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Original Article

Significance of blood cultures in nursing home–acquired pneumonia

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ABSTRACT

The significance of blood cultures in nursing home–acquired pneumonia (NHAP) is incompletely understood. We retrospectively analyzed the clinical and laboratory features of 515 patients with NHAP admitted to our hospital over an 11-year period.

Blood cultures were obtained from 336 patients (65.2%). We compared 13 and 323 patients with positive and negative blood cultures, respectively. The former showed lower systolic blood pressure and higher blood urea nitrogen (BUN), creatinine, C-reactive protein (CRP), and A-DROP scores than the latter. With regard to A-DROP parameters, patients with positive blood cultures showed significantly higher rates of dehydration (BUN $\geq$ 21 mg/dL) and low blood pressure (systolic blood pressure $\leq$ 90 mmHg). Multivariate analysis identified CRP values and low blood pressure as independent predictors of bacteremia: CRP (odds ratio [OR] 1.11; 95% confidence interval [CI] 1.04–1.19, $P = 0.003$) and low blood pressure (OR 6.03; 95% CI 1.06–34.25, $P = 0.04$). A receiver operating characteristic curve indicated that CRP was of moderate accuracy (area under the curve = 0.75), and its diagnostic accuracy was optimal at a cut-off point of 19.2 mg/dL (sensitivity 69%, specificity 87%).

Since the probability of true bacteremia is very low in NHAP, obtaining blood cultures from all patients with NHAP is unnecessary. However, our results suggest blood cultures are warranted from patients with high CRP values ($\geq$20 mg/dL) or low blood pressure.

1. Introduction

Blood culture examinations are useful in investigating causative micro-organisms and antibiotic sensitivities, and in performing antibiotic escalations or de-escalations. However, only 5–15% [1–3] of cases with pneumonia yield positive blood cultures. Some have questioned the need for blood cultures from all patients with pneumonia [4], particularly considering the significant costs of handling false-positive results. The Infectious Disease Society of America/American Thoracic Society (IDSA/ATS) recommend blood cultures be obtained from patients with community-acquired pneumonia (CAP) who require admission to an intensive care unit (ICU) or who show specific clinical characteristics (cavity infiltrates, leukopenia, active alcohol abuse, chronic severe liver diseases, asplenia, positive pneumococcal urine antigen tests [UATs], pleural effusion) [5]. Japanese Respiratory Society (JRS) guidelines for the management of pneumonia in adults in 2017 state blood cultures be obtained in severe CAP [6].

However, in other types of pneumonia, especially nursing home–acquired pneumonia (NHAP) that develops among residents in nursing homes or extended care facilities, the significance of blood culture examinations is unclear. In NHAP, swallowing dysfunctions and aspiration are risk factors for developing pneumonia [7,8]. Blood culture examinations may therefore be insignificant. We retrospectively analyzed the clinical and laboratory features of patients with NHAP admitted to our hospital. Specifically, our aims were to examine the significance of blood cultures in NHAP and to define clinical and laboratory findings informing the decision to obtain such cultures.

2. Patients and methods

We retrospectively analyzed consecutive patients with NHAP from nursing homes or extended care facilities who were admitted to our hospital between January 2005 and December 2015.

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Pneumonia was defined as the presence of fever or a wet cough, an increased white blood count (WBC) or C-reactive protein (CRP), and the presence of a new infiltrate on chest imaging. Cases diagnosed as other diseases after admission were excluded. Baseline demographic and clinical data, and outcomes were obtained from clinical records. Data included age, sex, comorbid diseases, vital signs, laboratory data, percutaneous oxygen saturation, bacteriological examinations, length of hospital stay, and in-hospital deaths. A urinary tract infections (UTI) was defined as a urine culture containing a pathogenic organism at $\geq$ 100,000 colony-forming units per milliliter. The severity of pneumonia was evaluated using predictive rules according to an A-DROP 6-point scale (0–5) proposed by the JRS [7]. Blood cultures were obtained prior to antibiotic treatment and examined using a commercial blood culture system (BACTEC™ FX, BD, Franklin Lakes, NJ, USA). Pneumococcal UATs were performed using commercial kits (BinaxNOW; Alere Scarborough, Inc., Scarborough, ME, USA).

We divided patients into two groups: blood culture and non-blood culture groups. Blood cultures which grew bacteria, excluding contaminants, were defined as positive. When coagulase-negative *Staphylococcus* species (spp.), *Corynebacterium* spp., *Clostridium* spp., and *Bacillus* spp. were isolated, they were considered contaminants [9,10]. We compared baseline demographic and clinical data, and the outcomes of the blood culture group were divided into positive and negative groups.

