Lower respiratory tract infections are caused by a wide range of pathogens and, where appropriate, antibiotic treatment should be chosen with resistance and side-effects in mind. Our Drug review discusses recommended management of LRTIs in the community, followed by Resources and the Datafile.

Lower respiratory tract infections (LRTIs) cover a broad spectrum of pathological processes and aetiologies, including acute and chronic bronchitis, bronchiolitis and acute and chronic pneumonia, as well as pleural effusions, empyemas and lung abscesses.

The latter three conditions will usually be managed in hospital initially, and treatment will depend on the microbiology. In complicated pneumonias, eg in immunosuppressed or HIV-infected individuals, and in chronic lung conditions such as cystic fibrosis, decisions on antibiotic therapy should be made by the specialist physician looking after the patient in conjunction with a microbiologist, virologist or infectious disease physician.

This review concentrates on the LRTIs that are seen and managed by GPs. Appropriate patient selection for treatment and the correct use of agents is important, not only in optimising therapy for the individual patient but also in order to keep emergence of resistance and side-effects such as *Clostridium difficile* diarrhoea to a minimum. In these conditions the indication for
antibiotic use and the type of antibiotic used will depend upon the diagnosis and the severity of the disease, which may give clues as to the likely aetiology.

Other factors to be considered in choosing an antibiotic are the spectrum of activity of the drug, the local resistance pattern, the side-effect profile, contraindications, interactions with other drugs that the patient may be taking (see Table 1; refer to the BNF for a comprehensive list), tolerability (including the frequency of dosing) and the cost.

Community-acquired pneumonia
Community-acquired pneumonia (CAP) is an LRTI with lung parenchymal involvement. CAP affects 5-11 per 1000 of the population per year, with a greater proportion affected at the extremes of age.

Diagnosis of CAP in the community relies on clinical features. Patients may present with some of the following features: cough, fever, sputum production (may be purulent or blood stained), dyspnoea, pleuritic chest pain and localised chest signs. Older patients may present with nonrespiratory symptoms such as confusion, falls or worsening of a chronic illness, and may not have a fever. Very young patients may also present with nonspecific symptoms such as abdominal pain.

Initial assessment
Disease severity should be assessed in order to decide whether the patient requires hospital admission. Various severity indices have been produced, but one of the simplest is the CURB-65 severity score summarised in the 2004 update of the 2001 British Thoracic Society (BTS) guidelines. This has been adapted to the CRB-65 score (see Figure 1) for use in the community where a blood urea is not generally available at the time of initial assessment.

Using the CRB-65 score, patients are at low risk of death if they have no core prognostic features, and can therefore be considered for treatment at home. If there are more than two core features, mortality rises steeply and the patient should be managed in hospital.

In intermediate groups scoring 1 or 2, clinical judgement should be used taking into account the patient’s wishes and social circumstances. Co-existent disease or the presence of confusion – Mini-Mental State Examination (MMSE) test score of ≤8/10 or new disorientation in time, place or person – in the patient should prompt consideration of hospitalisation. Status should be reviewed regularly.

Causative agents and investigations
A diverse selection of pathogens are responsible for CAP, and clinical, epidemiological and radiographic information is frequently unhelpful in predicting the aetiology. Even when microbiology results are available, the delay in obtaining results and the limitations of the available diagnostic tests in identifying the aetiological agent make empirical treatment necessary (see Table 2).

Differentiation of pneumonia caused by ‘typical’ and ‘atypical’ pathogens on clinical grounds alone has been shown to be unreliable. The latest BTS guidelines suggest that microbiology tests are of low sensitivity, particularly in patients with nonsevere CAP and no co-morbid

