Non-invasive ventilation in the treatment of severe polymicrobial community-acquired pneumonia

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ABSTRACT

Polymicrobial pneumonia may be caused by the combination of respiratory viruses, bacteria and fungi in a host. Colonization by *Streptococcus pneumoniae* was associated with increased risk of Intensive Care Unit admission or death in the setting of influenza infection, whereas the colonization by methicillin sensible *Staphylococcus aureus* co-infection was associated with severe disease and death in adults and children. The principal association of pathogens in community-acquired pneumonia (CAP) is bacteria and viral co-infection, and accounts approximately for 39% of microbiological diagnosed cases of CAP. The differential clinical diagnosis between a viral and a bacterial CAP is not easy: no clinical signs or radiological findings help the clinician to suspect to the diagnosis. Patients with polymicrobial infections are more likely to have underlying medical conditions and have more severe outcome. Severe respiratory failure and need of mechanical ventilation occur in several cases. Non invasive ventilation (NIV) use aims to avoid invasive mechanical ventilation. NIV treatment is controversial owing to high reported treatment failure. In this case series we report three cases of severe polymicrobial CAP: all of them required NIV with a good outcome.

Introduction

Community-acquired pneumonia (CAP) is the leading cause of death from infectious diseases. Bacterial pneumonia in association with virus infection has been considered an important factor leading to poor patient outcomes.[1-3]

The role of bacterial co-infection in complicating the clinical course of virus-associated pneumonia is poorly known, although it is often considered a cause of excess morbidity and mortality in community-acquired pneumonia.[1,4-7]

Microbial synergies among bacteria, fungi, and viruses are further described.[8] Bilateral pneumonia is a risk factor for the need for respiratory support and death. Development of respiratory complications confers greater risk of morbidity. Polymicrobial-community-acquired pneumonia are more frequently associated with more severe course compared with monomicrobial pneumonia cases.[3,8]

Currently, the treatment of severe-CAP consists of antibiotic therapy and ventilator support. The use of invasive ventilation causes several complications, such as the admission to Intensive Care Unit (ICU): for this reason, non-invasive ventilation (NIV) has been used for acute respiratory failure to avoid endotracheal intubation. However, few studies have assessed the usefulness of NIV in pneumonia patients. The use of NIV in patients with pneumonia is controversial because of a greater variability in failure rates than those observed in other diagnoses.[9,10,11] On this regard, we report three cases of severe polymicrobial CAP: all of them required NIV with good outcome. Patients gave their consent to publish material related to them.

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Case Series

Case #1

A 57-year-old man, homeless was taken to the Emergency Department (ED) after a history of three day of fever (39°C) cough and purulent expectoration. He presented alcohol abuse, and untreated chronic obstructive pulmonary diseases. Later he was transferred to Respiratory Sub-ICU. At admission to Respiratory Sub-ICU, vital signs were: breathing frequency 38 m',

cardiac frequency 124 beats m' arterial pressure 95/55 mmHg. Laboratory data revealed marked elevation of inflammation and infectious parameters (leukocytes 22.30×10^9 /L, with neutrophils 85%, lymphocytes 9%, C-reactive protein 20.06 mg/dL, Pro-calcitonin 2.5 ng/mL sodium 132 mEq/L, potassium 3.3 mEq/L). Arterial blood gas analysis showed hypoxemic respiratory failure (paO_2 45 mmHg, $paCO_2$ 32 mmHg, pH 7.49, paO_2/FiO_2 ratio 214). Chest X-ray and computed tomography (CT) of the thorax (Figure 1) showed an opacity in the lower pulmonary lobe. The patient was treated with empirical therapy ceftriaxone 2 g per day + levofloxacin 500 mg twice a day, and oxygen *via* Venturi mask 50%. Over the next 6 h the respiratory conditions worsened as shown by the next arterial blood gas analysis (ABG) (paO_2 60, $paCO_2$ 42, pH 7.35, paO_2/FiO_2 120). The patient underwent non-invasive ventilation, bilevel positive airway pressure (BiPAP), inspiratory PAP 15 cmH_20, expiratory PAP 8 cmH_20, FiO_2 30% with prompt improvement of gas exchange (paO_2 75, $paCO_2$ 37, pH 7.37, paO_2/FiO_2 250). Urinary antigen was positive both for *Legionella pneumophila* and *Streptococcus pneumoniae*. Blood culture was positive for *S. pneumoniae* as well *Legionella* antibodies. The clinical picture progressively improved. NIV was suspended after a week; after seventeen days was observed a normalization of inflammation parameters (leukocytes 5.8×10^9/L, C-reactive protein 0.45) and the patient was discharged.

