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Original Article

Postoperative pneumonia among patients with and without COPD in Spain from 2001 to 2015

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ABSTRACT

Background: To describe and compare incidence, characteristics and outcomes of postoperative pneumonia among patients with or without COPD.
Methods: We included hospitalized patients aged ≥40 years whose medical diagnosis included pneumonia and ventilator-associated pneumonia in the secondary's diagnosis field and who were discharged from Spanish hospitals from 2001 to 2015. Irrespectively of the position at the procedures coding list, we retrieved data about the type of surgical procedures using the enhanced ICD-9-CM codes. We grouped admissions by COPD status. The data were collected from the National Hospital Discharge Database.
Results: We included 117,665 hospitalizations of patients that developed postoperative pneumonia (18.06% of them had COPD). The incidence of postoperative pneumonia was significantly higher in COPD patients than in those without COPD (IRR 1.93, 95%CI 1.68–2.24). In hospital-mortality (IHM) was significantly lower in the first group of patients (29.79% vs 31.43%, $p < 0.05$). Factors independently associated with IHM, among COPD and non-COPD patients, were older age, more comorbidities, mechanical ventilation, pleural drainage tube, red blood cell transfusion, dialysis and emergency room admission. Time trend analysis showed a significant decrease in IHM from 2001 to 2015. COPD was associated with lower IHM (OR 0.91, 95%CI 0.88–0.95).
Conclusions: The incidence of postoperative pneumonia was higher in COPD patients than in those without this disease. However, IHM was lower among COPD patients. IHM decreased over time, regardless of the existence or not of COPD.

1. Background

Chronic obstructive pulmonary disease (COPD) is a common condition and one of the leading causes of disability and mortality in the world [1]. It is characterized by persistent and progressive airflow limitation and is often associated with a smoking history [2]. COPD prevalence increases with age and it is growing, both globally and regionally [3]. Many of these patients will require invasive procedures and surgical treatment throughout his life and may experience pulmonary complications [4,5].

Postoperative pulmonary complications are common after major surgery [6]. They may increase length of hospital stay, intensive care units care, mortality, hospital readmissions and medical cost [7–9]. Specifically, postoperative pneumonia is the third most common complication for all surgical procedures and it is also associated with increased patient morbidity and mortality [10]. Among the possible mechanisms for developing pneumonia after surgery are the pain, that can impair the coughing function and secretions clearance, which would reduce respiratory effort and lead to develop atelectasis and subsequent pneumonia [11], the older age, that can be associated with inadequate physiological reserves poor functional residual capacity [12], and the pre-existing comorbidities, such as diabetes, congestive heart failure, ischemic heart disease, cirrhosis and COPD [11,12].

COPD patients have been found with higher rates of complications

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after surgery than the general population [13–16], probably because of impairment of gas exchange and mucociliary clearance of aspirated bacteria [17]. Furthermore, previous studies have shown that postoperative pulmonary complications and the postoperative mortality rate increased in these patients following general and thoracic surgery [18–20]. However, information on the relationship between COPD and postoperative pneumonia is limited, despite the immune system of these patients may be weakened due to airway inflammation, obstruction, destruction of epithelium and loss of defensive abilities [21].

In this study, we used national hospital discharge data to describe and compare incidence, characteristics and outcomes of postoperative pneumonia among patients with or without COPD in Spain from 2001 to 2015. In particular, we analyzed patient comorbidities, diagnostic and therapeutic procedures, pneumonia pathogens and in-hospital mortality (IHM).

2. Methods

A retrospective observational study using the Spanish National Hospital Discharge Database (CMBD, *Conjunto Mínimo Básico Datos*) was conducted. This administrative database compiles all public and private hospital data, covering > 98% of hospital admissions [22]. The CMBD includes patient variables (sex, date of birth), admission and discharge dates, up to 14 discharge diagnoses, and up to 20 procedures performed during the hospital stay, by using the International Classification of Diseases-Ninth Revision, Clinical Modification (ICD-9-MC) [22].

We included only subjects aged 40 years or over because according to the Global Initiative for Chronic Obstructive Lung Disease (GOLD), the prevalence of COPD is appreciable higher in adults aged 40 years or older compared to those below 40 [23]. Furthermore this cut point has also been used in studies conducted by other authors [24,25]. We selected those patients whose medical diagnosis included pneumonia and ventilator-associated pneumonia (ICD-9-CM codes: 480.xx-488.xx, 507.xx, 997.31) in the secondary's diagnosis field and who were discharged between January 1, 2001 and December 31, 2015.

In our investigation, we did not differentiate VAP within postoperative pneumonia because unfortunately the code for VAP was introduced in the CMBD in 2010 [26].