| Drug                      | Important interactions                                           |
|---------------------------|-----------------------------------------------------------------|
| Beta-lactams, eg amoxicillin | • allopurinol – risk of rash with ampicillin and amoxicillin   |
|                           | • oral contraceptive pill – possible decreased efficacy         |
|                           | • warfarin – increased anticoagulant effect                     |
| Erythromycin and other macrolides | • antiarrhythmics – increased risk of arrhythmias               |
|                           | • antiepileptics – inhibition of metabolism of carbamazepine,  |
|                           | • phenytoin and possibly sodium valproate                       |
|                           | • antihistamines – risk of hazardous arrhythmias with           |
|                           | • terfenadine                                                   |
|                           | • anxiolytics – inhibition of metabolism resulting in an       |
|                           | • increased sedative effect, eg midazolam                      |
|                           | • cimetidine – increased toxicity of macrolide, eg deafness    |
|                           | • warfarin – increased anticoagulant effect                     |
| Tetracyclines             | • antiepileptics – increased metabolism of doxycycline         |
|                           | • with carbamazepine, phenytoin and some other anticonvulsants |
|                           | • calcium salts and dairy products – reduced absorption         |
|                           | • of tetracyclines (less marked with doxycycline and minocycline) |
|                           | • iron and zinc – reduced absorption of both the metal         |
|                           | • and the tetracycline                                            |
|                           | • COC – possible decreased efficacy of COC                      |
|                           | • warfarin – possible increased anticoagulant effect            |
| Quinolones                | • antacids – decreased absorption of quinolones                 |
|                           | • metal salts, eg iron, zinc and calcium – reduced absorption of quinolones |
|                           | • NSAIDs – possible increased risk of convulsions               |
|                           | • theophylline – possible increased risk of convulsions         |
|                           | • warfarin – increased anticoagulant effect                     |
|                           | • some of the newer fluoroquinolones, eg moxifloxacin,          |
|                           | • have an increased risk of arrhythmias with a number of drugs (see BNF) |

Table 1. Some of the more commonly encountered drug interactions to be considered in patients taking antibiotics for the treatment of LRTIs
disease. Although legionella and pneumococcal antigen testing kits are now available and have considerably greater sensitivity than blood or sputum cultures, their routine use in patients at low risk is felt not to be cost effective. The extent of microbiological investigations in patients with nonsevere CAP should be guided by clinical and epidemiological factors and by the response to previous antibiotic therapy.2

*Streptococcus pneumoniae* is the major cause of CAP, accounting for over a third of cases in the community, *Mycoplasma pneumoniae* exhibits periodicity, with epidemics every four to five years, and mainly affects younger individuals. Influenza virus, along with a number of other viruses, contributes a sizeable proportion of cases (13 per cent). Other causes of CAP include *Haemophilus influenzae* (10 per cent), *Legionella pneumophila, Coxiella burnetii, Chlamydia* species and *Staphylococcus aureus*, especially when influenza co-exists in the community.2

More unusual forms of pneumonia to consider are *Pneumocystis carinii* pneumonia in patients with HIV and other forms of immunosuppression – much less frequently seen these days because of the use of prophylactic co-trimoxazole – TB in those with a more chronic pneumonia, and rare fungal and bacterial forms of pneumonia in those who have travelled.

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**Figure 1.** When to refer patients with CAP. Adapted from the BTS Guidelines for the Management of Community Acquired Pneumonia2

| Core feature | Cut-off |
|--------------|---------|
| Confusion    | MMSE≤8/10 or new disorientation in time, place or person |
| Respiratory rate | ≥30 per min |
| Blood pressure | systolic <90mmHg or diastolic ≤60mmHg |
| Age          | ≥65 years |

- no core features
- 1-2 core features
- ≥3-4 core features

- assess pre-existing adverse prognostic features, eg co-existing disease
  - yes
    - consider additional adverse prognostic features, eg oxygen saturation <92%
    - clinical judgement
    - urgent hospital referral
  - no
    - management at home likely to be appropriate provided this is consistent with patient’s wishes and with social circumstances

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We need to remain alert to emerging causes of pneumonia such as avian flu and severe acute respiratory syndrome (SARS). These should be considered in all patients presenting with a fever, cough or shortness of breath who have a relevant travel or contact history.\textsuperscript{3,4} Infection control issues will need to be addressed in these patients and an expert should be consulted in cases fitting the diagnostic criteria.

