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FACTORS ASSOCIATED WITH 30-DAY READMISSION AFTER DISCHARGE DUE TO COMMUNITY-ACQUIRED PNEUMONIA IN PEOPLE AGED 65 YEARS OR MORE DURING TWO INFLUENZA SEASONS. A PROSPECTIVE STUDY.

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ABSTRACT

Objective: Rehospitalization after discharge due to community-acquired pneumonia (CAP) discharge is frequent in the elderly and patients with multiple comorbidities, resulting in a clinical and economic burden.The aim of this study was to determine factors associated with 30-day readmission in patients with CAP.

Design: A prospective study.

Setting: The stydy was conducted in patients admitted to 20 hospitals in seven Spanish regions during two influenza seasons

Participants: We included patients aged ≥65 years admitted through the emergency department with a diagnosis compatible with CAP. Patients who died during the initial hospitalization and those hospitalized > 30 days were excluded.

Main outcome measures: 30-day readmission.

Results: Factors associated with 30-day readmission were male sex (aOR 1.44 95% CI 1.01-2.04), living with a person aged < 15 years (aOR 2.12, 95% CI 1.01-4.47), moderate-to-high degree of dependency (aOR 1.52, 95% CI 1.09-2.11), chronic respiratory failure (aOR 1.73, 95% CI 1.22-2.44), congestive heart disease (aOR 1.70, 95% CI 1.21-2.38), chronic liver disease (aOR 2.39, 95% CI 1.21-4.36) and discharge to home with home health care (aOR 5.53, 95% CI 1.67-18.30). No associations were found with pneumoccocal or seasonal influenza vaccination in any of the three previous seasons.

Conclusions: This study shows that 11.39% of patients aged ≥65 years initially hospitalized for CAP were rehospitalized within 30 days after discharge. Rehospitalization was associated with preventable and non-preventable factors.

Strengths and limitations of this study

- All the information on readmission was obtained from medical records.
- The study is part of a multi-center study carried out in seven autonomous communities representing 70% of the Spanish population.
- It was not possible to collect detailed information about the readmission episode.

INTRODUCTION

Community-acquired pneumonia (CAP) is a frequent, potentially serious disease in people aged ≥65 years and one of the leading causes of hospitalization and mortality worldwide in this age group,[1-4] in whom recovery from an episode of CAP is predictive of increased mortality in subsequent years.[5]

The incidence of CAP differs between European countries due to variations in age distribution, the introduction of vaccination programs and the clinical guidelines used. However, the incidence of cases and hospitalizations increases with age in all countries.[6,7] In Spain, CAP is not a notifiable disease and therefore the incidence in the population is unknown, although 2013 data also show an increase in hospitalization (394.04 per 10^5 in the 65-74 years age group and 2584.95 per 10^5 in the >85 years age group).[8]

In people aged ≥ 65 years, full recovery after hospital discharge due to CAP is usually slow and the probability of readmission during a period of time after discharge is greater.9 30 day readmission post discharge is usually used as an indicator of vulnerability.[2,10-12]

Readmission after discharge due to CAP is relatively frequent (especially in the elderly and patients with multiple comorbidities), and is often associated with a worsening of a baseline disease or the appearance of a new pathology,[13] and this becomes a significant clinical and economic burdern for health systems.[2,14] Studies have explored the factors associated with readmission following hospitalization due to CAP, and have identified factors that improve the prognosis at discharge and are considered preventable, such as influenza and pneumococcal vaccination, use of hospital care protocols, discharge planning and post-discharge follow-up. Adequate discharge

planning, including patient stability and destination, has been associated with reduced readmission.[15-17] However, the effect of seasonal influenza and pneumococcal vaccination and the adequacy of hospital care (use of clinical guidelines and antibiotic plans) may be more controversial.[18-21] The initial severity of CAP, worsening of comorbidities and some individual patient characteristics have been described as non-preventable factors,[15,21-25] and factors such as age, sex, socioeconomic status, education and some comorbidities have been independently associated with a greater likelihood of readmission.[25,26]

The objective of this study was to determine the risk factors associated with 30-day readmission in people aged ≥ 65 years initially hospitalized due to CAP.

MATERIALS AND METHODS

Study design

This study was carried out as part of a multicenter study in 20 hospitals from seven Spanish regions (Andalusia, the Basque Country, Castile and Leon, Catalonia, Madrid, Navarre, and Valencia Community). Patients aged ≥65 years hospitalized due to CAP in the participating hospitals during the 2013–2014 and 2014–2015 influenza seasons were recruited.

Study population

Patients included were aged ≥65 years admitted through the emergency department to any of the participating hospitals for ≥ 24 hours with a chest X-ray showing pulmonary infiltrate compatible with pneumonia and ≥1 of the following symptoms or signs of acute lower respiratory tract infection: cough, pleural chest pain, dyspnea, fever >38ºC, hypothermia < 35ºC, and abnormal auscultator respiratory sounds unexplained by other causes.

Patients who died during the initial hospitalization and patients hospitalized for > 30 days were not included. Institutionalized patients, patients with nosocomial pneumonia (onset ≥ 48 hours after hospital admission) and those who did not provide signed informed consent were excluded.

Outcomes

The dependent variable was 30-day readmission, defined as 'hospitalization for any reason within 30 days of discharge after index admission'. Information on readmission was collected by re-review of medical records up to more than 30 days after initial discharge.

All participating hospitals had a specifically-trained team of health professionals who used a structured questionnaire to collect information by patient interview on confirmation of the case and review of medical records.

Information collected included sociodemographic variables: age, sex, marital status, educational level, cohabitation; lifestyle factors: smoking status (current smoker, ex-smoker, non-smoker) and alcohol intake (> 40 g/day in men, > 20 g/day in women); the Barthel index (ranging from 0 - complete dependence - to 100 - complete independence) was used to assess the functional capacity at hospital admission.[27] Patients were considered vaccinated against pneumococcal disease if they had receive a dose of pneumococcal vaccine in the last 5 years and against seasonal influenza if they had received a dose of the influenza vaccination at least 14 days before symptom onset. The presence or absence of underlying diseases (chronic respiratory failure, history of pneumonia during the last two years, solid or hematologic neoplasm, diabetes mellitus, renal failure, chronic obstructive pulmonary disease (COPD), congestive heart disease, disabling neurological disease, chronic liver disease and hemoglobinopathy or anemia),

prior medical utilization (number of primary care nurse visits in the last 3 months, number of hospital visits in the last 3 months) and hospital care process (severity of illness quantified in 5 risk classes using the Pneumonia Severity Index at admission, length of stay ≥8 days and <7days,[8] intensive care unit (ICU) admission, mechanical ventilation, adequacy of antibiotic treatment plan (validated according to clinical guidelines) (Yes/No) and discharge disposition (home without services, home with home health care and social health centre) were collected.[16]

Statistical analysis

The Barthel index, a continuous variable, was dichotomized into 0-89 (moderate to high degree of dependency) and ≥90 (little or no dependency).

A bivariate analysis was made to compare 30-day readmission and no readmission according to sociodemographic variables, lifestyle factors, the Barthel index, immunizations, risk medical conditions, prior medical utilization and hospital care process. Independent variables were checked for collinearity using the variance inflation factor.[28]

As Spanish autonomous communties have varying degrees of autonomy in organizing health services, persons living in the same region tend to have similar access to health care. Therefore, to estimate the crude and adjusted odds ratio (OR), we used multilevel regression models that considered the outcome variable in people from the same region to obtain accurate statistical estimates of predictors of 30-day readmission.[28] Covariates were introduced into the model using a backward stepwise procedure,with a cut-off point of $p < 0.2$.

The analysis was performed using the SPSS v.24 statistical package and Rv3.3.0 statistical software.

Ethical approval

The study was approved by the Ethics Committees of the participating hospitals.

RESULTS

Overall, 1929 inpatients met all study eligibility criteria for CAP: 93 patients died during the initial hospitalization and 80 were hospitalized for > 30 days.Therefore, 1756 CAP cases were discharged within 30 days after the initial hospitalization: of these, 200 (11.39%) were readmitted within 30 days after hospital discharge (Figure 1).

Figure 1. Flowchart of hospital readmissions

Reasons for 30-day readmission were collected in 188 cases and were unrelated to pneumonia in in 52.7% (99 cases-comorbidities in 80 and other causes in 19) and pneumonia-related in 47.3% (80 cases).

The descriptive analysis and unadjusted associations of factors related to 30-day readmission are shown in table 1. Readmission was associated with sociodemographic variables (male sex, living with a person aged < 15 years vs. living alone, moderate-to-high degree of dependency according to the Barthel Index), chronic respiratory failure, pneumonia during the last two years, congestive heart disease, chronic liver disease, mechanical ventilation, length of hospital stay ≥8 days and discharge to home with home health care vs. discharge to home without services.

