Review paper

Chryseobacterium indologenes as an aetiological agent for ventilator-associated pneumonia: a case report and review of the literature

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Abstract

The objective of this study was to present a case of ventilator-associated pneumonia (VAP) caused by *Chryseobacterium indologenes* and to review the literature on this rare pathogen. A 50-year-old female patient hospitalised in the intensive care unit developed VAP. *C. indologenes* was identified as the sole pathogen in a culture of bronchoalveolar lavage. Targeted treatment, taking into account its natural resistance to many beta-lactam antibiotics, resulted in clinical improvement of the patient. A literature review was conducted on the aetiology and risk factors of VAP, as well as infections caused by *C. indologenes*, using the PubMed and Google Scholar databases. The analysis indicates that infections caused by *C. indologenes* are associated with high mortality, particularly among critically ill patients. This case highlights the necessity of considering *C. indologenes* as a potential pathogen in VAP patients. Early diagnosis and the implementation of targeted antibiotic therapy may improve prognosis.

Introduction

Ventilator-associated pneumonia (VAP) is one of the most common nosocomial infections acquired in the intensive care unit (ICU). It is defined as an infection of the pulmonary parenchyma occurring 48–72 hours after endotracheal intubation. VAP leads to sepsis, which in turn is defined as an acute organ dysfunction caused by infection – in this case, acute respiratory failure [1]. The prevalence of VAP is higher in trauma patients, whereas chronic obstructive pulmonary disease (COPD) is not a risk factor for VAP [2]. Reports indicate that VAP affects 5–40% of patients receiving invasive mechanical ventilation for more than 2 days, with significant variability depending on the criteria used to diagnose VAP, the type of ICU, and the region [1]. In a single-centre study conducted in 2015, the prevalence of VAP was 8.5%, with an incidence density of approximately 18.2 cases per 1000 ventilation days [3]. Similarly, a study analysing data from seven general adult ICUs in southern Poland from 2013–2015 reported a VAP prevalence of 8.0% and an incidence density of 12.3 cases per 1000 ventilation days [4]. Another study, which included 371 ventilated ICU patients, found that 14% of patients developed VAP, with an incidence density of 9.7 cases per 1000 ventilation days [5].

Various pathogens can be the aetiological factors for VAP. Gram-negative bacteria, particularly *Klebsiella*, *Acinetobacter*, *Pseudomonas*, *Escherichia coli*, and other *Enterobacteriaceae*, are the most prevalent pathogens. Some Gram-positive bacteria, like *Staphylococcus aureus* and *Enterococcus*, have been implicated [6–8]. In Poland, *Acinetobacter baumannii* is considered the dominant pathogen [4]. Identifying predominant pathogens is crucial for guiding empirical antibiotic therapy and improving patient outcomes. While Gram-negative bacteria are well-recognised causes of VAP, less common pathogens, including *Chryseobacterium indologenes*, are increasingly reported in nosocomial infections. The genus *Chryseobacterium* comprises aerobic, Gram-negative rods belonging to the *Flavobacteriaceae* family, with *Chryseobacterium indologenes* being the most common species. *C. indologenes* is known for causing nosocomial infections due to its presence in fluid-associated devices, which serve as potential reservoirs for infection [9]. It can cause various infections, including catheter-associated bacteraemia, urinary tract infection, biliary tract infection, peritonitis, surgical site infection, and hospital-associated pneumonia [10].

A 50-year-old female patient with a history of COPD, nicotine and alcohol dependence was admitted to the emergency department with dyspnoea

