Pneumonia in the ICU

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Abstract

Community-acquired and nosocomial pneumonia occur frequently within their defined populations. Community-acquired pneumonia presents a spectrum of severity from mild to rapidly fatal disease. The CURB-65 score is used to define severity together with co-morbid conditions and other criteria. In those patients identified as suffering from severe disease a multisystem approach must be used, focusing on resuscitation and organ-system support as well as antibiotic therapy. Most fatalities are the result of complications of multiorgan failure, hence the requirement for invasive circulatory monitoring together with varying degrees of ventilatory, cardiovascular and other organ system support. Nosocomial pneumonia particularly affects patients requiring endotracheal intubation for provision of mechanical ventilatory support. Nosocomial pneumonia may occur early or late in the patient's clinical course, with different causative organisms necessitating different treatment strategies. Many risk factors and preventative measures have been recognized for ventilator-associated pneumonia and only late-onset disease is associated with an excess mortality. Many diagnostic techniques can be applied to the management of ventilator-associated pneumonia. Initial treatment with antimicrobial agents is usually empirical and should reflect local experience and guidelines. Pneumonia also frequently affects immunocompromised patients, where the causative pathogens are very different, the commonest being *Pneumocystis jirovecii* for which specific antimicrobial treatment is required.

Keywords community-acquired pneumonia; immunocompromised; *Pneumocystis jirovecii*; nosocomial pneumonia; ventilator-associated pneumonia

Community-acquired and nosocomial (hospital-acquired) pneumonia are common conditions. Community-acquired pneumonia has an estimated incidence of 2–12 cases/1000 population per year. Most of these cases are managed outside hospital with about 20% requiring hospital admission. Of this group about 10% develop severe pneumonia requiring treatment in an ICU. Risk stratification can be refined using the CURB-65 score. This is a 5-point score, 1 point for each for Confusion, Urea greater than 7 mmol/litre, Respiratory rate of 30/minute or more, systolic Blood pressure below 90 mm Hg (or diastolic 60 mm Hg or lower, and age 65 years or older.[1] Nosocomial pneumonia is the second most frequent hospital-acquired infection and the most frequently acquired infection in the ICU. Nosocomial pneumonia usually affects mechanically ventilated patients and is described as ventilator-associated pneumonia. Death rates are increased in critically ill patients developing ventilator-associated pneumonia, with an estimated attributable mortality of 10–50%.

Community-acquired pneumonia in hospital has been defined as symptoms and signs consistent with an acute lower respiratory tract infection associated with new shadowing on the chest radiograph for which there is no other explanation (e.g. not pulmonary oedema or infarction). The illness is the primary reason for hospital admission.

Nosocomial pneumonia is defined as pneumonia acquired after hospital admission. It is divided into:

- early-onset (<5 days after hospital admission or intubation)
- late-onset (≥5 days after hospital admission or intubation).

Community-acquired pneumonia

Severe community-acquired pneumonia (CAP) is almost always a multisystem disease and at presentation patients will have, or will be rapidly developing, multiple organ failure. The importance of recognizing this aspect of the disease cannot be overemphasized. Apparent stability on high-flow oxygen can rapidly change to respiratory, circulatory and renal failure. Progressive loss of tissue oxygenation needs to be anticipated, recognized and acted on to prevent progression to established organ failure.

Assessing the severity of disease in patients with CAP is therefore an integral part of hospital management, in terms of both initial presentation and monitoring response to treatment (Table 1). Patients who have a CURB-65 score of 0 or 1 are at low risk of death (up to 3.2% mortality) and may be suitable for outpatient treatment. Patients with a CURB-65 score of 2 are at increased risk of death (up to 13% mortality) and inpatient management should be considered. Patients with a CURB-65

British Thoracic Society severity assessment used to determine the management of community-acquired pneumonia in hospital

Consider pre-existing adverse prognostic features

- Any coexisting chronic illness

Consider core adverse prognostic features – CURB-65 score

- **C**onfusion (new onset)
- **U**rea > 7 mmol/litre
- **R**espiratory rate 30/min or more
- **B**lood pressure (systolic < 90 mm Hg or diastolic blood pressure ≤ 60 mm Hg)
- Age ≥ **65** years

Score 1 point for each core feature present

Consider additional adverse prognostic features

- PaO_2 < 8 kPa/SaO_2 < 92% (any FiO_2)
- Chest radiograph: bilateral/multilobar shadowing

FiO_2, fraction of inspired oxygen; PaO_2, partial pressure of oxygen in arterial blood; SaO_2, arterial oxygen saturation

Table 1

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score of 3, 4 or 5 are at high risk of death (17, 41 and 57% mortality, respectively) and should be managed as having severe community-acquired pneumonia.[1] The presence of pre-existing and/or additional adverse prognostic features can assist the decision as to whether to treat such patients as having severe CAP. Patients who fulfil the criteria for severe CAP on admission and who do not improve rapidly should be considered for transfer to an ICU. Persistent hypoxia with partial pressure of oxygen in arterial blood (PaO_2) of less than 8 kPa despite maximal oxygen administration, progressive hypercapnia, severe acidosis (pH < 7.26), and persistent hypotension or depressed consciousness are also independent indications for transfer to the ICU for respiratory and cardiovascular support. The mortality for patients with severe CAP requiring ICU admission is high, ranging from 21.7 to 57.3% with an average of 36.5% in various studies.

