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Original Article

Comprehensive analysis of prognostic factors in hospitalized patients with pneumonia occurring outside hospital: Serum albumin is not less important than pneumonia severity assessment scale☆

Hiroyuki Miyazaki [a], Nobuhiko Nagata [a, *], Takanori Akagi [a], Satoshi Takeda [a], Taishi Harada [a], Shinichiro Ushijima [a], Takashi Aoyama [a], Yuji Yoshida [a], Hiroshi Yatsugi [a], Masaki Fujita [b], Kentaro Watanabe [b]

[a] Department of Respiratory Medicine, Fukuoka University Chikushi Hospital, Japan
[b] Department of Respiratory Medicine, Faculty of Medicine, Fukuoka University, Japan

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ABSTRACT

Purpose: This study aimed to elucidate factors related to 30-day mortality of pneumonia occurring outside hospital by comprehensively analyzing data considered relevant to prognosis.
Methods: Data considered relevant to prognosis were retrospectively examined from clinical charts and chest X-ray images of all patients with pneumonia occurring outside hospital admitted to our hospital from 2010 to 2016. The primary outcome was 30-day mortality.
Results: Data were collected from 534 patients (317 community-acquired pneumonia and 217 nursing- and healthcare associated pneumonia patients; 338 men (63.3%); mean age, 76.2 years-old). Eighty-three patients (9.9%) died from pneumonia within 30 days from the date of admission. The numbers of patients with pneumonia severity index (PSI) classes of I/II/III/IV/V and age, dehydration, respiratory failure, orientation disturbance, pressure (A-DROP) scores of 0/1/2/3/4/5 were 29/66/127/229/83, and 71/107/187/132/30/7, respectively. Mean (standard deviation) body mass index (BMI), serum albumin, blood procalcitonin, white blood cell and C-reactive protein were 20.00 (4.12) kg/m^2, 3.16 (0.60) g/dL, 3.69 (13.15) ng/mL, 11559.4 (5656.9)/mm^3, and 10.92 (8.75) mg/dL, respectively. Chest X-ray images from 152 patients exhibited a pneumonia shadow over a quarter of total lung field. Logistic regression analysis revealed that PSI class or A-DROP score, BMI, serum albumin, and extent of pneumonia shadow were related to 30-day mortality. Receiver operating characteristics curve analysis revealed that serum albumin was superior to PSI class or A-DROP score for predicting 30-day mortality.
Conclusion: Serum albumin is not less important than PSI class or A-DROP score for predicting 30-day mortality in hospitalized patients with pneumonia occurring outside hospital.

1. Introduction

Community-acquired pneumonia (CAP) is a prominent cause of morbidity and mortality throughout the world [1]. Until now, many investigators have reported various prognostic factors of pneumonia occurring outside hospital, such as pneumonia severity index (PSI) [2–6], age, dehydration, respiratory failure, orientation disturbance, pressure (A-DROP) scoring system [7,8], procalcitonin (PCT) [9–12], albumin [13–16], body mass index (BMI) [13,17], healthcare-associated pneumonia (HCAP) [18,19] or nursing- and healthcare-associated pneumonia (NHCAP) [20,21], aspiration [22], or extent of pneumonia shadow [15]. Of these, recent studies of prognostic factors seem to focus their attention on the severity assessment scale such as PSI or A-DROP, or biomarker such as PCT. However, some investigators have still emphasized the prognostic importance of albumin, though they did not directly compare the prognostic significance of albumin with that of PSI or PCT [14–16]. Few studies have comprehensively examined the prognostic importance of these parameters in patients with pneumonia

☆ All authors meet the ICMJE authorship criteria.
* Corresponding author. Department of Respiratory Medicine, Fukuoka University Chikushi Hospital, 1-1-1 Zokumyoin, Chikushino-city, Fukuoka 818-8502, Japan.
E-mail address: nbnagata@fukuoka-u.ac.jp (N. Nagata).

