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Short report

Incidence and impact of hospital-acquired pneumonia: a Portuguese nationwide four-year study

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SUMMARY

This article presents the incidence of hospital-acquired pneumonia (HAP) in Portugal during a four-year period (2014–2017). Data were retrieved from the 100 Portuguese hospital diagnosis discharge database for adult patients and included gender, age, chronic comorbidities, mortality and hospital length of stay. There were 28,632 episodes of HAP, an incidence of 0.95 per 100 admissions. HAP patients had both a prolonged hospital length of stay (mean 26.4 days) and high mortality (33.6%). Most episodes occurred in patients aged ≥65 years and in males (76.1% and 61.7%, respectively). Invasive ventilation was required in 18.8%.

Introduction

Hospital-acquired infections, especially pneumonia (HAP), remain one of the most important challenges clinicians face in everyday work [1]. Nevertheless, the epidemiology of HAP is uncertain. Epidemiological studies focusing on HAP in non-ventilated patients suggest that the incidence may be twice as high as that of ventilator-associated pneumonia, with similar mortality rate and frequently leading to intensive care unit (ICU) admission [2,3].

There is scarce information regarding both HAP risk and incidence outside the ICU, and epidemiological data regarding HAP global incidence is clearly needed.

This study addressed the incidence of HAP at a national level. Data from four consecutive years (2014–2017) were studied to account for possible seasonal variation. We included all hospitals, both community and university, of the Portuguese

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mainland healthcare system. The aim was to determine the burden of HAP nationally, and to identify the subgroups at higher risk.

Methods

The Central Administration of the Health System of the Portuguese Ministry of Health records administrative and clinical discharge data for all admissions to the 100 (77 general) National Health System hospitals in mainland Portugal. The anonymized database includes all discharge diagnoses of hospital inpatients, either dead or alive, codified according to the International Classification of Diseases, 9th Revision Clinical Modification (ICD-9-CM), until 2016, and the 10th Revision (ICD-10-CM), from 2017 onwards. The ICD-9 and ICD-10 codes used to identify the different pathologies for this study are described in detail in Supplementary Appendix A.

In 2014 a complementary codification approach was introduced in Portugal. All diagnoses were coded according to their presence or absence on admission. Pneumonia not 'present on admission' is, by definition, acquired in the hospital. Consequently, this codification allowed an easier and more accurate identification of HAP episodes.

We retrospectively analysed data from all adult patients discharged between January 1st, 2014, and December 31st, 2017, with HAP, that is a pneumonia 'not present on admission'. Patients aged <18 years or with a hospital length of stay (LOS) of <48 h were excluded. Administrative data were collected, namely age and gender, the presence of chronic comorbidities, acute stroke, type of admission (either medical or for a surgical procedure) or ICU admission, along with outcomes, especially mortality, invasive mechanical ventilation, and hospital LOS.

A descriptive statistical analysis approach was adopted. Rates of HAP per 100 episodes of hospitalization and per 1000 hospital patient-days (with 95% confidence intervals (CIs)), according to age and gender, were computed for the whole population, for each year of the study and for the relevant subgroups.

Continuous variables were expressed as mean ± square deviation and/or median (interquartile range) according to data distribution; the discrete variables were expressed as total number (percentage).

The statistical significance analysis was performed using the χ^2-test (for discrete variables), Student's *t*-test, Mann–Whitney test, or Kolmogorov–Smirnov test (for continuous variables), according to data distribution. Odds ratios (ORs) with 95% CI were computed.

All the calculations presented were obtained using the statistical software package R statistical computing environment (R Core Team 2020, R Foundation for Statistical Computing, Vienna, Austria) and the Microsoft Excel spreadsheet (Microsoft Corp., Redmond, WA, USA).

This study was approved by the Central Administration of the Portuguese National Health System. As all individual patient information was protected and only aggregated data were available, the requirement for patient informed consent was waived.

