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Case report

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

Eric C. Leung [a,*], Sean McFadden [b], Alain Tremblay [a]

[a] Department of Respirology, University of Calgary, Calgary, Canada
[b] Department of Thoracic Surgery, University of Calgary, Calgary, Canada

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 147bpm, 18 respirations/min, temperature of 39.2C, 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 5.0×10^9/L, platelets 164×10^9/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 cavitary RUL mass; an arterial branch arising from a right intercostal

* Corresponding author.
E-mail address: eric.leung@albertahealthservices.ca (E.C. Leung).

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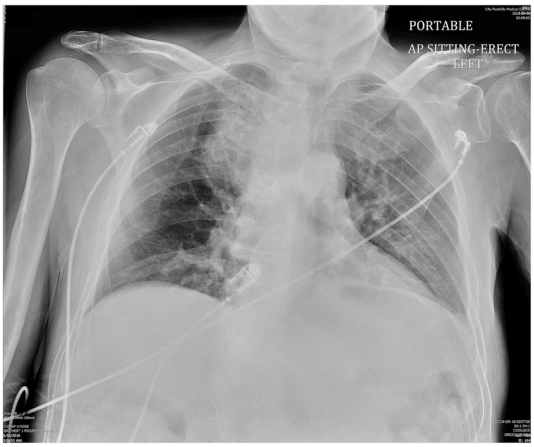

Fig. 1. Chest X-ray on admission: right upper lobe airspace disease and consolidation.

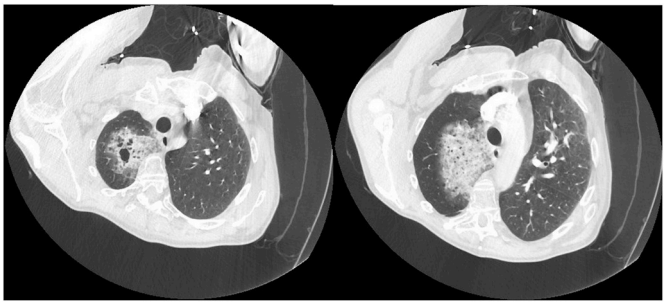

Fig. 2. Computed tomography pulmonary angiography protocol. Cystic and cavitary changes with ground glass opacities in the right upper lobe consistent with necrotizing pneumonia and hemorrhage. The esophagus is dilated secondary to the partially obstructing esophageal cancer.

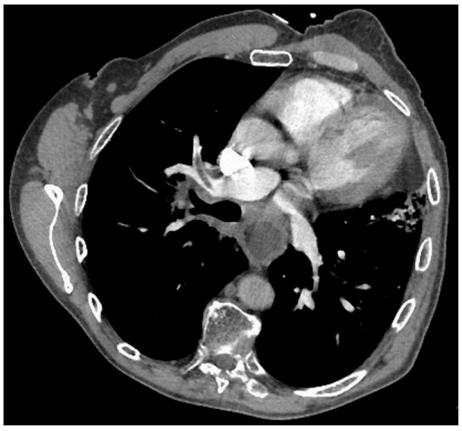

Fig. 3. Computed tomography pulmonary angiography protocol. Intraluminal filling defect in the distal right main pulmonary artery consistent with acute pulmonary embolism.

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

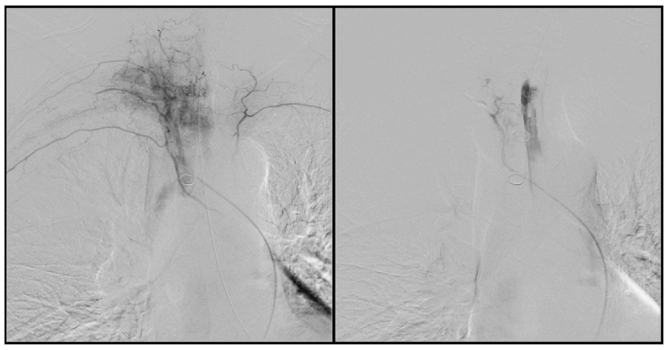

Fig. 4. Bronchial artery embolization of right upper lobe. Left: extravasation of contrast from a branch of the bronchial artery prior to embolization. Right: successful embolization of the culprit artery.

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.

Patient 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	Ihde 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 [3]
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, cough, hemoptysis, chills	Died	Miller et al., 1997 [7]
12	52/F	Aplastic anemia	Pseudomembranous tracheobronchitis (fever, cough, chest pain, dyspnea)	Died	Strauss et al., 2001 [20]
13	37/F	Acute leukemia	Fever, dry cough, chest pain	Died, unrelated to Bacillus cereus infection	Frankard et al., 2004 [21]
14	39/M	None (metal worker)	Fever, productive cough, chills, vomiting	Died	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	Katsuya 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 [8]
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

rifampin, daptomycin, and linezolid [10].

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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