\textit{Pneumonia in children} has a slightly different epidemiological pattern. Neonates may develop pneumonia from organisms acquired from the mother’s genital tract such as Group B Strep\textit{t}ococcus, Gram-negative organisms and \textit{Chlamydia}. These children will usually be admitted to hospital for treatment. In one-month- to four-year-old children, most pneumonias are viral in origin and will not require antibiotics. Bacterial pneumonias in this age group are predominantly due to \textit{Strep. pneumoniae}, whereas in the over-fours \textit{Strep. pneumoniae} and \textit{M. pneumoniae} are the most frequently isolated organisms.\textsuperscript{5}

\textit{Resistance} Concerns exist over the growing number of resistant bacteria, in particular \textit{Strep. pneumoniae}, \textit{H. influenzae} and methicillin-resistant Staph. aureus (MRSA). Penicillin-resistant \textit{Strep. pneumoniae} of concern, especially as resistance is frequently linked to macrolide resistance. Penicillin resistance in \textit{Strep. pneumoniae} varies widely between countries, communities and groups of patients within those communities. In the UK in the year 2000, the rate of penicillin resistance was around 7 per cent but with a range of 4-13 per cent. Erythromycin resistance had a range of 10-22 per cent. Resistance of \textit{H. influenzae} to ampicillin – mainly due to beta-lactamase production – is around 20 per cent in the UK.\textsuperscript{6}

\textbf{Treatment}

Empirical treatment in the community is based on the fact that \textit{Strep. pneumoniae} remains the leading cause of CAP. Prudent use of antibiotics is important in order to treat infections appropriately to curb the growing problem of antimicrobial resistance and to minimise side-effects and maximise compliance. Once a decision is made to treat, local resistance patterns must be taken into account.

BTS recommendations are based on current practice and experience and take into account the cost, tolerance, safety and side-effect profile of the drugs currently available. As yet, the incidence of highly penicillin-resistant strains of \textit{Strep. pneumoniae} in most areas of the UK is sufficiently low to allow amoxicillin to remain the first-line therapy for adults and for children under five years of age – provided that the patient has not just returned from an area where the incidence is much greater. Note, however, that the latest BTS guidelines recommend adequate dosing with amoxicillin (500mg-1g three times daily) to cover intermediate-resistant strains.\textsuperscript{2,7}

| Condition                      | Causative organism                      | Empiric therapy                              | Other considerations                                      |
|-------------------------------|----------------------------------------|----------------------------------------------|-----------------------------------------------------------|
| Pneumonia                     | • Strep. pneumoniae, influenza virus, M. pneumoniae, H. influenzae, L. pneumophila, C. burnetii, C. pneumoniae, Enterobacteriaceae, Staph. aureus | • must be active against Strep. pneumoniae, eg amoxicillin, erythromycin | • immunisation against influenza and pneumococcus  
• beware of increasing penicillin-resistant Strep. pneumoniae |
| Acute exacerbation of COPD    | • most are viral, some due to H. influenzae, Strep. pneumoniae or M. catarrhalis | • often no need for antibiotics  
• see Table 4 for criteria for antibiotics | • immunisation against influenza and pneumococcus  
• stop smoking |
| Acute bronchitis              | • usually viral, occasionally B. pertussis, M. pneumoniae or C. pneumoniae | • rarely indicated  
• if evidence of pertussis, Mycoplasma or Chlamydia infection, treat with a macrolide | • consider pertussis as a cause  
• immunise as per Green Book against pertussis and influenza |
| Bronchiolitis                 | • RSV, other viruses, occasionally Mycoplasma | • none usually necessary  
• antivirals may be used by hospital doctors | • if in a high-risk group consider prophylaxis on the advice of a paediatrician |

Table 2. Summary of conditions, causative agents, empirical therapy and other considerations in LRTIs treated in the community.
Erythromycin is the second-line agent of choice if there are contraindications to amoxicillin or the patient fails to tolerate it. Macrolides are the first-line agents in children over five years in whom *M. pneumoniae* is common. Many people favour clarithromycin over erythromycin because of its better GI tolerance. Azithromycin (Zithromax) is another alternative to erythromycin. The macrolides are also the treatment of choice in people with pneumonia proven to be due to ‘atypical’ organisms, and are routinely added to the treatment regimen in hospitalised patients with moderately severe pneumonia.