Table 1. Distribution of 30-day readmission cases according to patient characteristics

	Readmission n=200	No Readmission n=1556	Crude OR	p value
Sociodemographic				
Age group				
65-74 y.	56 (28.0%)	501 (32.2%)	1	
75-84 y.	98 (49.0%)	729 (46.9%)	1.20 (0.85-1.70)	0.31
>84 y.	46 (23.0%)	326 (20.5%)	1.26 (0.83-1.91)	0.27
Sex				
Female	64 (32.0%)	622 (40.0%)	1	
Male	136 (68.0%)	934 (60.0%)	1.44 (1.05 – 1.97)	0.02
Educational level				
No/primary education	153 (78.1%)	1118 (72.4%)	1	
Secondary or higher	43 (21.9%)	427 (27.6%)	0.75 (0.51-1.10)	0.14
Marital status				
Married/Cohabiting	116 (58.0%)	912 (58.6%)	1	
Single	21 (10.5%)	107 (6.9%)	1.56 (0.94-2.59)	0.09
Widowed/divorced	63 (31.5%)	536 (34.4%)	0.93 (0.67-1.29)	0.66
Cohabitants				
Live alone	31 (15.5%)	289 (18.6%)	1	
Lives with cohabitant >15 y.	155 (77.5%)	1203 (77.4%)	1.20 (0.80 – 1.80)	0.39
Lives with cohabitant <15 y.	14 (7.0%)	63 (4.1%)	2.03 (1.02 – 4.04)	0.04
Lifestyle factors				
Smoking status				
Non smoker	79 (39.5%)	693 (44.5%)	1	
Smoker	16 (8.0%)	138 (8.9%)	1.04 (0.59-1.83)	0.90
Ex-smoker	105 (52.5%)	725 (46.6%)	1.28 (0.94-1.75)	0.11
Alcohol intake >40gr				
No	197 (98.5%)	1524 (97.9%)	1	
Yes	3 (1.5%)	32 (2.1%)	1.38 (0.42-4.54)	0.60
Prior utilization of resources				
Nº of nurse visits within 90d				
0-2	147 (73.5%)	1182 (76.4%)	1	
≥3	53 (26.5%)	365 (23.6%)	1.17 (0.82-1.65)	0.39
Nº of hospital visits within 90d				
0-2	164 (82.8%)	1355 (87.6%)	1	
≥3	34 (17.2%)	192 (12.4%)	1.53 (1.02-2.31)	0.04
Barthel index				
Little or no dependency >90	108 (54.0%)	990 (63.6%)	1	
Moderate-to-high dependency <=90	92 (46.0%)	566 (36.4%)	1.47 (1.08-2.01)	0.01
Immunizations				
Influenza vaccination in any of the 3 previous seasons				
No	54 (27.0%)	464 (29.8%)	1	
Yes	146 (73.0%)	1092 (70.2%)	1.16 (0.83-1.61)	0.39
23-valent pneumococcal polysaccharide vaccine				
No	161 (80.5%)	1281 (82.3%)	1	
Yes	39 (19.5%)	275 (17.7%)	1.11 (0.76-1.62)	0.58
Risk medical conditions				
Chronic respiratory failure				
No	136 (68.0%)	1269 (81.6%)	1	
Yes	64 (32.0%)	287 (18.4%)	2.08 (1.50 – 2.88)	<0.001
Pneumonia during the last 2 years				

No	146 (73.0%)	1267 (81.4%)	1	
Yes	54 (27.0%)	289 (18.6%)	1.65 (1.18 – 2.32)	0.004
Any malignancy				
No	161 (80.5%)	1271 (81.7%)	1	
Si	39 (19.5%)	285 (18.3%)	1.08 (0.74 – 1.58)	0.67
Diabetes				
No	139 (69.5%)	1023 (65.7%)	1	
Si	61 (30.5%)	533 (34.3%)	0.83 (0.60 – 1.14)	0.26
Renal failure				
No	151 (75.5%)	1263 (81.2%)	1	
Si	49 (24.5%)	293 (18.8%)	1.38 (0.97 – 1.96)	0.07
COPD				
No	128 (64.0%)	1074 (69.0%)	1	
Si	72 (36.0%)	482 (31.0%)	1.25 (0.92 – 1.70)	0.16
Congestive heart disease				
No	128 (64.0%)	1168 (75.1%)	1	
Si	72 (36.0%)	388 (24.9%)	1.69 (1.24 – 2.31)	0.001
Chronic liver disease				
No	186 (93.0%)	1504 (96.7%)	1	
Si	14 (7.0%)	52 (3.3%)	2.13 (1.15 – 3.94)	0.01
Hemoglobinopathy or anemia				
No	160 (80.0%)	1324 (85.1%)	1	
Si	40 (20.0%)	232 (14.9%)	1.40 (0.96 – 2.04)	0.08
Disabling neurological disease				
No	179 (89.5%)	1416 (91.0%)	1	
Si	21 (10.5%)	140 (9.0%)	1.17 (0.72 – 1.90)	0.52
Hospital process of care				
ICU				
No	188 (94.5%)	1499 (96.9%)	1	
Si	11 (5.5%)	48 (3.1%)	1.93 (0.97 – 3.81)	0.06
Mechanical ventilation				
No	157 (78.5%)	1317 (84.9%)	1	
Si	43 (21.5%)	235 (15.1%)	1.50 (1.03 – 2.18)	0.03
Pneumonia severity index				
I-III	69 (34.7%)	645 (41.7%)	1	
IV-V	130 (65.3%)	902 (58.3%)	1.40 (1.02 – 1.92)	0.04
Length of hospital stay				
<8 days	80 (40.0%)	766 (49.2%)	1	
>=8 days	120 (60.0%)	790 (50.8%)	1.45 (1.05 – 2.02)	0.02
Antibiotic treatment				
No	97 (50.3%)	700 (46.6%)	1	
Yes	96 (49.7%)	802 (53.4%)	1.07 (0.76 – 1.50)	0.70
Discharge disposition				
Home without services	185 (92.5%)	1477 (94.9%)	1	
Home with home health care	9 (4.5%)	19 (1.2%)	5.05 (1.58 – 16.15)	0.01
Social health centre	6 (3.0%)	60 (3.9%)	1.23 (0.41 – 2.92)	0.63

COPD: Chronic obstructive pulmonary disease.

Table 2. Results of multilevel regression of factors associated with 30-day readmission.

	aOR	p value
Sex-Male	1.44 (1.01 – 2.04)	0.04
Educational level		
Secondary or higher	0.77 (0.53-1.13)	0.18
Cohabitants		
Live alone	1	
Lives with cohabitant >15 y.	1.25 (0.75 – 2.09)	0.39
Lives with cohabitant <15 y.	2.12 (1.01 – 4.47)	0.048
Marital status		
Married/Cohabiting	1	
Single	1.81 (1.00-3.30)	0.05
Widowed/divorced	1.07 (0.71-1.61)	0.74
Nº. of hospital visits ≥3	1.52 (1.00-2.32)	0.05
Barthel index		
Moderate-to-high dependency <=90	1.52 (1.09-2.11)	0.01
Pneumonia during the last 2 years	1.34 (0.94 – 1.93)	0.11
Chronic respiratory failure	1.73 (1.22 – 2.44)	0.01
Diabetes	0.72 (0.51 – 1.01)	0.05
Congestive heart disease	1.70 (1.21-2.38)	0.002
Chronic liver disease	2.29 (1.21 – 4.36)	0.01
Mechanical ventilation	1.33 (0.90 – 1.97)	0.15
Discharge disposition		
Home without services	1	
Home with home health care	5.53 (1.67-18.30)	0.005
Social health centre	1.23 (0.51-2.97)	0.64

Factors independently associated with 30-day readmission in the multilevel analysis (Table 2) were male sex (aOR 1.44 95% CI 1.01-2.04; p=0.04), living with a person aged < 15 years (aOR 2.12, 95% CI 1.01-4.47; p=0.04), a moderate-to-high degree of dependency (aOR 1.52, 95% CI 1.09-2.11; p=0.01), chronic respiratory failure (aOR 1.73, 95% CI 1.22-2.44; p=0.01), congestive heart disease (aOR 1.70, 95% CI 1.21-2.38; p=0.002), chronic liver disease (aOR 2.39, 95% c 1.21-4.36; p=0.01) and discharge to home with home health care (aOR 5.53, 95% CI 1.67-18.30; p=0.005).

Being single and ≥ 3 hospital visits during the last three months were tentatively associated with readmission (aOR 1.81, 95% CI 1.00-3.30; p=0.05 and aOR1.52, 95% CI 1.00-2.32; p=0.05, respectively).

No associations were observed with age, pneumoccocal vaccination or seasonal influenza vaccination in any of the three previous seasons, the pneumonia severity index, or any variable related to the hospital care process.

DISCUSSION

The overall 30-day readmission rate in our study was 11.39%. Although al participating hospitals were referrence centres, readmission rates ranged from 2.5% to 14% between autonomous communities. Possible explanations include variations in the number of people assigned to each hospital and the protocols used.

Readmission rates at 30 days after discharge due to CAP in people aged ≥ 65 years are usually between 8% and 27%, depending on the population and country studied.[11,19,21,25,29] In Spain, national data show hospital readmissions after 30 days of discharge due to CAP in adults had increased from 11.5% in 2004 to 13.5% in 2013.[8]

Some of the risk factors identified have not previously been reported and their identification provides a new perspective on the risk factors involved in 30-day readmission. Our results show that non-preventable factors, specifically patient characteristics (male sex, living with a person aged < 15 years, a Barthel Index < 90 and some comorbidities) were significantly associated with 30-day readmission. A systematic review by Calvillo-King et al. evaluated the impact of social factors on hospital readmission after an episode of CAP, considering socio-demographic,

socioeconomic and social environment elements, and found few studies that included them.[22]

Although the influence of sex varies between studies and may be closely related to other factors such as age, risk habits and some comorbidities, we found an association with male sex, as did studies by Neupane et al. and Bohannon et al.[19,30]

Patients living with children aged < 15 years had a two-fold higher probability of readmission than those living alone or with a partner. We found no studies that investigated the type of cohabitation in this context, possibly because one factor usually associated with readmission in people aged ≥ 65 years is living in geriatric residences.[11] We also found no association with factors identified by other authors, such as the educational level or the history of smoking or alcohol use.[25,31]

In the studies by Neupane et al. in two Canadian cities and Adamuz et al. in a tertiary hospital in Barcelona, seasonal influenza and pneumococcal vaccination were included in the adjusted analysis of readmission due to CAP, but no association was found.[19,23] We investigated seasonal influenza and pneumococcal vaccination in the last five years but found no association in the crude or adjusted models.

