

Recognising severe pneumonia with simple clinical and biochemical measurements

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ABSTRACT – Community-acquired pneumonia (CAP) is the most common reason for acute admission to hospital and the fourth most common cause of death in the UK. It is important to identify patients with severe pneumonia and the worst prognosis. We conducted this study to validate a rule designed to do this devised in New Zealand. CAP was defined by evidence of new shadowing on the chest X-ray and clinical features of pneumonia. A standardised proforma was completed documenting clinical features and investigation results. Severe pneumonia was identified by two or more of the following: confusion; respiratory rate ≥ 30 /min; diastolic blood pressure ≤ 60 mmHg; urea > 7 mmol/l. One hundred patients (mean age 58.8 years) were included; 32 satisfied the rule. Seven died, all of whom satisfied the rule. Ten patients received intensive care, including six who died. Of 11 patients who died and/or received intensive care, nine satisfied the rule. The sensitivity and specificity of the rule for predicting death and/or intensive care were 82% and 73% respectively.

KEY WORDS: Community acquired pneumonia, confusion, respiratory rate, diastolic blood pressure, urea

Community-acquired pneumonia (CAP) results in between 50,000¹ and 83,000² admissions to hospitals in the UK each year, is the most common reason for acute admission to hospital,¹ and the fourth most common cause of death.² The rapid identification of patients with the most severe pneumonia is of great

importance, because of the poor outcome in this group if appropriate treatment is delayed. The hospital mortality in patients whose pneumonia leads to cardiac arrest is 100% in some large studies.^{3,4} By contrast, the use of clinical rules or scoring systems to prompt early referral to intensive care can significantly reduce the incidence of cardiac arrest, and probably mortality, in mixed patient populations.⁵ We have shown that up to 71% of patients admitted to an intensive care unit (ICU) with CAP survive when looked after by expert teams.⁶ Simple clinical rules, permitting early identification of patients with CAP with the worst prognosis, exist.^{7,8} We have analysed the effectiveness of the most recently derived and potentially most useful of these rules, prospectively.⁸

In 1987, the British Thoracic Society (BTS) and the Public Health Laboratory Service published results of a survey of CAP in patients admitted to hospital over 14 months in 1982 and 1983.⁷ From these results two rules were derived for identifying patients with the most severe pneumonia, those likely to die. The first rule (BTS 1) used threshold levels of respiratory rate, diastolic blood pressure (BP) and blood urea on admission. If two out of three of the criteria were satisfied patients had a 21-fold greater risk of dying than if one or no criteria were present. The second rule (BTS 2) substituted confusion, in the history or on examination, for blood urea. This rule was based entirely on symptoms and signs and, if two out of these three criteria were present on admission, the patient had an 10-fold greater risk of dying. The usefulness of the first rule was validated in three studies – one in the USA⁸ and two in New Zealand.^{9,10} In the third of these studies,¹⁰ Neill and colleagues derived a modified BTS rule (mBTSr) which was positive if two or more of the four criteria used in the BTS rules were present on admission: confusion, respiratory rate ≥ 30 /minute, diastolic BP ≤ 60 mmHg and blood urea > 7.0 mmol/l. In their study, those who satisfied BTS 1 had a 22-fold greater risk of dying, BTS 2 a 9.9-fold greater risk of dying, and the mBTSr a 36.5-fold greater risk of dying. For the mBTSr, this was the population from which the modified rule had been derived.

Two studies from Nottingham have addressed the value of the mBTSr. In a retrospective case control

Table 1. Patients satisfying each of the four criteria in the mBTSr, and number in each group satisfying the mBTSr in 100 patients admitted with community-acquired pneumonia. Thirty-two patients satisfied two or more of the criteria.

	Number of patients	mBTSr satisfied
1 confusion	26/99	18
2 RR ≤ 30 /min	24/99	16
3 BP ≤ 60 mmHg	22/100	18
4 urea > 7	40/100	25

RR =respiratory rate; BP = blood pressure.

notes review, Lim *et al*² found that both the BTS 1 and mBTSr were markedly less sensitive than in the derivation studies^{7,10} but the specificity was very similar. In a prospective study performed predominantly to look at microbiological aetiology, the same group¹¹ found that the mBTSr was sensitive but not very specific in predicting death.

The aim of the study reported here was to assess the value of the mBTSr in predicting severe pneumonia as part of a prospective pragmatic assessment of patients with CAP admitted to a large acute general hospital over a 14-month period.

Methods

Unselected adult patients (age ≥16 years) admitted to the Norfolk and Norwich Hospital with community-acquired pneumonia (CAP) over a 14-month period (April 1999 to June 2000) were included in the study. Patients were identified by one of the authors visiting the medical admissions unit at least daily and also by contacting the on-call acute medical teams. For the first seven months patients with CAP remained under the admitting team. Thereafter such patients were triaged to the respiratory team. Hospital guidelines based on the BTS study⁷ have been used in this hospital since 1987 and were in use throughout the study. CAP was defined by the presence of new shadowing on the admission chest X-ray (CXR) and clinical features consistent with pneumonia.⁷ Patients who developed consolidation while inpatients were excluded from the study. Patients in whom pneumonia was not the main reason for admission or was an expected terminal event, were excluded.

A standardised study proforma completed following admission by one of the authors included patient demographics, clinical features and CXR findings. Routine investigations included haematology, renal and liver function tests. Microbiological investigations included sputum culture, blood culture, urine pneumococcal and legionella antigen, blood and sputum pneumococcal antigen and atypical organism serology. A record was made of all antibiotics prescribed and any subsequent changes in antibiotic cover. Patients were followed up in the respiratory medical clinic six weeks after admission.

