Study of community acquired pneumonia aetiology (SCAPA) in adults admitted to hospital: implications for management guidelines

W S Lim, J T Macfarlane, T C J Boswell, T G Harrison, D Rose, M Leinonen, P Saikku

Abstract

***Background*—Since the last British study of the microbial aetiology of community acquired pneumonia (CAP) about 20 years ago, new organisms have been identified (for example, *Chlamydia pneumoniae*), new antibiotics introduced, and fresh advances made in microbiological techniques. Pathogens implicated in CAP in adults admitted to hospital in the UK using modern and traditional microbiological investigations are described.**

***Methods*—Adults aged 16 years and over admitted to a teaching hospital with CAP over a 12 month period from 4 October 1998 were prospectively studied. Samples of blood, sputum, and urine were collected for microbiological testing by standard culture techniques and new serological and urine antigen detection methods.**

***Results*—Of 309 patients admitted with CAP, 267 fulfilled the study criteria; 135 (50.6%) were men and the mean (SD) age was 65.4 (19.6) years. Aetiological agents were identified from 199 (75%) patients (one pathogen in 124 (46%), two in 53 (20%), and three or more in 22 (8%)): *Streptococcus pneumoniae* 129 (48%), influenza A virus 50 (19%), *Chlamydia pneumoniae* 35 (13%), *Haemophilus influenzae* 20 (7%), *Mycoplasma pneumoniae* 9 (3%), *Legionella pneumophilia* 9 (3%), other *Chlamydia* spp 7 (2%), *Moraxella catarrhalis* 5 (2%), *Coxiella burnetii* 2 (0.7%), others 8 (3%). Atypical pathogens were less common in patients aged 75 years and over than in younger patients (16% *v* 27%; OR 0.5, 95% CI 0.3 to 0.9). The 30 day mortality was 14.9%. Mortality risk could be stratified by the presence of four "core" adverse features. Three of 60 patients (5%) infected with an atypical pathogen died.**

***Conclusion*—*S pneumoniae* remains the most important pathogen to cover by initial antibiotic therapy in adults of all ages admitted to hospital with CAP. Atypical pathogens are more common in younger patients. They should also be covered in all patients with severe pneumonia and younger patients with non-severe infection.**

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Respiratory Infection Research Group, Respiratory Medicine, Nottingham City Hospital, Hucknall Road, Nottingham NG5 1PB, UK
W S Lim
J T Macfarlane

Department of Medical Microbiology
T C J Boswell

Department of Diagnostic Radiology
D Rose

Respiratory and Systemic Infection Laboratory, Central Public Health Laboratory, Colindale, London NW9 5EQ, UK
T G Harrison

National Public Health Institute, Department in Oulu, FIN-90101 Oulu, Finland
M Leinonen

Department of Medical Microbiology, University of Oulu, FIN-90401 Oulu, Finland
P Saikku

Correspondence to:
Dr J T Macfarlane
john.macfarlane@nottingham.ac.uk

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Community acquired pneumonia (CAP) is common in the UK, affecting 250 000 adults per year of whom 83 000 (33%) are admitted to hospital (67% for patients aged 65 years and over).[1] Mortality ranges from 6% to15%.[2–4]

Initial antibiotic management of CAP is empirical and dependent on a clear understanding of the likely pathogens. In the UK this knowledge is based on studies performed in the 1970s and early 1980s.[5] The largest study, conducted by the British Thoracic Society (BTS) in 1982, excluded adults over 74 years of age, thus missing the group of patients who carry the burden and mortality of CAP.[3]

In the last two decades a number of factors have potentially affected the pattern of adult CAP in the UK. The increasing age of the population, often with co-morbid illnesses or resident in residential and nursing homes, has raised concerns of Gram negative enteric bacterial infection in CAP.[6] Concerns of antibiotic resistance and the emergence of "new" pathogens such as *Chlamydia pneumoniae*, implicated in 3–18% of cases of CAP elsewhere,[7–9] has led to the promotion of fluoroquinolones and newer macrolides for the treatment of CAP.[10]

The impact of these changes on the microbial aetiology of CAP in the UK and how they should influence new management guidelines is unknown. We have performed a large prospective study of the aetiology of CAP and the outcome in adults admitted to hospital using a wide range of microbiological investigations.