We excluded patients with a primary diagnosis of pneumonia (codes: 480.xx-488.xx, 507.xx, 997.31), sepsis (codes: 995.91, 995.92, 0.38), meningitis (codes:322.xx), empyema (codes: 510.0, 510.9) and bacteremia (codes: 790.7). The exclusion of sepsis, meningitis, empyema and bacteremia has been recommended by Guevara et al. because these codes in primary position, with pneumonia as a secondary diagnosis, may represent a community acquired pneumonia [27].

We grouped admissions by COPD status as follows: COPD (ICD-9-CM codes: 490, 491, 491.0, 491.1, 491.2×, 491.8, 491.9, 492, 492.0, 492.8, 496) or no-COPD in any diagnostic position. Clinical characteristics included information on overall comorbidity at the time of discharge, which was assessed by calculating the Charlson comorbidity index (CCI) [28]. Logically the calculation of the CCI was done excluding COPD as a disease.

Irrespectively of the position at the procedures coding list, we retrieved data about the type of surgical procedures using the enhanced ICD-9-CM codes. The following categories were created: operations on the nervous system (codes: 01–05), operations on the respiratory system (codes: 30–34), operations on the cardiovascular system (codes: 35–39), operations on the digestive system (codes: 42–54), operations on the urinary system/male and female genital organs/obstetrical procedures (codes: 55–59; 60–64; 65–71, 72–75), operations on the musculoskeletal system/integumentary system (codes: 76–84; 85–89) and miscellaneous surgical procedures (codes: 06–07; 08–16; 17–20; 21–29; 40–41; 87–99).

Also, we specifically identified the following procedures: non-invasive mechanical ventilation (code 93.90), invasive mechanical ventilation (codes: 96.7, 96.70, 96.71, 96.72), thoracentesis (ICD-9 code 34.91), pleural drainage tube (ICD-9 codes 34.0, 34.01–34.09), bronchoscopy (ICD-9-CM code 33.21–33.24), red cell transfusion (ICD-9 codes 99.00, 99.01–99.08), dialysis (ICD-9 codes 39.95, 54.98), tracheostomy (ICD-9 code 31.1) and pressure ulcers (707.xx).

We analyzed pneumonia pathogens documented during hospitalizations for postoperative pneumonia using the following ICD-9-CM codes: 481 for *Streptococcus pneumoniae*, 482.0 for *Klebsiella pneumoniae*, 482.2 for *Haemophilus influenza*, 482.1 for *Pseudomonas aeruginosa*, 482.3× for non specificied *Streptococcus*, 482.41 and 482.42 for *Staphylococcus aureus*, 482.82 for *Escherichia coli*, 482.83 for other Gram negative bacteria, and 117.3 for *Aspergillus*. We also identified blood culture (codes: 90.5×) and respiratory culture (codes: 90.4×).

We estimated the proportion of admissions at the emergency room (ER), length of hospital stay (LOHS) and the IHM defined by the proportion of patients who died during admission for each year of study.

2.1. Statistical analysis

We have considered three study periods that included five consecutive years each (2001–05; 2006–10; 2011–15).

Incidence rates of admissions for postoperative pneumonia in patients with COPD and non-COPD patients were calculated per 100,000 admissions of patients who underwent a surgical procedure. We used Poisson regression models adjusted by sex and age to assess time trend.

A descriptive statistical analysis was performed for all continuous and categorical variables stratified according to COPD status. Variables are expressed as proportions or as means with standard deviations. A bivariate comparison of variables between those with and without COPD was performed using the χ^2 test (proportions) Kruskal–Wallis test and T student or ANOVA (means) as appropriate. These same tests were used to compare characteristics of those who died and survived to the hospitalization according to COPD status.

To assess changes over time in categorical variables we used logistic regression models adjusted by age and sex when appropriate.

Lastly, we performed logistic regression analyses with IHM as a binary outcome using the independent variables and age, sex, CCI, diagnostic and therapeutic procedures and pathogens for those with and without COPD and for the entire population to assess the influence of COPD variables on IHM. The variables included in the models were those with significant results in the bivariate analysis and those considered relevant in other investigations.

We conducted two sensitivity analyses. First, we compared those patients with VAP, for the period 2011–2015, with those suffering any postoperative pneumonia that same period. Secondly, we provide the major findings on operations performed on the respiratory system compared with those operations conducted in other systems.

Estimates were Odds Ratios (OR) with their 95% confidence intervals. Statistical analyses were performed using Stata version 10.1 (Stata, College Station, Texas, USA). Statistical significance was set at $p < 0.05$ (2-tailed).

2.2. Ethical aspects

Data confidentiality was maintained at all times in accordance with Spanish legislation. Given the anonymous and mandatory nature of the dataset, it was not deemed necessary to obtain informed consent or the approval by an Ethics Committee.

3. Results

In our study, we identified 117,665 hospitalizations of patients aged 40 years or more that developed postoperative pneumonia in Spain (2001–2015). Patients with COPD accounted for 18.06% of total (21,255).

Table 1 shows the incidence and the clinical characteristic,