# APPROPRIATENESS OF OBTAINING BLOOD CULTURES IN PATIENTS WITH COMMUNITY ACQUIRED PNEUMONIA

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**Abstract.** Community acquired pneumonia (CAP) is a common disease and blood cultures are frequently performed to identify a causative agent, but doing this results in an economic burden. We evaluated the appropriateness of performing blood cultures in clinical practice and determined predictors for positive blood cultures in CAP patients. We reviewed patients diagnosed with CAP at Khon Kaen Hospital, Thailand between January 1 and December 31, 2009. Clinical features, and results of blood and sputum cultures were studied. Clinical factors predictive for positive blood cultures were evaluated by multiple logistic analysis. During the study period 1,160 patients were diagnosed with pneumonia; of those, 261 patients (22.5%) met the criteria for CAP. All patients were performed blood and sputum cultures. Blood cultures were positive in 24 patients (9.2%); 15 patients had severe pneumonia. On multivariate analysis, neutrophils comprising more than 80% of the white blood cell count in peripheral blood was the only significant predictor for a positive blood culture. The adjusted odds ratio was 3.713 (95% confidence interval was 1.333-10.340). In our study population blood cultures are only appropriate among CAP patients with a neutrophil count greater than 80%.

**Keywords**: community acquired pneumonia, blood culture, appropriateness, predictors, neutrophils

## INTRODUCTION

Community acquired pneumonia (CAP) is a common health problem. Knowledge of the causative organism is crucial for appropriate treatment. Pathogens may be identified by blood or sputum cultures. Culture positive CAP varies from 6.6-34.8% (Chalasani *et al*, 1995; Campbell *et al*, 2003; Reechaipichitkul *et al*, 2005). Generally, blood cultures are recommended only in severe CAP (Chalasani *et al*, 1995; ATS, 2001; Campbell *et al*, 2003).

The role and appropriateness of blood cultures in CAP patients is unclear. Obtaining routine blood cultures in CAP patients causes an economic burden. This study aimed to evaluate the appropriateness of blood cultures in CAP the predictors for positive blood cultures. The role and appropriateness of blood cultures in CAP patients is unclear in endemic area of melioidosis.

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## MATERIALS AND METHODS

We conducted a search of the hospital database for adult patients (aged > 15 years) admitted to the Internal Medicine Ward, Khon Kaen Hospital, Khon Kaen, Thailand between January 1 and December 31, 2009 with pneumonia (ICD 10 codes: J181, J189, J150, J151, J152, J 154, J155, J156, J157, J159, J168, J14).

CAP was defined as a new pulmonary infiltration with at least 3 out of 5 of the following findings: fever, cough or productive sputum, dyspnea, pleuritic chest pain and signs of consolidation or crackles. The symptoms or pulmonary infiltrations must have been present for less than 2 weeks without a history of hospital admission (ERS, 1998; IDSA, 2000; ATS, 2001). Severe CAP was diagnosed by the need for mechanical ventilation, septic shock, or two of the following: a systolic blood pressure less than 90 mmHg, multilobar disease, or an oxygen saturation less than 90% with the need for oxygen supplementation. The inclusion criteria were patients diagnosed with CAP and who had never received treatments for that condition.

Baseline characteristics, symptoms, physical signs, laboratory findings including sputum and blood cultures, treatment, and outcomes for each patient were recorded. Descriptive statistics were used to evaluate the means of variables. Correlation between blood and sputum cultures was evaluated. Clinical features of those with positive and negative blood cultures were compared. Clinical predictors for positive blood cultures were calculated using multiple logistic regression.

Univariable logistic regression analyses were conducted to calculate the crude odds ratios of individual variables for positive blood cultures. All variables with

Table 1
Clinical features of community acquired pneumonia patients.

| Signs and symptoms | Number (%) |
|---|---|
| Cough | 257 (98.5) |
| Fever | 255 (97.7) |
| Consolidation/crackles | 247 (94.6) |
| Productive sputum | 220 (84.3) |
| Dyspnea | 219 (83.9) |
| Oxygen saturation < 90% | 103 (39.5) |
| Respiratory failure | 99 (37.9) |
| SBP ≤ 90 mmHg | 68 (26.1) |
| Septic shock | 61 (23.4) |
| Pleuritic chest pain | 34 (13.0) |

a $p$-value < 0.20 on univariable analysis or of clinical significance were included in multivariable logistic regression analysis. Variables with a $p$-value < 0.10 were retained in the final model. Analytical results were presented as an adjusted odds ratio (aOR), with 95% confidence intervals (CI). All statistical analyses were conducted with STATA, version 7.

The study protocol was reviewed and approved by the institutional review board and the Ethics Committee of Khon Kaen Hospital (18-01-2554).

