ORIGINAL ARTICLE

Limited usefulness of initial blood cultures in community acquired pneumonia

J Corbo, B Friedman, P Bijur, E J Gallagher

Emerg Med J 2004;**21**:446–448. doi: 10.1136/emj.2003.005306

See end of article for authors' affiliations

Correspondence to: Dr J Corbo, Department of Emergency Medicine, Jacobi Medical Center, 1400 Pelham Parkway South, Room 1W20, Bronx, New York 10462, USA; jillcorbo@AOL.com

Accepted for publication 15 February 2003

Objective: The incidence of community acquired pneumonia (CAP) is about 4 million cases per year, with a hospitalisation rate of 20%. In non-immunocompromised patients hospitalised for CAP the rate of bacteraemia is less than 7% with predictable pathogens. Despite this, guidelines still recommend use of blood cultures (BCs) to direct treatment. This study tested the primary hypothesis that the proportion of false positive BCs would exceed the proportion of true positives. A secondary aim was to quantify the frequency with which antibiotic therapy was changed based on BC results.

Method: Consecutive adults hospitalised from an urban emergency department (ED) with CAP between January 1999 and March 2001 were assessed retrospectively for study eligibility. Those with an infiltrate consistent with pneumonia on the admission chest radiograph and at least one set of BCs taken in the ED before antibiotics were given were entered into the study. Patients hospitalised within the previous two weeks, nursing home residents, and immunosuppressed patients were excluded.

Results: 821 patients were admitted for CAP and 355 met inclusion criteria. The proportion of false positive BCs (10%) exceeded the proportion of true positives (9%), by 1% (95%CI −3.3% to 5.5%). Antibiotic therapy was changed on the basis of BC results in 5% of patients (95%CI 3% to 8%).

Conclusion: The rate of false positive BCs in patients hospitalised with CAP is similar to the rate of true positives. BCs only infrequently lead to changes in antibiotic therapy, and in no instance were therapeutic changes driven by detection of resistant organisms. The results question the utility of routine BCs in immunocompetent patients with CAP.

Community acquired pneumonia (CAP) is common and costly. The incidence of CAP ranges from 3.5 to 4 million cases per year, with a hospitalisation rate of 20%,[1] and an annual mortality of 45 000.[2] Traditionally, blood cultures (BCs) have been a routine part of the diagnostic investigation of this disease, and have been considered mandatory by some authors.[2 3] However, others have suggested that BCs are of little clinical value, particularly among immunocompetent adult patients with CAP.[4 5]

In an effort to quantify the clinical utility of BCs in immunocompetent adults with CAP, we designed a study to test the hypothesis that the proportion of false positive BC results would exceed the proportion of true positives among BCs obtained in the emergency department (ED) from this population of patients. Secondly, we also wished to determine the frequency with which physicians changed antibiotic therapy on the basis of BC results.

METHODS

A retrospective observational cohort of all patients aged 18 years or older hospitalised from an urban ED between January 1999 and March 2001 with the primary diagnosis of CAP was examined. Those with an attending radiologist's reading of an infiltrate consistent with pneumonia on the admission chest radiograph and at least one set of BCs taken in the ED before administration of antibiotics met inclusion criteria for study entry. Patients hospitalised within the previous two weeks, nursing home residents, immunosuppressed patients (including patients with HIV or AIDS, neoplastic disease, sickle cell disease, or long term corticosteroid therapy) were excluded. The study protocol was reviewed and approved by the institutional review boards of the medical school and the hospital participating in the study. All eligible study participants' data were collected via a computerised medical records system containing discharge summaries, radiological results, laboratory results, and antibiotics administered. If data could not be obtained from computerised medical records, they were extracted from written medical records. A BC consisted of a pair of aerobic and anaerobic Fan bottles. BCs were considered negative if they grew no organisms after five days. Antibiotic sensitivities were obtained on all positive BCs. BCs were classified as false positive if the treating physicians concluded that the organism was a contaminant and treated the patient accordingly. Otherwise, positive BCs were classified as true positives. True negative BCs were defined as those in which initial BCs were negative, and subsequent BCs, if obtained, were either negative or contained an organism classified by the physicians caring for the patient as a contaminant. False negative BCs were defined as those in which initial BCs were negative, but subsequent BCs, if obtained, contained an organism classified by the physicians caring for the patient as a true pathogen rather than a contaminant.