Methods

All adults aged 16 years and over admitted to a large teaching hospital (Nottingham City Hospital) over a 12 month period from 4 October 1998 with CAP were eligible for inclusion in the study. The hospital shares all unselected adult medical admissions on a daily basis equally with the University Hospital in Nottingham, both covering a population of about 700 000.

All patients admitted with a provisional diagnosis of CAP were identified in the admissions unit where standardised clinical data and investigations were obtained. CAP was defined as the presence of an acute illness of 21 days or less duration with:

(1) features of a lower respiratory tract infection including:
    (a) two or more of: new or increasing cough, sputum production, shortness of breath, wheeze, chest pain, new focal or diffuse signs on chest examination;

Table 1 Criteria for microbiological diagnosis

Organism	*Diagnostic criteria*
All bacteria	Isolation from blood processed in Bactec 9240 system or from pleural fluid, bronchoscopic aspirates, or post mortem lung aspirates
S pneumoniae, *H influenzae* or *M catarrhalis* infection	(a) Isolation from washed and diluted sputum in significant numbers by semiquantitative culture or (b) for *S pneumoniae*: • Pneumococcal antigen (PCA) detected in urine (BINAX-NOW kit, results read at 60 minutes) or in sputum by countercurrent immunoelectrophoresis (CIE) or (c) Serological criteria for *S pneumoniae*: • ⩾3-fold rise in antibody titre against C-polysaccharide (CPS) or ⩾2-fold rise against pneumolysin (PLY), pneumococcal surface antigen A (PsaA)[22] or PLY-, PsaA- or CPS-specific immune complexes detected[23] (d) Serological criteria for *H influenzae or M catarrhalis*: • ⩾3-fold rise in antibody titre[24]
Infection with other bacteria including Gram negative enterobacteria (GNEB) and *Staph aureus*	The predominant organism in the sputum Gram stain in addition to isolation from washed and diluted sputum in significant numbers by semiquantitative culture
Atypical and viral pathogens	
C pneumoniae	(a) at least 3-fold rise in IgG or IgA antibodies or (b) presence of IgM antibody, using EIA kit (Labsystems, Helsinki, Finland)
L pneumophila	Isolation of organism from respiratory samples or *Legionella* antigen detected in urine by Biotest kit[25 26] or 4-fold or greater rise in immunofluorescent antibody titre to ⩾64 using formalised yolk sac antigen to *L pneumophila* serogroup 1
M pneumoniae, *Chlamydia* spp, *C burnetti*, influenza A and B, respiratory syncytial virus (RSV) and adenoviruses	4-fold or greater antibody rise or a single titre of ⩾128, by complement fixation test

Serum samples were tested at the National Public Health Institute, Department in Oulu, Finland for antibody responses to *C pneumoniae*, *H influenzae*, *M catarrhalis*, and *S pneumoniae*. Urine antigen testing was performed in conjunction with the Central Public Health Laboratory, Colindale, London, UK.
The criteria used to define infection in the 1982 BTS study were followed, updated for new investigations and pathogens.[3]

(b) one or more constitutional symptoms including fever, confusion, sweating, headaches, aches and pains, sore throat or coryza;
(2) radiographic shadowing on an admission chest radiograph consistent with infection and which was neither pre-existing nor of other known cause; and
(3) treatment with antibiotics for pneumonia by the attending physician.