## RESULTS

During the study period, 1,160 patients were diagnosed with pneumonia. Of those, 261 (22.5%) patients met the criteria for CAP. All those patients had blood and sputum cultures taken. The mean age (SD) of enrolled patients was 56.6 (17.3) years. Male patients accounted for 56.3% of subjects (147 patients). Most patients (77, 30%) were farmers. One hundred fifty-nine patients (62%) had underlying disease. The three most common underlying diseases were diabetes mellitus (42 patients, 26.4%), chronic

Table 2

Top four pathogens defined by blood and sputum cultures in community acquired pneumonia patients.

| Positive blood cultures *n* (%) Total 24 patients | Positive sputum culture *n* (%) Total 29 patients |
|---|---|
| *Burkholderia pseudomallei* 8 (3.1) | *Klebsiella pneumoniae* 12 (4.6) |
| *Streptococcus pneumoniae* 6 (2.3) | *Pseudomonas aeruginosa* 6 (2.3) |
| *Klebsiella pneumoniae* 4 (1.5) | *Acinetobacter baumannii* 3  (1.2) |
| *E.coli* ESBL 2 (0.8) | *Burkholderia pseudomallei* 2 (0.8) |
| Others 4 (1.5) | Others 6 (2.3) |

Table 3

Patients with positive blood or sputum cultures and severe or non-severe community acquired pneumonia.

| Culture | Severe CAP *n* (%) | Non-severe CAP *n* (%) | *p*-value |
|---|---|---|---|
| Blood culture positive | 15 (13.3) | 9  (6.1) | 0.046 |
| Sputum culture positive | 14 (12.4) | 15  (10.1) | 0.566 |

CAP, community acquired pneumonia

Table 4

Correlation between blood and sputum cultures in patients with severe or non-severe community acquired pneumonia.

| Culture | Severe CAP *n* (%) | Non-severe CAP *n* (%) | *p*-value |
|---|---|---|---|
| Blood culture positive, sputum culture negative | 12 (10.6) | 7  (4.7) | 0.070 |
| Blood culture negative, sputum culture positive | 11 (9.7) | 13 (8.8) | 0.792 |
| Blood culture positive, sputum culture positive | 3 (2.7) | 2 (1.4) | 0.447 |

CAP, community acquired pneumonia

obstructive pulmonary disease or asthma (20 patients, 12.6%); and hypertension (18 patients, 11.3%).

The clinical features of the patients are shown in Table 1. Fever, cough, and consolidation/crackles were found in more than 95% of patients. The average time of illness from symptom onset (SD) to presentation to our hospital was 3.8 (5.4) days. The most common pulmonary infiltration pattern of x-ray was patchy infiltrates (181 patients, 69.3%), followed by interstitial infiltrations (58 patients, 22.2%), diffuse alveolar infiltrations (13 patients, 5.0%) and multilobar infiltrations (9 patients, 3.5%). Severe and non-severe CAP were diagnosed in 113 (43.3%) and 148 (56.7%) patients, respectively.

Table 5
Baseline characteristics of study patients with positive and negative blood cultures.

| Variables | Positive blood cultures $n = 24$ | Negative blood cultures $n = 237$ | $p$-value |
|---|---|---|---|
| Age in years, mean (range) | 59 (37-81) | 60 (15-91) | 0.602 |
| Male, $n$ | 18 (84.0%) | 129 (54.4%) | 0.082 |
| Fever, $n$ | 24 (100.0%) | 231 (97.5%) | 1.000 |
| Cough, $n$ | 23 (95.8%) | 234 (98.7%) | 0.322 |
| Sputum production, $n$ | 20 (83.3%) | 200 (84.4%) | 0.777 |
| Dyspnea, $n$ | 22 (91.7%) | 197 (83.1%) | 0.388 |
| Chest pain, $n$ | 3 (12.6%) | 31 (13.1%) | 1.000 |
| Duration of symptoms in days, mean (range) | 3 (1-7) | 3 (1-14) | 0.915 |
| Underlying diseases, $n$ | 16 (66.7%) | 143 (60.3%) | 0.663 |
| Shock, $n$ | 7 (29.2%) | 54 (22.8%) | 0.457 |
| Crackles, $n$ | 24 (100.0%) | 223 (94.1%) | 0.625 |
| Low oxygen saturation, $n$ | 16 (66.7%) | 87 (36.7%) | 0.007 |
| On endotracheal tube, $n$ | 15 (62.5%) | 84 (35.4%) | 0.014 |
| Severe pneumonia, $n$ | 15 (62.5%) | 98 (41.4%) | 0.053 |
| Laboratory tests | | | |
|    Hemoblobin in g%, mean (range) | 10.9 (5.9-13.6) | 11.1 (4.9-16.1) | 0.233 |
|    White blood cell count in cells/$mm^3$, mean (range) | 15,150 (2,900-39,700) | 13,800 (1,800-40,300) | 0.188 |
|    Percent neutrophils, mean (range) | 86 (72.8-95) | 80 (20-99) | <0.001 |
|    Percent lymphocytes, mean (range) | 10 (1.5-45.6) | 13 (1-44) | 0.043 |
|    Platelet count x $10^3$, mean (range) | 185 (68-434) | 214 (27-727) | 0.327 |
|    Blood urea nitrogen in mg/dl, mean (range) | 19.5 (8-45) | 12 (2-134) | 0.013 |
|    Serum creatinine in mg/dl, mean (range) | 1.3 (0.7-6.7) | 1 (0.4-13.3) | 0.002 |
|    Diffuse pulmonary infiltrations, $n$ | 4 | 18 | 0.129 |