In our study, 52.7% of 30-day readmissions were due to causes unrelated to CAP. Patients with chronic liver disease, congestive heart disease and respiratory failure had higher 30-day readmission rates, findings consistent other studies showing that comorbidities play an important role in the risk of readmission in patients with CAP,[12,23-25] and that the reason for readmission generally differs from the initial diagnosis of CAP.[10.23-26,32,33]

We found an association with hospital consultations in the 90 days before admission for CAP, but no association with GP and primary care nurse visits in the bivariate analysis,

and this variable was not included in the final model. Health care in Spain is free, which encourages patients to make multiple visits to primary care centers and/or hospitals, ensuring patient care and follow-up. Adamuz et al. and Tang et al. found an association between readmission and hospitalization in the 90 days before admission for CAP.[11.23]

One preventable factor that influences CAP episodes in people aged ≥ 65 years is the quality of care they receive during hospitalization, while discharge planning and follow-up until recovery influence patient recovery and, therefore, readmission.[16,21,23,24] We found, as did Dong et al.,[16] an association with discharge to home with home health care. Although other variables were studied to assess these aspects, there was no association between them and readmission.

Strengths and limitations

The main strength of the study is that the information on readmission was obtained from the medical record and, therefore, was unlikely to be biased. Another strength is the prospective design, as it is part of a multi-center study carried out in seven autonomous communities representing 70% of the Spanish population.

A limitation is that it was not possible to collect patient characteristics at discharge, and therefore we cannot say whether there was instability at discharge that may have caused the readmission. Also it was not possible to collect detailed information about the readmission episode. Therefore the variable 'discharge disposition' was considered as a proxy to define instability.

CONCLUSIONS

In conclusion, this study shows that 11.39% of patients aged ≥ 65 years hospitalized due to CAP are readmitted within 30 days after discharge and that this was associated with

male sex, living with a cohabitant aged <15 years, a moderate-to-high degree of dependency, chronic respiratory failure, congestive heart disease, chronic liver disease and discharge to home with home health care services.

Because social factors, in addition to post-discharge and pre-readmission clinical information, may influence the prognosis, it is important they continue to be considered in future research.

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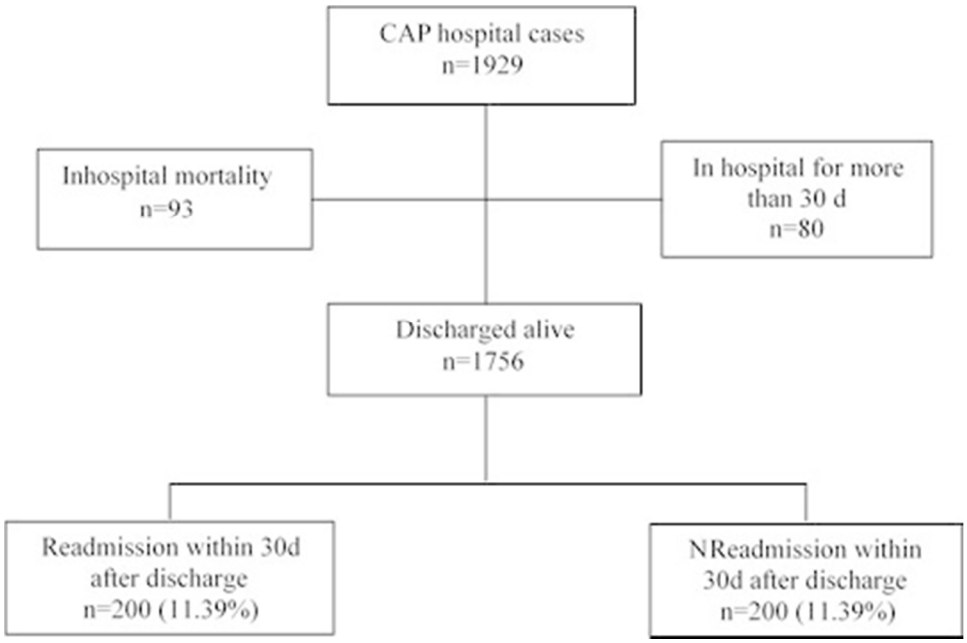

Figure 1. Flowchart of hospital readmissions

40x26mm (300 x 300 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
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	6-7
Bias	9	Describe any efforts to address potential sources of bias	7
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	7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	7
		(*c*) Explain how missing data were addressed	7
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	7
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	8
		(c) Consider use of a flow diagram	8
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8
		(b) Indicate number of participants with missing data for each variable of interest	
Outcome data	15*	Report numbers of outcome events or summary measures	8
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12
		(*b*) Report category boundaries when continuous variables were categorized	12
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
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	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14-15
Generalisability	21	Discuss the generalisability (external validity) of the study results	
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	15

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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FACTORS ASSOCIATED WITH 30-DAY READMISSION AFTER HOSPITALIZATION FOR COMMUNITY-ACQUIRED PNEUMONIA IN OLDER PATIENTS. A CROSS-SECTIONAL STUDY IN SEVEN SPANISH REGIONS

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FACTORS ASSOCIATED WITH 30-DAY READMISSION AFTER HOSPITALIZATION FOR COMMUNITY-ACQUIRED PNEUMONIA IN OLDER PATIENTS. A CROSS-SECTIONAL STUDY IN SEVEN SPANISH REGIONS

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ABSTRACT

Objective: Hospital readmission in patients admitted for community-acquired pneumonia (CAP) is frequent in the elderly and patients with multiple comorbidities, resulting in a clinical and economic burden.The aim of this study was to determine factors associated with 30-day readmission in patients with CAP.

Design: A cross-sectional study.

Setting: The study was conducted in patients admitted to 20 hospitals in seven Spanish regions during two influenza seasons (2013-2014 and 2014-2015).

Participants: We included patients aged ≥65 years admitted through the emergency department with a diagnosis compatible with CAP. Patients who died during the initial hospitalization and those hospitalized >30 days were excluded.

Main outcome measures: 30-day readmission.

Results: Factors associated with 30-day readmission were living with a person aged <15 years (aOR 2.10, 95% CI 1.01-4.41), >3 hospital visits during the 90 previous days (aOR 1.53; 95% CI 1.01-2.34) , chronic respiratory failure (aOR 1.74, 95% CI 1.24-2.45), heart failure (aOR 1.69, 95% CI 1.21-2.35), chronic liver disease (aOR 2.27, 95% CI 1.20-4.31) and discharge to home with home health care (aOR 5.61, 95% CI 1.70-18.50). No associations were found with pneumoccocal or seasonal influenza vaccination in any of the three previous seasons.

Conclusions: This study shows that 11.39% of patients aged ≥65 years initially hospitalized for CAP were readmitted within 30 days after discharge. Rehospitalization was associated with preventable and non-preventable factors.

Strengths and limitations of this study

- All the information on readmission was obtained from medical records.
- The study is part of a multi-center study carried out in seven autonomous communities representing 70% of the Spanish population.
- It was not possible to collect detailed information on the readmission episode.

INTRODUCTION

Community-acquired pneumonia (CAP) is a frequent, potentially serious disease in people aged ≥65 years and one of the leading causes of hospitalization and mortality worldwide in this age group,[1-4] in whom recovery from an episode of CAP is predictive of increased mortality in subsequent years.[5]

The incidence of CAP differs between European countries due to variations in age distribution, the introduction of vaccination programs and the clinical guidelines used. However, the incidence of cases and hospitalizations increases with age in all countries.[6,7] In Spain, CAP is not a reportable disease and therefore the incidence in the population is unknown, although 2013 data also show an increase in hospitalization (394.04 per 10^5 in the 65-74 years age group and 2584.95 per 10^5 in the >85 years age group).[8]

In people aged ≥65 years, full recovery after hospitalization due to CAP is usually slow and the probability of readmission during a period of time after discharge is greater.[9] 30-day readmission post discharge is usually used as an indicator of vulnerability.[2,10-12]

Readmission in patients admitted for CAP is relatively frequent (especially in the elderly and patients with multiple comorbidities), and is often associated with a worsening of a baseline disease or the appearance of a new pathology,[13] and this results in a significant clinical and economic burdern for health systems.[2,14] Studies have explored the factors associated with readmission following hospitalization due to CAP, and have identified factors that improve the prognosis at discharge and are considered preventable, such as influenza and pneumococcal vaccination, the use of hospital care protocols, discharge planning and post-discharge follow-up. Adequate

discharge planning, including patient stability and destination, has been associated with reduced readmission.[15-17] However, the effect of seasonal influenza and pneumococcal vaccination and the adequacy of hospital care (use of clinical guidelines and antibiotic plans) may be more controversial.[18-21] The initial severity of CAP, worsening of comorbidities and some individual patient characteristics have been described as non-preventable factors,[15,21-25] and factors such as age, sex, socioeconomic status, education and some comorbidities have been independently associated with a greater likelihood of readmission.[25,26]

The objective of this study was to determine the risk factors associated with 30-day readmission in people aged ≥65 years initially hospitalized due to CAP.

MATERIALS AND METHODS

Study design

This cross-sectional study was carried out as part of a multicenter study in 20 hospitals from seven Spanish regions (Andalusia, the Basque Country, Castile and Leon, Catalonia, Madrid, Navarre, and Valencian Community). Patients aged ≥65 years hospitalized due to CAP in the participating hospitals during the 2013–2014 and 2014–2015 influenza seasons were recruited.

Study population

Patients included were aged ≥65 years admitted through the emergency department to any of the participating hospitals for ≥ 24 hours with a chest X-ray showing pulmonary infiltrate compatible with pneumonia and ≥1 of the following symptoms or signs of acute lower respiratory tract infection: cough, pleural chest pain, dyspnea, fever >38ºC, hypothermia < 35ºC, and abnormal auscultator respiratory sounds unexplained by other causes.

