Drugs 1998 Jan; 55 (1): 31-45
0012-6667/98/0001-0031/$15.00/0

Practical Considerations and Guidelines for the Management of Community-Acquired Pneumonia

Roger G. Finch[1] and *Mark A. Woodhead*[2]

1. Department of Microbiology and Infectious Diseases, City Hospital and University of Nottingham, Nottingham, England
2. Department of General and Respiratory Medicine, Manchester Royal Infirmary, Manchester, England

Contents

Summary

Community-acquired pneumonia (CAP) is a common condition which has a significant mortality. The management of a patient with CAP is centred around assessment and correction of gas exchange and fluid balance together with administration of appropriate antibiotics. Up to 10 different pathogens regularly cause CAP, of which *Streptococcus pneumoniae* is the most important. These different pathogens cannot be distinguished by clinical features or simple laboratory tests. Microbiological tests are slow and insensitive, so empirical therapy is necessary, at least initially. Accurate assessment of illness severity is the most important factor determining initial management, since this assists the decision of whether to admit the patient to hospital in addition to guiding antibiotic choice and route of administration.

Two different approaches to severity assessment are outlined. Our antibiotic

recommendation for empirical therapy for the patient managed at home and the previously fit patient admitted to hospital is amoxicillin. Amoxicillin/clavulanate plus a macrolide is our choice for the severely ill previously fit patient and a third-generation cephalosporin plus a macrolide is recommended for the severely ill patient with comorbidity. Alternative pathogens and specific treatment regimens are also described. There may be several causes of treatment failure, and in patients who fail to respond to therapy, it is essential to review all the initial clinical and laboratory information, which if necessary must be repeated.

Community-acquired pneumonia (CAP) is a common condition which is caused by a variety of microbial pathogens with differing antibiotic sensitivities. It presents as a spectrum of disease ranging from a simple febrile respiratory infection to a severe and fulminating illness leading to death. It is therefore managed in a number of different settings by a variety of different physicians, including general practitioners, and those with a special interest in general (internal) medicine, chest disease, infectious disease, healthcare of the elderly, paediatrics and intensive care. Much has been learned about CAP and how it should be managed, especially from studies performed over the past 15 years. It is the purpose of this article to produce a synthesis of this information for use by those involved in the care of patients with CAP.

1. Definitions of Community-Acquired Pneumonia (CAP)

A reasonable working definition of CAP is an acute illness acquired in the community with symptoms suggestive of a lower respiratory tract infection (e.g. fever, cough, sputum – which may be purulent, chest pain, dyspnoea), together with the presence on a chest radiograph of intrapulmonary shadowing which is likely to be new and has no clear alternative cause (e.g. lung cancer, pulmonary oedema). Although chest signs are not included in the definition because the correlation with radiographic consolidation is poor,[1] in the community, where many patients will not have a chest radiograph performed, a clinical definition of CAP is necessary. Symptoms suggestive of a lower respiratory tract infection together with the presence of new focal signs on chest examination has been one definition used in clinical studies in the community.[2] Patients with known immune compromise (sufficient for a risk of opportunist pathogens) or malignant disease and those discharged from hospital within the previous 10 days are excluded from the definitions.

2. Epidemiology

In adults, CAP occurs in 1 to 3 per 1000 of the adult population per year.[2] The incidence is higher below the age of 5 years and rises from the age of 50 upwards, being especially common in old age.[3] In addition to age, chronic disease (especially lung disease), alcoholism, smoking and institutionalisation are risk factors for CAP.[4]

About 80% of cases are managed in the community, where the mortality rate is 1 to 2%.[2] Of those admitted to hospital 5 to 10% will die, rising to 50% in the group who are ill enough to require intensive care.[5-10]

There is a seasonal variation in the frequency of CAP, which in temperate climates is more common in the winter months. Individual causative pathogens have their own unique epidemiological characteristics (table I) which may sometimes be helpful in individual patients for directing initial therapy.

3. Aetiology

The common pathogens and their frequencies in prospective studies of CAP aetiology are shown in table II.[2,5-35] *Streptococcus pneumoniae* is the most frequently identified pathogen in virtually every study, whether in the community, hospital or intensive care unit (ICU), accounting for up to 75%

of cases, emphasising the great importance of this organism.

The variation in frequency of *S. pneumoniae* between studies usually reflects the use of different diagnostic tests with different sensitivities. While this may be true for the different frequencies of some of the other organisms, for some these may reflect genuine differences between the populations under study. For example, in the following circumstances the indicated pathogens occur with increased frequencies:

- *Legionella* in countries bordering the Mediterranean[19] (and perhaps New Zealand[45]) and in severely ill patients;[22,26]
- Q-fever in sheep-rearing communities, e.g. northwest Spain and Nova Scotia;[27,28]
- *Klebsiella pneumoniae* in South Africa;[29] and
- *Mycobacterium tuberculosis* in Hong Kong[30] (and perhaps by extrapolation in other non-industrialised countries).

The precise importance of Gram-negative enteric bacteria (GNEB) remains unclear and indeed may vary, with only 1.6% of 185 cases of severe CAP identified as being caused by such organisms in 4 UK studies[22,26,31,32] compared with at least 5 European studies with frequencies of between 10 and 21%.[23,25,33-35] Recent studies, largely in patients with mild pneumonia, have suggested that *Mycoplasma pneumoniae* and *Chlamydia pneumoniae* may be more common than pneumococcal infection.[12,21] These studies did not, however, use sensitive methods for detecting pneumococcal infection, and thus such infections may have been missed. The clinical importance of these findings is uncertain since studies have not been performed comparing outcome using different antibiotic regimens in these often self-limiting infections (see below).

Two subgroups worthy of special mention are those with chronic lung disease and the elderly. It is a widely held view that causative pathogens are different in these 2 groups. In our view, a role for different pathogens in these 2 groups has not been clearly demonstrated due to inadequate investigation and requires further research. In the former group it has long been the view that *Haemophilus influenzae* is a more common cause of CAP compared with those with previously healthy lungs; however, few studies have investigated this. A recent study in patients with chronic lung disease

Table I. Epidemiological features of causative pathogens implicated in community-acquired pneumonia

Pathogen	Comment
Streptococcus pneumoniae	Commonest pathogen
Haemophilus influenzae	Probably more frequent in the presence of chronic lung disease
Staphylococcus aureus	Often follows influenza virus infection IV drug abusers
Mycoplasma pneumoniae	Epidemics in young people (e.g. in schools) Epidemics follow 4-yearly cycle
Chlamydia psittaci	Acquired from birds
Coxiella burnetii	Acquired from animals
Legionella spp.	Acquired from contaminated water aerosols (e.g. air conditioning towers) Late summer and autumn Exposure to potting mix (Australia – *L. longbeacheae*)
Influenza virus	Occurs annually in winter plus occasional epidemics

Abbreviation: IV = intravenous.