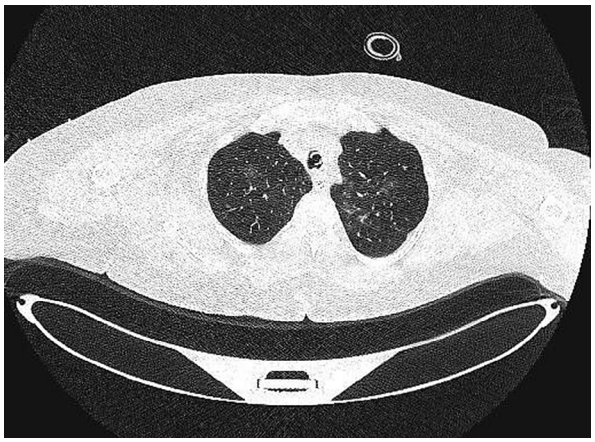

Figure 1. Chest computed tomography (CT) showing fine patchy ground-glass opacities with small areas of consolidation in the apical regions of the lungs. The scan was performed using a 64-slice SOMATOM Definition Edge CT scanner (Siemens Healthineers, Erlangen, Germany)

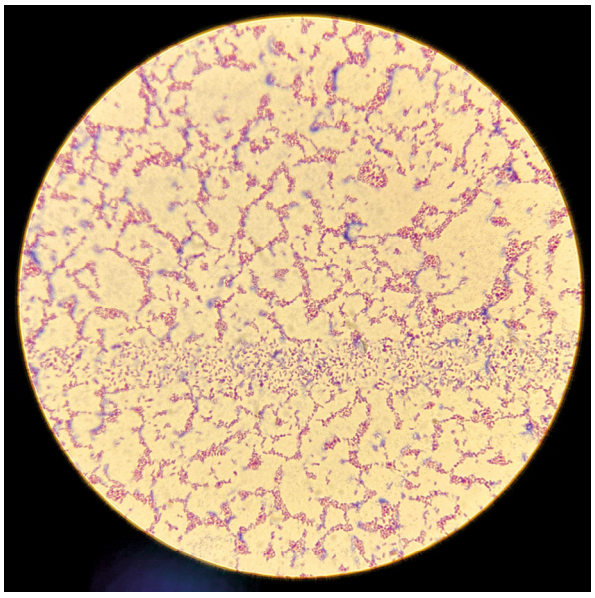

Figure 3. Microscopic image of Chryseobacterium indologenes at 100× magnification using oil immersion (Primostar microscope, Zeiss, Oberkochen, Germany)

and decreased consciousness. The patient's medical records revealed a recent hospitalisation for interstitial pneumonia secondary to influenza virus type A infection. An anaesthesiology consultation was requested. At the time of the consultation, the patient was unresponsive, with no logical contact, scoring 7 points on the Glasgow Coma Scale. The patient exhibited tachypnoea with marked respiratory effort. Given the overall clinical picture, the patient was intubated, and mechanical ventilation was initiated. A high-resolution chest computed tomography (CT)

Figure 2. Colonies of Chryseobacterium indologenes on 5% sheep blood agar (Graso, Poland) after 48 hours of aerobic incubation at 37°C, showing characteristic yellow pigmentation

scan revealed changes consistent with inflammatory changes, possibly due to viral infection (Figure 1).

Upon admission to the ICU, the patient was sedated, intubated, and ventilated with a transport respirator; peripheral haemoglobin oxygen saturation (SpO_2) was 99%. The patient was haemodynamically unstable, supported with norepinephrine infusion at the dose of 0.053 µg/kg/min. Samples for laboratory and microbiological tests were collected. The initial microbiological tests came back negative. Tracheal aspirate and bronchoalveolar lavage (BAL) cultures collected on days 5 and 6 of ICU hospitalisation revealed the growth of an alarm pathogen – *Chryseobacterium indologenes*. The identification was performed using culture methods (Figure 2) and mass spectrometry. Microscopic examination of *C. indologenes* was also performed (Figure 3).

Antibiotic susceptibility testing confirmed the pathogen's resistance to all antibiotics apart from trimethoprim + sulfamethoxazole (TMP-SMX) (Table 1). The patient was started on TMP-SMX (Trimesolphar®, Polpharma, Poland) at the dose of 0.96 g i.v. twice daily.