Furthermore, we analyzed blood cultures in several clinical situations in CAP as recommended by IDSA/ATS. Such clinical situations included ICU admission, leukopenia, active alcohol abuse, chronic severe liver disease, asplenia and a positive pneumococcal UAT [5]. Cavity infiltrates and pleural effusion were excluded.

All statistical analyses were performed using JMP software package version 13.0 (SAS Institute Inc., Cary, NC, USA). Continuous variables were compared using unpaired *t* and Mann–Whitney *U* tests. Categorical variables were compared using Chi-square and Fisher's exact tests. Multivariate analysis by logistic regression identified independent risk factors of predictors of bacteremia. A receiver operating characteristic (ROC) curve was drawn and the area under the curve (AUC) was calculated to assess the predictive value of CRP for bacteremia. *P* values < 0.05 were considered significant. This study was approved by the Ethics Review Committee of Kobe City Medical Center West Hospital (approval number: 17-005).

3. Results

Patients (515) with NHAP consisted of 242 males (47.0%) and 273 females (53.0%) with a mean age of 84.6 years (range: 18–104 years). Blood cultures were obtained on admission from 336 patients (65.2%; Fig. 1): two and one set from 258 and 78 patients, respectively. The characteristics of blood and non-blood culture groups are shown in Table 1. The blood culture group had a significantly higher percentage of cerebrovascular diseases as underlying diseases, as well as significantly higher body temperature and CRP, than the non-blood culture group. Other significant differences, except CRP, were not noted between the two groups.

Twenty-two blood cultures grew bacteria, with 13 considered true positives (Fig. 2). The precise exclusion process was as follows: First, six blood cultures that grew coagulase-negative *Staphylococcus* spp. (n = 3), *Corynebacterium* spp. (n = 1), *Clostridium* spp. (n = 1) and *Bacillus* spp. (n = 1) were defined as contaminants. Second, blood samples from three patients were positive in only one set and their sputum cultures were negative. Their three blood cultures (*Streptococcus equisimilis*, methicillin-susceptible *Staphylococcus aureus* [MSSA], and *Kocuria rosea* [n = 1, respectively) were also classified as contaminated.

Thirteen patients showed true positive blood cultures: 2/2 sets were positive in six patients (*Streptococcus pneumoniae* [n = 2], *Escherichia coli* (n = 2), β-*Streptococcus* G group [n = 1], and *Streptococcus dysgalactiae* [n = 1]); 1/2 sets was positive in five patients (*S. pneumoniae* [n = 2], *E. coli* [n = 1], *Streptococcus anginosus* [n = 1], and *Moraxella lacunata* [n = 1]); and 1/1 set was positive in two patients (*Hemophilus influenzae* and MSSA [n = 1, respectively]).

Comparisons of characteristics of positive and negative blood culture groups are shown in Table 2. The positive blood culture group showed significantly lower systolic blood pressure (SBP) and higher blood urea nitrogen (BUN), creatinine (Cr), CRP, and A-DROP scores, as well as their two parameters (dehydration and low blood pressure [SBP $\leq$ 90 mmHg]). Other significant differences were not noted between the two groups. In the positive blood culture group, UTIs were complicated by pneumonia in three patients with *E. coli*

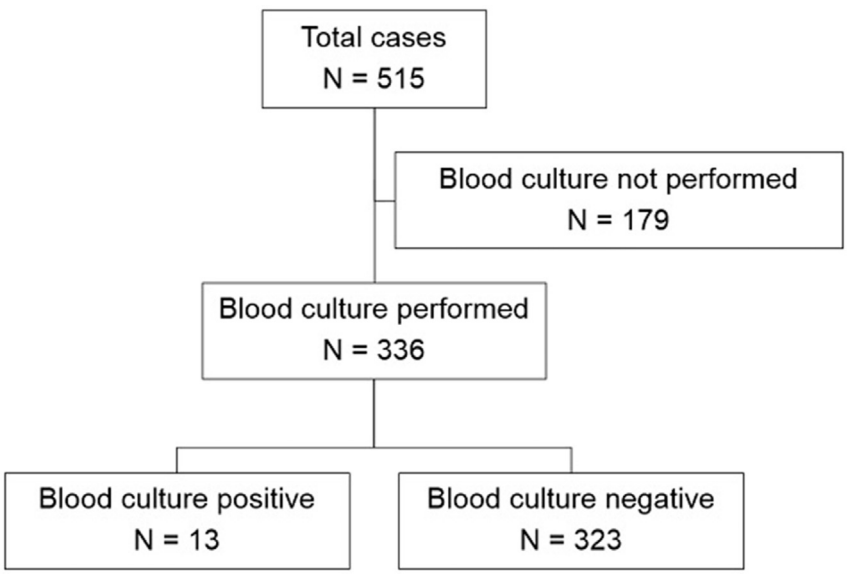

Fig. 1. Case selection chart.

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