Table II. Microbial causes of community-acquired pneumonia in adults according to where the patient is managed; data from recent prospective studies[2,5-35]

Organism	Community (%)	Hospital (%)	Intensive care (%)
Streptococcus pneumoniae	1-36	7-76	10-36
Haemophilus influenzae	0-14	1-11	0-12
Staphylococcus aureus	0-1	0-4	0-22
Legionella spp.	0-3	0-16	0-30
Gram-negative enteric bacteria	0-1	0-7	0-32
Mycoplasma pneumoniae	1-26	0-29	0-7
Chlamydia psittaci	0-3	0-3	0-6
C. pneumoniae	0-16	0-18	Unknown
Coxiella burnetii	0-3	0-3	0-2
Influenza viruses	0-19	0-16	0-12
Other viruses	0-14	0-10	0-14

reported only 12% of cases of CAP caused by this organism.[36] Recent studies suggest that, with the exception of the lower frequency of infections due to *M. pneumoniae*, the spectrum of causative pathogens in the elderly is similar to that in other age groups.[37] GNEB infection may be more frequent in the very dependent, institutionalised elderly, but this requires further study.

The identification of more than one pathogen in an individual with CAP is unusual, occurring in most studies in <10% of cases.[6-8,11,12,14,16,21-23,26,31,34] The implications for initial empirical therapy of such dual isolations are not clear.

Two relatively newly recognised pathogens which have been implicated as causes of CAP are *C. pneumoniae* and hantaviruses. The role of *C. pneumoniae* remains uncertain since a 'gold standard' diagnostic method has yet to be found; bacterial copathogens are frequently found and recovery frequently occurs with antibiotics to which the organism is insensitive.[38] Hantaviruses may cause sporadic zoonotic pneumonia acquired from rodents in North and South America, but are not a frequent cause of CAP.[39]

4. Diagnostic Issues

Establishment of the microbial cause in an individual patient allows targeted narrow spectrum (usually single agent) antibiotic therapy, the advantages of which are the minimisation of adverse effects to the individual, limitation of the capacity for the development of acquired antibiotic resistance and removal of the need for further microbial investigations (and peace of mind for the prescriber). To this end, there has been much interest in the predictive value of clinical features, radiology and other nonmicrobial laboratory investigations. Although it is beyond the scope of this article to discuss this in depth, it can be said that it is now well established that features which have traditionally been considered to be helpful, such as the 'typical' or 'atypical' presentation and lobar versus patchy radiographic shadowing, except in exceptional circumstances, are of no value in predicting causative pathogens.[40] This is because statistical differences in the frequencies of features in pathogen-specific cohort studies are of little value in managing an individual patient.

For a microbiological investigation to be helpful to the practising physician it should be both sensitive and specific, easy to use and should provide a rapid result at acceptable cost. Microbial investigations are insensitive so even in prospective studies where more care is taken in sample handling and more investigations are used than are usually routinely available, a pathogen is not found in 50% or more of patients. As used routinely in the hospital setting, the yield of microbial investigation is even less, with no pathogen being found in up to 75% of cases.[41] The value of any investigation, therefore, depends on the setting in which the patient is being managed. In the community none is required, since the patient is seldom severely ill and is at low risk of death. Furthermore, antibiotic therapy need only cover the one or two most frequent pathogens, and delays (for example in sputum samples reaching the laboratory) may reduce yield and result in a further delay of the results getting back to the prescriber. In the hospital setting, the choice and use of investigations should relate to illness severity (fig. 1).

Sputum examination must be qualified by the limitation of investigation to good quality specimens only. Despite continuing debate, our opinion is that in the presence of CAP, a predominant pathogen on Gram stain or a heavy pure growth of a single organism in a purulent sample almost always indicates the causal pathogen.[6]

Samples for culture from normally sterile sites, such as blood or pleural fluid, are always useful because of their specificity even if sensitivity may be low (about 10 to 15% for blood cultures).

Infection by some pathogens is only easily confirmed by serology (e.g. *Mycoplasma*, *Chlamydia*, *Legionella*, viruses). A raised initial titre may suggest a causal pathogen, but this is unusual and it is often necessary to wait for a convalescent sample for a diagnostic rise in antibody titres. The results may be too late to be of clinical relevance. Such samples should only be taken in severely ill pa-

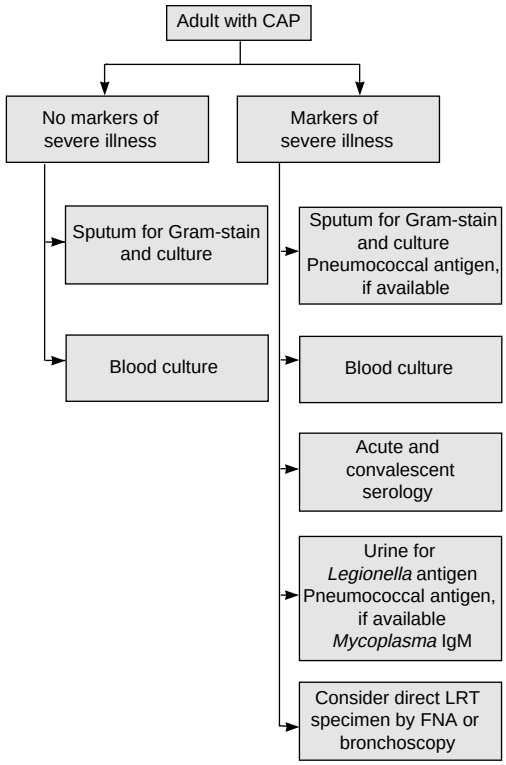

Fig. 1. Algorithm for laboratory investigations for adult patients hospitalised with community-acquired pneumonia (CAP). *Abbreviations:* FNA = fine needle aspiration (for those familiar with this technique); LRT = lower respiratory tract.

tients or those with a high probability of such infection. A raised *Mycoplasma* immunoglobulin M (IgM) titre is often present early in such infection and if available can be useful in making this diagnosis.

Urinary *Legionella* antigen detection by enzyme-linked immunosorbent assay (ELISA) is worthwhile in all severely ill patients for a rapid diagnosis of Legionnaires' disease, but is not of value in those less severely ill. Pneumococcal antigen detection by latex agglutination (blood, sputum) or countercurrent immunoelectrophoresis (blood, sputum, urine) is probably the most sensitive test for pneumococcal infection[6] but is probably impractical for routine testing of all patients. It may be useful, if available, in those who are severely ill. Newer molecular biological techniques [e.g. using polymerase chain reaction (PCR)] for noncommensal pathogens currently remain a research tool, but may come into wider clinical use in the near future.