Patients who died during the initial hospitalization and patients hospitalized for >30 days were not included. Institutionalized patients, patients with nosocomial pneumonia (onset ≥48 hours after hospital admission), patients whose main residence was not in any of the seven participating regions and those who did not provide signed informed consent were excluded.

Outcomes

The dependent variable was 30-day readmission, defined as 'hospitalization for any reason within 30 days of discharge'. Information on readmission was collected by re-review of index hospital medical records up to 30 days after initial discharge.

All participating hospitals had a specifically-trained team of health professionals who used a structured questionnaire to collect information by patient interview on confirmation of the case and review of medical records.

Information collected included sociodemographic variables: age, sex, marital status, educational level, cohabitation; lifestyle factors: smoking status (current smoker, ex-smoker, non-smoker) and high alcohol comsumption (> 40 g/day in men, > 20 g/day in women); the Barthel index,[27] was used to assess the functional capacity at hospital admission (ranging from 0 - complete dependence - to 100 - complete independence). Immunization history: patients were considered vaccinated against pneumococcal disease if they had receive a dose of pneumococcal vaccine in the last 5 years and against seasonal influenza if they had received a dose of the influenza vaccination at least 14 days before symptom onset. Risk medical conditions: comorbidities considered at high or moderate risk (chronic respiratory failure, history of pneumonia during the last two years, solid or hematologic neoplasm, diabetes mellitus, renal failure, chronic obstructive pulmonary disease (COPD), heart failure, disabling neurological disease,

chronic liver disease and hemoglobinopathy or anemia) were collected from medical records; comorbidities were assessed using the Charlson comorbidity index,[28] which assigns a weight to each comorbid condition (0 No comorbidity; 1 Low comorbidity and 2 High comorbidity); Prior medical utilization (number of primary care nurse visits and number of hospital visits in the last 90 days) and hospital care process (severity of illness quantified in 5 risk classes using the Pneumonia Severity Index (PSI) at admission,[29] length of stay (LOS) <8 days and ≥8 days,[8] intensive care unit (ICU) admission, mechanical ventilation, adequacy of antibiotic treatment plan (validated according to clinical guidelines) (Yes/No) and discharge disposition (home without services, home with home health care or social health centre).[16]

Statistical analysis

The Barthel index, a continuous variable, was dichotomized into 0-89 (moderate-to-high degree of dependency) and ≥90 (little or no dependency).

A bivariate analysis was conducted to compare 30-day readmission and no readmission according to sociodemographic variables, lifestyle factors, the Barthel index, immunization history, risk medical conditions, prior medical utilization and hospital care process. Independent variables were checked for collinearity using the variance inflation factor.[30]

As Spanish regions have varying degrees of autonomy in organizing health services, persons living in the same region tend to have similar access to health care. Therefore, to estimate the crude odds ratio (cOR) and adjusted odds ratio (aOR), we used multilevel regression models that considered the outcome variable in people from the same region to obtain accurate statistical estimates of predictors of 30-day

readmission.[30] Covariates were introduced into the model using a backward stepwise procedure,with a cut-off point of p <0.2.

The analysis was performed using the SPSS v.24 statistical package and Rv3.3.0 statistical software.

Ethical approval

The study was approved by the Ethics Committees of the participating hospitals.

RESULTS

Overall, 1929 inpatients met all study eligibility criteria for CAP: 93 patients died during the initial hospitalization and 80 were hospitalized for > 30 days.Therefore, 1756 CAP cases were discharged within 30 days after the initial hospitalization: of these, 200 (11.39%) were readmitted within 30 days after hospital discharge (Figure 1).

Figure 1. Flowchart of hospital readmissions

The reasons for 30-day readmission were unrelated to pneumonia in 49.5% (99 cases), pneumonia-related in 44.5% (89 cases) and unknown diagnosis in 6% (12 cases).

The descriptive analysis and unadjusted associations of factors related to 30-day readmission are shown in table 1. No differences were observed according to lifestyle factors and immunization history.

Table 1. Distribution of 30-day readmission cases according to patient characteristics

	Readmission n=200	No Readmission n=1556	Crude OR	p value
Sociodemographic				
Age median (range)	80 (65-101)	78 (64-100)	1.02 (0.99-1.04)	0.07
Age group				
65-74 y.	56 (28.0%)	501 (32.2%)	1	
75-84 y.	98 (49.0%)	729 (46.9%)	1.20 (0.85-1.70)	0.31
>84 y.	46 (23.0%)	326 (20.5%)	1.26 (0.83-1.91)	0.27
Sex				
Female	64 (32.0%)	622 (40.0%)	1	
Male	136 (68.0%)	934 (60.0%)	1.44 (1.05 – 1.97)	0.02
Educational level				
No/primary education	153 (78.1%)	1118 (72.4%)	1	
Secondary or higher	43 (21.9%)	427 (27.6%)	0.75 (0.51-1.10)	0.14
Marital status				
Married/Cohabiting	116 (58.0%)	912 (58.6%)	1	
Single	21 (10.5%)	107 (6.9%)	1.56 (0.94-2.59)	0.09
Widowed/divorced	63 (31.5%)	536 (34.4%)	0.93 (0.67-1.29)	0.66
Cohabitation				
Lives alone	31 (15.5%)	289 (18.6%)	1	
Lives with cohabitant aged >15 y.	155 (77.5%)	1203 (77.4%)	1.20 (0.80 – 1.80)	0.39
Lives with cohabitant aged <15 y.	14 (7.0%)	63 (4.1%)	2.03 (1.02 – 4.04)	0.04
Lifestyle factors				
Smoking status				
Non smoker	79 (39.5%)	693 (44.5%)	1	
Smoker	16 (8.0%)	138 (8.9%)	1.04 (0.59-1.83)	0.90
Ex-smoker	105 (52.5%)	725 (46.6%)	1.28 (0.94-1.75)	0.11
High alcohol comsumption				
No	197 (98.5%)	1524 (97.9%)	1	
Yes	3 (1.5%)	32 (2.1%)	1.38 (0.42-4.54)	0.60
Prior utilization of resources				
Nº of nurse visits in last 90d				
0-2	147 (73.5%)	1182 (76.4%)	1	
≥3	53 (26.5%)	365 (23.6%)	1.17 (0.82-1.65)	0.39
Nº of hospital visits in last 90d				
0-2	164 (82.8%)	1355 (87.6%)	1	
≥3	34 (17.2%)	192 (12.4%)	1.53 (1.02-2.31)	0.04
Barthel index				
Little or no dependency >90	108 (54.0%)	990 (63.6%)	1	
Moderate-to-high dependency <=90	92 (46.0%)	566 (36.4%)	1.47 (1.08-2.01)	0.01
Immunizations				
Influenza vaccination in any of the 3 previous seasons				
No	54 (27.0%)	464 (29.8%)	1	
Yes	146 (73.0%)	1092 (70.2%)	1.16 (0.83-1.61)	0.39
Pneumococcal vaccination in 5 previous years				
No	161 (80.5%)	1281 (82.3%)	1	
Yes	39 (19.5%)	275 (17.7%)	1.11 (0.76-1.62)	0.58
Risk medical conditions				
Chronic respiratory failure				
No	136 (68.0%)	1269 (81.6%)	1	
Yes	64 (32.0%)	287 (18.4%)	2.08 (1.50 – 2.88)	<0.001

Pneumonia during the last 2 years				
No	146 (73.0%)	1267 (81.4%)	1	
Yes	54 (27.0%)	289 (18.6%)	1.65 (1.18 – 2.32)	0.004
Any malignancy				
No	161 (80.5%)	1271 (81.7%)	1	
Yes	39 (19.5%)	285 (18.3%)	1.08 (0.74 – 1.58)	0.67
Diabetes				
No	139 (69.5%)	1023 (65.7%)	1	
Yes	61 (30.5%)	533 (34.3%)	0.83 (0.60 – 1.14)	0.26
Renal failure				
No	151 (75.5%)	1263 (81.2%)	1	
Yes	49 (24.5%)	293 (18.8%)	1.38 (0.97 – 1.96)	0.07
COPD				
No	128 (64.0%)	1074 (69.0%)	1	
Yes	72 (36.0%)	482 (31.0%)	1.25 (0.92 – 1.70)	0.16
Heart failure				
No	128 (64.0%)	1168 (75.1%)	1	
Yes	72 (36.0%)	388 (24.9%)	1.69 (1.24 – 2.31)	0.001
Chronic liver disease				
No	186 (93.0%)	1504 (96.7%)	1	
Yes	14 (7.0%)	52 (3.3%)	2.13 (1.15 – 3.94)	0.01
Hemoglobinopathy or anemia				
No	160 (80.0%)	1324 (85.1%)	1	
Yes	40 (20.0%)	232 (14.9%)	1.40 (0.96 – 2.04)	0.08
Disabling neurological disease				
No	179 (89.5%)	1416 (91.0%)	1	
Yes	21 (10.5%)	140 (9.0%)	1.17 (0.72 – 1.90)	0.52
Charlson Index				
No comorbidity (0)	18 (9.0%)	233 (15.0%)	1	
Low comorbidity (1)	54 (27.0%)	378 (24.3%)	1.83 (1.05-3.20)	0.03
High comorbidity (≥2)	128 (64.0%)	945 (60.7%)	1.71 (1.02-2.86)	0.04
Hospital care process				
ICU				
No	188 (94.5%)	1499 (96.9%)	1	
Yes	11 (5.5%)	48 (3.1%)	1.93 (0.97 – 3.81)	0.06
Mechanical ventilation				
No	157 (78.5%)	1317 (84.9%)	1	
Yes	43 (21.5%)	235 (15.1%)	1.50 (1.03 – 2.18)	0.03
Pneumonia severity index (PSI)				
I-III	69 (34.7%)	645 (41.7%)	1	
IV-V	130 (65.3%)	902 (58.3%)	1.40 (1.02 – 1.92)	0.04
Length of hospital stay (LOS)				
<8 days	80 (40.0%)	766 (49.2%)	1	
>=8 days	120 (60.0%)	790 (50.8%)	1.45 (1.05 – 2.02)	0.02
Antibiotic treatment				
No	97 (50.3%)	700 (46.6%)	1	
Yes	96 (49.7%)	802 (53.4%)	1.07 (0.76 – 1.50)	0.70
Discharge disposition				
Home without services	185 (92.5%)	1477 (94.9%)	1	
Home with home health care	9 (4.5%)	19 (1.2%)	5.05 (1.58 – 16.15)	0.01
Social health centre	6 (3.0%)	60 (3.9%)	1.23 (0.41 – 2.92)	0.63

COPD: Chronic obstructive pulmonary disease.

