of impairment >=3					
Cardiac, n (%)		71 (48.97)	291 (46.86)	1.09 (0.76–1.56)	0.65
Hypertension, n (%)		70 (48.28)	297 (47.83)	1.02 (0.71–1.46)	0.92
Vascular, n (%)		58 (40.00)	185 (29.79)	1.57 (1.08–2.28)	0.02
Respiratory, n (%)		59 (40.69)	243 (39.13)	1.06 (0.74–1.54)	0.73
Eye/ear/nose/throat, n (%)		19 (13.10)	60 (9.68)	1.40 (0.81–2.44)	0.24
Upper gastrointestinal, n (%)		25 (17.24)	116 (18.68)	0.91 (0.56–1.46)	0.69
Gastrointestinal, n (%)		13 (8.97)	58 (9.34)	0.96 (0.51–1.80)	0.89
Liver, n (%)		32 (22.07)	64 (10.31)	2.46 (1.54–3.94)	0.0003
Renal, n (%)		23 (15.86)	81 (13.04)	1.26 (0.76–2.08)	0.38
Other genitourinary, n (%)		23 (15.86)	79 (12.72)	1.29 (0.78–2.14)	0.33
Musculoskeletal, n (%)		33 (22.76)	135 (21.74)	1.06 (0.69–1.63)	0.79
Neurological, n (%)		27 (18.62)	107 (17.23)	1.09 (0.69–1.75)	0.69
Endocrine/metabolic, n (%)		43 (29.66)	182 (29.31)	1.02 (0.68–1.51)	0.93
Psychiatric/behavioral category, n (%)		22 (15.17)	65 (10.47)	1.53 (0.90–2.56)	0.12

<sup>a</sup> N = 764 (144/620).<sup>b</sup> N = 752 (138/614).<sup>c</sup> N = 763 (145/618).<sup>d</sup> N = 765 (145/620).

hospital readmission. We also analyzed the effect on readmission of the most common diseases at discharge and found that heart failure significantly affected 3-month readmission (OR = 1.9, 95%CI = 1.18–2.97;  $p = 0.008$ ). It was the second reason of the index hospitalization in patients with 3-month readmission, with a prevalence of 11% and was the first cause of readmission in the same group, with a prevalence of 13%. Among liver diseases, cirrhosis at discharge was significantly associated with the likelihood of readmission (OR = 1.8, 95%CI = 1.12–3.05;  $p = 0.021$ ). CIRS severity and CIRS comorbidity indexes were statistically significant only in model 2 (Table 2).

#### 4. Discussion

In this study the rate of hospital readmission within 3 months from discharge (19%) was slightly lower than the results of a previous study conducted in elderly patients (23%) [12], and than those of the study of Jencks et al. (34%) conducted in patients not selected for age in the frame of Medicare [3]. Our rate is almost equal to that of Maurer et al. (20%), who performed a pilot study in patients recruited by internal medicine wards in Switzerland [6].

According to the literature, there are several factors that might be related to the risk of hospital readmission in elderly people, such as functional status score, illness severity, co-morbidity, polypharmacy, presenting illness and age [18]. This study showed that readmitted patients suffered of more chronic illnesses with a higher severity index, consumed more drugs, and were often hospitalized in the 6 months prior to the index hospitalization, developed an AE during index hospitalization and had vascular or liver diseases. These findings are broadly consistent with other observations, showing that previous hospital admission, morbidity/comorbidity and also functional disability and length of hospital stay were common risk factors in people aged  $\geq 75$  years [9]. In some studies, the duration of hospital stay (defined as longer than the 90th percentile of hospital stays or than median or than 3 days) was associated with a higher risk of short term readmission [12,19–21], most likely indicative of the severity of the basic illness. In the present study the duration of hospitalization did not affect the rate of readmission. However, 44% of patients with at least one readmission within 3 months from discharge had had a hospital admission in the previous 6 months. Recurrent admissions have also been pointed out as a predictor of readmission [22], perhaps because in the elderly relapse of the

**Table 2**

Risk factors affecting hospital readmission within 3 months after discharge in 5 multivariate logistic regression models.

Re-hospitalization	Model 1		Model 2		Model 3		Model 4		Model 5	
	OR (95%CI)	P-value	OR (95%CI)	P-value	OR (95%CI)	P-value	OR (95%CI)	P-value	OR (95%CI)	P-value
Sex (female)	1.16 (0.81–0.68)	0.43	1.23 (0.85–1.78)	0.28	1.18 (0.81–1.72)	0.37	1.23 (0.84–1.80)	0.27	1.27 (0.87–1.88)	0.20
Age ( $\geq 85$ )	0.98 (0.61–0.52)	0.92	0.93 (0.58–1.46)	0.76	0.93 (0.56–1.47)	0.78	0.90 (0.55–1.42)	0.66	1.01 (0.62–1.60)	0.97
CIRS severity index	–	–	2.24 (1.25–4.03)	0.007	–	–	1.80 (0.98–3.31)	0.06	–	–
Adverse clinical events during hospitalization	–	–	–	–	1.78 (1.22–2.60)	0.003	1.76 (1.21–2.58)	0.003	1.74 (1.19–2.56)	0.0045
Previous hospital admission (6 months before current admission)	–	–	–	–	2.03 (1.39–2.96)	0.0003	1.93 (1.31–2.83)	0.009	1.92 (1.31–2.82)	0.0009
Cardiovascular diseases (level of impairment $\geq 3$ )	–	–	–	–	–	–	–	–	1.48 (1.00–2.17)	0.0481
Liver diseases (level of impairment $\geq 3$ )	–	–	–	–	–	–	–	–	2.32 (1.42–3.77)	0.0010

Model 1: multivariate with sex and age.