Case #2

A 63-year-old woman was admitted to ED complaining dyspnea, cough, purulent expectoration and fever (39°), polyuria, vomit and diahrrea and transferred to ICU because of severity of clinical condition. At admission to the ICU clinical picture was as follows: respiratory breathing 36 m' cardiac frequency 139 beats m' arterial pressure 95/45 mmHg. Laboratory data showed: leukocytes 19.60×10^9 /L, with neutrophils 79%, lymphocytes 12%, C-reactive protein 18.12 mg/dL, pro-calcitonin 2.0 ng/mL, creatinine 1.40 mg/dL [normal values (n.v.) 0.55-1.2 mg/dL] sodium 144 mEq/L, potassium 3.4 mEq/L. Arterial blood gas analysis showed hypoxemic respiratory failure (paO_2 36 mmHg, $paCO_2$ 30 mmHg, pH 7.48, paO_2/FiO_2 ratio 171). Chest X-ray and CT of the thorax (Figure 2) revealed an opacity in the medio-basal right lung zone. The patient was treated with broad-spectrum empirical antibiotics (piperacillin + tazobactam 4.5 g/8 h plus levofloxacin 500 mg/12 h). Non-invasive ventilation pressure support (PS) mode was implemented by setting PS 10 cmH_20, positive end expiratory pressure (PEEP) 8 cmH_20 and FiO_2 30%. The ABG performed after 1 hour showed: paO_2 74, $paCO_2$ 35, pH 7.39, paO_2/FiO_2 246. A bronchoaspirate and bronchoalveolar lavage yielded: multi-drug resistant *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Streptococcus agalactiae* and *Candida albicans*. The patient changed antibiotic therapy: tigecycline 50 mg/12 h, colistimethate 300 mg per day, fluconazole 400 mg per day. Five days later clinical picture improved: leukocytes 8.30×10^9/L, neutrophils 66%, lymphocytes 20%, C-reactive protein 3.2 mg/dL, creatinine 0.69 mg/dL. ABG: paO_2 68, $paCO_2$ 38, pH 7.44, paO_2/FiO_2 283 on FiO_2 24%. NIV was suspended and patient continued oxygen therapy. Ten days later she was transferred to Respiratory Diseases Unit and discharged five days later.

Case #3

A 71-year-old patient who recently underwent a surgical intervention because of lung cancer and adjuvant chemotherapy was admitted to ED complaining fever (38.5°C), purulent expectoration and dyspnea and transferred to the Respiratory Sub-ICU. Clinical examination at admission to Respiratory Sub-ICU showed: respiratory rate 30 cardiac frequency 112 beats m' arterial pressure 100/50 mmHg. ABG in air

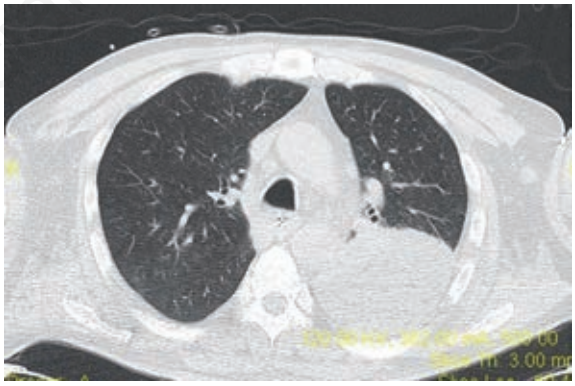

Figure 1. Computed tomography of the thorax. Opacity in the lower left pulmonary lobe.

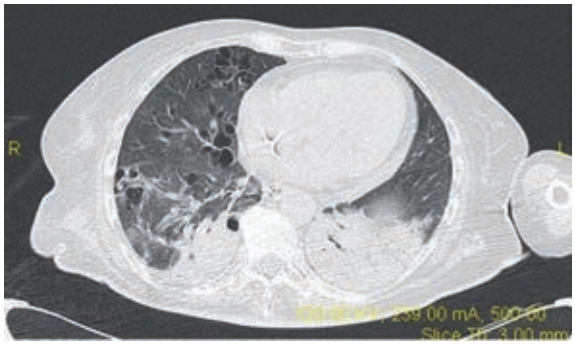

Figure 2. Computed tomography of the thorax. Opacity in the medio-basal right lung zone.

room showed severe respiratory failure: PaO_2 39, $paCO_2$ 29, pH 7.48, paO_2/FiO_2 185. The non-invasive ventilation was started PS 12 cmH_20, PEEP 7 cmH_20, FiO_2 35%. Chest X-ray and CT showed an opacity involving the upper right lobe with a wide excavation, and a small opacity at lower right lobe level (Figure 3). Laboratory findings showed: leukocytes 10.7×10^9/L, neutrophils 95.4%, lymphocytes 1.9%, C-reactive protein 25.85 mg/dL, pro-calcitonin 1.6 mg/mL, fibrinogen 857 mg/dL (n.v. 180-450 mg/dL). The patient was treated initially with empirical antibiotic therapy: ceftriaxone 2 g day and levofloxacin 500 mg every 12 h. Blood culture, urinary antigen and sputum sample taken at admission were negative. Culture of bronchoalveolar lavage was positive for *S. aureus* methicillin-resistant, *Enterococcus amnigenus* and *Enterococcus* species. The three bacteria were sensitive to tigecycline, which was started (50 mg/12 h). Seven days later the patient's condition had improved and NIV was stopped. ABG showed: paO_2 78, $paCO_2$ 39, pH 7.42, paO_2/FiO_2 312 in O_2 25%. Laboratory findings were: leukocytes 8.2×10^9/L, neutrophils 81%, lymphocytes 12%, and C-reactive protein 0.85 mg/dL. After fifteen days, the patient was discharged and twenty-seven day the chest X-ray findings cleared out.

