

# Commentary

## Cost effectiveness in treating ventilator-associated pneumonia

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### Abstract

Ventilator-associated pneumonia is a common illness in intensive care unit patients. The costs of management are increased when infection involves resistant organisms, as well as unnecessary and prolonged therapy. Efforts at accurate diagnosis, therapy and prevention can reduce the cost impact of this illness.

**Keywords** diagnostic bronchoscopy, infection, nosocomial, pneumonia, resistant bacteria

Nosocomial pneumonia is the most commonly acquired infection in hospitalized patients, particularly those on mechanical ventilators in the intensive care unit [1]. The impact of this infection is dramatic, increasing mortality, length of stay, and utilization of resources such as mechanical ventilation and antibiotic therapy [2]. Nosocomial pneumonia adds as much as \$20,000 to hospital costs per episode, and can increase hospital length of stay by as much as 14 days [3]. In spite of aggressive, accurate therapy, some patients die as a direct result of pneumonia, and it is difficult to put a cost value on this endpoint. Patients who die rapidly generally incur little excess cost of care, while those who die after a prolonged hospital stay may require therapies that lead to huge cost excesses. In terms of costs, as in other areas, prevention of nosocomial pneumonia may be better than effective treatment and cure.

### Resistant organisms increase costs

Another factor has recently added to the cost impact of nosocomial pneumonia, namely the increasing frequency of infection caused by antibiotic-resistant organisms. The impact of pneumonia can be even more dramatic if it involves a multi-resistant Gram-positive organism (such as methicillin-resistant *Staphylococcus aureus*) or a Gram-negative organism (such as *Pseudomonas aeruginosa* or *Acinetobacter* spp.) [2]. Resistant organisms can add to costs in a number of ways. First, since patients who acquire these organisms are already very ill and the availability of effective therapy is limited,

pneumonia due to resistant organisms can lead to a higher mortality and length of stay than pneumonia due to antibiotic-sensitive organisms [2]. This may partly be the result of the natural history of infection with such organisms, with some organisms being more virulent than others, as well as a result of the fact that patients infected with such organisms are more likely to receive 'inadequate' initial empiric antibiotic therapy [4].

In addition, infection with resistant organisms requires more costly therapies. The effective antibiotics may be expensive and may need to be given for a prolonged duration, often in combination with multiple other agents. Management may cost more because of the need for private isolation rooms, more staff, and more equipment, such as gowns, gloves, masks, and sterile medical equipment. Finally, the complications of infection (such as delayed return to normal functional status, shock and renal failure) and the need for tracheostomy may be greater in patients infected with resistant organisms than in those infected with sensitive organisms.

### Cost of diagnosis

What can be done to control nosocomial pneumonia and add to cost effective management? First, we must focus on algorithms for diagnosis and therapy. For example, controversy exists about whether to diagnose ventilator-associated pneumonia (VAP) by invasive methods or by clinical assessment. One argument in favor of invasive

methods is that clinical diagnosis is too sensitive, and that some patients receive antibiotic therapy unnecessarily, with predictable impact on both costs and the emergence of resistant organisms. One prospective, randomized controlled trial in fact showed that patients managed with bronchoscopic diagnosis had more antibiotic-free days than patients managed clinically, without an adverse impact on outcomes, and this certainly could add to cost effectiveness [5]. While using fewer unnecessary antibiotics is a desirable endpoint, it may also be achieved by careful and serial clinical evaluation, using the Clinical Pulmonary Infection Score. In one study, serial measurement of the Clinical Pulmonary Infection Score, identifying patients who did not have progressive clinical worsening, allowed investigators to shorten duration of therapy in some patients, reducing emergent antibiotic resistance [6]. These studies clearly document the need for recognizing that some patients are currently receiving therapy when it is not needed and are being treated for too long.

### Cost of therapy

The need to use antibiotics more selectively must, however, be weighed against the observation that inadequate initial empiric therapy of VAP is the most important determinant of excess mortality [7]. One way to use antibiotics more accurately is to have guidelines for usage that have been adapted to local microbiologic patterns, recognizing that each intensive care unit has its own unique patterns of antibiotic resistance [8]. In addition, if these resistance patterns are documented and used as a basis for antibiotic selection, the accuracy and cost effectiveness of therapy can be improved. A responsible and cost effective approach to VAP may thus require the use of broad spectrum empiric therapy, designed to avoid inadequate coverage of multi-resistant pathogens, combined with a 'de-escalation of therapy' in selected patients once culture data and clinical evolution information become available.

### Cost of prevention

Perhaps the most cost effective way to manage VAP is by prevention and, while there are many proposed strategies, the simplest will probably be the most effective. These strategies include: positioning patients semi-erectly, not supine, using endotracheal tubes that allow for subglottic secretion drainage; maintaining endotracheal tube cuff pressures at levels that prevent aspiration of pooled secretions above them; monitoring for excess gastric residuals that can lead to aspiration; feeding into the small bowel whenever possible to avoid aspiration and bacterial translocation; careful handling of ventilator circuits to avoid washing condensate back to patients; and the use of non-invasive ventilation rather than intubation whenever possible. In addition, several antibiotic interventions may be effective, such as giving 24 hours of therapy to patients with witnessed aspiration, rotation of empiric regimens, and using selective digestive decontamination in carefully selected populations [9].

In the future, our evaluation of new therapeutic approaches to nosocomial pneumonia will clearly focus on a measurement of improved outcomes, and not just on assessment of the microbiologic and clinical response to antibiotic therapy. While mortality is the ultimate endpoint to prove the value of new approaches, cost effectiveness is also an important goal. If achieved, cost effectiveness can point to great value for new management strategies.

### Competing interests

None declared.

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