Microbiology

A small number of pathogens account for most infections, with *Streptococcus pneumoniae* being the commonest pathogen in Europe and North America. Furthermore, in at least one-third of cases no pathogen can be isolated. The British Thoracic Society (BTS) recommends routine investigations for all patients with severe CAP (Table 2).

Clinical overlap amongst different pathogens is large and no single or combination of symptoms and plain chest radiography will reliably differentiate between the different pathogens. Thus, the terms typical and atypical pneumonia, developed to differentiate differing pneumonic syndromes, are redundant and have no place in clinical practice.

Antimicrobial treatment

If the specific pathogen has been identified, the choice of antibiotic treatment is straightforward. The optimal choice of antibiotics for the empirical treatment of severe CAP is less clear. In Europe such treatment must include effective treatment for *S. pneumoniae*, *Legionella* spp., *Haemophilus* spp. and *Staphylococcus* spp. Gram-negative bacteria are a rare cause of severe CAP but may be found in patients with pre-existing lung disease. The BTS guidelines recommend the combination of amoxicillin/clavulanate with clarithromycin and the optional addition of rifampicin. Alternative combinations for patients intolerant of the preferred combination include:

- substitution of cefuroxime, cefotaxime or ceftriaxone for amoxicillin/clavulanate; clarithromycin and rifampicin remain
- a single fluoroquinolone with Gram-positive cover (e.g. moxifloxacin or levofloxacin).

British Thoracic Society routine investigations for patients with severe community-acquired pneumonia

- Blood cultures
- Sputum or lower respiratory tract sample for Gram stain, routine culture and sensitivity tests
- Pleural fluid analysis, if present
- Pneumococcal antigen test on sputum, blood or urine
- Investigations for legionella pneumonia, including
  - Urine for legionella antigen
  - Sputum or lower respiratory tract samples for legionella culture and direct immunofluorescence
  - Initial and follow-up legionella serology
- Respiratory samples for direct immunofluorescence to respiratory viruses, *Chlamydia* spp. and possibly *Pneumocystis*
- Initial and follow-up serology for *Mycoplasma* and *Chlamydia* spp.

Table 2

ICU management

The BTS severe CAP study identified that most patients die of the complications of multiorgan failure rather than from respiratory failure alone. Of patients admitted to ICU with severe CAP, 32% developed acute renal failure, 55% septic shock, and 25% developed CNS problems, including vascular events and convulsions. Such patients are therefore optimally managed by a team with experience of the complications of sepsis and will frequently require invasive circulatory monitoring, aggressive fluid resuscitation, the use of vasopressors and inotropes and haemofiltration for renal replacement therapy.

Patients with severe CAP require high-flow oxygen therapy. Hypercapnia is a sign of ventilatory failure, indicating the need for more intensive support. Depending on the clinical setting, more aggressive respiratory support can be provided by the application of continuous positive airway pressure (CPAP) or biphasic positive airway pressure (non-invasive ventilation, NIV) delivered via a facemask. Alternatively, a decision to proceed directly to endotracheal intubation with mechanical ventilation may be made. It must be emphasized that unnecessary delay in intubation is associated with an excess mortality. Non-invasive respiratory support (CPAP or NIV) should be given only to patients with severe CAP in designated and properly staffed critical-care areas. In addition, enthusiasm for non-invasive support should not delay intubation.

The optimal ventilatory strategy for patients with severe CAP has not been established. However, the approach of limiting tidal volume and airway pressure (while not evidenced-based in patients with severe CAP) is appealing because of its relative success in the management of patients with acute respiratory distress syndrome.

Failure to improve

Lack of clinical response at 48–72 hours should prompt a review of the diagnosis and consideration of other conditions such as cardiac failure or thromboembolic disease. Other measures include a review of microbiological results and consideration of complications of infection. These include the development of pulmonary abscess or necrosis, empyema, meningitis, endocarditis and nosocomial infection. The possibility of immunosuppression should be considered and recent travel history reviewed.

Ventilator-associated pneumonia

The division of patients with ventilator-associated pneumonia (VAP) into early and late onset has been shown to be of paramount importance in terms of aetiology and subsequent treatment. Early-onset VAP commonly results from aspiration of endogenous community-acquired pathogens such as *S. pneumoniae*, *Haemophilus* spp. and *Staphylococcus* spp., with