Discussion

The role of mixed pneumonia in CAP has been described in recent years and demonstrated that has a different inflammatory pattern compared to bacterial or viral CAP.[8] In a study conducted by Gutierrez *et al.*[12] on 493 adult patients with CAP, polymicrobial infection was found in 5.7% of patients with microbiologically confirmed diagnosis. Polymicrobial infections were seen across all age groups and in patients treated both in hospital and in outpatient clinic. The most common polymicrobial infections were *S. pneumoniae* with *L. pneumophila* and *S. pneumoniae* and *Pseudomonas* spp. Patients with polymicrobial infections are more likely to have underlying medical conditions and have more severe outcome.[13,14] *S. pneumoniae* was the most frequent co-pathogen in polymicrobial infections as previously reported.[15,16] Our case series report the most frequent causative organisms in hospitalized patients:[17] it is not clear if the severity of the clinical picture is due to polymicrobial etiology or to causative organism in itself (*e.g.*, *L. pneumophila*).[18] Undoubtedly bacterial respiratory infection is often preceded by a viral infection which favors the secondary bacterial infection caused by a pathogen colonizing the respiratory mucosa. When a viral respiratory infection occurs, this destroys the respiratory epithelium, thus increases the adhesion of bacteria to the mucosa.[13] The same can happen for atypical bacteria. Mycoses and in particular *C. albicans*, increases the virulence of *P. aeruginosa* and allows *S. aureus* to evade phagocytosis.[13] For clinicians, it is very important: combined-empirical antimicrobial therapy may reduce mortality:[18] International Guidelines have incorporated the idea that CAP could be due to polymicrobial agents in all patients.[10,15-17] Rapid detection of Influenza may allow physician to use neuraminidase inhibitors effectively within 36 to 48 h from symptoms onset as well as rapid detection of *L. pneumophila* or *S. pneumoniae via* urinary test.[18] The role of NIV is still under debate for patients with severe respiratory failure due to community acquired pneumonia because of lack of controlled clinical trials and its efficacy is less evident in decreasing the needs of intubation than in other diseases such as chronic obstructive pulmonary disease or cardiogenic pulmonary edema.[19-21] Moreover, no study has investigated the difference between continuous PAP and BiPAP or pressure support ventilation (PSV) in severe respiratory failure due to pneumonia.[11,19,21,22] Regarding the interfaces used to administering NIV in patients with hypoxemic acute respiratory failure some studies compared the helmet to facial mask:[23,24] although the helmet group had a higher increase in oxygenation the total duration of NIV as well as the intubation rate and hospital mortality were similar in both groups. The mask group showed a higher intolerance to NIV.[23] PSV administered via facial mask reduces work of breathing more significantly than helmet. The latter requires a higher pressurization to give the same level of PS.[23,24] Thus, the use of helmet is suggested in cases in which NIV is used for long periods in order to avoid facial lesions and mask intolerance.[23] However, in most patients, the best strategy is inter-change between different interfaces during the treatment.[23,24] Our case series shows that in severe respiratory failure due to severe CAP the use of NIV is useful to avoid the needs of intubation.

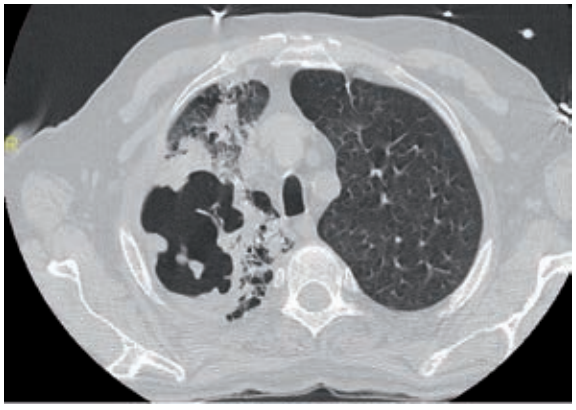

Figure 3. Computed tomography of the thorax. Opacity involving the upper right lobe with a wide excavation.

Conclusions

This case series suggests that polymicrobial CAP is often associated with more severe disease in adult patients. Rapid detection of all involved pathogens is paramount for a correct antimicrobial therapy, which allows reducing intensive care stay or mechanical ventilation.

Few laboratory parameters may be useful to suspect a polymicrobial CAP.

Non-invasive ventilation should be considered in the management of severe respiratory failure due to polymicrobial CAP.

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