Tetracyclines are not recommended as empirical therapy in the UK mainly because of concerns over inadvertent prescribing in children and pregnant women. Treatment may be rationalised if a specific pathogen is identified or if sensitivities are at variance with the empirical regimen. This should be guided by local microbiological advice.

Patients should improve on appropriate therapy within 48 hours. It is therefore important to review them at this stage or earlier. If they have failed to improve they should be considered for addition of an agent to cover atypical organisms if not already on one.
or for radiography and/or hospital admission (see Figure 1). Over the last few years several new drugs with greatly improved bioavailability and tolerability have become available for use in the treatment of CAP. The fluoroquinolones, *eg* moxifloxacin (Avelox) and levofloxacin (Tavanic), which have antistreptococcal activity, have both an excellent antimicrobial spectrum – they are active against atypical pathogens and *Legionella* species as well as the common ‘typical’ organisms – and advantageous pharmacodynamic characteristics. They are likely to become more widely used with an increase in penicillin- and macrolide-resistant pneumococci and demonstrable failure of current therapies.

Moxifloxacin has now been licensed for use in mild CAP. However, due to concerns over the rapid development of fluoroquinolone resistance in pneumococci and other organisms, current recommendations are that these newer fluoroquinolones should be kept in reserve and considered only when the first-line agents have been ineffective and when the causative organism is known to be sensitive. Some hospitals are using these agents to treat CAP in penicillin-allergic individuals. Quinolones are not recommended for use in the under-18s except on the advice of a paediatrician or microbiologist.

Viruses contribute to about 13 per cent of cases of CAP, of which influenza A and B account for about 8 per cent. In the over-65s and those with concomitant chronic disease or immunosuppression, influenza contributes to a particularly high mortality. Patients at risk of severe influenza who can start on treatment within 48 hours of the onset of symptoms may be candidates for oseltamivir (Tamiflu) or zanamivir (Relenza); see www.hpa.org.uk/infections/topics_az/influenza for the latest guidelines.

**Prevention**

Emphasis needs to be placed on primary prevention of LRTIs. Influenza vaccination has been shown to reduce hospital admissions, death rates from pneumonia and flu, prevent pneumonia and decrease outpatient visits for all respiratory conditions in over-65s and patients with chronic lung disease. Vaccination should be offered to all those in high-risk groups – including institutionalised

| Lung function and other considerations | Aetiology | Antibiotics | Persistent symptoms |
|----------------------------------------|----------|-------------|---------------------|
| normal lung function and ≤60 years old | usually viral | none | try a macrolide in case C. pneumoniae or Mycoplasma |
| FEV₁ ≥50% predicted and <4 exacerbations per year and ≤60 years old | *H. influenzae* or *Strep. pneumoniae* | beta-lactam (but add beta-lactamase inhibitors in regions with high rates of beta-lactamase-producing *H. influenzae*) | beta-lactam + beta-lactamase inhibitor, second- or third-generation cephalosporin |
| FEV₁ ≤50% predicted or 50-65% but with significant concomitant medical disease or ≥4 exacerbations per year* or elderly | *H. influenzae*, *Strep. pneumoniae* or *M. catarrhalis* | beta-lactam + beta-lactamase inhibitor, quinolone, second- or third-generation cephalosporin, second-generation macrolide |

*people fitting into this category who have continuous sputum production all year round may also be colonised with coliform bacilli or pseudomonads, and this will need to be taken into account when choosing an antibiotic

Table 4. Stratification of patients with acute exacerbation of COPD (adapted from Wilson¹⁵ and Grossman¹⁶)
individuals – on an annual basis. Influenza vaccine is con-
traindicated in those severely allergic to eggs.10

In at-risk persons of 13 years or older who have not
been vaccinated, and in institutionalised individuals,
when influenza A or B is known to be circulating in the
community, oseltamivir may be used for postexposure
prophylaxis within 48 hours of exposure.3

