An unusual case of massive hemoptysis due to *Bacillus cereus* necrotizing pneumonia

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**A B S T R A C T**

*Bacillus cereus* is a gram-positive bacillus that is ubiquitously present in the environment, often regarded as a contaminant when isolated in clinical testing. Cases of *B. cereus* causing lower respiratory tract infections are sparse, with less than 20 reported in the literature, and even fewer as a cause of massive hemoptysis. The majority of cases occur in the setting of an immunosuppressed patient. We describe a case of a 59-year-old male with esophageal adenocarcinoma undergoing chemotherapy presenting with a right upper lobe necrotizing pneumonia secondary to *B. cereus* with consequent massive hemoptysis.

1. **Introduction**

*Bacillus cereus* (*B. cereus*) is a gram-positive, aerobic-to-facultative, spore forming rod that is widely present throughout the environment [1]. It is well recognized in toxin mediated food poisoning and is a self-limiting illness. Their natural reservoir includes decaying organic matter, fresh and marine waters, vegetables and fomites, as well as the intestinal tract of invertebrates [2]. Its spores are resistant to extreme environmental conditions including heat, cold, drying, and radiation. It can be problematic in the food industry given its resistance to gamma radiation and ability to adhere to surfaces. Given its ubiquitous nature, it is usually considered a contaminant when isolated from clinical samples.

However, a wide range of systemic *B. cereus* infections have been described, including bacteremia, endocarditis, meningitis, and the lower respiratory tract [3,4]. These are most often in the context of a compromised immune system and have led to fatal outcomes despite aggressive therapy. We present a case of massive hemoptysis in an immunocompromised patient receiving chemotherapy and radiation for esophageal cancer with an invasive *B. cereus* infection and concurrent pulmonary embolism (PE) that provided an interesting challenge to its management.

2. **Case report**

A 59-year-old male with a recent diagnosis of a Stage IIIa distal esophageal adenocarcinoma undergoing neoadjuvant radiation and chemotherapy consisting of paclitaxel and carboplatin (3rd cycle CROSS protocol) presented to the emergency department (ED) with sudden onset hemoptysis of approximately 200mL. He felt completely well in the days prior. He had rapid onset of nausea, epigastric pain, and a history of retching coinciding with the of hemoptysis. His initial vital signs (VS) were a BP 90/65 mmHg, HR 147 bpm, 18 respirations/min, temperature of 39.2°C, and spO2 94% on room air. After fluid resuscitation, his VS were 95/50 mmHg, 121 bpm. His portable chest x-ray on admission showed a large right upper lobe (RUL) opacity (Fig. 1). His hemoptysis persisted and progressed while in the ED. Computed tomography demonstrated a cavitating RUL mass and extensive ground glass opacities suggestive of a necrotizing pneumonia (Fig. 2) and an intraluminal filling defect in the distal right main pulmonary artery consistent with a PE (Fig. 3).

The patient’s clinical status deteriorated with subsequent VS: BP 75/47 mmHg, 111 bpm, 28 respirations/min, and 93% spO2 on 3Lpm O2. Initial laboratory investigations were: hemoglobin 100g/L, white blood cells 5.0 × 10⁹/L, platelets 164 × 10⁹/L, INR 1.1; arterial blood gas: pH 7.32, pCO₂ 41 mmHg, pO₂ 63 mmHg, HCO₃ 21 mmol/L. He was given 1 unit of packed red blood cells and intravenous antibiotics (piperacillin/tazobactam, azithromycin, and vancomycin), and brought urgently to the operating room (OR) for rigid bronchoscopy and flexible gastroscopy. The RUL was identified as the source of bleeding. For lung isolation a size 37 double lumen endotracheal tube was placed.

Gastroscopy revealed a partially treated fungating tumor at 30cm but no bleeding was identified at the site of the tumor or stomach. Urgent bronchial artery angiography and embolization was performed and an infrarenal inferior vena cava (IVC) retrievable filter was inserted. Two arterial sources of bleeding were identified to be directly related to the cavitory RUL mass; an arterial branch arising from a right intercostal...
artery as well as a branch of the right bronchial artery (Fig. 4). The patient’s hemoptysis ceased shortly after the embolization. He self-extubated within 24 hours of arrival and was transferred to the ward for continued management of his PE and pneumonia.

Samples from the OR included a bronchoalveolar lavage yielded heavy neutrophils only. Initial blood cultures on admission were positive two out of two bottles for a gram-positive bacillus species detected at 11 hours. Empiric antibiotic therapy with piperacillin/tazobactam and vancomycin continued given the uncertainty in the etiological agent. On day 4, the patient defervesced and final cultures grew Bacillus cereus sensitive to gentamicin, levofloxacin, and vancomycin. Treatment was tailored to 14 days of moxifloxacin and vancomycin. Two agents were maintained given concern of his immunocompromised status and the likelihood of treatment failure with single agent fluoroquinolone therapy. Subsequent blood cultures were negative.

On day 5 of admission, after no further hemoptysis, anticoagulation with unfractionated heparin for his PE was initiated. After 3 days of stability and continued improvement, he was transitioned to tinzaparin. On day 10, the patient was discharged in stable condition, on room air. The IVC filter was left in place as Doppler examination of his lower limbs confirmed a deep vein thrombosis and interruption of anticoagulation was anticipated for the planned surgical resection of his esophageal cancer. No further neo-adjuvant therapy given the complication; surgery was planned for 6–8 weeks post bleeding for restaging.