Patients were excluded if the pneumonia was (a) not the primary cause for hospital admission, (b) an expected terminal event or (c) distal to bronchial obstruction (for example, from lung cancer). Patients with tuberculosis and HIV infection were excluded as were those who had been in hospital within the previous 10 days, were immunocompromised (received chemotherapeutic agents during 6 month period before admission or more than the equivalent of prednisolone 10 mg daily for at least 3 months before admission), or had previously been entered in the study. Comorbid illness was defined as the presence of any of the following conditions for which the patient was under active medical supervision or was receiving treatment at the time of hospital admission: chronic lung disease, cardiac disease (ischaemic heart disease, cardiac failure, hypertension, atrial fibrillation), cerebrovascular disease (including previous transient ischaemic attacks), cognitive impairment, diabetes mellitus, chronic liver disease, chronic renal disease, and inflammatory rheumatological disorders (excluding osteoarthritis). Mental confusion was defined as an abbreviated mental test score of 8 or less and severe pneumonia was defined using the modified BTS (mBTS) severity rule.[7] For the benefit of the discussion, patients aged 75 years and over are termed "elderly". The study was approved by the Nottingham City Hospital ethics committee.

Patients were seen within 24 hours of admission by a study investigator to confirm study entry criteria and informed consent. All chest radiographs were reviewed by an experienced radiologist (DR) blinded to patient details to confirm the radiographic study entry criteria. All patients were seen regularly in hospital and after discharge until their clinical and radiological features had stabilised. Patients who failed to attend were visited at home. A repeat chest radiographic and blood sample for serological testing were obtained at follow up. The main outcome measure was 30 day mortality.

LABORATORY INVESTIGATIONS: CRITERIA FOR MICROBIOLOGICAL DIAGNOSIS

Samples were held at 4°C and transported rapidly to the Nottingham Public Health Laboratory Service (PHLS) laboratory for standard and specialised investigations as previously described and summarised in table 1. The criteria used to define infection in the 1982 BTS study were followed but updated for new techniques (table 1).[3] The pathogens included in the term "atypical" pathogen are specified in table 3. Results for the BINAX-NOW pneumococcal antigen detection kit were read at 60 minutes instead of 15 minutes (as recommended by the manufacturers), based on the increased sensitivity of the 60 minute reading and no apparent difference in specificity (100%) determined in a series of 50 cases of non-pneumococcal proven pneumonias (authors, unpublished data).

STATISTICAL ANALYSIS

Data were analysed using SPSS version 8.0 for Windows. χ^2 or Fisher's exact tests were used to compare categorical variables. Multivariate analysis was performed by stepwise logistic regression. Results are expressed as odds ratios (ORs) with 95% confidence intervals (CI) and p values, taking $p<0.05$ as the level of statistical significance.

Results

Of 309 patients diagnosed with CAP on admission, eight were unwilling to participate

Table 2 Characteristics and outcome of study cohort (n=267)

Characteristic	*No (%)*
Age (years)	
Mean (SD)	65.4 (19.6)
Range	18–97
Age groups (years)	
18–44	49(18)
45–64	59(22)
65–74	47(18)
75–84	68(25)
85+	44(16)
Men	135(51)
Admitted from nursing home	22(8)
Smoking status	
Current	73(27)
Ex-smoker (>6 months)	100(37)
Never	80(30)
Not known	14(5)
Alcohol consumed	
None	158(59)
<21 units/week	76
⩾21 units/week	15(6)
Not known	18
Vaccination status	
Influenza vaccine (in last 12 months)	76(28)
Pneumococcal vaccine (in last 10 years)	39(14.6)
Comorbid illnesses	
None	83(31)
Chronic lung disease	82(31)
Ischaemic heart disease	33(12)
Cardiac failure	12(5)
Cerebrovascular disease	30(11)
Diabetes mellitus	22(8)
Dementia	22(8)
Cancer	15(6)
Chronic liver disease	2(0.7)
Antibiotics prior to hospital admission	104(39)
Amoxycillin	57
Macrolide	22

and 34 were subsequently found not to fulfil study entry criteria, leaving 267 patients in the study cohort, 112 (41%) of whom were elderly (table 2). Of the 267 patients, 190 (71%) were admitted over the winter (October to March), most in December and January (n=88 cases (33%)). Comorbid illnesses were more common in the elderly than in younger patients (86% *v* 59%; OR 4.1, 95% CI 2.2 to 7.5, p<0.001).