Pneumococcal vaccine should also be offered to
selected individuals. The current 23-valent vaccine
(Pneumovax II) includes serotypes responsible for 96
per cent of bacteraemic infections in the UK. It is rec-
commended by the DoH for all persons over two years
of age in whom pneumococcal infection is more com-
mon or more dangerous. This includes individuals with
asplenia or functional asplenia (eg sickle-cell disease,
coeliac disease), chronic renal, heart, lung and liver
disease, diabetes mellitus, immunodeficiency and
immunosuppression. It is contraindicated in acute
infection and in pregnancy.10,11

The conjugate vaccine (Prevenar) has increased
immunogenicity in infants, and is being introduced into
the routine immunisation programme (see The Green
Book).10 There are no plans for the widespread intro-
duction of the conjugate vaccine in the over-60s as yet.

Smoking should be discouraged.

Chronic pneumonia

In cases of chronic pneumonia where a pulmonary
parenchymal process has been present for weeks to
months, other causes need to be considered including
TB and a host of both infectious and noninfectious
causes.12 Exacerbations of infection in patients with
cystic fibrosis should be treated in conjunction with
the specialist involved in their care.

Empyemas and lung abscesses

The majority of empyemas are secondary to pneumo-
nia, but can result from other causes such as trauma,
oesophageal perforation or subdiaphragmatic infec-
tions, and the bacterial agent(s) isolated will depend
upon the aetiology of the disease. This is a complex
case with a poor prognosis if missed or misman-
aged. Patients with these conditions should be man-
ger in hospital in the first instance.

Acute exacerbation of COPD

Acute exacerbations of chronic obstructive pulmonary
disease (AECOPD) are characterised by increased
cough, sputum production, purulence of sputum, and
dyspnoea in someone with a background of excessive
cough productive of sputum on most days of more
than three months of at least two consecutive years.
Infections account for most exacerbations, but aller-
gens, pollutants and irritants can also contribute.

Aetiology

The majority of exacerbations are self-limiting with a
viral aetiology and do not require antibiotic therapy,
despite the presence of neutrophils and bacteria in the
sputum. Three bacterial pathogens are predominant
in AECOPD and account for over 70 per cent of the
bacteria isolated: H. influenzae, Strep. pneumoniae and
Moraxella catarrhalis. Less commonly, Staph. aureus,
Gram-negative bacilli, other streptococci, Mycoplasma
and Chlamydia pneumoniae play a role.

Initial assessment

Despite the frequent viral aetiology, a meta-analysis of
the literature on treatment of AECOPD favoured the
use of antibiotics in patients with severe disease,
although the benefit seen was small and could be
attributed to the expected variation of peak expiratory
flow rate (PEFR) results in patients.13

The largest study on the use of antibiotics in acute
exacerbations demonstrated that patients with two or
more of increased dyspnoea, increased sputum volume
and sputum purulence improved significantly if given
antibiotics compared to those on placebo.14

Stratifying patients into risk groups has been sug-
gested in order to minimise hospitalisation and target
therapy more appropriately (see Table 4). In the lower-
risk groups narrower-spectrum antibiotics can be used
first line, whereas for those in whom failure of antibiotic
therapy could have serious consequences, treatment
should be directed against resistant organisms.15,16

Antibiotic therapy

A fair percentage of H. influenzae (approximately 20 per
cent in the UK in 2000)4 and of M. catarrhalis (approx-
Acute bronchitis

Acute bronchitis is an inflammatory condition of the tracheobronchial tree characterised by a severe cough, frequently lasting several weeks. Patients may also have a fever, hoarseness, sputum production, dyspnoea or a wheeze, with a background of a preceding upper respiratory tract infection (URTI).

Aetiology

Acute bronchitis is usually due to respiratory viruses, eg rhinovirus, coronavirus, influenza, parainfluenza, respiratory syncytial virus (RSV), adenovirus and, though rarely seen nowadays, measles. Nonviral causes include Bordetella pertussis, M. pneumoniae and C. pneumoniae. The role of Strep. pneumoniae and H. influenzae in acute bronchitis remains unclear – these organisms are commonly isolated from specimens, but this is likely to reflect the fact that they are normal commensals of the upper respiratory tract. Symptoms are worse in those exposed to cigarette smoke and other pollutants.