RESULTS

From the period of January 1999 to March 2001, 821 patients were admitted to the hospital with the diagnosis of CAP, of which 355 patients met study entry criteria. Table 1 details reasons for exclusion of the remaining 466 patients from the study. The average age of study participants was 60 (SD 19) years with a range from 18 to 94 years. There were 187 (53%) women. The most common underlying medical illnesses were hypertension (30%) and asthma (27%). There was no significant difference in underlying diseases when those patients with positive and negative BCs were compared. The median length of stay of study participants was eight days with a range of 2 to 61 days.

Abbreviations: ED, emergency department; BC, blood culture; CAP, community acquired pneumonia

Table 1 Reasons for exclusion of patients

Reasons	Number of patients (%)
No infiltrate on chest radiograph	113 (24)
No blood cultures	61 (13)
Nursing home resident	134 (29)
Recent admissions	9 (2)
HIV*	80 (17)
Neoplasia*	39 (8)
Long term corticosteroid use*	11 (2)
Other immunocompromised states*	19 (4)
Total	466 (100)

*Patients classified as having an immunocompromised state.

Of the 355 study patients, 70 (20% (95%CI 16% to 24%)) had positive BCs. There were 33 patients (9% (95%CI 6% to 12%)) with true positive BCs, and 37 patients (10% (95%CI 7% to 14%)) with false positive BCs containing contaminants. Although there were slightly more false positive than true positive BCs, the difference of 1% was neither clinically nor statistically significant (95%CI –3.3% to 5.5%). Of the 33 patients with true positive BCs, 30 grew *Streptococcus pneumoniae*, two grew *Staphylococcus aureus*, and one grew *Staphylococcus haemolyticus*. Of the 37 patients with false positive blood cultures, 14 grew *Staphylococcus epidermis*, 18 grew Coagulase negative *Staphylococci*, two grew *Diphtheroids*, and three patients grew two organisms (one grew *Staphylococcus epidermis* plus *Diphtheroids* and two grew Coagulase negative *Staphylococci* plus *Diphtheroids*).

Table 2 shows the choice of initial empiric antibiotic therapy. One hundred and seventy patients (48%) received a cephalosporin plus macrolide, while 76 (21%) patients received a cephalosporin alone.

Of the 355 study participants, 238 (67%) had a change in antibiotic regimen during their hospitalisation. Antibiotics were changed in 25 of 33 (76%) patients with true positive BCs, 26 of 37 (70%) patients with false positive results, and 187 of 285 (65%) patients with true negative BCs. There were no false negative BCs that we were able to detect—that is, no patients in whom BCs were initially negative when obtained in the ED, but grew non-contaminants, when subsequent sets were obtained later in the patient's hospital course. Table 3 summarises changes in antibiotic therapy.

Of the 25 true positives with a change of antibiotics, 10 were secondary to results of BCs, 10 secondary to clinical improvement, one secondary to worsening symptoms, and four secondary to other factors. These other factors included one attributable to antibiotic reaction (increase in liver function tests), one attributable to results of pleuracentesis, one attributable to urine culture results, and one that could not be determined by chart review. Among the 10 cases in which true positive BCs caused a change in antibiotic therapy, seven patients had their antibiotic spectrum narrowed. The antibiotic coverage of the remaining three patients was broadened, but not because of antibiotic resistance. In fact, antibiotic resistance was not the reason for a change in the management of any patient.

Table 2 Initial empiric antibiotic therapy

Initial empiric therapy	Number of patients (%)
Penicillin derivative	11 (3)
Cephalosporin only	76 (21)
Macrolide only	16 (4)
Quinolone only	21 (6)
Cephalosporin+doxycyline	1 (0.3)
Cephalosporin+quinolone	1 (0.3)
Cephalosporin+macrolide	170 (48)
Macrolide+doxycyline	1 (0.3)
Macrolide+quinolone	2 (0.6)
Penicillin derivative+other	9 (2)
Quinolone+other	5 (1)
Cephalosporin+macrolide+other	16 (4)
Cephalosporin+vancomycin+other	12 (3)
Macrolide+quinolone+other	1 (0.3)
Other	13 (4)
Total	355 (100)

Of 26 false positives with a change of antibiotics, six were secondary to BC results, 15 secondary to clinical improvement, and three secondary to sputum culture results. Antibiotics were changed in one patient after seizure to cover an aspiration pneumonia, and in one other to accommodate a decision to focus on palliative care and withdraw venipuncture for antibiotic levels. Among the six cases in which false positive cultures caused a change in antibiotic therapy, four patients had their antibiotic coverage broadened, while two patients had their antibiotics narrowed. All four patients who had their antibiotics initially broadened in response to a false positive BC received vancomycin for two days until the final organism was identified, permitting withdrawal of vancomycin and a return to their original antibiotic regimen.