Table 2. Multilevel regression analysis of factors associated with 30-day readmission.

	aOR	p value
Age	1.02 (0.99-1.04)	0.13
Sex-Male	1.39 (0.99-3.12)	0.06
Cohabitation		
Lives alone	1	
Lives with cohabitant aged >15 y.	1.17 (0.71-1.95)	0.54
Lives with cohabitant aged <15 y.	2.10 (1.01-4.41)	0.04
Marital status		
Married/Cohabiting	1	
Single	1.73 (0.96-3.11)	0.07
Widowed/Divorced	0.94 (0.61-1.44)	0.77
Nº. of hospital visits ≥3	1.53 (1.01-2.34)	0.04
Barthel index		
Moderate-to-high dependency <=90	1.39 (0.99-1.95)	0.05
Pneumonia during the last 2 years	1.31 (0.91-1.88)	0.14
Chronic respiratory failure	1.74 (1.24-2.45)	0.001
Diabetes	0.74 (0.53-1.04)	0.08
Heart failure	1.69 (1.21-2.35)	0.002
Chronic liver disease	2.27 (1.20-4.31)	0.01
Mechanical ventilation	1.33 (0.90-1.97)	0.15
Discharge disposition		
Home without services	1	
Home with home health care	5.61 (1.70-18.50)	0.005
Social health centre	1.27 (0.53-3.05)	0.59

Factors independently associated with 30-day readmission in the multilevel analysis (Table 2) were living with a person aged < 15 years (aOR 2.10, 95% CI 1.01-4.41; p=0.04), > 3 hospital visits during the 90 previous days (aOR 1.53; 95% CI 1.01-2.34; p=0.04) chronic respiratory failure (aOR 1.74, 95% CI 1.24-2.45; p=0.001), heart failure (aOR 1.69, 95% CI 1.21-2.35; p=0.002), chronic liver disease (aOR 2.27, 95% CI 1.21-4.36; p=0.01) and discharge to home with home health care (aOR 5.61, 95% CI 1.70-18.50; p=0.005).

A moderate-to-high degree of dependency was tentatively associated with readmission (aOR 1.39, 95% CI 0.99-1.95; p=0.05).

No associations were observed with age, sex, pneumoccocal vaccination or seasonal influenza vaccination in any of the three previous seasons, the PSI, or any variable related to the hospital care process.

DISCUSSION

The overall 30-day readmission rate in our study was 11.39%. Although all participating hospitals were referral centers, readmission rates ranged between regions from 2.5% to 14%. This might be due to the differences in the hospital healthcare burden of participating hospitals and in the protocols used.

In the Pneumonia Patient Outcomes Research Team (PORT) cohort study, carried out in the United States and Canada, the readmission rate in adults was 10.1%.[31] Readmission rates at 30 days in people aged ≥ 65 years admitted for CAP vary between 8% and 27%, depending on the population and country studied.[11,19,21,25,32] In Spain, national data show 30-days readmissions increased from 11.5% in 2004 to 13.5% in 2013 in adults admitted for CAP.[8]

Our results show that non-preventable factors, specifically patient characteristics (living with a person aged < 15 years, > 3 hospital visits during the 90 previous days and some comorbidities) and one preventable factor (discharge disposition) were significantly associated with 30-day readmission. Factors such as cohabitation and the discharge dispostion have been little studied and their identification provides a new perspective on the risk factors involved in 30-day readmission of these patients.

Calvillo-King et al. in a thorough review of studies on readmission, underlined the importance of considering social factors (sociodemographic, socioeconomic and the social environment) as elements that could influence readmission after an episode of CAP. [22] Our study evaluated sociodemographic and socioeconomic factors and the

social environment. Although the influence of sex varies between studies and may be closely related to other factors such as age, risk habits and some comorbidities, the association with male sex disappeared in the final model, in contrast to the results found by Neupane et al. and Bohannon et al.[19,33]

Patients living with children aged <15 years had a two-fold higher probability of readmission than those living alone or with a partner. Although it is known that schoolchildren may be a source of infection of the elderly in some infectious diseases, we found no studies that investigated the type of cohabitation in this context, possibly because one factor usually associated with readmission in people aged ≥65 years is living in geriatric residences.[11] In Spain, the recommendation of vaccination of persons in contact with high-risk persons, including persons aged ≥65 years with risk factors has been maintained.[34] We also found no association with factors identified by other authors, such as the educational level or the history of smoking or alcohol use.[25,35]

In the studies by Neupane et al. in two Canadian cities and Adamuz et al. in a tertiary hospital in Barcelona, seasonal influenza and pneumococcal vaccination were included in the adjusted analysis of readmission due to CAP, but no association was found.[19,23] We investigated seasonal influenza and pneumococcal vaccination in the previous five years but found no association in the crude or adjusted models.

In our study, 49.5% of 30-day readmissions were due to causes unrelated to CAP and 91% of readmitted patients presented comorbidities. Patients with chronic liver disease, heart failure and respiratory failure had higher 30-day readmission rates, findings consistent with other studies showing that some cardiovascular and respiratory diseases play an important role in the risk of readmission in patients with CAP,[12,23-25,36] and

that the reason for readmission generally differs from the initial diagnosis of CAP due, in most cases, to destabilization of comorbidities.[10.23-26,37,38] Fine et al., in a cohort study, found that pneumonia often occurs in patients with underlying comorbidities and often results in a worsening of such underlying conditions.[31]

We found an association with prior hospital utilization in the 90 days before admission for CAP, but no association with GP and primary care nurse visits. Health care in Spain is free, which encourages patients to make multiple visits to primary care centers and/or hospitals, ensuring patient care and follow-up. Adamuz et al. and Tang et al. found an association between readmission and hospitalization in the 90 days before admission for CAP.[11.23]

One preventable factor that influences CAP episodes in people aged ≥ 65 years is the quality of care received during hospitalization, while discharge planning and follow-up until recovery influence patient recovery and, therefore, readmission.[16,21,23,24] We found, as did Dong et al.,[16] an association with discharge to home with home health care. A possible explanation might be an inadequate evaluation of the patient's stability at discharge. Various authors have suggested the importance of the discharge dispostion in patients admitted due to other causes. However, with respect to patients with CAP, only Dong et al. and the present study have found an association between the discharge dispostion and readmission. Other variables related to the quality of care were studied to assess these aspects but no association with readmission was found.

Strengths and limitations

The main strength of the study is that all clinical information was obtained from patient medical records and, therefore, was unlikely to be biased. Another strength is the cross-

sectional design, as it is part of a multi-center study carried out in seven regions representing 70% of the Spanish population.

A limitation is that it was not possible to collect patient characteristics at discharge, and therefore we cannot say whether there was instability at discharge that may have caused the readmission. Therefore the variable 'discharge disposition' was considered as a proxy to define instability.

CONCLUSIONS

In conclusion, this study shows that 11.39% of patients aged ≥ 65 years hospitalized due to CAP are readmitted within 30 days after an episode of CAP and that this was associated with living with a cohabitant aged <15 years, >3 hospital visits during the 90 previous days , chronic respiratory failure, heart failure, chronic liver disease and discharge to home with home health care services.

Because social factors, in addition to post-discharge and pre-readmission clinical information, may influence the prognosis, it is important that these factors continue to be considered in future research.