Noninfectious conditions that may mimic acute bronchitis and should be considered include foreign body aspiration and malignancy.17 In those at risk, TB should also be excluded.

Management

The majority of patients with acute bronchitis do not require anything other than symptomatic therapy, and antibiotics are not indicated for the majority of cases, even in the presence of purulent sputum.5 Recent studies have suggested that up to one-fifth of adults with acute severe cough have pertussis.18 Adults whose immunity to pertussis is waning are a major reservoir for B. pertussis. It is therefore important to consider this as a diagnosis in those with a persistent cough and to take a nasopharyngeal swab/aspirate for culture if indicated. Treatment for pertussis is 14 days of erythromycin and is primarily aimed at eliminating carriage. It is also effective in decreasing the duration and severity of disease in the catarhal phase, but may not alter the course once patients are in the paroxysmal stage.

Patients with acute bronchitis due to M. or C. pneumoniae should also receive antibiotics. Macrolides are the first-line therapy for these conditions. Tetracyclines can be used in the groups in which they are not contraindicated (children under eight years old and pregnant women). In patients with significant co-morbidity, first-line antibiotics are amoxicillin, erythromycin or tetracyclines. If patients do not respond to these, consider co-amoxiclav, tetracyclines, clarithromycin or azithromycin.5 Anti-influenza agents may be considered in those in whom a swift diagnosis is made.8

Prevention

Immunisation against influenza and pertussis as guided by current DoH recommendations5 will reduce some of the burden of this disease, and discouraging smoking is another important preventive strategy.

Acute bronchiolitis

Bronchiolitis is an acute LRTI characterised by acute onset of wheeze, cough, rhinorrhea, tachypnoea and respiratory distress, although it may manifest as lethargy, irritability, poor feeding and apnoeic episodes. RSV is the most important cause of bronchiolitis in infants and young children. Other aetiological agents include parainfluenzae, adenovirus, rhinovirus and occasionally Mycoplasma.

Management

Many cases can be managed in the community, but children may need admission for greater supportive therapy, such as intravenous hydration and oxygen. Risk

Key points

- appropriate patient selection for treatment and use of antibiotics is important both for the individual and from the public health perspective of minimising the emergence of resistance
- CAP is a common infection with significant mortality
- Strep. pneumoniae is the commonest aetiological agent in CAP and antibiotics should be directed against this unless there is clear evidence of an alternative aetiology
- the majority of cases of acute bronchitis and acute exacerbations of COPD are viral in origin
- assessment of severity of LRTIs is important in deciding whether antibiotics are needed and, if so, the spectrum of cover required
- local and national antibiotic resistance patterns should be taken into account when drawing up local guidelines
- immunisation against influenza and Strep. pneumoniae are important preventive measures in at-risk individuals
- smoking should be discouraged in all individuals
factors for more severe disease include cyanotic or complicated congenital heart disease, underlying pulmonary disease, prematurity and immunodeficiency due to underlying disease or therapy, and children falling into these categories should be admitted in most cases.

Preventive measures should be taken to reduce the risk of exposure of these children to infected individuals. Particular attention should be paid to hand-washing to reduce transmission if someone in the household is suffering from a URTI.

**Conclusion**

LRTIs encapsulate a wide range of pathologies caused by a broad spectrum of organisms and need differentiating in order to decide on the most appropriate empirical therapy. CAP is a common infection with significant mortality and, because of the proportion of cases that are due to *Strep. pneumoniae*, therapy should always include adequate cover against this organism. Increasing levels of antibiotic resistance are of concern and local patterns may lead to different regimens for different regions, or for patients who have acquired their infections elsewhere.

Most cases of acute bronchitis and exacerbations of COPD are viral in origin and do not require antibiotic therapy. However, certain groups of patients are more vulnerable and antibiotics may be warranted. Lung function, age and premorbid condition should be taken into account when assessing such patients.

Preventive measures, such as immunisation against influenza and *Strep. pneumoniae*, should be considered in at-risk individuals, and smoking discouraged.

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