Finally, in some severely ill patients it may be helpful to directly sample lower respiratory secretions. Bronchoscopy is usually necessary, but should usually only be performed after intubation. Percutaneous, fine needle aspiration is an alternative for those skilled in the technique.[42]

5. Principles of Management

The 3 main targets of management are the correction of gas exchange and fluid balance and selection of antibiotic(s) appropriate to the causative pathogen. The key to all 3 goals is accurate severity assessment.

An accurate severity assessment will help to answer the question of where to manage the patient: home, hospital or intensive care (see section 5.1). The route of initial antibiotic administration will also be determined primarily by illness severity. For the less severely ill patient an oral antibiotic active against only the one or two most common pathogens may be adequate. In the severely ill patient antibiotic therapy must cover all major pathogens initially, which currently usually means dual antibiotic therapy.

5.1 Severity Assessment

A variety of clinical, laboratory, microbiological and radiographic features have been found to be associated with poor outcome in CAP (table III). A list such as this does not help in the management of the individual patient, for which reason an attempt has been made to develop scoring systems which allow a prognosis to be attached to an individual. In the British Thoracic Society (BTS) CAP study the presence of two or more of certain criteria – respiratory rate ≥30/min, diastolic blood pressure (DBP) ≤60mm Hg and blood urea >7mmol/L – was associated with a 20% mortality compared with 2% mortality when one or none of these features was present.[6] Three other studies have confirmed

Table III. Severity markers in community-acquired pneumonia

Clinical feature	Laboratory test
Increasing age	Increased blood urea
Pre-existing chronic illness	Very low *or* very high leucocyte count
Alcoholism	Hypoxia
Tachypnoea	Hypercapnia
Hypotension	Acidosis
Confusion	Abnormal liver function
	Hypoalbuminaemia
	Multilobar infiltrates
	Atrial fibrillation
	Bacteraemia
	Legionella, staphylococcal *or* Gram-negative bacterial infection

the value of this simple prognostic rule for severity assessment.[43-45]

In a recent study from North America, after exclusion of lowest risk (Fine Class I) patients (i.e. no chronic disease, normal mental status, pulse <125 beats/min, respiratory rate <30/min, systolic blood pressure (SBP) ≥90mm Hg and temperature ≥35 or <40°C), a scoring system based on 19 different items has been shown in a large patient cohort to predict outcome on the basis of risk classification into 5 groups.[46]

We would suggest that patients without markers of illness severity (none of the features from the BTS study or meeting criteria of Fine Class I – and possibly II and III) should be considered for home management. The ability of individuals to take oral medication and their social circumstances are also important in this decision.

At the other end of the spectrum, patients with two or more of the features from the BTS study or Fine Class V have a 20 to 30% mortality and should be considered for intensive care management.

6. Drug Management

Pneumonia is an acute disease. As a consequence, it is unusual for a microbial diagnosis to be established sufficiently rapidly for specific therapy to be administered, although as stated above valuable information can be gained from the prompt examination of a good quality Gram-stained sputum specimen. Treatment is therefore of necessity largely empirical, at least initially.

The choice of empirical antibiotic therapy is based on the range of possible pathogens, epidemiological information that may indicate the likelihood of a particular pathogen, and disease severity. A common international practice is to separate those with and without comorbidity (e.g. chronic lung, heart, liver or kidney disease, alcoholism, diabetes mellitus) in the decision as to which empirical antibiotics to prescribe.[47,48] While we have adopted this approach here we believe that this may be a contentious issue. As described above, the evidence that different pathogens are important is weak.

Similarly, there is little clinical evidence to support the view that antibiotic-resistant organisms (especially β-lactamase–producing *H. influenzae*), which may be more frequent in those with comorbidity, should influence antibiotic prescribing. There can be no doubt that those with comorbidity are at increased risk of death. This may be a reason for a different antibiotic policy, but such a policy may be unnecessary if the severity stratifications suggested above are adopted. Comorbidity (and increasing age) may be no more than surrogate markers of the biological fitness of the individual.

Information on the pathogens responsible for CAP and their relative frequencies have been gleaned from many international studies (table II). However, it should be stressed that in all the published studies, approximately one-third of patients had no microbial aetiology established. In normal clinical practice this may rise to as many as three-quarters.[41] In a meta-analysis of 127 studies, which included in excess of 33 000 patients, the mortality from microbiologically undefined pneumonia was of the order of 13%.[10] Overall, *S. pneumoniae* remains the predominant pathogen and hence must always be targeted by any empirical regimen.

The issue of whether to cover for atypical pathogens such as *M. pneumoniae*, *C. pneumoniae*, *Coxiella burnetii* and *Legionella* spp. in nonsevere CAP must take into consideration their relative in-

frequency as a cause of pneumonia accounting for only 2.9% of infections in the cited meta-analysis.[10] However, the issue of periodicity (*M. pneumoniae*) and, as stated earlier, geographical variation (*C. burnetii* and possibly *C. pneumoniae*) needs to be considered. It should also be remembered that a fatal outcome is uncommon apart from *Legionella* pneumonia, where rates of 15% are usual.[10]

The choice of initial empirical therapy is significantly influenced by disease severity, which is a balance between microbial virulence and host response which in turn may be compromised by pre-existing disease and age. These factors conspire to engender variation in disease severity and the risk of death. These issues all affect the decision as to whether all likely pathogens should be targeted, despite the relative infrequency of some, or whether less comprehensive therapy should be given with the opportunity to observe progress and reassess according to response. In medicine, this approach, based on risk assessment, is not unique to the management of CAP. Clearly, it is also important to balance the likelihood of a favourable outcome against the potential for adverse reactions engendered by multidrug regimens. Furthermore, such regimens add to the expense of treatment, particularly when agents other than penicillins are selected.

6.1 International Guidelines

The importance of CAP has led to the publication of guidelines for its initial empirical management by a number of international professional groups. The French guidelines were the first to be published and were rapidly followed by those from the UK and North America.[47-50] These documents reflect the principles guiding the evolution of our understanding of the factors affecting disease severity and take into account the distribution of identifiable pathogens.

The recommendations for initial and alternative drug therapy from France,[49] Britain,[50] Canada,[47] the US[48] and Spain[51] are summarised in table IV. These distinguish between patients who may be treated at home, those with risk factors and those with more severe disease requiring hospitalisation or care within an ICU.