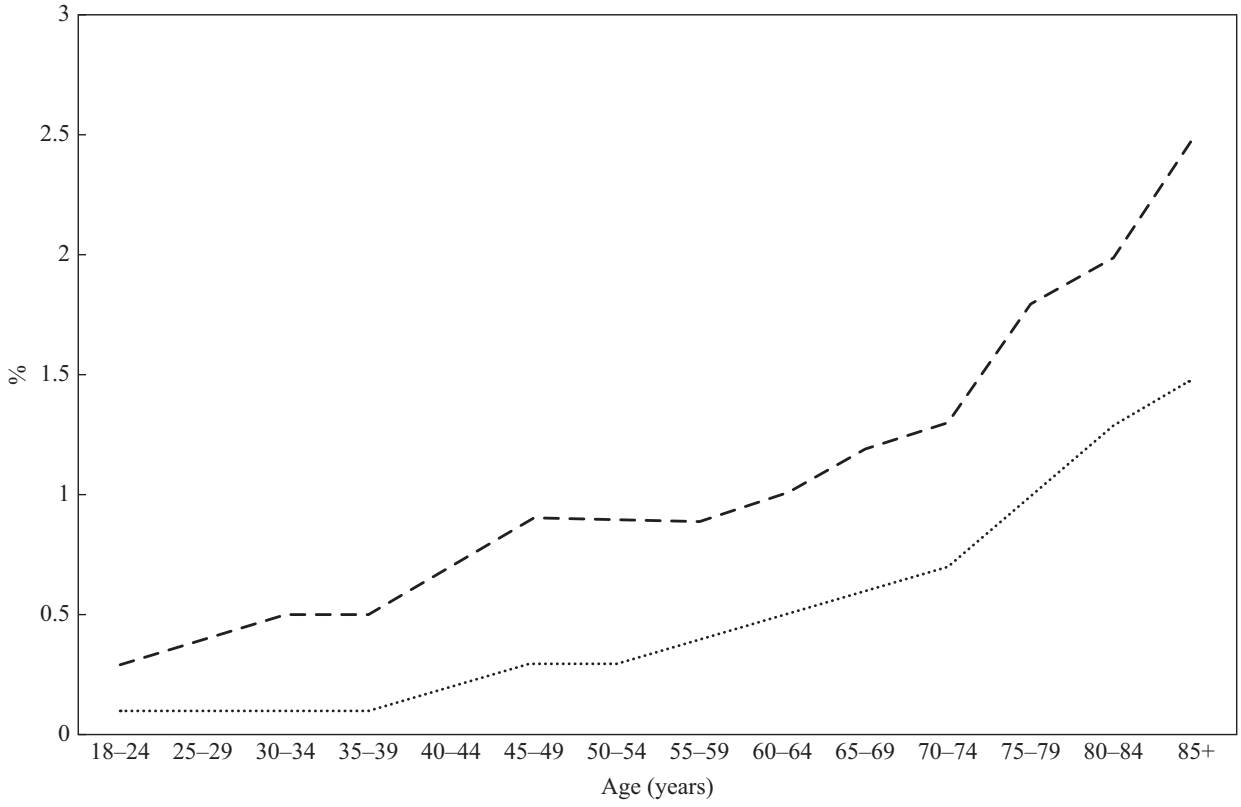

Figure 1. Incidence of hospital-acquired pneumonia for females (dotted line) and males (dashed line). The incidence of hospital-acquired pneumonia increased almost five times with age, mainly after 70 years. The curve trend was similar for both genders, although the incidence was twice as high in males (OR: 2.05; 95% CI: 2.0–2.1; $P < 0.001$).

Results

Hospital-acquired pneumonia incidence

A total of 3,026,233 hospital discharges were evaluated. We identified 28,632 episodes of HAP. The overall incidence was 0.95% and this increased almost five times with age (Figure 1). The incidence of HAP per 1000 hospital-days was 1.13 (1.42 in men and 0.85 in women). Male patients represented only 42.3% of all hospital admissions but accounted for 61.9% of HAP cases (Figure 1).

Overall, HAP was strongly associated with prolonged LOS (mean 26.4 days) and with very high mortality (33.6%), both significantly above the recorded values for general hospitalizations of ≥48 h (mean LOS: 8.4 days; mortality rate 6.7%; $P < 0.0001$). Mortality of patients with HAP also increased with age, attaining 40.1% in patients aged >85 years. Even in patients aged <30 years, mortality was still 12.4%.

The incidence of HAP was higher in patients admitted for a medical reason (1.1% vs 0.69% of surgical admissions, $P < 0.0001$). As many as 5383 (12.5%) of all patients ventilated in mainland Portugal during the study period had HAP, either before or as a complication of invasive mechanical ventilation, unveiling a significant burden of HAP in intensive care medicine. Again, these patients had a high mortality rate (42%) and long hospital LOS (29 (17–44.5)).

