Risk factors and bacterial spectrum for pneumonia after abdominal surgery in elderly Chinese patients

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A B S T R A C T

Postoperative pneumonia is a common complication of abdominal surgery in the elderly. The aim of this study was to determine risk factors and bacterial spectrum for pneumonia after abdominal surgery in elderly Chinese patients. We performed a case–control study in a total of 5431 patients aged 65 years and over who had undergone abdominal surgery at the 2nd affiliated hospital of Kunming medical college between June 2003 and June 2011. Postoperative pneumonia developed in 86 patients (1.58%). Gram-negative bacilli were the principal microorganisms (82.86%) isolated from patients. The most common organisms isolated were *Klebsiella* spp. (28.57%), *Acinetobacter* spp. (17.14%) and *Pseudomonas aeruginosa* (17.14%). Multivariate analysis confirmed the following to be independent risk factors for postoperative pneumonia in the elderly after abdominal surgery: age ≥ 70 (OR 1.93, 95% CI 1.16–3.22, $p = 0.01$), upper abdominal surgery (OR 2.07, 95% CI 1.18–3.64, $p = 0.01$) and duration of operation >3 h (OR 2.48, 95% CI 1.49–4.15, $p = 0.00$). Identifying these risk factors may help achieve better prevention and treatment for postoperative pneumonia in elderly patients after abdominal surgery.

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1. Introduction

As the population continues to age, a growing proportion of elderly patients are presenting for surgery. The elderly show an increased morbidity and mortality after surgery compared to younger adults (Turrentine, Wang, Simpson, & Jones, 2006); thus intense attention is required to prevent complications in the elderly after surgery. A previous study by the National Surgical Quality Improvement Program (NSQIP, US) revealed that among various postoperative complications, pulmonary complications were the most costly and required the longest mean hospital stay (Dimick et al., 2004). For these reasons, it's clearly worthwhile to identify the elderly patients at risk for postoperative pulmonary complications, aiming at improving prognosis as well as controlling hospital costs. Postoperative pneumonia is one of the most morbid pulmonary complications after surgery, especially in elderly patients (Iwamoto, Ichiyama, Shimokata, & Nakashima, 1993). Smetana et al. reported that abdominal surgery was a risk factor for the development of postoperative pneumonia, while other contributing factors included advanced age, poor health, congestive heart failure, functional dependency etc. (Smetana, 2009).

A previous study of 2969 patients including 45 postoperative pneumonia cases revealed that blood loss >1200 ml during surgery, age >65 and preoperative utilization of inhalation therapy devices were significantly correlated to the development of postoperative pneumonia in patients after abdominal surgery (Fujita & Sakurai, 1995). Another prospective cohort study involving 266 adults demonstrated that age >50 years, body mass index (BMI) <21 kg/m^2 or ≥ 30 kg/m^2, and upper or upper/lower abdominal incision were independent risk factors for postoperative pulmonary complications including pneumonia in patients who underwent emergency abdominal surgery (Serejo et al., 2007). Although the risk factors for postoperative pneumonia have been intensively studied, data concerning the elderly patients are still lacking.

The present study described the characteristics of pneumonia after abdominal surgery in the elderly as well as the bacterial spectrum. Through univariate and multivariate analysis, we evaluated 20 potential risk factors for postoperative pneumonia, aiming at better prevention and treatment for this surgery-related complication in the elderly.

2. Patients and methods

We screened 5431 patients aged 65 years and older who had undergone elective abdominal surgery at the 2nd affiliated hospital of Kunming medical college between June 2003 and June

2011, of which 86 patients developed postoperative pneumonia. The study was approved by the 2nd Affiliated Hospital Ethics Committee of Kunming Medical College. Pneumonia was defined as the presence of a new infiltrate on the chest radiography plus at least one of the following: fever (temperature $\geq 38.0\,^{\circ}$C) or hypothermia (temperature $< 35.0\,^{\circ}$C), new cough with or without sputum production, pleuritic chest pain, dyspnea or altered breath sounds on auscultation (Carratala et al., 2005). Postoperative pneumonia was defined as pneumonia diagnosed before discharge from hospital or in the first 30 days post operation if the patient had been discharged already. Patients who were ventilator dependent before surgery or had preoperative pneumonia were excluded. The microbiological data comprised cultures of the respiratory tract (sputum, tracheal or bronchial aspirate) and blood cultures. Sputum was obtained either by spontaneous expectoration or by the aid of nebulized saline. The VITEK® bacterial identification instrument (BioMerieux, French) was used for bacterial identification.

For risk factor analysis, we identified all consecutive cases (86 cases) with postoperative pneumonia as the case group, and randomly selected 258 patients (3 fold of the case group) from the remaining who did not develop pneumonia as the control group. Potential risk factors were selected based on literature, the authors' clinical experience, and data availability. 20 variables were involved in the present study, of which 13 were associated with basic pre-surgery conditions of the patients: age ≥ 70, gender, BMI, cigarette use, alcohol use, chronic obstructive pulmonary disease (COPD), systemic arterial hypertension, diabetes mellitus, chronic heart disorders, blood urea nitrogen (BUN), serum albumin level, abnormal chest examination, and American Society of Anesthesiologists (ASA) classification of more than 3; 7 were associated with surgery and postoperative conditions: general anesthesia, upper abdominal surgery, duration of operation > 3 h, bleeding amount > 500 ml during surgery, admission to intensive care unit (ICU), nasogastric decompression, and mobilization after 48 h. Cigarette use was defined as smoking more than 10 years; alcohol use was defined as drinking more than 5 years with each day more than 40 g. Abnormal chest examination referred to any abnormality detected on a chest X-ray. Nasogastric decompression referred to the use of nasogastric tubes after surgery until gastrointestinal motility returned. Mobilization after 48 h was defined as no assisted ambulation within 48 h post surgery. All information was collected by reviewing the charts, laboratory data, and radiologic reports.