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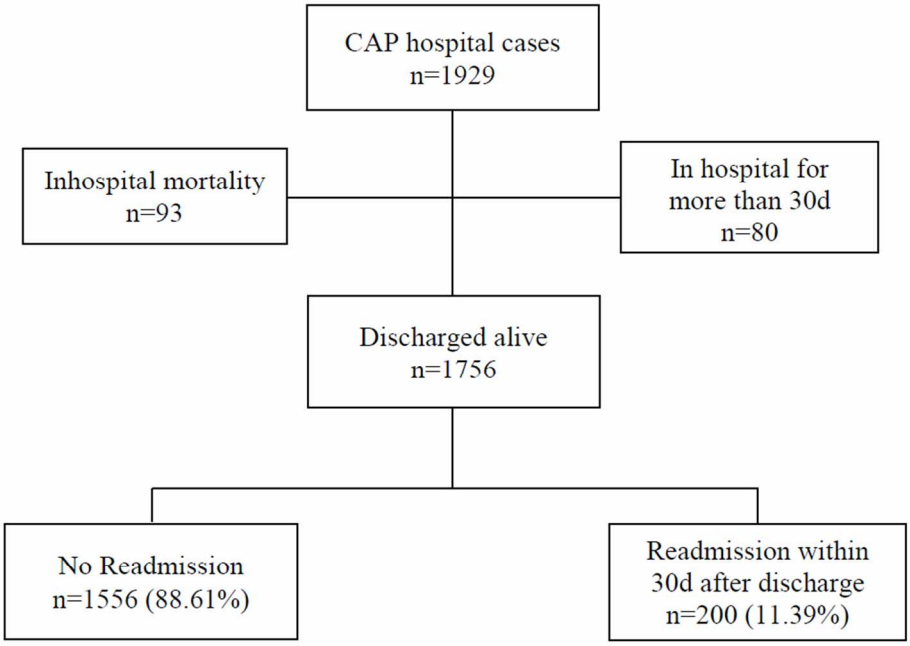

Figure 1. Flowchart of hospital readmissions

88x59mm (300 x 300 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1/ line 3-5
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5/line 21-23
Methods			
Study design	4	Present key elements of study design early in the paper	5/line 30
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5/line 30-38
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5/line 44-55 6/line 2-12
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6/line 17-56 7/line 3-23
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	6/line 17-56 7/line 3-23
Bias	9	Describe any efforts to address potential sources of bias	6/line 17-56 7/line 3-23
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	7/line 28-30
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7/line 33-54 8/line 3-9
		(*b*) Describe any methods used to examine subgroups and interactions	7/line 33-54 8/line 3-9
		(*c*) Explain how missing data were addressed	7/line 14-23

			8/line 1-2
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	Not appplicable
		(*e*) Describe any sensitivity analyses	7/line 14-23 8/line 1-2
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8/ line 22-29
		(b) Give reasons for non-participation at each stage	8/ line 22-29
		(c) Consider use of a flow diagram	8 / line 32
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8/35-45 Page 9-10
		(b) Indicate number of participants with missing data for each variable of interest	Not appplicable
Outcome data	15*	Report numbers of outcome events or summary measures	8
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11/line36-55
		(*b*) Report category boundaries when continuous variables were categorized	Not appplicable
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not appplicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Not appplicable
Discussion			
Key results	18	Summarise key results with reference to study objectives	12/ line 13-47
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	14/line 51-53 15/ line 3-15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12/ line 12-55 13/ line 3-55 14/ line 6-46
Generalisability	21	Discuss the generalisability (external validity) of the study results	15/ line 20-36
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	15/ line 48-57

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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FACTORS ASSOCIATED WITH 30-DAY READMISSION AFTER HOSPITALIZATION FOR COMMUNITY-ACQUIRED PNEUMONIA IN OLDER PATIENTS. A CROSS-SECTIONAL STUDY IN SEVEN SPANISH REGIONS

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FACTORS ASSOCIATED WITH 30-DAY READMISSION AFTER HOSPITALIZATION FOR COMMUNITY-ACQUIRED PNEUMONIA IN OLDER PATIENTS. A CROSS-SECTIONAL STUDY IN SEVEN SPANISH REGIONS

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ABSTRACT

Objective: Hospital readmission in patients admitted for community-acquired pneumonia (CAP) is frequent in the elderly and patients with multiple comorbidities, resulting in a clinical and economic burden.The aim of this study was to determine factors associated with 30-day readmission in patients with CAP.

Design: A cross-sectional study.

Setting: The study was conducted in patients admitted to 20 hospitals in seven Spanish regions during two influenza seasons (2013-2014 and 2014-2015).

Participants: We included patients aged ≥65 years admitted through the emergency department with a diagnosis compatible with CAP. Patients who died during the initial hospitalization and those hospitalized >30 days were excluded. Finally, 1756 CAP cases were included and of these, 200 (11.39%) were readmitted.

Main outcome measures: 30-day readmission.

Results: Factors associated with 30-day readmission were living with a person aged <15 years (aOR 2.10, 95% CI 1.01-4.41), >3 hospital visits during the 90 previous days (aOR 1.53; 95% CI 1.01-2.34) , chronic respiratory failure (aOR 1.74, 95% CI 1.24-2.45), heart failure (aOR 1.69, 95% CI 1.21-2.35), chronic liver disease (aOR 2.27, 95% CI 1.20-4.31) and discharge to home with home health care (aOR 5.61, 95% CI 1.70-18.50). No associations were found with pneumoccocal or seasonal influenza vaccination in any of the three previous seasons.

Conclusions: This study shows that 11.39% of patients aged ≥65 years initially hospitalized for CAP were readmitted within 30 days after discharge. Rehospitalization was associated with preventable and non-preventable factors.

Strengths and limitations of this study

- All the information on readmission was obtained from medical records.
- The study is part of a multi-center study carried out in seven autonomous communities representing 70% of the Spanish population.
- It was not possible to collect detailed information on the readmission episode.

INTRODUCTION

Community-acquired pneumonia (CAP) is a frequent, potentially serious disease in people aged ≥65 years and one of the leading causes of hospitalization and mortality worldwide in this age group,[1-4] in whom recovery from an episode of CAP is predictive of increased mortality in subsequent years.[5]

The incidence of CAP differs between European countries due to variations in age distribution, the introduction of vaccination programs and the clinical guidelines used. However, the incidence of cases and hospitalizations increases with age in all countries.[6,7] In Spain, CAP is not a reportable disease and therefore the incidence in the population is unknown, although 2013 data also show an increase in hospitalization (394.04 per 10^5 in the 65-74 years age group and 2584.95 per 10^5 in the >85 years age group).[8]

In people aged ≥65 years, full recovery after hospitalization due to CAP is usually slow and the probability of readmission during a period of time after discharge is greater.[9] 30-day readmission post discharge is usually used as an indicator of vulnerability.[2,10-12]

Readmission in patients admitted for CAP is relatively frequent (especially in the elderly and patients with multiple comorbidities), and is often associated with a worsening of a baseline disease or the appearance of a new pathology,[13] and this results in a significant clinical and economic burdern for health systems.[2,14] Studies have explored the factors associated with readmission following hospitalization due to CAP, and have identified factors that improve the prognosis at discharge and are considered preventable, such as influenza and pneumococcal vaccination, the use of hospital care protocols, discharge planning and post-discharge follow-up. Adequate

discharge planning, including patient stability and destination, has been associated with reduced readmission.[15-17] However, the effect of seasonal influenza and pneumococcal vaccination and the adequacy of hospital care (use of clinical guidelines and antibiotic plans) may be more controversial.[18-21] The initial severity of CAP, worsening of comorbidities and some individual patient characteristics have been described as non-preventable factors,[15,21-25] and factors such as age, sex, socioeconomic status, education and some comorbidities have been independently associated with a greater likelihood of readmission.[25,26]

The objective of this study was to determine the risk factors associated with 30-day readmission in people aged ≥65 years initially hospitalized due to CAP.

MATERIALS AND METHODS

Study design

This cross-sectional study was carried out as part of a multicenter study in 20 hospitals from seven Spanish regions (Andalusia, the Basque Country, Castile and Leon, Catalonia, Madrid, Navarre, and Valencian Community). Patients aged ≥65 years hospitalized due to CAP in the participating hospitals during the 2013–2014 and 2014–2015 influenza seasons were recruited.

Study population

The Spanish health system assigns each citizen a primary healthcare centre and a referral hospital to be attended. The assignation of the population to each hospital is made according to geography. Consequently, if there is a readmission, it would be in the same hospital. However, in an emergency, the patient may be treated in any hospital.

Patients included were aged ≥65 years admitted through the emergency department to any of the participating hospitals for ≥ 24 hours with a chest X-ray showing pulmonary

infiltrate compatible with pneumonia and ≥1 of the following symptoms or signs of acute lower respiratory tract infection: cough, pleural chest pain, dyspnea, fever >38ºC, hypothermia < 35ºC, and abnormal auscultator respiratory sounds unexplained by other causes.

Patients who died during the initial hospitalization and patients hospitalized for >30 days were not included. Institutionalized patients, patients with nosocomial pneumonia (onset ≥48 hours after hospital admission), patients whose main residence was not in any of the seven participating regions and those who did not provide signed informed consent were excluded.

Outcomes

The dependent variable was 30-day readmission, defined as 'hospitalization for any reason within 30 days of discharge'. Information on readmission was collected by re-review of index hospital medical records up to 30 days after initial discharge.

All participating hospitals had a specifically-trained team of health professionals who used a structured questionnaire to obtain sociodemographic information and lifestyle factors by patient interview and the review of patient's medical record to collect immunization history, risk medical conditions and the CAP hospital care process.

Information collected included sociodemographic variables: age, sex, marital status, educational level, cohabitation; lifestyle factors: smoking status (current smoker, ex-smoker, non-smoker) and high alcohol comsumption (> 40 g/day in men, > 20 g/day in women); the Barthel index,[27] was used to assess the functional capacity at hospital admission (ranging from 0 - complete dependence - to 100 - complete independence). Immunization history: patients were considered vaccinated against pneumococcal disease if they had receive a dose of pneumococcal vaccine in the last 5 years and

against seasonal influenza if they had received a dose of the influenza vaccination at least 14 days before symptom onset. Risk medical conditions: comorbidities considered at high or moderate risk (chronic respiratory failure, history of pneumonia during the last two years, solid or hematologic neoplasm, diabetes mellitus, renal failure, chronic obstructive pulmonary disease (COPD), heart failure, disabling neurological disease, chronic liver disease and hemoglobinopathy or anemia) were collected from the patient's medical record through chart review; comorbidities were assessed using the Charlson comorbidity index,[28] which assigns a weight to each comorbid condition (0 No comorbidity; 1 Low comorbidity and 2 High comorbidity); Prior medical utilization (number of primary care nurse visits and number of hospital visits in the last 90 days) and hospital care process (severity of illness quantified in 5 risk classes using the Pneumonia Severity Index (PSI) at admission,[29] length of stay (LOS) <8 days and ≥8 days,[8] intensive care unit (ICU) admission, mechanical ventilation, adequacy of antibiotic treatment plan (validated according to clinical guidelines) (Yes/No) and discharge disposition (home without services, home with home health care or social health centre).[16]

Statistical analysis

The Barthel index, a continuous variable, was dichotomized into 0-89 (moderate-to-high degree of dependency) and ≥90 (little or no dependency).