Comorbidities and hospital-acquired pneumonia

Mortality was consistently higher in patients with HAP and chronic diseases, especially chronic hepatic disease (44.2%). Moreover, mortality rate increased with the cumulative number of comorbidities, from 29.1% in patients without any diagnosed comorbidity to 40.8% in patients with two or more (mortality OR for ≥1 comorbidity: 1.48; 95% CI: 1.33–1.65).

Acute stroke was strongly associated with HAP (Figure 2). The overall stroke prevalence in HAP patients was 14.3% (with no significant gender difference), well above the reported 3.24% stroke prevalence for the general hospitalizations ≥48 h. This association increased with age, roughly 1% per each five years, being 17.3% in patients aged >85 years, whereas only 6% of all hospitalizations in the same age group had a diagnosis of stroke. Stroke patients (either ischaemic or haemorrhagic) who developed HAP during their hospital stay had a much higher risk of death (OR: 4.84; 95% CI: 4.53–5.16).

Discussion

The incidence of HAP in mainland Portugal during a consecutive four-year period, from 2014 to 2017, was 0.95%, which corresponded to 1.13 episodes per 1000 hospital-days. Patients aged ≥65 years and male gender were significantly more prone to HAP, especially patients with an acute stroke. Hospital

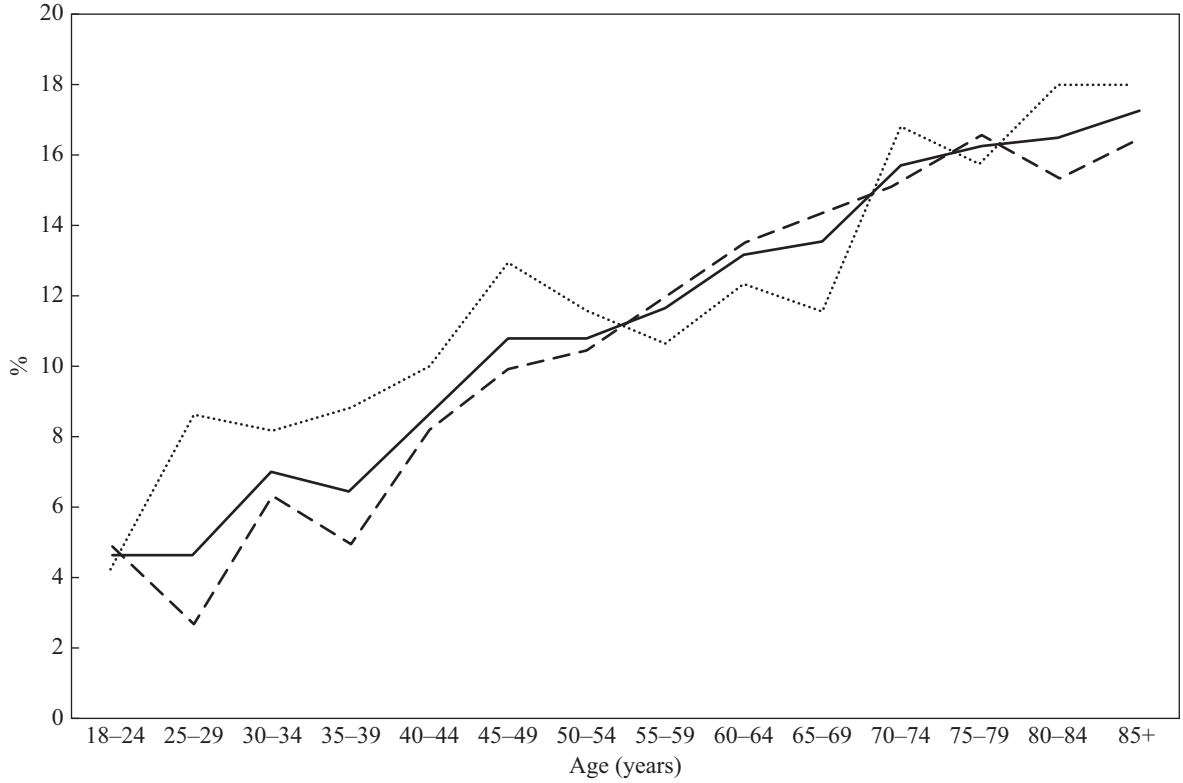

Figure 2. Association of acute stroke and hospital-acquired pneumonia for females (dotted line) and males (dashed line). A close association between age and the presence of stroke in patients with hospital-acquired pneumonia was noted. The incidence of hospital-acquired pneumonia in all patients with stroke increased roughly 1.05% per every five years of age ($P < 0.001$ for comparisons between two time-points).

mortality was very high, at 33.6% overall, and increased sharply with age. Even patients without significant comorbidities had a mortality rate of roughly 30%, suggesting that attributable mortality may be substantial. Hospital LOS was very long (26.4 days), roughly three times higher than that of the general population. Invasive mechanical ventilation was provided to 18.8% of these patients.