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occurring outside hospital. Therefore, it is our question which parameter best predicts the prognosis of pneumonia occurring outside hospital among those previously reported to influence the prognosis of pneumonia, especially albumin, PSI or A-DROP, PCT, NHCAP, or extent of pneumonia shadow.

The present study was undertaken to elucidate prognostic factors of pneumonia occurring outside hospital by comprehensively analyzing factors previously reported to influence the prognosis of pneumonia.

2. Patients and methods

Clinical charts and chest X-ray images of all consecutive patients admitted to our hospital from October 2010 to September 2016 with primary diagnoses of CAP and NHCAP were retrospectively reviewed. Cases that fulfilled the following criteria of pneumonia were enrolled in the study: (1) onset of illness occurring outside the hospital, (2) an acute illness and symptoms including new cough with or without sputum, fever or chills, pleuritic chest pain, or dyspnea, and (3) a chest X-ray showing an opacity compatible with the presence of acute pneumonia. Validity of the pneumonia diagnosis was confirmed by two respiratory physicians. NHCAP included any patients who (1) were hospitalized in an acute care hospital for two or more days within the past 90 days, (2) resided in a nursing home or long-term care facility, (3) were elderly or handicapped persons who needed daily healthcare, or (4) continuously visited a hospital or hemodialysis clinic for intravenous antibiotic therapy, chemotherapy, or hemodialysis [20]. Exclusion criteria were the presence of pulmonary edema, massive pleural fluid, or other non-pneumonia conditions that would interfere with the assessment of the extent of pneumonia. Data on admission considered related to prognosis were examined, including age, sex, category of pneumonia occurring outside the hospital (CAP or NHCAP), aspiration pneumonia or the lack thereof, PSI class, A-DROP score, comorbidities, body mass index (BMI), serum albumin levels, white blood cell (WBC) counts, C-reactive protein (CRP) and PCT levels, and chest X-ray extent of pneumonia shadow. We also examined the serial data of serum albumin and blood PCT levels, and obtained the lowest albumin and highest PCT levels within a first week after admission in available cases. The microbiologic examinations included sputum samples for Gram stain and culture, two blood samples for culture, urine samples for detection of *Streptococcus pneumoniae* and *Legionella pneumophila* antigens, and serum samples for serologic testing against IgM antibodies for *Mycoplasma pneumoniae* and *Chlamydophila pneumoniae*. As for sputum examination, predominantly grown bacteria detected in the qualified sputum were considered to be causative pathogens.

The chest X-ray extent of the pneumonia shadow was examined by dividing each lung field on plain chest X-ray into upper and lower zones. Each zone encompassed half of the craniocaudal distance of the lung on frontal radiographs, and the number of zones with the lesions was counted [23].

The initial antibiotic treatment was chosen based on guidelines set forth by the Japan Respiratory Society. The primary outcome was death within 30 days from the date of admission. We analyzed factors related to 30-day mortality using logistic regression and receiver operating characteristic (ROC) curve analyses. The difference in mortality between two groups was analyzed with the Mann-Whitney *U* test (Excel Tokei 2015, Social Survey Research Information, Co., Ltd., Tokyo, Japan). $P < 0.05$ was considered statistically significant. This study was performed in accordance with the Declaration of Helsinki. This human study was approved by Fukuoka University-Medical Ethics Review Board - approval: R16-059. The review board exempted the acquisition of informed consent from patients included in the study.