A bivariate analysis was conducted to compare 30-day readmission and no readmission according to sociodemographic variables, lifestyle factors, the Barthel index, immunization history, risk medical conditions, prior medical utilization and hospital care process. Independent variables were checked for collinearity using the variance inflation factor.[30]

As Spanish regions have varying degrees of autonomy in organizing health services, persons living in the same region tend to have similar access to health care. Therefore, to estimate the crude odds ratio (cOR) and adjusted odds ratio (aOR), we used multilevel regression models that considered the outcome variable in people from the same region to obtain accurate statistical estimates of predictors of 30-day readmission.[30] Covariates were introduced into the model using a backward stepwise procedure,with a cut-off point of $p < 0.2$.

The analysis was performed using the SPSS v.24 statistical package and Rv3.3.0 statistical software.

Ethical approval

The study was approved by the Ethics Committees of the participating hospitals.

RESULTS

Overall, 1929 inpatients met all study eligibility criteria for CAP: 93 patients died during the initial hospitalization and 80 were hospitalized for > 30 days.Therefore, 1756 CAP cases were discharged within 30 days after the initial hospitalization: of these, 200 (11.39%) were readmitted within 30 days after hospital discharge (Figure 1).

Figure 1. Flowchart of hospital readmissions

The reasons for 30-day readmission were unrelated to pneumonia in 49.5% (99 cases), pneumonia-related in 44.5% (89 cases) and unknown diagnosis in 6% (12 cases).

The descriptive analysis and unadjusted associations of factors related to 30-day readmission are shown in table 1. No differences were observed according to lifestyle factors and immunization history.

Table 1. Distribution of 30-day readmission cases according to patient characteristics

	Readmission n=200	No Readmission n=1556	Crude OR	p value
Sociodemographic				
Age median (range)	80 (65-101)	78 (64-100)	1.02 (0.99-1.04)	0.07
Age group				
65-74 y.	56 (28.0%)	501 (32.2%)	1	
75-84 y.	98 (49.0%)	729 (46.9%)	1.20 (0.85-1.70)	0.31
>84 y.	46 (23.0%)	326 (20.5%)	1.26 (0.83-1.91)	0.27
Sex				
Female	64 (32.0%)	622 (40.0%)	1	
Male	136 (68.0%)	934 (60.0%)	1.44 (1.05 – 1.97)	0.02
Educational level				
No/primary education	153 (78.1%)	1118 (72.4%)	1	
Secondary or higher	43 (21.9%)	427 (27.6%)	0.75 (0.51-1.10)	0.14
Marital status				
Married/Cohabiting	116 (58.0%)	912 (58.6%)	1	
Single	21 (10.5%)	107 (6.9%)	1.56 (0.94-2.59)	0.09
Widowed/divorced	63 (31.5%)	536 (34.4%)	0.93 (0.67-1.29)	0.66
Cohabitation				
Lives alone	31 (15.5%)	289 (18.6%)	1	
Lives with cohabitant aged >15 y.	155 (77.5%)	1203 (77.4%)	1.20 (0.80 – 1.80)	0.39
Lives with cohabitant aged <15 y.	14 (7.0%)	63 (4.1%)	2.03 (1.02 – 4.04)	0.04
Lifestyle factors				
Smoking status				
Non smoker	79 (39.5%)	693 (44.5%)	1	
Smoker	16 (8.0%)	138 (8.9%)	1.04 (0.59-1.83)	0.90
Ex-smoker	105 (52.5%)	725 (46.6%)	1.28 (0.94-1.75)	0.11
High alcohol comsumption				
No	197 (98.5%)	1524 (97.9%)	1	
Yes	3 (1.5%)	32 (2.1%)	1.38 (0.42-4.54)	0.60
Prior utilization of resources				
Nº of nurse visits in last 90d				
0-2	147 (73.5%)	1182 (76.4%)	1	
≥3	53 (26.5%)	365 (23.6%)	1.17 (0.82-1.65)	0.39
Nº of hospital visits in last 90d				
0-2	164 (82.8%)	1355 (87.6%)	1	
≥3	34 (17.2%)	192 (12.4%)	1.53 (1.02-2.31)	0.04
Barthel index				
Little or no dependency >90	108 (54.0%)	990 (63.6%)	1	
Moderate-to-high dependency <=90	92 (46.0%)	566 (36.4%)	1.47 (1.08-2.01)	0.01
Immunizations				
Influenza vaccination in any of the 3 previous seasons				
No	54 (27.0%)	464 (29.8%)	1	
Yes	146 (73.0%)	1092 (70.2%)	1.16 (0.83-1.61)	0.39
Pneumococcal vaccination in 5 previous years				
No	161 (80.5%)	1281 (82.3%)	1	
Yes	39 (19.5%)	275 (17.7%)	1.11 (0.76-1.62)	0.58
Risk medical conditions				
Chronic respiratory failure				
No	136 (68.0%)	1269 (81.6%)	1	
Yes	64 (32.0%)	287 (18.4%)	2.08 (1.50 – 2.88)	<0.001

Pneumonia during the last 2 years				
No	146 (73.0%)	1267 (81.4%)	1	
Yes	54 (27.0%)	289 (18.6%)	1.65 (1.18 – 2.32)	0.004
Any malignancy				
No	161 (80.5%)	1271 (81.7%)	1	
Yes	39 (19.5%)	285 (18.3%)	1.08 (0.74 – 1.58)	0.67
Diabetes				
No	139 (69.5%)	1023 (65.7%)	1	
Yes	61 (30.5%)	533 (34.3%)	0.83 (0.60 – 1.14)	0.26
Renal failure				
No	151 (75.5%)	1263 (81.2%)	1	
Yes	49 (24.5%)	293 (18.8%)	1.38 (0.97 – 1.96)	0.07
COPD				
No	128 (64.0%)	1074 (69.0%)	1	
Yes	72 (36.0%)	482 (31.0%)	1.25 (0.92 – 1.70)	0.16
Heart failure				
No	128 (64.0%)	1168 (75.1%)	1	
Yes	72 (36.0%)	388 (24.9%)	1.69 (1.24 – 2.31)	0.001
Chronic liver disease				
No	186 (93.0%)	1504 (96.7%)	1	
Yes	14 (7.0%)	52 (3.3%)	2.13 (1.15 – 3.94)	0.01
Hemoglobinopathy or anemia				
No	160 (80.0%)	1324 (85.1%)	1	
Yes	40 (20.0%)	232 (14.9%)	1.40 (0.96 – 2.04)	0.08
Disabling neurological disease				
No	179 (89.5%)	1416 (91.0%)	1	
Yes	21 (10.5%)	140 (9.0%)	1.17 (0.72 – 1.90)	0.52
Charlson Index				
No comorbidity (0)	18 (9.0%)	233 (15.0%)	1	
Low comorbidity (1)	54 (27.0%)	378 (24.3%)	1.83 (1.05-3.20)	0.03
High comorbidity (≥2)	128 (64.0%)	945 (60.7%)	1.71 (1.02-2.86)	0.04
Hospital care process				
ICU				
No	188 (94.5%)	1499 (96.9%)	1	
Yes	11 (5.5%)	48 (3.1%)	1.93 (0.97 – 3.81)	0.06
Mechanical ventilation				
No	157 (78.5%)	1317 (84.9%)	1	
Yes	43 (21.5%)	235 (15.1%)	1.50 (1.03 – 2.18)	0.03
Pneumonia severity index (PSI)				
I-III	69 (34.7%)	645 (41.7%)	1	
IV-V	130 (65.3%)	902 (58.3%)	1.40 (1.02 – 1.92)	0.04
Length of hospital stay (LOS)				
<8 days	80 (40.0%)	766 (49.2%)	1	
>=8 days	120 (60.0%)	790 (50.8%)	1.45 (1.05 – 2.02)	0.02
Antibiotic treatment				
No	97 (50.3%)	700 (46.6%)	1	
Yes	96 (49.7%)	802 (53.4%)	1.07 (0.76 – 1.50)	0.70
Discharge disposition				
Home without services	185 (92.5%)	1477 (94.9%)	1	
Home with home health care	9 (4.5%)	19 (1.2%)	5.05 (1.58 – 16.15)	0.01
Social health centre	6 (3.0%)	60 (3.9%)	1.23 (0.41 – 2.92)	0.63

COPD: Chronic obstructive pulmonary disease.

Table 2. Multilevel regression analysis of factors associated with 30-day readmission.

	aOR	p value
Age	1.02 (0.99-1.04)	0.13
Sex-Male	1.39 (0.99-3.12)	0.06
Cohabitation		
Lives alone	1	
Lives with cohabitant aged >15 y.	1.17 (0.71-1.95)	0.54
Lives with cohabitant aged <15 y.	2.10 (1.01-4.41)	0.04
Marital status		
Married/Cohabiting	1	
Single	1.73 (0.96-3.11)	0.07
Widowed/Divorced	0.94 (0.61-1.44)	0.77
Nº. of hospital visits ≥3	1.53 (1.01-2.34)	0.04
Barthel index		
Moderate-to-high dependency <=90	1.39 (0.99-1.95)	0.05
Pneumonia during the last 2 years	1.31 (0.91-1.88)	0.14
Chronic respiratory failure	1.74 (1.24-2.45)	0.001
Diabetes	0.74 (0.53-1.04)	0.08
Heart failure	1.69 (1.21-2.35)	0.002
Chronic liver disease	2.27 (1.20-4.31)	0.01
Mechanical ventilation	1.33 (0.90-1.97)	0.15
Discharge disposition		
Home without services	1	
Home with home health care	5.61 (1.70-18.50)	0.005
Social health centre	1.27 (0.53-3.05)	0.59

Factors independently associated with 30-day readmission in the multilevel analysis (Table 2) were living with a person aged < 15 years (aOR 2.10, 95% CI 1.01-4.41; p=0.04), > 3 hospital visits during the 90 previous days (aOR 1.53; 95% CI 1.01-2.34; p=0.04) chronic respiratory failure (aOR 1.74, 95% CI 1.24-2.45; p=0.001), heart failure (aOR 1.69, 95% CI 1.21-2.35; p=0.002), chronic liver disease (aOR 2.27, 95% CI 1.21-4.36; p=0.01) and discharge to home with home health care (aOR 5.61, 95% CI 1.70-18.50; p=0.005).