### 3. Discussion

*Bacillus cereus* produces hemolysins, phospholipases, an emesis-inducing toxin, and pore-forming enterotoxins to elicit tissue destruction [5]. The majority of cases occurred in the setting of an immune compromised host (ie. leukemia), though are rare even in this context. Interestingly, four fatal cases of pneumonia in immunocompetent metal workers have been reported [6, 7]. However, *B. cereus* pneumonia was recently reported in an immunocompetent 81 year old female [8] and 60 year old male [9]. This may reflect increasing recognition of this rare entity.

Table 1 is a compilation of the current published cases in the English literature of lower respiratory tract infections as a result of *B. cereus*, illustrating the rarity of this disease, with over half resulting in death. Only 2 cases, including the current report, describe massive hemoptysis as a consequence of *B. cereus*.

Although often presumed to be an environmental contaminant, *B. cereus* should be recognized as a pathogenic organism under the appropriate clinical circumstances. This finding may be significant in clinical practice with increasing numbers of immunosuppressed patients in rheumatologic, pulmonary, hematologic, and oncologic populations as a result of solid organ transplants, biologic agents, and chemotherapy.

Importantly, *B. cereus* produces β-lactamases and is therefore resistant to penicillin and cephalosporin antibiotics. This has important implications as broad-spectrum antibiotics such as piperacillin and tazobactam are often the first choice for empiric coverage when presented with a severe pneumonia, and would not be effective. *B. cereus* is typically susceptible to clindamycin, erythromycin, vancomycin, aminoglycosides, and fluoroquinolones [5, 10]. Notably, fluoroquinolone resistance has been reported and is estimated to be <10% in *B. cereus* [11]. Other antibiotics that have demonstrated 100% sensitivity include...
Table 1
Compilation of cases of Bacillus cereus as a cause of lower respiratory tract infection.

| No. | Age/Sex | Risk Factor | Clinical Presentation | Outcome | Reference |
|-----|---------|-------------|-----------------------|---------|-----------|
| 1   | N/A     | N/A         | N/A                   | Died    | Stopler et al., 1965 [12] |
| 2   | 52/M    | Acute leukemia | Fever, chest pain, hemoptysis | Died    | Coonrod et al., 1971 [13] |
| 3   | 63/M    | Acute leukemia | Fever, cough, hemoptysis | Died    | Inbe et al., 1973 [14] |
| 4   | 17/M    | Acute leukemia | Fever, chest pain     | Died    | Feldman et al., 1974 [15] |
| 5   | 29/M    | Leukemia     | Fever, cough, hemoptysis | Recovered | Leff et al., 1977 [16] |
| 6   | 60/M    | Alcohol abuse | Fever, chest pain, cough | Recovered | Panwalker et al., 1983 [17] |
| 7   | 18/M    | Alcohol abuse | Fever, cough, massive hemoptysis, dyspnea | Recovered | Bekemeyer et al., 1985 [18] |
| 8   | 54/M    | Leukemia     | Fever                   | Recovered | Sliman et al., 1987 [19] |
| 9   | 21/M    | Bronchiectasis | Fever, cough, rigors     | Recovered | Gascoigne et al., 1991 [19] |
| 10  | 46/M    | None (welder) | Fever, cough, hemoptysis, chills | Died    | Miller et al., 1997 [7] |
| 11  | 41/M    | None (welder) | Fever, chest pain, hemoptysis, chills | Died    | Miller et al., 1997 [7] |
| 12  | 52/F    | Aplastic anemia | Pseudomembranous tracheobronchitis (fever, cough, chest pain, dyspnea) | Died    | Straus et al., 2001 [20] |
| 13  | 37/F    | Acute leukemia | Fever, dry cough, chest pain | Died     | Frankard et al., 2004 [21] |
| 14  | 39/M    | None (metal worker) | Fever, productive cough, chills, vomiting | Recovered | Avashia et al., 2007 [6] |
| 15  | 56/M    | None (metal worker) | Fever, cough, hemoptysis, dyspnea | Died    | Avashia et al., 2007 [6] |
| 16  | 60/M    | Acute leukemia, chemotherapy | Fever, cough, chest pain, diarrhea | Died    | Katsuura et al., 2009 [22] |
| 17  | 43/M    | Nephrotic syndrome, high dose steroids | Diarrhea, vomiting | Recovered | Miyata et al., 2013 [23] |
| 18  | 81/F    | None         | Fever, dry cough, dyspnea | Recovered | Shimoyama et al., 2017 [15] |
| 19  | 60/M    | None         | Right shoulder pain, dyspnea, hemoptysis | Died    | Ishida et al., 2019 [9] |
| 20  | 59/M    | Esophageal adenocarcinoma, neoadjuvant radiation and chemotherapy | Fever, massive hemoptysis, retching | Recovered | Current case |

This is a rare instance of massive hemoptysis secondary to B. cereus necrotizing pneumonia in an immunocompromised patient. It is infrequently reported in the literature, perhaps as a result of the organism being regarded as a contaminant. This case highlights the importance of recognizing B. cereus as a pathogenic organism with the potential for fatal outcomes rather than an environmental contaminant.

Disclosure of interest

The authors report no conflict of interest.

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