There are clearly differences, not only in the choice of therapy but also in dosage recommendations. Some of these differences reflect international variation in the practice of medicine. The choice of amoxicillin 1g three times daily in the French guidelines is higher than in the UK and in part reflects concerns over the importance of pneumococci with reduced susceptibility to penicillin which is further exemplified by the selection of a dosage recommendation of amoxicillin 150 mg/kg intravenously for unresponsive pneumonia or where penicillin-resistant pneumococci (PRP) are documented.[51]

The issue of antibiotic-resistant pneumococci is of fundamental importance and deserves further comment. This is clearly of international concern, particularly in relation to currently defined high level resistance [minimum inhibitory concentration (MIC) >1mg/L] which has been associated with failure of treatment for infections such as pneumococcal meningitis and otitis media. PRP of intermediate resistances (MIC 0.1 to 1mg/L) causing pneumonia usually respond to high dose penicillin.[52] Uncertainty remains with regard to pneumonia caused by PRP that have greatly reduced susceptibility such as >4mg/L. PRP are more commonly isolated from children, those with HIV infection and in those who have recently received penicillins. They are most prevalent in Spain, South Africa and Eastern Europe but are increasing in all areas.

Therapeutic failure reflects not only an ineffective host response to infection but also issues such as the relationship between drug dosage and pharmacokinetic and pharmacodynamic considerations, as well as variation in target susceptibility of the pathogen.[53] The exact treatment dose necessary remains uncertain for several classes of antibiotic. In addition, the manner in which pharmacodynamic principles apply to such agents as the macrolides and quinolones, which achieve high tissue-to-serum concentrations in the bronchial mu-

Table IV. Summary comparison of international guidelines[51-55] on the initial empirical antibiotic therapy of community-acquired pneumonia

Nationality	Regimen	Age (y)			Intensive care management
		<60, no comorbidity	≥60[a]		
			and/or comorbidity	hospitalised	
French	Preferred	Amoxicillin	Oral cephalosporin	Oral cephalosporin	Macrolide[b] + third-generation cephalosporin
	Alternative	Macrolide[b]	Amoxicillin/clavulanate	Amoxicillin/clavulanate	
British	Preferred	Amoxicillin, ampicillin (IV) *or* benzylpenicillin (penicillin G)	Amoxicillin, ampicillin (IV) *or* benzylpenicillin	Amoxicillin, ampicillin (IV) *or* benzylpenicillin	Macrolide[b] + second- *or* third-generation cephalosporin
	Alternative	Macrolide[b] *or* second- *or* third-generation cephalosporin	Macrolide[b] *or* second- *or* third-generation cephalosporin	Macrolide[b] *or* second- *or* third-generation cephalosporin	Ampicillin + flucloxacillin + macrolide[b]
American/Canadian	Preferred	Macrolide[b]	Second-generation cephalosporin	Second- *or* third-generation cephalosporin	Macrolide[b] + antipseudomonal cephalosporin
	Alternative	Tetracycline	TMP/SMX *or* β-lactam + β-lactamase inhibitor *or* macrolide[b]	Macrolide[b] or β-lactam + β-lactamase inhibitor	Macrolide[b] + imipenem, ciprofloxacin *or* other antipseudomonal β-lactam
Spanish	Preferred	Penicillin/ampicillin	Second- *or* third-generation cephalosporin	Second- *or* third-generation cephalosporin	Macrolide[b] + third-generation cephalosporin
	Alternative	Macrolide[b]	Amoxicillin/ clavulanate	Amoxicillin/ clavulanate	Macrolide[b] + amoxicillin/clavulanate *or* quinolone + third-generation cephalosporin

a French >75y.

b Macrolide = erythromycin or alternative such as clarithromycin.

Abbreviations: IV = intravenous; TMP/SMX = cotrimoxazole (trimethoprim/sulfamethoxazole).

cosa and high intracellular concentrations in alveolar macrophages, is also unclear. These principles have stressed the importance of the relationship between MIC, peak serum concentration and the area under the concentration-time curve (AUC) in relation to the performance of various antibiotic classes.[53] Sustained concentrations of β-lactams above the MIC are important whereas high peak serum concentrations are more predictive of outcome when referring to quinolones and aminoglycosides. The relationship of pharmacodynamic principles to the treatment of pneumonia requires further study in order to better define the most appropriate choice of agent and dosage regimens.

A further example of the differences in emphasis is the reliance on erythromycin in the North American guidelines. This raises concerns, since in certain countries pneumococci are no longer uniformly susceptible to this agent. For example, in the UK 8.6% of strains tested by the Central Public Health Laboratory were resistant to erythromycin, of which some were also of reduced susceptibility to penicillin.[54] Similar concerns arise with regard to the choice of tetracycline (5% resistance in the UK) when treating pneumococcal infection.[54] Clearly, local susceptibility data are important, as is the need for regular revision of any guidelines.

It is also worth commenting on the recommendation for the use of cotrimoxazole (trimethroprim/sulfamethoxazole) in North America. This agent has been the subject of 2 warning letters in 1984 and 1995 by the UK Committee on Safety of Med-

icines because of an increasing number of reports concerning major skin reactions and myelotoxicity.[55] The licence of this agent has now been restricted to the point that it is no longer indicated for the treatment of pneumonia.

Severity assessment figures prominently in the international guidelines, while the issue of comorbidity is emphasised in the guidelines from North America as can be seen in table IV. As stated above, evidence for a clear association of a different range of core pathogens in those with or without comorbidities remains controversial. Overall, the North American guidelines are more detailed than the European ones and clearly distinguish between outpatient and inpatient therapy and, in the case of the latter, whether this is hospital ward- or ICU-based. Furthermore, there is clear guidance in relation to CAP arising within a nursing home population[47,48] where the core pathogens also include Gram-negative enteric organisms, which underscores the point that patients often develop infections based on the flora of their usual environment. With an increasing elderly population and growth in nursing home care this issue will inevitably become more important internationally.

6.2 Recommendations

In putting forward proposals (table V) for the management of CAP it is important to recognise that these are simply guidelines and reflect our interpretation of good practice within an evolving area. Guidelines cannot capture every clinical situation and it therefore remains the responsibility of the physician to balance the history and clinical features, assess the importance of risk factors and interpret local epidemiology and laboratory data in order to make the best judgement for an individual patient. Furthermore, while management will largely be empirical in the first instance, this should be subject to regular review on the basis of