Table 3 No (%) of pathogens detected in 267 adults studied according to age

Pathogen	*Total (%) (n=267)*	*Died (%)*	*Age <75 years (n=155)*	*Age ⩾75 years (n=112)*
Bacterial pathogens	144 (54)	19 (13)	88 (57)	56 (50)
Streptococcus pneumoniae	129 (48)	18 (14)	80 (52)	49 (43)
Haemophilus influenzae	20 (7)	1 (5)	11 (7)	9 (8)
Moraxella catarrhalis	5 (2)	0 (0)	1 (0.6)	4 (4)
Staphylococcus aureus	4 (1.5)	2 (50)	2 (1)	2 (2)
GNEB*	4 (1.4)	1 (25)	3 (1.9)	1 (0.9)
Anaerobes†	3 (1.1)	0 (0)	2 (1)	1 (0.9)
Atypical pathogens	60 (22)	3 (5)	42 (27)	18 (16)
Chlamydia pneumoniae	35 (13)	2 (6)	20 (13)	15 (13)
Mycoplasma pneumoniae	9 (3)	0 (0)	8 (5)	1 (0.9)
Legionella pneumophila	9 (3)	1 (11)	8 (5)	1 (0.9)
Chlamydia spp‡	7 (2)	0 (0)	5 (3)	2 (2)
Coxiella burnetti	2 (0.7)	0 (0)	2 (1)	0 (0)
Viral pathogens	62 (23)	6 (10)	36 (23)	26 (23)
Influenza virus A	50 (19)	6 (12)	30 (19)	20 (18)
Influenza virus B	2 (1)	0 (0)	0 (0)	2 (2)
Respiratory syncytial virus	11 (4)	0 (0)	6 (4)	5 (4)
Rhinovirus	2 (0.7)	0 (0)	2 (1.3)	0 (0)
Adenovirus	1 (0.4)	0 (0)	1 (0.6)	0 (0)
Pathogen not identified	68 (25)	15 (22)	33 (21)	35 (31)

Pathogens were identified from bronchial washings in two patients (*L pneumophilia*, influenza A), post mortem lung tissue in one (*S pneumoniae*), and pleural fluid in one (*Bacteroides* spp).
*Gram negative Enterobacteriaceae (details in text).
†*Bacteroides* spp isolated from pleural fluid in one patient, *Fusobacterium necrophorum* from blood of a patient with dental caries, and *Gemella morbilloram* from blood of another patient.
‡Excluding those found to be diagnostic in *C pneumoniae* assays.

SPECIMEN COLLECTION

Specimens obtained included blood cultures prior to antibiotics in hospital from 225 (84%) patients, acute serum from 250 (94%) and follow up serum from 204 (90%) survivors, urine from 214 (80%) patients, and sputum within 24 hours of admission from 155 (58%) patients, 128 of whom were tested for pneumococcal antigen.

AETIOLOGICAL AGENTS IDENTIFIED

Aetiological agents were found in 199 (75%) patients: one pathogen in 124 (46%), two in 53 (20%), and three or more in 22 (8%). Altogether, 144 (54%) bacterial, 62 (23%) viral, and 60 (22%) atypical pathogens were detected (table 3).

Bacterial pathogens

The methods of diagnosing the 129 (48%) pneumococcal cases are shown in detail in table 4. Only one penicillin resistant strain was isolated from blood culture of one patient. Pneumococcal infection was diagnosed in 90 of 163 patients (55%) who had not received any antibiotics before admission compared with 39 of 104 (37%) who had been treated with antibiotics (OR 2, 95% CI 1.3 to 3.4, p=0.004). *Staphylococcus aureus* was isolated from the blood of two patients, both of whom had influenza A infection and required treatment in the intensive care unit within 24 hours of admission. *Haemophilus influenzae* and *Moraxella catarrhalis* were diagnosed by sputum culture in 11 (four ampicillin resistant) and two (one ampicillin resistant) cases, respectively, and by serological testing in 10 and four cases, respectively.