On day 10 of ICU hospitalisation, due to prolonged respiratory failure, a percutaneous dilatational tracheostomy (Griggs method) was performed. Cultures on day 11 continued to be positive for *C. indologenes*, whereas those on day 17 demonstrated no bacterial growth. The patient required regular bronchoscopic cleaning of the airways, during which signs of airway mucosal shedding with intermittent bleeding from the airways were observed. The patient developed acute kidney injury, and continuous renal replacement therapy was initiated and continued from day 13 to 27. Signs

of critical illness polyneuropathy were confirmed, and neurological rehabilitation consultation was requested. It was possible to gradually reduce respiratory support, initially using mechanical ventilation only at night, followed by oxygen therapy via the tracheostomy. On day 60, the patient was transferred to the Department of Neurological Rehabilitation, where the tracheostomy tube was finally removed.

We describe a rare case of a patient who developed VAP due to *C. indologenes*. The genus *Chryseobacterium* was first defined in 1994, previously classified as *Flavobacterium*. Six species are commonly isolated from clinical specimens: *C. meningosepticum*, *C. odoratum*, *C. multivorum*, *C. breve*, *C. gleum*, and *C. indologenes* [11].

Infections caused by *C. indologenes* are rarely described in the literature, with limited reports from Poland. *C. indologenes* may cause bacteraemia, peritonitis, empyema, pyelonephritis, cystitis, meningitis, central line-associated bloodstream infection, and pneumonia [12]. A retrospective study performed at a 642-bed university hospital in Korea, analysing records from January 2001 to December 2020, revealed only 22 blood cultures positive for *C. indologenes* [13]. A single publication from Poland described the detection of *C. indologenes* producing IND-1-type metallo-lactamase from a blood culture of a patient with adenocarcinoma [14]. There were some reports of keratitis caused by *C. indologenes* [15–17]. We found only 2 case reports of VAP due to *C. indologenes*, both in paediatric patients. A case report from the year 2011 describes a newborn with congenital heart disease who was successfully treated with piperacillin-tazobactam [18]. Another report from the year 2016 describes a 3-month-old infant with meningomyelocele and congenital diaphragmatic hernia repaired within the first month of life, who was successfully treated with ciprofloxacin [19].

C. indologenes infections predominantly affect patients with multiple comorbidities and immunosuppressive conditions. Identified risk factors include malignancy, neutropaenia, diabetes mellitus, organ transplantation, COPD, and chronic kidney disease. Furthermore, steroid use, malnutrition, and the presence of indwelling devices, such as tracheostomy tubes and urinary catheters, significantly contribute to the risk of infection [20–23]. Another study showed that the introduction of colistin and tigecycline led to an increase in infections [24]. The patient described in our case report presented four risk factors for *C. indologenes* infection mentioned above: COPD, steroid use, artificial airway, and prolonged hospital stay (previous and index hospitalisation). Infections caused by *C. indologenes* are also linked to hospital environments, where the bacteria colonise wet surfaces, water sources, and medical equipment [25]. Mismanagement of VAP risk factors, such as inadequate hygiene protocols or delayed replacement of indwelling devices, increases the risk. In our case, replacing vascular and urinary catheters and maintaining strict infection control measures were crucial in achieving therapeutic success. All vascular and urinary catheters were replaced to minimise catheter-related infections. While some studies have reported successful eradication of *C. indologenes* without catheter removal, we opted for replacement as a preventive strategy [26].

Table 1. Antibiogram for Chryseobacterium indologenes

Antibiotic	MIC	Susceptibility
Penicillin	> 32 mg/l	Resistant
Amoxicillin + clavulanic acid	> 32 mg/l	Resistant
Cefotaxime	> 32 mg/l	Resistant
Imipenem	> 32 mg/l	Resistant
Meropenem	> 32 mg/l	Resistant
Ciprofloxacin	> 32 mg/l	Resistant
Levofloxacin	> 32 mg/l	Resistant
Amikacin	128 mg/l	Resistant
Gentamicin	> 256 mg/l	Resistant
Trimethoprim + sulfamethoxazole	0.38 mg/l	Potentially sensitive

MIC – minimal inhibitory concentration.

Furthermore, the patient described in our case report presented with a history of chronic alcohol use, which might have contributed to an immunosuppressive state, further increasing the risk of *C. indologenes* infection.