Table V. Empirical treatment of community-acquired pneumonia

Regimen	Comorbidity	
	absent	present
Home-treated, not severe		
Preferred	Amoxicillin 0.5-1.0g tds PO	Amoxicillin/clavulanate 625mg tds PO
Alternative	Erythromycin[a] 250mg qds PO	Clarithromycin 250-500mg bd PO
Hospital-treated (non-ICU), not severe		
Preferred	Amoxicillin 0.5-1.0g tds PO *or* ampicillin 0.5g q6h IV *or* benzylpenicillin (penicillin G) 1.2g q6h IV	Amoxicillin/clavulanate 625mg tds PO *or* 1.2g q8h IV
Alternative	Erythromycin[a] 250-500mg q6h PO *or* IV	Clarithromycin 250-500mg bd PO *or* sparfloxacin[b] 400mg/200mg od PO *or* cefuroxime 750mg q8h IV
Hospital-treated (ICU), severe		
Preferred	Amoxicillin/clavulanate 1.2g q8h IV *and* erythromycin 0.5-1.0g q6h IV/clarithromycin 500mg q12h IV ± rifampicin (rifampin) 600mg q12h PO *or* IV	Cefotaxime 1g q8h IV *or* ceftriaxone 2g od IV *and* erythromycin 0.5-1.0g q6h IV/clarithromycin[c] 0.5g q12h IV ± rifampicin 600mg q12h PO *or* IV
Alternative	Cefuroxime 1.5g q8h IV *and* erythromycin 0.5-1.0g q6h IV/clarithromycin[c] 500mg q12h IV ± rifampicin 600mg q12h PO *or* IV	Imipenem/meropenem 0.5g q8hr IV *and* erythromycin 0.5-1.0g q6h IV/clarithromycin[c] 0.5g q12h IV ± rifampicin 600mg q12h PO *or* IV

a Or alternative macrolide (clarithromycin, azithromycin).

b Or alternative quinolone with Gram-positive activity (see text).

c Alternative agents include ofloxacin, ciprofloxacin, sparfloxacin or doxycycline.

Abbreviations: bd = twice daily; ICU = intensive care unit; IV = intravenous; od = once daily; PO = oral; qds = 4 times daily; q*x*h = every *x* hours; tds = 3 times daily.

Table VI. Empirical treatment of community-acquired suspected *Staphylococcus aureus* pneumonia (non-MRSA and MRSA)

Non-MRSA	MRSA
Hospital-treated, severe	
Flucloxacillin 1-2g q6h IV ± rifampicin (rifampin) 600mg q12h PO/IV + cefotaxime 1-2g q8h IV/ceftriaxone[a] 1-2g q12h IV + erythromycin 0.5-1.0g q6h IV/clarithromycin 0.5g q12h IV	Vancomycin 1g q12h IV ± rifampicin 600mg q12h PO/IV + cefotaxime 1-2g q8h IV/ceftriaxone 1-2g q12h IV + erythromycin[b] 0.5-1.0g q6h IV/clarithromycin 0.5g q12h IV

a MRSA should be considered in known carriers or those admitted from a nursing home where the pathogen is endemic.

b Where *Legionella* infection is also a concern.

Abbreviations: IV = intravenous; MRSA = methicillin-resistant *S. aureus*; PO = oral; q*x*h = every *x* hours.

response to therapy and any subsequent diagnostic information. Recommendations for the specific treatment of suspected *Staphylococcus aureus* (table VI) and other documented pneumonias (table VII) follow our initial empirical recommendations.

Patients with CAP may be treated in the home or in hospital and in the latter may be cared for in low to high dependency units including ICU. The practice of medicine varies internationally in relation to the ratio of home-treated to hospital-treated individuals, and also in the availability of ICU beds which in turn is likely to result in variations in management. The growing practice of earlier transfer from parenteral to oral therapy and earlier discharge will also influence management, while the increasing popularity of non-inpatient intravenous antibiotic therapy adds a further dimension to the interpretation of any recommendations. As in all areas of medicine, there will also be cognisance of the social circumstances of the patient and the availability of carers.

6.2.1 Empirical Drug Therapy

The preferred management of pneumonia treated in the community in the absence of comorbidity is oral amoxicillin (table V). Where there is intolerance to amoxicillin, erythromycin or clarithromycin is proposed largely for activity against *S. pneumoniae* rather than atypical pathogens. On balance clarithromycin has a number of advantages in terms of less frequent administration and better gastrointestinal tolerance; its greater cost is the main reason for the continued use of erythromycin.

Although an increased likelihood of *H. influenzae* in the presence of comorbidities remains controversial,[36] amoxicillin/clavulanate is recommended for its broader spectrum of activity and in particular its ability to deal with that pathogen, regardless of β-lactamase production, particularly in the severely ill. The alternative is clarithromycin where the greater activity of the hydroxy metabolite against *H. influenzae* may add to its effectiveness.

When a decision is made to hospitalise the patient, the recommendations for treatment of non-severe pneumonia are similar but with the option of administering treatment orally or parenterally (table V); when comorbidities are absent oral amoxicillin is recommended with parenteral ampicillin or benzylpenicillin (penicillin G) when oral therapy is contraindicated. In the presence of comorbidities, amoxicillin/clavulanate is proposed while for those intolerant of β-lactams erythromycin, clarithromycin or a new quinolone such as sparfloxacin is suggested. It is recognised that there are a number of new quinolone agents under development with activity against *S. pneumoniae*. At the time of writing these include levofloxacin, trovafloxacin, grepafloxacin, gatifloxacin and sparfloxacin; to date, only sparfloxacin and levofloxacin have been licensed in some countries.

In the management of severe pneumonia it is assumed that treatment will take place within the hospital, either in a standard ward or, according to the severity of the illness, in the ICU. Because of concerns over the possibility of severe atypical pneumonia and in particular Legionnaires' disease, the empirical regimens will cover this possibility regardless of the presence or absence of comorbidities (table V). In their absence, amoxicillin/clavulanate is again proposed by the intravenous

route with cefuroxime as the alternative. In the presence of comorbidities the preferred agents are either cefotaxime or ceftriaxone; the alternatives include either imipenem or meropenem. In treating severe Legionnaires' disease rifampicin should supplement erythromycin. Where there is intolerance to the latter, clarithromycin can be considered; other agents include ofloxacin, ciprofloxacin, sparfloxacin and doxycycline.

Normally, cephalosporins are a satisfactory alternative in those allergic to penicillin, but for those with a history of severe hypersensitivity reactions to penicillins, such as anaphylaxis, cephalosporins and other β-lactams are contraindicated; this is an uncommon clinical dilemma. However, should it arise vancomycin or clindamycin plus an aminoglycoside, or ciprofloxacin and vancomycin can be considered.

6.2.2 Staphylococcus aureus *Pneumonia*

S. aureus pneumonia varies widely in frequency but is clearly a concern in certain countries and is an occasional complication of antecedent influenza.[56] Table VI identifies the initial empirical approach to such patients as well as those known to be a carrier of methicillin-resistant *S. aureus* (MRSA) or admitted from a nursing home where MRSA is known to be endemic and in whom sputum microscopy is suggestive of *S. aureus* pneumonia. In general, *S. aureus* pneumonia is a severe infection and treatment should be by the parenteral route. Treatment should also cover the possibility of other pathogens pending microbiological information. In the absence of comorbidities flucloxacillin (or oxacillin) with or without rifampicin (rifampin) for its antistaphylococcal activity is proposed. For the penicillin-allergic patient clindamycin and cefuroxime provide alternative choices although cefazolin is often preferred in North America. Where there are clear concerns over the possibility of MRSA, vancomycin with or without rifampicin and in combination with a broad spectrum third-generation cephalosporin is suggested.