Blood and sputum cultures were positive in 24 patients (9.2%) and 29 patients (11.1%), respectively. *Burkholderia pseudomallei* and *Streptococcus pneumoniae* were the two most common pathogens found in blood cultures and *Klebsiella pneumoniae* was the most common organism found in sputum cultures (Table 2). Only one out of five patients with septicemic melioidosis had a positive sputum culture for *B. pseudomallei*. Seven out of 8 patients with mellioidosis had underlying disease; 5 patients had diabetes mellitus, one had cirrhosis and one had HIV infection.

Blood cultures were postitive in 15 patients (13.3%) with severe CAP and in 9 patients (6.1%) with non-severe CAP (Table 3). There were significantly more patients with positive blood cultures among those with severe CAP than non-severe CAP ($p$=0.046) but positive sputum cultures were not significantly different between the two groups (Table 3). The correlation between blood and sputum cultures in severe and non-severe CAP are presented in Table 4.

A higher percent of the follwing factors were associated with positive blood cultures: male sex, patients with a low oxygen saturation, patients word requiring endotracheal tube on presentation, severe pneumonia patients, patients with high neutrophil and low lymphocyte counts and with high blood urea nitrogen and creatinine levels (Table 5). On multivariate analysis, greater than 80% neutrophils on peripleral blood smear was the only significant predictor for positive blood cultures. The adjusted odds ratio was 3.713 (95% confidence interval was 1.333, 10.340).

## DISCUSSION

Taking blood cultures is invasive, usually requiring at least two specimens. Although it reveals the causative organism if positive, it may not be cost-effective. Nine point two percent of blood cultures were positive in the present study which is somewhat higher than previous reports (5.7 - 6.6%) (Chalasani *et al*, 1995; Campbell *et al*, 2003). Thirteen point three percent of severe pneumonia patients in our study had positive blood cultures, compared to 6.6% of those with non-severe pneumonia (Table 3). We recommend obtaining blood cultures in severe pneumonia patients. All pneumonia patients in our study had both blood and sputum cultures performed routinely. These findings indicate over investigation with blood cultures in CAP cases at our hospital.

The numbers of patients with positive blood and sputum cultures was higher in severe CAP than non-severe CAP patients (Table 3). However, the correlation between blood and sputum cultures was poor (Table 4). Only four patients had the same results on blood and sputum cultures in our study.

There were several factors that differed between those with and without positive blood cultures in our study (Table 5). Most were related to severity of pneumonia, such as the need for endotracheal tube intubation, the presence of shock, low oxygen saturation or having underlying diseases. Having the percent of neutrophils >80% on peripheral smear was the only independent predictor for positive blood cultures among CAP patients in our study. A study evaluating neutrophis and their correlation between positive blood cultures in emergency department patients also found >80% neutrophil was associated with positive blood cultures (Shapiro *et al*, 2008). An animal model showed neutrophil-depleted H1N1 infected mice had less severe pneumonitis (Narasaraju *et al*, 2011). Therefore, CAP patients with neutrophils >80% should have blood cultures obtained.

Melioidosis caused by *Burkholderia pseudomallei*, is common among patients with sepsis and severe pneumonia in northeastern Thailand (Boonsawat *et al*, 1990; Reechaipichitkul *et al*, 2004, 2005). The diagnosis is made by positive blood or sputum cultures. Diabetes and chronic renal disease are common risk factors for melioidosis. Melioidosis was the most common identifiable pathogen in our study (3.1%). All five patients with a history of diabetes had positive blood cultures for *B. pseudomallei*. Of those, only one patient had a positive sputum culture for melioidosis. Even though there is a low yield for sputum cultures in melioiodosis, they should be obtained due to high mortality with this disease. CAP patients with risk factors for melioidosis and elevated neutrophil counts should have both blood and sputum cultures obtained (Boonsawat *et al*, 1990; Reechaipichitkul *et al*, 2004).

A neutrophil percentage >80% is an indicator for positive blood culture. Severe CAP, underlying diseases, or local endemic pathogen are other reasons for obtains blood cultures in CAP patients.

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