SPSS version 12.0 was used for the statistical analysis. Data were expressed as mean $\pm$ standard deviation (SD) and percentages. Group comparisons for categorical variables were made using Pearson's χ^2-test. For quantitative variables, Student's t-test was used because those data were normally distributed. A $p < 0.05$ was deemed to indicate statistical significance. Univariate and multivariate logistic regression analyses were performed to identify variables associated with postoperative pneumonia. For multivariate analyses, we used a conditional stepwise forward model, by which variables that are highly correlated were excluded.

3. Results

5431 patients aged 65 years or older who underwent elective abdominal surgery in our hospital were included in the present study. Among those patients, preoperative diagnoses were liver and gall bladder pathology (46.32%), colorectal disease (15.19%), hernia (12.13%), stomach disease (8.95%), pancreas disease (3.42%), spleen disease (2.95%) and other disease (11.04%). Postoperative pneumonia developed in 86 out of the 5431 patients (1.58%). 7 of those pneumonia cases died (mortality rate 8.14%). Postoperative pneumonia appeared at 5.03 ± 3.11 days after surgery.

Table 1
Bacterial spectrum for postoperative pneumonia.

Pathogen	Number (%)
Klebsiella spp.	10 (28.57%)
Acinetobacter spp.	6 (17.14%)
Pseudomonas aeruginosa	6 (17.14%)
Escherichia coli	4 (11.43%)
Staphylococcus aureus	3 (8.58%)
Enterobacter cloacae	2 (5.71%)
Staphylococcus epidermidis	2 (5.71%)
Streptococcus pneumoniae	1 (2.86%)
Proteus spp.	1 (2.86%)

In order to identify the bacterial spectrum, we reviewed the blood and respiratory culture reports for all patients that developed postoperative pneumonia. Altogether, 35 bacteria were isolated from 27 patients out of the 86 pneumonia cases (31.40%): 20 patients (23.26%) had a single pathogen and other 7 (8.14%) had two or three pathogens. The majority of isolated bacteria were Gram-negative bacteria (82.86%), among which the most common ones were *Klebsiella* spp. (28.57%), *Acinetobacter* spp. (17.14%) and *Pseudomonas aeruginosa* (17.14%). The Gram-positive bacteria isolated included *Staphylococcus aureus*, *Staphylococcus epidermidis* and *Streptococcus pneumoniae* (Table 1).

To determine risk factors for postoperative pneumonia, all 20 variables were compared between the case group and the control group using Pearson's χ^2-test or Student's t-test. Of the 20 variables, the following 7 exhibited statistically significant difference ($p < 0.05$) between the 2 groups: age ≥ 70, COPD, ASA classification of more than 3 (Table 2), upper abdominal surgery, duration of operation > 3 h, admission to ICU, and mobilization after 48 h (Table 3). Univariate analysis identified all those 7 variables to be related to an increased risk of postoperative pneumonia: age ≥ 70 (OR = 1.68; $p = 0.01$), COPD (OR = 2.30; $p = 0.04$), ASA ≥ 3 (OR = 2.90; $p = 0.03$), upper abdominal surgery

Table 2
Characteristics of the study population.

	Pneumonia group ($n = 86$)	Non-pneumonia group ($n = 258$)	p value
Age ≥ 70	45 (52%)	41 (16%)	0.04
Gender (male/female)	50/36	147/111	0.90
BMI (kg/m²)	24.22 ± 3.29	23.83 ± 3.19	0.17
Cigarette use	28 (33%)	75 (29%)	0.59
Alcohol use	17 (20%)	66 (26%)	0.31
COPD 12	(14%)	17 (7%)	0.04
Systemic arterial hypertension	30 (35%)	102 (40%)	0.52
Diabetes mellitus	5 (6%)	19 (7%)	0.81
Chronic heart disorders	6 (7%)	10 (4%)	0.24
BUN (mg/dl)	16.40 ± 5.31	16.15 ± 4.99	0.68
Serum albumin level (g/dl)	4.22 ± 0.53	4.28 ± 0.50	0.31
Abnormal chest examination	32 (37%)	87 (34%)	0.60
ASA ≥ 3	10 (12%)	13 (5%)	0.04

Table 3
Characteristics of the surgery and postoperative period.

	Pneumonia group ($n = 86$)	Non-pneumonia group ($n = 258$)	p value
General anesthesia	83 (97%)	247 (96%)	1.0
Upper abdominal surgery	63 (73%)	157 (61%)	0.03
Duration of operation > 3 h	46 (53%)	89 (34%)	0.00
Bleeding amount > 500 ml	9 (10%)	20 (8%)	0.50
Admission to ICU	28 (33%)	55 (21%)	0.04
Nasogastric Decompression	57 (66%)	166 (64%)	0.80
Mobilization after 48 h	36 (42%)	77 (30%)	0.04