Of the four cases who fulfilled our criteria for aerobic Gram negative enterobacterial infection, both *Klebsiella* spp and *Escherichia coli* were isolated from blood culture in one patient. *Pseudomonas aeruginosa* was identified by Gram stain and culture from sputum in three patients with chronic lung disease and prior antibiotic use, two of whom recovered without receiving antipseudomonal therapy which strongly suggests that, in these cases, *Pseudomonas* was not an aetiological agent. Details of the three patients with anaerobic infection are given in table 3.

Atypical and viral pathogens

Chlamydia pneumoniae was identified serologically in 35 (13%) cases, more commonly in the winter (31 of 190 patients) than in the summer (four of 77; p=0.015).

Legionella pneumophila infection was diagnosed in nine patients (by urine antigen detection in seven and serological testing in eight). Three cases were associated with travel. There was no seasonal variation. Only two patients fulfilled the admission criteria for having severe pneumonia and both survived.

Atypical pathogens were found less often in elderly than in younger patients (16% *v* 27%; OR 0.5, 95% CI 0.3 to 0.9, p=0.03) both in the group as a whole and when divided into those with severe and non-severe infection (table 5). Their identification was not influenced by prior

Table 4 Value of pneumococcal diagnostic tests for the 129 patients diagnosed as having pneumococcal infection

Diagnostic test	Sensitivity* (%)	Sole means of diagnosis (no of patients)	No (%) positive		p value
			Prior antibiotics (n=104)	No prior antibiotics (n=163)	
Blood culture	9/114 (8)	3	0	9	0.01
Urine antigen	69†/114 (61)	31	17 (16)	52 (32)	0.005
Serology	78/123 (63)	36	26 (25)	53 (33)	0.19
Sputum culture	9/73 (12)	3	1	8	0.08
Sputum CIE	15/66 (23)	3	4	11	0.3

CIE = countercurrent electrophoresis.
*Sensitivity = proportion of patients with one or more positive pneumococcal test.
†49 were positive at 15 minutes. Of the remaining 20, seven had pneumococcal infection diagnosed by other tests.

Table 5 Relationship between infection and atypical pathogen, age, and severity

	Number with atypical pathogen detected		
	Total (n=60)	Age <75 years (n=42)	Age ⩾75 years (n=18)
Total no of patients	267	155	112
Total with atypical pathogen	60 (22%)	42 (27%)	18 (16%)
Proportion with severe infection who had an atypical infection	22/103 (21%)	11/41 (27%)	11/62 (18%)
Proportion with non-severe infection who had an atypical infection	38/164 (23%)	31/114 (27%)	7/50 (14%)
Severe CAP (died)	22 (2)	11 (0)	11 (2)*
Non-severe CAP (died)	38 (1)	31 (1)†	7 (0)

*Both patients had *C pneumoniae* as the sole pathogen detected. One man aged 90 died 7 days after hospital admission and another aged 78 died at home on day 29 having been previously discharged well.
†Travel associated *L pneumophilia* infection.

antibiotic use. Only three of the 60 patients (5%) with infection by an atypical pathogen died, two of whom had *C pneumoniae* infection and one *Legionella*.

Of the 50 cases with influenza A virus infection, 38 (76%) occurred in December and January. Respiratory syncytial virus (RSV) was the second most common viral pathogen identified. Of the 11 RSV cases, at least one other pathogen was identified in nine (a bacterial pathogen in eight and influenza A virus in one).

Mixed infections

In infections in which *Streptococcus pneumoniae* was identified, co-pathogens were diagnosed in 60 (47%) patients (influenza A virus in 25, *C pneumoniae* in 20, *H influenzae* in nine, other atypical pathogens in four, and other viral pathogens in 11). Where *C pneumoniae* infection was detected, a co-pathogen was diagnosed in 26 (74%) cases (*S pneumoniae* in 20, influenza A virus in six, *H influenzae* in four, other bacterial pathogens in four, and other viral pathogens in one). Overall, of 144 patients in whom infection with a bacterial pathogen was diagnosed, an atypical pathogen was also identified in 30 (21%) cases and a viral pathogen in 41 (28%) cases.