While early identification of susceptibility and targeted therapy are crucial, empirical antibiotic treatment often proves ineffective due to the resistance profile of *C. indologenes*. *Chryseobacterium indologenes* exhibits intrinsic resistance to several commonly used antibiotics, complicating its treatment. Studies indicate resistance to aminoglycosides, tetracyclines, chloramphenicol, erythromycin, clindamycin, teicoplanin, and glycopeptides, including vancomycin [17–19]. According to the SENTRY antimicrobial surveillance program (1997–2001), *C. indologenes* is resistant to vancomycin, chloramphenicol, and linezolid, highlighting their ineffectiveness in treating infections caused by this organism [27]. Despite its resistance profile, *C. indologenes* demonstrates sensitivity to certain antibiotics. The most potent agents include TMP-SMX and quinolones such as levofloxacin and gatifloxacin, with susceptibility rates exceeding 95% [15, 18]. Ciprofloxacin, cefepime, ceftazidime, piperacillin, and rifampin have also shown significant activity against this pathogen. Additionally, a study by Kirby *et al.* [27] reported > 85% susceptibility of *C. indologenes* isolates to piperacillin, piperacillin-tazobactam, ceftazidime, cefepime, ciprofloxacin, levofloxacin, and TMP-SMX. The susceptibility of *C. indologenes* to TMP-SMX was further supported by

Chen *et al.,* who evaluated 113 isolates obtained between 2004 and 2011. Their findings revealed 87.6% susceptibility to TMP-SMX, 41.8% susceptibility to tigecycline, 34.4% susceptibility to levofloxacin, 31.6% susceptibility to ciprofloxacin, and 29.4% susceptibility to piperacillin-tazobactam [24]. Similarly, as early as 1996, Hsueh *et al.* reported that more than 80% of the isolates were resistant to ofloxacin, ciprofloxacin, rifampin, and vancomycin [28]. Our patient was treated with TMP-SMX based on the antibiogram, which showed resistance to all other antibiotics. Following the initiation of therapy, the patient showed clinical improvement, consistent with outcomes described in prior studies. TMP-SMX treatment was also effective in other reported cases, such as a young adult kidney transplant recipient treated with TMP-SMX [29] and a case of pleural effusion caused by *C. indologenes* [30]. Literature supports the efficacy of TMP-SMX in treating *C. indologenes* infections, with reported success rates reaching 100% in specific cohorts [31]. In cases of *Chryseobacterium indologenes* keratitis, treatment can be more complex due to variable resistance patterns. For example, a case described by Lee and Mauger highlighted the susceptibility of the bacteria to cefepime, ciprofloxacin, and piperacillin-tazobactam. Accordingly, the treatment was switched to topical ciprofloxacin and ceftazidime [17]. However, other reports have documented the challenges in treating keratitis caused by *C. indologenes*. In 1 case, a 47-year-old Asian male with corneal perforation was initially treated for presumed *Pseudomonas aeruginosa* infection with fortified topical gentamicin and cefazolin. Once *C. indologenes* was identified, showing multidrug resistance but an intermediate response to ceftazidime, the patient was treated with hourly ceftazidime eye drops for 3 weeks, resulting in resolution of infection [15]. Similarly, an 83-year-old female with bacterial keratitis caused by a highly resistant *C. indologenes* strain improved clinically after 1 month of treatment with TMP-SMX [16]. These cases highlight the variability in antibiotic susceptibility among *C. indologenes* strains, emphasizing the lack of standardised treatment guidelines. The challenges in treating *C. indologenes* infections stem from its diverse resistance patterns, necessitating individualised treatment based on susceptibility testing.

Chryseobacterium indologenes is an extremely rare aetiological agent for VAP. *C. indologenes* primarily affects immunocompromised patients with certain underlying conditions, prolonged hospital stays, and invasive medical devices. These infections are challenging to treat due to resistance to multiple antibiotics. The resistance pattern for *C. indologenes* grew even further within the last decade.

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Ethical approval

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Conflict of interest

The authors declare no conflict of interest.

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