3. Results

3.1. Study population

We identified 566 patients with a primary diagnosis of pneumonia during the study period. Of these, 12 patients with hospital-acquired pneumonia were excluded. We also excluded 20 patients with pulmonary edema, massive pleural fluid, or other non-pneumonia conditions that would interfere with the assessment of the extent of pneumonia. The final study population comprised 534 patients. Serial data of serum albumin and blood PCT levels were available in 492 and 329 patients, respectively. Clinical features of these patients are summarized in Table 1. The study population consisted of 534 patients (317 CAP and 217 NHCAP patients; 338 men (63.3%); mean age, 76.2 years-old). Eighty-four patients (15.7%) were considered to have aspiration pneumonia; 134 patients (25.1%) were administered antibiotics before admission; and 53 patients (9.9%) died from pneumonia within 30 days from the date of admission. Numbers (percentage) of patients with PSI classes of I/II/III/IV/V and A-DROP scores of 0/1/2/3/4/5 were 29 (5.4%)/66 (12.4%)/127 (23.8%)/229 (42.9%)/83 (15.5%), and 71 (13.3%)/107 (20.1%)/187 (35.0%)/132 (24.7%)/30 (5.6%)/7 (1.3%), respectively. Mean (standard deviation) BMI, albumin, lowest albumin levels within a first week after admission, blood PCT, highest PCT levels within a first week after admission, WBC, and CRP were 20.00 (4.12) kg/m^2, 3.16 (0.60) g/dL, 2.58 (0.53) g/dL, 3.69 (13.15) ng/mL, 5.17 (15.12) ng/mL, 11559.4 (5656.9)/mm^3, and 10.92 (8.75) mg/dL, respectively. Numbers (percentage) of patients with an extent of pneumonia shadow of 1, 2, 3, and 4 were 382 (71.5%), 120 (22.5%), 28 (5.3%), and 4 (0.7%), respectively. With regard to comorbidities, 140 patients presented with chronic lung disease, 103 with diabetes mellitus, 98 with dementia, 54 with cerebrovascular disease, 49 with chronic heart failure, 24 with kidney disease, 20 with malignancy, and 12 with liver disease. We identified 296 causative pathogens, as follows: *Streptococcus pneumoniae* was the leading pathogen (n = 101), followed by *Haemophilus influenzae* (n = 31), *Mycoplasma pneumoniae* (n = 27), *Chlamydophila pneumoniae* (n = 24), *Klebsiella pneumoniae* (n = 20), *Escherichia coli* (n = 19), *Pseudomonas aeruginosa* (n = 18), *Moraxella catarrhalis* (n = 14), and *Methicillin-resistant Staphylococcus aureus* (n = 11).

3.2. Factors related to 30-day mortality

Univariate analysis revealed the following variables to be significantly associated with 30-day mortality: age (odds ratio (OR): 1.0454, 95% confidence interval (CI): 1.0167−1.0749, $p = 0.0018$), PSI class (OR: 3.1187, 95%CI: 2.0724−4.6933, $p < 0.001$), A-DROP score (OR: 2.4518, 95%CI: 1.8256−3.2927), category of pneumonia (OR: 2.2348, 95%CI: 1.2558−3.9771, $p = 0.0062$), BMI (OR: 0.7696, 95%CI: 0.6953−0.8518, $p < 0.001$), albumin (OR: 0.1370, 95%CI: 0.0769−0.2442, $p < 0.001$), lowest albumin levels within a first week after admission (OR: 0.0641, 95%CI: 0.0295−0.1396, $p < 0.001$), PCT (OR: 1.0275, 95%CI: 1.0112−1.0440, $p < 0.001$), highest PCT levels within a first week after admission (OR: 1.0212, 95%CI: 1.0049−1.0378, $p = 0.0108$), CRP (OR: 1.0386, 95%CI: 1.0087−1.0694; $p = 0.0111$), extent of pneumonia shadow (OR: 4.8238, 95%CI: 3.2060−7.2580, $p < 0.001$), malignant disease (OR: 4.2584, 95%CI: 1.5630−11.6020, $p = 0.0046$), dementia (OR: 2.3320, OR: 1.2491−4.3535, $p = 0.0079$), and liver disease (OR: 4.8265, 95%CI: 1.4027−16.6078, $p = 0.0125$) (Table 2). Age and/or malignant and liver diseases were excluded from the multivariate analysis, because these factors are included in PSI or A-DROP as clinical parameters. Multivariate analysis revealed that PSI class (OR: 1.7574, 95%CI: 1.0806−2.8581, $p = 0.0231$), BMI (OR: 0.8147, 95%CI: 0.7178−0.9246, $p = 0.0015$), albumin (OR: 0.3545, 95%CI:

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