Patients were assessed for severity using the modified BTS rule (mBTSr) criteria:¹⁰ confusion (in history or examination); respiratory rate ≥30/min; diastolic BP ≤60 mmHg; and urea >7 mmol/l. The presence of two or more of these indicates

Key Points

Patients with severe community-acquired pneumonia can be identified reliably following admission to hospital

Identification requires measurement and recording of the presence or absence of confusion, the respiratory rate, diastolic blood pressure and blood urea

Patients with two or more of confusion, respiratory rate of 30 per minute or greater, diastolic blood pressure 60 mmHg or less, and blood urea greater than 7mmol/l have severe pneumonia

This rule has high sensitivity, specificity and negative predictive value

Specialist respiratory team advice and assistance should be requested for such patients

severe CAP. The ability of the mBTSr to identify those patients who required intensive care or died was determined and its sensitivity and specificity for detecting patients with such severe CAP was derived.

Results

One hundred patients (M = 58, F = 42) were included in the study. Their mean age was 58.8 years (range 17–96 years). Respiratory rate and the presence or absence of confusion on admission were recorded in 99 patients. Diastolic BP and blood urea on admission were recorded in all patients. Thirty-two patients satisfied the severity criteria (Table 1).

One or more pathogens were identified in forty-seven patients. These results will be reported elsewhere.

Seven patients died (age range 44–80 years), all of whom had been identified by the mBTSr. Ten patients were admitted to the ICU, including six of those who died. The four survivors were aged 22–70 years. Of the 11 patients who died and/or went to ICU, nine met the severity criteria. The rule was positive in all seven aged over 60 years and in two of the four younger patients, who both died.

The sensitivity and specificity for detecting such severe CAP along with the positive and negative predictive values are shown in Table 2. We also show values for these reported in the derivation study¹⁰ and the two Nottingham studies.^{2,11}

Table 2. Sensitivity, specificity, positive and negative predictive values of the mBTSr in 11 patients with the most severe CAP.

	Death (n = 7)	ITU (n = 10)	Death and/or ITU (n = 11)	New Zealand ¹⁰	Nottingham Retrospective ²	Nottingham Prospective ¹¹
Sensitivity	100%	80%	82%	95%	66%	78%
Specificity	72%	72%	73%	71%	73%	68%
Positive predictive value	0.21	0.20	0.27	0.22	NR	NR
Negative predictive value	1.0	0.97	0.97	0.99	NR	0.95

NR = not recorded

Discussion

We have confirmed the value of the modified BTS rule first suggested by Neill *et al.*¹⁰ For patients who died, it was 100% sensitive and 72% specific compared with values of 95% for sensitivity and 71% for specificity in the derivation study. The retrospective study by Lim *et al.*² found a sensitivity of 66% with a specificity of 73%. There are several important differences between that study² and ours. Ours was prospective study in a hospital where pneumonia management guidelines were established in 1987, are regularly up-dated and part of the culture. This is reflected by only two missing pieces of data required for the mBTSr. The earlier study was a retrospective notes review of patients admitted to five hospitals. There is no information concerning the availability of CAP management guidelines in these hospitals but respiratory rate was not recorded in 20% patients. Their study also found a lower sensitivity for BTS 1 than the derivation⁷ or subsequent validation^{8,10} studies. The prospective study by the same authors,¹¹ coordinated by a research registrar, found a sensitivity for the mBTSr of 78% and specificity of 68% with a negative predictive value of 0.95 values similar to, but slightly lower than, those in our study.

In our study we also observed the value of the mBTSr in predicting severe CAP requiring intensive care. Though six of the patients admitted to the ICU died, combining those who died and those who survived after intensive care suggests that the mBTSr is indeed sensitive and specific in identifying patients with severe CAP.

We chose to record confusion if it was present in the recent history or during examination. This was the method used in the BTS study.⁷ Subsequently confusion was formally assessed by Neill *et al* using the mental state quotient¹⁰ and by Lim *et al* using the abbreviated mental test score.¹¹ Our results indicate that recording confusion as present or absent in the history and/or examination contributes perfectly adequately to the mBTSr.

Despite CAP being a leading cause of death in the UK, a recent survey of 27 deaths from CAP in young adults¹² revealed that the BTS antibiotic guidelines for severe CAP were followed in only ten cases.

Neill *et al*¹⁰ demonstrated that the clinical assessment of severity was markedly inferior to any of the BTS rules which use objective criteria. We agree with this. All patients admitted with CAP should be objectively assessed. That assessment should include accurate measurement of respiratory rate and diastolic blood pressure and a record made of whether or not the patient is confused. Patients with two or all three of these clinical signs of severity satisfy the mBTSr. The blood urea should be measured in all patients. A raised blood urea coupled with any of the above signs also indicates that the patient satisfies the mBTSr. Such patients have severe pneumonia and a much greater chance of dying or requiring intensive care than patients with one or none of these features. These patients can be identified early and should be treated with antibiotics that cover all the common or likely organisms that cause severe pneumonia.¹³

They should also be transferred to the care of a specialist res-

piratory team where management expertise and access to specialist diagnostic testing, like fiberoptic bronchoscopy, are optimal. Specialist respiratory physicians are more likely to have accurate information on local antibiotic resistance patterns and to make more appropriate and timely referrals for scarce intensive care resources.^{6,14} In our study, 32% of patients admitted with CAP under other general physicians would have required transfer to the specialist team. Many larger hospitals, including ours, already triage patients to specialist teams.¹⁵ In smaller hospitals a step in this direction could be the identification and appropriate triage of the most severely ill.

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