Of the 187 true negative BCs with changes in their antibiotic coverage, only two such cases were secondary to the results of BCs. As noted previously, there were no false negative BCs (0%, 95%CI 0% to 1%).

In total, of 355 study participants, the management of only 18 cases (5% (95%CI 3% to 8%)) was changed by BC results. There were 151 patients (43% (95%CI 37% to 48%)) who had their antibiotic management changed by clinical improvement, and 23 patients (6% (95%CI 4% to 10%)) who had their antibiotic management changed by clinical deterioration.

DISCUSSION

In this retrospective cohort study, we examined the BC results of 355 immunocompetent adults admitted from the ED with a clinical and radiographic diagnosis of CAP. We examined only adults who were immunocompetent because of their lower bacteraemia rate.[4] Our results showed a rate of true positive BCs to be 9%, with a similar rate of false positive BCs to be 10% (95%CI for difference of 1%, –3.3% to 5.5%). The study by Chalasani *et al*,[4] with similar exclusion criteria, found comparable rates of true positive BCs (6.8%) and false positive BCs (4.8%). True positive BCs were as likely as false positive BCs to cause a change in antibiotic management (76% compared with 70% respectively). Only 18 of our 355 patients (5%) had their antibiotic regimen changed by the results of the BC. Of these, 11 patients had their antibiotic coverage narrowed, and seven patients had their antibiotic coverage broadened. In this study, the antibiotic resistance patterns sometimes caused clinicians to narrow antibiotic coverage, but never required them to broaden coverage. No organism identified in the positive BCs was resistant to the antibiotics initially chosen empirically by the clinician. This finding is similar to that reported in the retrospective study by Chalasani *et al*[4] and the prospective study by Woodhead *et al*.[6] This observation, combined with that of other investigators,[4 6] supports the routine use of empirical antibiotics in immunocompetent patients with CAP.

The study by Bates *et al* showed that because of the results of false positive BCs, there is an increase in length of stay and thus an increase in hospital costs.[7] Although our study did not examine hospital costs, we found that the treating physician would typically broaden antibiotic coverage when a preliminary Gram stain of a BC performed by the hospital laboratory revealed an unidentified organism, only to narrow the coverage several days later when the culture failed to reveal a pathogen, thus unnecessarily increasing length of

Table 3 Changes in antibiotics therapy

Blood culture classification	Blood culture results, N1/N2 (% (95%CI))	Change in antibiotic therapy, N1/N2 (% (95%CI))	Change in antibiotic therapy secondary to BC results, N1/N2 (% (95%CI))
True positive	33/355 (9% (6% to 12%))	25/33 (76% (61% to 90%))	10/33 (30% (15% to 46%))
False positive	37/355 (10% (7% to14%))	26/37 (70% (56% to 85%))	6/37 (16% (4% to 28%))
True negative	285/355 (80% (76% to 84%))	187/285 (66% (60% to 71%))	2/187 (1% (0% to 3%))

stay. On the basis of this, we speculate that limiting the use of BCs would not only save in the cost of the BCs themselves, but, of greater importance, would be likely to reduce the increased duration of hospitalisation attributable to contaminants.

Physicians in our study seemed reluctant to narrow antibiotic therapy for CAP, even when BC results indicated this would be appropriate. This phenomenon has been noted by Waterer *et al* who reported that only a fifth of eligible cases were actually narrowed to penicillin therapy.[8] We found that the patient's clinical evolution (49%) had a far stronger influence on change of antibiotic therapy, than the results of BCs (5%).

Limitations and future questions

Several study limitations should be noted. Firstly, the classification of a BC being a contaminant was determined by the treating physician' judgment and not a pre-defined criteria.

In addition, this study was retrospective, in that the data were obtained by computerised and written records. The reason why an antibiotic was changed was determined by reviewing these records and thus inferred by the records. Using a prospective study would eliminate this inference that was made.

Conclusions

In summary, this study found that the rate of false positive BCs in patients hospitalised with CAP is similar to the rate of true positives. The results of the BCs only infrequently lead to changes in antibiotic therapy, and in no instance were therapeutic changes driven by detection of resistant organisms.

Our data question the practice of obtaining BCs among immunocompetent adults presenting to the ED with CAP.

Authors' affiliations

J Corbo, B Friedman, P Bijur, E J Gallagher, Department of Emergency Medicine, Albert Einstein College of Medicine, Bronx, New York, USA

Presented at SAEM, May 2002, St Louis, USA.

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