CLINICAL OUTCOME

Thirty day mortality was 15% (40 patients); 35 patients died during hospital admission, seven within the first 24 hours, 12 within the first 2 days, and 22 within the first 4 days. The median length of stay in survivors was 7 days (1st and 3rd quartile values 4 and 11 days, respectively). Of 17 (6%) patients admitted to the intensive care unit, five (30%) died. The median time to admission to the intensive care unit was 1 day; 12 (71%) were admitted within the first 24 hours of admission.

The mBTS severity prediction rule was 78% sensitive and 68% specific (negative predictive value (NPV) 95%) at predicting death in comparison with the BTS original prediction rule[3] which was 60% sensitive and 73% specific (NPV 91%). For elderly patients aged 75 years or over the sensitivity (77%) and NPV (86%) of the mBTS rule remained high, although specificity was reduced to 53%. Seven of 90 patients (8%) with one of the four features in the mBTS rule died compared with 14 of 61 (23%) with two features, 12 of 36 (33%) with three features, five of six (83%) with four features, and two of 74 (2.7%) with no features present (χ^2 test for trend: odds ratio 2.8, 95% CI 1.96 to 4.0, p<0.001).

Discussion

This is the first UK study to employ a wide range of diagnostic tools to identify the aetiological agents in adult CAP, including *C pneumoniae*, and to include patients aged 75 years and above. The high pathogen detection rate (75% of cases) reassuringly found no substantial shift in the causes of CAP or antibiotic sensitivity in the UK over the last 20 years, with penicillin sensitive *S pneumoniae* still the predominant causative agent in nearly half of cases.[2–4] This is an important finding when reviewing management guidelines for this common condition, particularly as perceived changes in the pattern of CAP have led to changes in national antibiotic guidelines elsewhere.[10]

Pneumococcal infection was diagnosed less commonly in patients who had received antibiotics before admission, presumably due to decreased sensitivity of microbiological tests in this circumstance.[3] None of the bacteraemic patients had received prior antibiotics. If prior antibiotic use is taken into account, then the true estimate of pneumococcal incidence is 55%, similar to the 1982 BTS study.

This is the first UK report on *C pneumoniae* infection in adult CAP and it was identified as the second most common pathogen. However, *C pneumoniae* was frequently found in mixed infections, in over half of the cases with *S pneumoniae*, as reported in other countries.[8 11 12] Pathogens such as *C pneumoniae* may play a role in promoting other bacterial infection through their effect on ciliated epithelial cells.[13] The evidence regarding the importance of *C pneumoniae* as a pathogen is conflicting. Some studies report that outcome is not affected when beta-lactam antibiotics alone are used for patients with evidence of *C pneumoniae* infection.[8 14] By contrast, studies from Finland have shown that mixed pneumococcal and *C pneumoniae* infections cause more severe CAP than that associated with either pathogen alone.[11 14] Our study did not find this (data not shown). The number of patients fulfilling the criteria for severe infection were similar for these three groupings. The overall mortality in patients with pneumococcal infection was much higher than in those infected with *C pneumoniae* (14% *v* 6%)

and no patients with mixed pneumococcal and *C pneumoniae* infection died. However, two elderly patients with *C pneumoniae* infection alone died. Outbreaks associated with significant mortality have been reported in homes for the elderly in the USA.[15]

Our study supports the view that, unlike other atypical infections, *C pneumoniae* infection affects adults of all ages, usually as a co-pathogen, and can be associated with severe infection and occasionally death. This provides support to the recommendations to include an antibiotic effective against atypical pathogens for patients of all ages with severe CAP.[5]

The frequency of *L pneumophilia* infection was lower than the 15% we reported 17 years ago, a trend seen in other countries.[2 16] Although yearly variation may partly explain these findings,[17] increased use of macrolides in the community may also be relevant.[16] Most of our cases had non-severe CAP, contrary to the view that *Legionella* infection is usually severe.[18] All our cases received an early macrolide as part of their hospital treatment, possibly influencing our low mortality. Delayed treatment for *Legionella* infection relates to increased mortality.[19] Furthermore, the report of a positive *Legionella* urine antigen test within 3 days of admission positively influenced early management in seven of nine patients, emphasising the likely value of urine antigen detection as a rapid diagnostic tool for patients admitted to hospital with CAP.