Model 2: multivariate with sex, age and CIRS severity index.

Model 3: multivariate with sex, age, adverse clinical events during hospitalization and previous hospital admission.

Model 4: multivariate with sex, age, adverse clinical events during hospitalization, previous hospital admission and CIRS severity index.

Model 5: model 3 + vascular and hepatic illnesses.

index illness is the main reason for readmission within 3 months of discharge [22]. This hypothesis is supported by our findings that in patients readmitted at least once, heart failure was the second reason of the index hospitalization and the first cause of readmission.

The role of functional disability as predictor is controversial. In the study of Lanièce et al. functional disability was relevant to explain the risk of early readmissions in a cohort of patients aged 75 and older [23]. However, in this study, functional disability as assessed by the Barthel index was not associated with readmission, in agreement with the findings of Alarcon et al., who showed that limited activities of daily living were only predictive of hospital mortality and prolonged stay [24].

We found no significant association between the likelihood of readmission and age, gender, marital status, education, living arrangement, BMI, smoke and alcohol consumption. In other studies readmission was mostly related to age, comorbidities and the type of chronic illnesses [5,6,8,9], the role of age being explained by the fact that older people have more chronic diseases and a lower mean functional status [5].

Vascular diseases and particularly heart failure at discharge were associated to readmission, in agreement with previous observations on the predictive role of diseases of the circulatory system [12] and particularly of heart failure [25]. Also liver diseases were associated with readmission, in agreement with a previous study based upon 30-day readmission [7].

By calculating the severity index and comorbidity index on the basis of a level of impairment of 3 or more, a significant association was found between severity of illnesses and readmission rate, in agreement with [26] who found that patients readmitted during the first three months after discharge were sicker than controls (CIRS classes 3–4: 52.1% vs 34.1%) and that those readmitted between the third and the sixth months had a significantly higher CIRS total score [26]. No previous studies investigated the effect of AEs on hospital readmission, but our previous study [13] found that the occurrence of AEs in hospital (defined as any acute clinical problem that newly occurred during hospitalization [27]) was the most significant predictor for the extension of hospital stay by nearly 4 days and increased sevenfold the risk of in-hospital death. In this study AEs that occurred during index hospitalization were associated with the likelihood to be readmitted, confirming that also a development of a new clinical problem could represent one of the principal reasons for readmission [22].

In conclusion, factors affecting hospital readmission in older patients are multiple and complex. Our results are important for clinical practice because they demonstrate that special clinical attention is needed when elderly patients are discharged from hospital with

specific features such as adverse clinical events that had newly occurred during hospitalization, prior hospital admission (within 6 month of the index hospitalization), illness severity and vascular and liver diseases.

#### 4.1. Strengths and limitations

The most important strength of the REPOSI study is the multicenter design that involved 66 internal medicine and geriatric wards through the country, resulting in a representative sample of the old Italian hospitalized population. Moreover, including the patients during four periods of four weeks (one per season) enabled balancing the effect of seasons on acute diseases leading to hospitalization. Collecting data from the patients by the physicians allowed the analysis of some variables often omitted in studies that relied on administrative database, such as severity of the illness, adverse clinical events which occurred during hospitalization, risk factors, clinical parameters, social and physical characteristics of the patients (education, marital status, living arrangement, and body mass index).

Anyway some limitations deserve to be cited. First, the 3 months of follow-up was not performed in all patients discharged, providing a lack of information and an incomplete picture of the sample. Second, the phone interviews collected from patients themselves could not be realistic or complete due to the fact that the elderly may not be always aware of their drug regimen, AE, and so on. Third, the problem with under-reported conditions such as depression has been previously reported [28]. Fourth, we didn't collect some important information such as Barthel index at discharge or destination at discharge, that are factors that may influence the risk of hospital readmission of elderly patients. Finally, we focused our attention only on internal medicine and geriatrics wards avoiding a generalization of our observations to all in-hospital settings.

#### Learning points

- 19% of patients discharged from a representative sample of Italian internal medicine and geriatric wards were rehospitalized at least once within 3 months.
- There was no significant association between some sociodemographic and clinical characteristics (length of stay, cognitive, functional and depression status) and probability of readmission.
- New adverse clinical events that had occurred during index hospitalization, prior hospital admission, illness severity and vascular and liver diseases with level of impairment  $\geq 3$  (according to Cumulative Illness Rating Scale-CIRS) were the main predictors of a later rehospitalization after discharge.



- Among cardiovascular and liver diseases, heart failure and cirrhosis were the most frequent diseases of the two categories.
- The identification of these factors leading to hospital readmission should prompt a more accurate surveillance of these patients in the attempt to reduce this adverse outcome.

### Conflict of interests

All authors have no conflicts of interests to disclose.

### Appendix I. Members of the REPOSI (Registro POLiterapie Società Italiana medicina interna) Study

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