Table VII. Definitive therapy of microbiologically documented pneumonia

Pathogen	Regimen	
	preferred	alternative
Streptococcus pneumoniae	Amoxicillin 500mg tds PO *or* benzylpenicillin (penicillin G) 1.2g q6h IV	Erythromycin 0.25-0.5g qds PO *or* ceftriaxone 2g od IV
Mycoplasma pneumoniae *Chlamydia pneumoniae*	Erythromycin 0.25-1.0g q6h PO *or* IV (*or* other macrolide)	Tetracycline 0.25-0.5g qds PO *or* 0.5g q12h IV *or* new quinolone[a]
C. psittaci *Coxiella burnetii*	Tetracycline 0.25-0.5g qds PO *or* 500mg q12h IV	Erythromycin 0.5-1.0g q6h PO *or* IV
Legionella spp.	Erythromycin 0.25-0.5g q6h PO *or* IV ± rifampicin (rifampin) 600mg q12h PO *or* IV	Quinolone PO *or* IV *or* doxycycline 100-200mg od PO ± rifampicin 600mg q12h PO *or* IV
Haemophilus influenzae	Non–β-lactamase–producing amoxicillin 500mg tds PO or ampicillin 500mg q8h IV β-lactamase–producing amoxicillin/clavulanate 625mg tds PO *or* 1.2g q12h IV	Cefuroxime 0.75-1.5g q8h IV Cefotaxime 1-2g q8h IV *or* ceftriaxone 2g od IV *or* quinolone PO *or* IV
Gram-negative enteric bacilli	Cefotaxime 1-2g q8h IV/ceftriaxone 1-2g q12h IV	Quinolone IV *or* imipenem/meropenem 0.5-1.0g q8h IV
Pseudomonas aeruginosa	Ceftazidime 2g q8h IV + gentamicin	Ciprofloxacin 400mg q12h IV *or* azlocillin 5g q8h IV + gentamicin *or* tobramycin
Staphylococcus aureus	Non-MRSA (see table VI)	MRSA (see table VI)

a e.g. sparfloxacin, levofloxacin (see text).

Abbreviations: IV = intravenous; MRSA = methicillin-resistant *S. aureus*; od = once daily; PO = oral; qds = 4 times daily; q*x*h = every *x* hours; tds = 3 times daily.

6.2.3 Definitive Therapy of Microbiologically Confirmed CAP

While much of the emphasis of this article is on the initial empirical management of CAP, it would be inappropriate not to conclude with some recommendations with regard to the definitive therapy of microbiologically documented infection. Table VII summarises our recommendations. This provides sufficient choice for either oral or parenteral therapy together with alternatives. In the case of pneumococcal pneumonia, benzylpenicillin still remains the most active and cheapest drug.

C. pneumoniae figures prominently in some published series from North America and Europe[7,21] for which erythromycin or an alternative macrolide antibiotic is preferred; another alternative is one of the more recently introduced quinolones such as sparfloxacin – although to date published information on its performance in this infection remains limited.[57] Table VII also recognises the likely growth in the use of quinolones in the treatment of CAP in view of rising concerns of high level resistant PRPs and their activity against *S. pneumoniae*, atypical organisms and Gram-negative pathogens.

Anaerobic bacteria can frequently be isolated in association with the major pathogens responsible for CAP.[58] However, they are rarely sought and hence anaerobic pneumonia is probably underrecognised. However, it should be considered when there is clear evidence for a major preceding aspiration event accompanying localised pneumonitis which may proceed to lung abscess. Traditionally, high dose benzylpenicillin or clindamycin are recommended for their activity against oropharyngeal anaerobes. Mixed infections may require combination with other agents such as ciprofloxacin.

7. Nondrug Management

Initial clinical assessment together with measurement of blood urea and electrolytes and arterial blood gases form the basis from which to direct management of gas exchange and fluid balance. For most patients admitted to hospital an increase in inspired oxygen fraction (FiO_2) is sufficient to correct gas exchange. High flow oxygen via a continuous positive airway pressure (CPAP) system may correct more severe gas exchange disturbance. For the patient with hypercapnic respiratory failure, especially if the patient is tiring, intubation and assisted ventilation may be required. Intravenous fluids with careful monitoring of fluid balance may be necessary.

Physiotherapy is seldom helpful unless the patient has copious secretions which are difficult to clear. Nonsedative analgesia may improve ventilation and secretion clearance in those with pleuritic chest pain.

8. Response to Therapy and Subsequent Management

In most patients signs of recovery appear within 24 to 48 hours. In these circumstances further investigations are not usually required. Two changes in antibiotic therapy must be considered: first, the switch from intravenous to oral therapy, and second, which oral therapy to switch to. The first question has recently received much attention in the North American literature.[59,60] It must be remembered that these studies are based on the premise that all patients admitted with a diagnosis of CAP should receive intravenous antibiotics. In the UK (and other countries) where one-third of those admitted are treated with oral antibiotics, these studies must be interpreted with this knowledge; nevertheless, a switch to oral therapy for those patients started empirically on parenteral therapy should occur as soon as they have recovered sufficiently. This decision should be directed by clinical assessment, with defervescence being the best sign. Some patients might be considered for hospital discharge at this point – such a decision would depend on the local healthcare system and the level of support and monitoring available at home.

Choice of oral agent is simplified in the minority where a causative pathogen is identified (table VII). In those patients in whom a causative organism is not found and where empirical therapy comprises a combination of antibiotics, it is our view

that in most, where a satisfactory initial antibiotic response occurs, a single oral agent can be selected. An aminopenicillin (± β-lactamase inhibitor) will usually suffice unless the patient is penicillin allergic. A macrolide provides an alternative. In the future, oral quinolones such as levofloxacin or sparfloxacin are likely to be used although the risk of phototoxicity with the latter will affect its use.

Total treatment duration for the uncomplicated pneumonia patient should be no more than 7 days. For *Legionella* and *Chlamydia* pneumonia up to 3 weeks' therapy is indicated. Staphylococcal pneumonia can sometimes respond slowly and treatment may need to be extended beyond 3 weeks. For other patients, their clinical progress should guide duration of therapy.