Infection with *M pneumoniae* was uncommon which is probably explained by the four yearly cycle of mycoplasma epidemics in Europe; our study coincided with the tail end of a national epidemic.[3] Our mycoplasmal pneumonia rate of 3% is similar to the 2% reported in 1982, contrasting with the 14% and 18% rates reported in UK studies during epidemic years.[2 4] Ready access to current epidemiological trends, as is available on the PHLS website (www.phls.co.uk), could be useful to clinicians for planning empirical antibiotic management.

Most of the cases of influenza were complicated by bacterial co-infections, emphasising the importance of influenza prevention. Only 68 of 175 eligible patients (39%) had received the influenza vaccine in the preceding 12 months, higher than the estimated 23% vaccine uptake among high risk patients in England and Wales in 1996/7 but still an area that can be improved.[20] Similarly, pneumococcal vaccination in the last 10 years was reported in only 29 (25%) of 114 eligible patients.

IMPLICATIONS FOR THE MANAGEMENT OF CAP

How does this study contribute to the development of an up to date management strategy for patients hospitalised with CAP?

Nearly all hospitals in the UK now operate an integrated emergency admission policy for adults of all ages, many of whom are elderly. Our patient cohort is typical of the pattern of CAP in the UK with half aged 65 years and above and about 40% over 75 years.[1 21] We have shown that penicillin sensitive *S pneumoniae* remains the most important pathogen in adults of all ages admitted with CAP and this should be covered effectively by the chosen empirical antibiotic. Ampicillin resistant bacteria are uncommon and concerns regarding Gram negative enterobacterial infections in the elderly seem unfounded.

Our study confirmed that pneumococcal, *Haemophilus*, and staphylococcal infections are the usual bacterial pathogens implicated in fatal CAP and such pathogens should always be covered by initial antibiotic therapy for severe pneumonia. We also recommend that empirical cover for atypical pathogens should be offered to all patients with severe CAP as 21% of our patients with atypical infection had features of severe pneumonia and three died. This is also important as several previous studies have found *Legionella* infection to be the second most common cause of CAP requiring intensive care.[3 18] The high proportion of patients who died or needed admission to the intensive care unit within the first few days of hospital admission emphasises the need for early identification of patients with severe pneumonia. The modified BTS rule performs better than the BTS rule in this regard, with sensitivity and NPV values being high, even in the elderly population. We found that patients could be stratified into increasing mortality risk groups using the four individual "core" features of the mBTS rule (*CURB*: Confusion, Urea, Respiratory rate, Blood pressure)—a strategy which may be more useful in management than just two categories of severe and non-severe. The "post-take" ward round is recommended as a good time to review patients and to decide on step up or step down of treatment options.

For non-severe CAP our study supports the use of empirical antibiotic cover for atypical pathogens for younger patients admitted to hospital but not for elderly patients. Atypical pathogens were twice as common in younger patients and led to no deaths in elderly patients presenting with features of non-severe pneumonia. Avoidance of early routine combination antibiotics, including a macrolide, in this latter patient group would probably be of net advantage in view of the complications of multiple antibiotic use in the elderly.

Overall, this study supports the current UK recommendations for covering the range of pathogens found in the management of CAP, stratified according to disease severity. Rapid urine antigen testing looks promising as an early way of detecting some pathogens including *S pneumoniae and L pneumophila*. More experience is needed before recommending these tests as a reliable way of directing more accurately the initial antibiotic choice for CAP.

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