An important limitation of retrospective studies addressing HAP is the reliance on clinical diagnoses, especially as two-thirds of HAP may be acquired outside of the ICU, where classic signs of pneumonia may be missing in as many as half of the patients [4—6]. Automatic detection of HAP patients, based on oxygenation fall and antibiotic use, has recently been proposed and may facilitate identification [7].

As a consequence, the reported incidence of HAP seems to be mostly related to the definitions used to identify the cases and the included population. In a recently published European point prevalence study an overall incidence of 1.3% was noted and a Portuguese HAP incidence of 2.7% was reported, much higher than we found in our study [3]. Hospital selection bias and a possible seasonal variation may help to explain these differences.

A large study from the USA, including more than six million patients, reported an HAP incidence of 1.6%, corresponding to 3.63 per 1000 hospital-days, again higher than our rates [8]. In that study, HAP was defined as a discharge secondary diagnosis of pneumonia, whereas we only included patients with pneumonia considered to be 'not present on admission' [8]. By contrast, a study done in 24 hospitals, using an HAP definition identical to ours, reported an incidence of 0.12—2.28 per 1000 hospital-days, very similar to that in our study [4]. In the same study, LOS was also very long and 37.3% of HAP patients stayed in the hospital for >20 days [4].

The impact of HAP on outcome also seems to extend to the ICU. In a large cohort of ICU patients, the incidence of HAP was 5% in ventilated patients and 2% in non-ventilated patients. The 30-day mortality was significantly increased in both groups (adjusted hazard ratio: 1.38 (1.24—1.52) in ventilated and 1.82 (1.35—2.45) in non-ventilated) [9].

In the current study, age was the most important predictor of HAP and >75% of HAP occurred in patients aged >65 years, revealing an association between this pathology, senescence, and frailty. Along with age, acute stroke may cause swallowing dysfunction and facilitate aspiration, both as a result of direct neurologic insult or as a consequence of oropharyngeal muscle weakness [10]. In our study, an interaction of age and acute stroke on the incidence of HAP was disclosed (Figure 2).

This study has some limitations. It relates only to Portuguese hospitals, it relies on a discharge diagnosis codification system, it is retrospective, and limitations of the database do not allow segregation of ventilator-associated HAP. Furthermore, the anonymized nature of the database did not allow us to perform discharge diagnosis audits to further validate the data. It also has several strengths. To our knowledge, it is the first HAP incidence study done at a national level, including both large and small community as well as teaching hospitals. In addition, it includes data from four complete consecutive years, accounting for a potential seasonal variation. A large database (including more than three million hospital admissions) was evaluated, which strengthens our conclusions.

In conclusion, HAP is common in hospital wards as well as in the ICU, and its incidence increased with age, male gender, and stroke. It is associated with significant mortality, hospital LOS, and healthcare resource utilization. The strong association with stroke deserves further study.

Conflict of interest statement

Dr Gonçalves-Pereira reports grants from Merck Sharp & Dohme (MSD), during the conduct of the study; grants and personal fees from MSD and Angelini Pharmaceuticals, personal fees from Pfizer Pharmaceuticals, Atral Pharmaceuticals, and bioMérieux outside of the submitted work. Dr Mergulhão reports personal fees and non-financial support from MSD, grants and personal fees from Pfizer, personal fees from bioMérieux and Accelerate diagnostics, outside the submitted work; and is currently heading the Portuguese Infection and Sepsis Group (Grupo de Infecção e Sepsis: http://www.gis.pt). The group has received financial support during the past 36 months from the following: MSD, Pfizer, Astellas, bioMérieux, Accelerate disgnostics, Maquet, Baxter, Gilead. Dr Nunes has nothing to disclose. Dr Froes reports personal fees and non-financial support from MSD, Pfizer, Novartis, Gilead, Sanofi, Novartis, Bial, and Astrazeneca outside the submitted work.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jhin.2021.03.012.

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