A moderate-to-high degree of dependency was tentatively associated with readmission (aOR 1.39, 95% CI 0.99-1.95; p=0.05).

No associations were observed with age, sex, pneumoccocal vaccination or seasonal influenza vaccination in any of the three previous seasons, the PSI, or any variable related to the hospital care process.

DISCUSSION

The overall 30-day readmission rate in our study was 11.39%. Although all participating hospitals were referral centers, readmission rates ranged between regions from 2.5% to 14%. This might be due to the differences in the hospital healthcare burden of participating hospitals and in the protocols used.

In the Pneumonia Patient Outcomes Research Team (PORT) cohort study, carried out in the United States and Canada, the readmission rate in adults was 10.1%.[31] Readmission rates at 30 days in people aged ≥ 65 years admitted for CAP vary between 8% and 27%, depending on the population and country studied.[11,19,21,25,32] In Spain, national data show 30-days readmissions increased from 11.5% in 2004 to 13.5% in 2013 in adults admitted for CAP.[8]

Our results show that non-preventable factors, specifically patient characteristics (living with a person aged < 15 years, > 3 hospital visits during the 90 previous days and some comorbidities) and one preventable factor (discharge disposition) were significantly associated with 30-day readmission. Factors such as cohabitation and the discharge dispostion have been little studied and their identification provides a new perspective on the risk factors involved in 30-day readmission of these patients.

Calvillo-King et al. in a thorough review of studies on readmission, underlined the importance of considering social factors (sociodemographic, socioeconomic and the social environment) as elements that could influence readmission after an episode of CAP. [22] Our study evaluated sociodemographic and socioeconomic factors and the

social environment. Although the influence of sex varies between studies and may be closely related to other factors such as age, risk habits and some comorbidities, the association with male sex disappeared in the final model, in contrast to the results found by Neupane et al. and Bohannon et al.[19,33]

Patients living with children aged <15 years had a two-fold higher probability of readmission than those living alone or with a partner. Although it is known that schoolchildren may be a source of infection of the elderly in some infectious diseases, we found no studies that investigated the type of cohabitation in this context, possibly because one factor usually associated with readmission in people aged ≥65 years is living in geriatric residences.[11] In Spain, the recommendation of vaccination of persons in contact with high-risk persons, including persons aged ≥65 years with risk factors has been maintained.[34] We also found no association with factors identified by other authors, such as the educational level or the history of smoking or alcohol use.[25,35]

In the studies by Neupane et al. in two Canadian cities and Adamuz et al. in a tertiary hospital in Barcelona, seasonal influenza and pneumococcal vaccination were included in the adjusted analysis of readmission due to CAP, but no association was found.[19,23] We investigated seasonal influenza and pneumococcal vaccination in the previous five years but found no association in the crude or adjusted models.

In our study, 49.5% of 30-day readmissions were due to causes unrelated to CAP and 91% of readmitted patients presented comorbidities. Patients with chronic liver disease, heart failure and respiratory failure had higher 30-day readmission rates, findings consistent with other studies showing that some cardiovascular and respiratory diseases play an important role in the risk of readmission in patients with CAP,[12,23-25,36] and

that the reason for readmission generally differs from the initial diagnosis of CAP due, in most cases, to destabilization of comorbidities.[10.23-26,37,38] Fine et al., in a cohort study, found that pneumonia often occurs in patients with underlying comorbidities and often results in a worsening of such underlying conditions.[31]

We found an association with prior hospital utilization in the 90 days before admission for CAP, but no association with GP and primary care nurse visits. Health care in Spain is free, which encourages patients to make multiple visits to primary care centers and/or hospitals, ensuring patient care and follow-up. Adamuz et al. and Tang et al. found an association between readmission and hospitalization in the 90 days before admission for CAP.[11.23]

One preventable factor that influences CAP episodes in people aged ≥ 65 years is the quality of care received during hospitalization, while discharge planning and follow-up until recovery influence patient recovery and, therefore, readmission.[16,21,23,24] We found, as did Dong et al.,[16] an association with discharge to home with home health care. A possible explanation might be an inadequate evaluation of the patient's stability at discharge. Various authors have suggested the importance of the discharge dispostion in patients admitted due to other causes such as COPD or some especif interventions.[39-41] However, with respect to patients with CAP, only Dong et al. and the present study have found an association between the discharge dispostion and readmission. Other variables related to the quality of care were studied to assess these aspects but no association with readmission was found.

Strengths and limitations

The main strength of the study is that all clinical information was obtained from patient medical records and, therefore, was unlikely to be biased. Another strength is the cross-

sectional design, as it is part of a multi-center study carried out in seven regions representing 70% of the Spanish population.

A limitation is that it was not possible to collect patient characteristics at discharge, and therefore we cannot say whether there was instability at discharge that may have caused the readmission. Therefore the variable 'discharge disposition' was considered as a proxy to define instability.

CONCLUSIONS

In conclusion, this study shows that 11.39% of patients aged ≥ 65 years hospitalized due to CAP are readmitted within 30 days after an episode of CAP and that this was associated with living with a cohabitant aged <15 years, >3 hospital visits during the 90 previous days , chronic respiratory failure, heart failure, chronic liver disease and discharge to home with home health care services.

Because social factors, in addition to post-discharge and pre-readmission clinical information, may influence the prognosis, it is important that these factors continue to be considered in future research.

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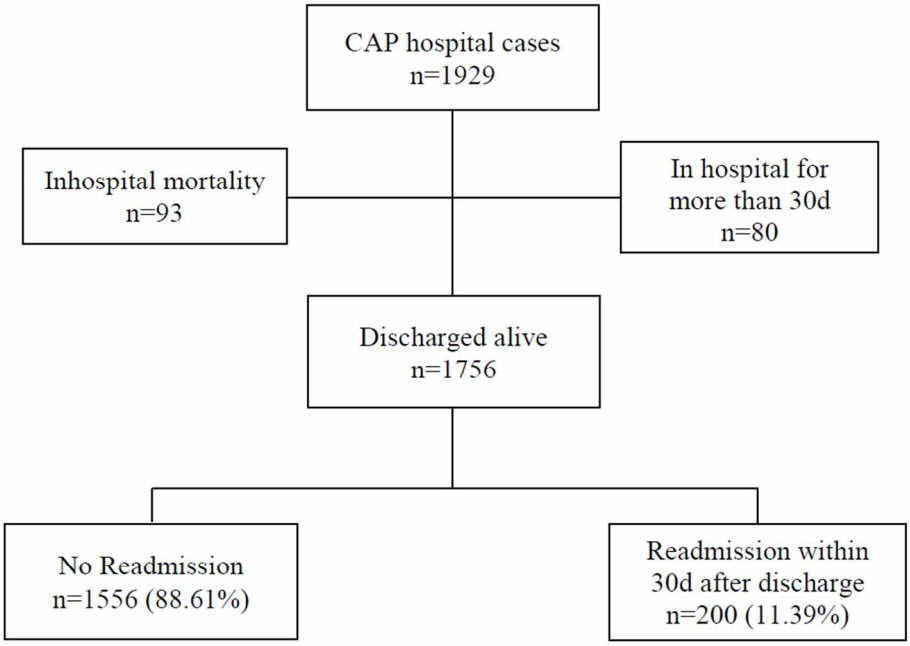

Figure 1. Flowchart of hospital readmissions

88x59mm (300 x 300 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1/ line 3-5
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5/line 21-23
Methods			
Study design	4	Present key elements of study design early in the paper	5/line 30
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5/line 30-38
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5/line 44-55 6/line 2-12
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6/line 17-56 7/line 3-23
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	6/line 17-56 7/line 3-23
Bias	9	Describe any efforts to address potential sources of bias	6/line 17-56 7/line 3-23
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	7/line 28-30
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7/line 33-54 8/line 3-9
		(*b*) Describe any methods used to examine subgroups and interactions	7/line 33-54 8/line 3-9
		(*c*) Explain how missing data were addressed	7/line 14-23

			8/line 1-2
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	Not appplicable
		(*e*) Describe any sensitivity analyses	7/line 14-23 8/line 1-2
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8/ line 22-29
		(b) Give reasons for non-participation at each stage	8/ line 22-29
		(c) Consider use of a flow diagram	8 / line 32
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8/35-45 Page 9-10
		(b) Indicate number of participants with missing data for each variable of interest	Not appplicable
Outcome data	15*	Report numbers of outcome events or summary measures	8
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11/line36-55
		(*b*) Report category boundaries when continuous variables were categorized	Not appplicable
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Not appplicable
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Not appplicable
Discussion			
Key results	18	Summarise key results with reference to study objectives	12/ line 13-47
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	14/line 51-53 15/ line 3-15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12/ line 12-55 13/ line 3-55 14/ line 6-46
Generalisability	21	Discuss the generalisability (external validity) of the study results	15/ line 20-36
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	15/ line 48-57

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.