It is important to remember when assessing progress that radiographic resolution usually lags behind clinical improvement and should not usually be used to guide therapy.[61] In most patients with uncomplicated pneumonia further chest radiographs are unhelpful. However, a repeat chest radiograph may be useful in those who fail to respond to initial therapy to identify radiographic progression, a complication such as empyema. A repeat chest radiograph to exclude underlying lung cancer may be required in smokers; however, it is not clear whether this is of any value in the absence of relevant symptoms (e.g. weight loss).[62]

9. Failure to Respond to Initial Therapy

A not uncommon and sometimes difficult group are the patients who fail to respond to initial therapy. While this is often due to inappropriate expectations on the part of the physician in a patient who is in fact recovering, there are many reasons for this picture (table VIII). In such circumstances it is essential to review all the initial clinical and laboratory information, which if necessary must be repeated. Depending on the circumstances, further investigation such as bronchoscopy may be required, both to directly visualise the airways to exclude obstruction and also to sample the lower respiratory tract.

Table VIII. Causes of treatment failure

Group	Examples
Noninfectious cause for consolidation	Pulmonary eosinophilia
	Wegener's granulomatosis
	Cryptogenic organising pneumonitis
Resistant infection	Actinomycosis
	Tuberculosis
Resistant organism	Penicillin-resistant *S. pneumoniae*
	Ampicillin-resistant *H. influenzae*
	Anaerobes
Associated disease	Lung cancer
	Unrecognised immune compromise
Complication	Empyema
	Metastatic infection
	Drug fever

10. Conclusions

This review of the management of CAP has not addressed issues of infection in childhood or prevention through immunisation. Furthermore, the importance of follow-up of the older patient and those with comorbidity deserves emphasis, particularly since CAP may be the initial harbinger of underlying disease and in particular lung cancer.

Our approach attempts to interpret current knowledge of the aetiology and pathophysiology of CAP. It also recognises the international variation in the approach to this disease and identifies the uncertainties that still surround the issues of age and comorbidity. We likewise recognise the impact of changing patterns of susceptibility of target pathogens on therapeutic choice and in turn have anticipated some of the likely changes that the availability of new drugs may have on the approach to the management of this important disease.

References

1. Melbye H, Berdal BP, Straume B, et al. Pneumonia – a clinical or radiographic diagnosis. Scand J Infect Dis 1992; 24: 647-55
2. Woodhead MA, Macfarlane JT, McCracken JS, et al. Prospective study of the aetiology and outcome of pneumonia in the community. Lancet 1987: I: 671-4

3. Jokinen C, Heiskanen L, Juvonen H, et al. Incidence of community-acquired pneumonia in the population of four municipalities in Eastern Finland. Am J Epidemiol 1993; 137: 977-88
4. Koivula I, Sten M, Makela PH. Risk factors for pneumonia in the elderly. Am J Med 1994; 96: 313-20
5. Macfarlane JT, Finch RG, Ward MJ, et al. Hospital study of adult community-acquired pneumonia. Lancet 1982; II: 255-8
6. British Thoracic Society. Community-acquired pneumonia in adults in British hospitals in 1982-1983: a survey of aetiology, mortality, prognostic factors, and outcome. Q J Med 1987; 62: 195-220
7. Fang G-D, Fine M, Orloff J, et al. New and emerging etiologies for community-acquired pneumonia with implications for therapy: a prospective multicenter study of 359 cases. Medicine 1990; 69: 307-16
8. Mundy LM, Auwaerter PG, Oldach D, et al. Community-acquired pneumonia: impact of immune status. Am J Respir Crit Care Med 1995; 152: 1309-15
9. Marrie TJ, Durant H, Yates L. Community-acquired pneumonia requiring hospitalisation: 5 year prospective study. Rev Infect Dis 1989; 11: 586-99
10. Fine MJ, Smith MA, Carson CA, et al. Prognosis and outcomes of patients with community-acquired pneumonia. JAMA 1996; 275: 134-41
11. Almirall J, Morato I, Riera F, et al. Incidence of community acquired pneumonia and *Chlamydia pneumoniae* infection: a prospective multicentre study. Eur Respir J 1993; 6: 14-8
12. Marrie TJ, Peeling RW, Fine MJ, et al. Ambulatory patients with community-acquired pneumonia: the frequency of atypical agents and clinical course. Am J Med 1996; 101: 508-15
13. Berntsson E, Lagergard T, Strannegard O, et al. Etiology of community-acquired pneumonia in outpatients. Eur J Clin Microbiol 1986; 5: 446-7
14. Ausina V, Coll P, Sambeat M, et al. Prospective study on the etiology of community-acquired pneumonia in children and adults in Spain. Eur J Clin Microbiol Infect Dis 1988; 7: 343-7
15. Berntsson E, Blomberg J, Lagergard T, et al. Etiology of community-acquired pneumonia in patients requiring hospitalisation. Eur J Clin Microbiol 1985; 4: 268-72
16. Bohte R, van Furth R, van den Broek P J. Aetiology of community-acquired pneumonia: a prospective study among adults requiring admission to hospital. Thorax 1995; 50: 543-7
17. Holmberg H. Aetiology of community-acquired pneumonia in hospital-treated patients. Scand J Infect Dis 1987; 19: 491-501
18. Levy M, Dromer F, Brion N, et al. Community-acquired pneumonia: importance of initial noninvasive bacteriologic and radiographic investigations. Chest 1988; 92: 43-8
19. Lieberman D, Schlaeffer F, Boldur I, et al. Multiple pathogens in adult patients admitted with community-acquired pneumonia: a one year prospective study of 346 consecutive patients. Thorax 1996; 51: 179-84
20. Ortqvist A, Hedlund J, Grillner L, et al. Aetiology, outcome and prognostic factors in community-acquired pneumonia requiring hospitalisation. Eur Respir J 1990; 3: 1105-13
21. Steinhoff D, Lode H, Ruckdeschel G, et al. *Chlamydia pneumoniae* as a cause of community-acquired pneumonia in hospitalized patients in Berlin. Clin Infect Dis 1996; 22: 958-64
22. British Thoracic Society Research Committee and the Public Health Laboratory Service. The aetiology, management and outcome of severe community-acquired pneumonia in the intensive care unit. Respir Med 1992; 86: 7-13
23. Moine P, Vercken J-B, Chevret S, et al. Severe community-acquired pneumonia: etiology, epidemiology and prognosis factors. Chest 1994; 105: 1487-95
24. Ortqvist A, Sterner G, Nilsson JA. Severe community-acquired pneumonia: factors influencing need of intensive care treatment and prognosis. Scand J Infect Dis 1985; 17: 377-86
25. Torres A, Serra-Batlles J, Ferrer A, et al. Severe community-acquired pneumonia: epidemiology and prognostic factors. Am Rev Respir Dis 1991; 144: 312-8
26. Woodhead MA, Macfarlane JT, Rodgers FG, et al. Aetiology and outcome of severe community-acquired pneumonia. J Infect 1985; 10: 204-10
27. Sobradillo V, Ansola P, Baranda F, et al. Q fever pneumonia: a review of 164 community-acquired cases in the Basque country. Eur Respir J 1989; 2: 263-6
28. Marrie TJ, Haldane EV, Faulkner RS, et al. The importance of *Coxiella burnetii* as a cause of pneumonia in Nova Scotia. Can J Publ Health 1985; 76: 233-6
29. Feldman C, Kallenbach JM, Levy H, et al. Community-acquired pneumonia of diverse aetiology: prognostic features in patients admitted to an intensive care unit and a 'severity of illness' score. Intensive Care Med 1989; 15: 302-7
30. Chan CHS, Cohen M, Pang J. A prospective study of community-acquired pneumonia in Hong Kong. Chest 1992; 101: 442-6
31. Alkhaeyer M, Jenkins PF, Harrison BDW. The outcome of community-acquired pneumonia treated on the intensive care unit. Respir Med 1990; 84: 13-6
32. Hirani N, Macfarlane JT. Impact of management guidelines on the outcome of severe community-acquired pneumonia. Thorax 1997; 52: 17-21
33. Sorensen J, Cederholm I, Carlsson C. Pneumonia: a deadly disease despite intensive care treatment. Scand J Infect Dis 1986; 18: 329-35
34. Pachon J, Prados MD, Capote F, et al. Severe community-acquired pneumonia: etiology, prognosis and treatment. Am Rev Respir Dis 1990; 142: 369-73
35. Leroy O, Santre C, Beuscart C, et al. A five year study of severe community-acquired pneumonia with emphasis on prognosis in patients admitted to an intensive care unit. Intensive Care Med 1995; 21: 24-31
36. Torres A, Dorca J, Zalacain R, et al. Community-acquired pneumonia in chronic obstructive pulmonary disease: a Spanish multicentre study. Am J Respir Crit Care Med 1996; 154: 1456-61
37. Venkatesan P, Gladman J, Macfarlane JT, et al. A hospital study of community-acquired pneumonia in the elderly. Thorax 1990; 45: 254-8
38. Bourke SJ, Lightfoot NF. *Chlamydia pneumoniae*: defining the clinical spectrum of infection requires precise laboratory diagnosis. Thorax 1995; 50 Suppl. 1: S43-8
39. Levy H. Hantavirus infection. Curr Opin Infect Dis 1997; 10: 103-8
40. Woodhead MA. Atypical pneumonia. Curr Opin Infect Dis 1997; 10: 101-2
41. Woodhead MA, Arrowsmith J, Chamberlain-Webber R, et al. The value of routine microbial investigation in community-acquired pneumonia. Respir Med 1991; 85: 313-7
42. Manresa F, Dorca J. Needle aspiration techniques in the diagnosis of pneumonia. Thorax 1991; 46: 601-3
43. Farr BM, Sloman AJ, Fisch MJ. Predicting death in patients hospitalised for community-acquired pneumonia. Ann Intern Med 1991; 115: 428-36

44. Karalus NC, Cursons RC, Leng RA, et al. Community-acquired pneumonia: aetiology and prognostic index evaluation. Thorax 1991; 46: 413-8
45. Neill AM, Martin IR, Weir R, et al. Community-acquired pneumonia: aetiology and usefulness of severity criteria on admission. Thorax 1996; 51: 1010-6
46. Fine MJ, Auble TE, Yealy DM, et al. A prediction rule to identify low-risk patients with community-acquired pneumonia. N Engl J Med 1997; 336: 243-50
47. Mandell LA, Niederman M, The Canadian community-acquired pneumonia consensus conference group. Can J Infect Dis 1993; 4: 25-8
48. Niederman MD, Low BJ, Campbell GD, et al. Guidelines for the initial management of adults with community-acquired pneumonia: diagnosis, assessment of severity and initial antimicrobial therapy. Am Rev Respir Dis 1993; 148: 1418-26
49. Société de Pathologie Infectieuse de Langue Française. Infections des voies respiratoires: conférence de concensus en thérapeutique anti-infectieuse. Rev Med Infect 1991; 21: 1s-8s
50. British Thoracic Society. Guidelines for the management of community-acquired pneumonia in adults admitted to hospital. Br J Hosp Med 1993; 49: 349-50
51. SEPAR (Spanish Thoracic Society). National recommendations for diagnosis and treatment of community acquired pneumonia. Barcelona: Ediciones Doyma SA , 1992
52. Pallares R, Linares J, Vadillo M, et al. Resistance to penicillin and cephalosporin and mortality from severe pneumococcal pneumonia in Barcelona, Spain. N Engl J Med 1995; 333: 474-80
53. Drusano G. Pharmacology of anti-infective agents. In: Mandell GL, Bennett JE, Dolin R, editors. Principles and practice of infectious diseases. Chap 14. New York: Churchill Livingstone, 1995: 225-33
54. Johnson AP, Speller DCE, George RC, et al. Prevalence of antibiotic resistance and serotypes in pneumococci in England and Wales: results of observational surveys in 1990 and 1995. BMJ 1996; 312: 1454-6
55. Committee on Safety of Medicines. Current Problems. Curr Probl Pharmacovig 1996; 21: 6
56. Woodhead MA, Radvan J, Macfarlane JT. Adult community-acquired staphylococcal pneumonia in the antibiotic era: a review of 61 cases. Q J Med 1987; 64: 783-90
57. Gialdroni Grassi G, Brumpt I. Sparfloxacin empirical therapy in community-acquired pneumonia: results of a meta-analysis of 2 comparative studies. Drugs 1995; 49 Suppl. 2: 406-8
58. Bartlett JG, Mundy LM. Community-acquired pneumonia. N Engl J Med 1995; 333: 1618-24
59. Weingarten SR, Riedinger MS, Varis G, et al. Identification of low-risk hospitalised patients with pneumonia: implications for early conversion to oral antimicrobial therapy. Chest 1994; 105: 1109-15
60. Ramirez JA, Srinath L, Ahkee S, et al. Early switch from intravenous to oral cephalosporins in the treatment of hospitalised patients with community-acquired pneumonia. Arch Intern Med 1995; 155: 1273-6
61. Macfarlane JT, Miller AC, Smith WHR, et al. Comparative radiographic features of community-acquired legionnaires' disease, pneumococcal pneumonia, mycoplasma pneumonia and psittacosis. Thorax 1984; 39: 28-33
62. Holmberg H, Kragsbjerg P. Association of pneumonia and lung cancer: the value of convalescent chest radiography and follow up. Scand J Infect Dis 1993; 25: 93-100

Correspondence and reprints: Professor *Roger G. Finch*, Department of Microbiology and Infectious Diseases, City Hospital and University of Nottingham, Nottingham NG5 1PB, England.
E-mail: r.finch@nottingham.ac.uk