

Case report

Respiratory failure in a 28-year-old male

A 28-year-old male was admitted to the intensive care unit (ICU) for hypoxic respiratory failure requiring intubation and ventilation. He had been dyspnoeic for months leading up to admission with acute worsening 2 weeks prior and reported a 6-kg weight loss over the same time. Occasional dark sputum was reported without haemoptysis, wheeze, chest pain, fever or infectious symptoms. In regard to social history, he smoked 10 cigarettes per day at the time of presentation (<10-pack-year history) and occasionally used marijuana. He worked as a soapstone carver daily and did not use any respiratory protection. In addition, the patient had exposure to a tuberculosis contact ~1 year prior to presentation.

On examination, he was noted to be quite thin with decreased breath sounds bilaterally but no adventitious sounds. He was fully ventilated, requiring an inspiratory oxygen fraction between 50% and 85% to maintain saturations. Chest radiography (figure 1) and, subsequently, a high-resolution computed tomography (HRCT) chest were completed (figure 2).



Figure 1 Posteroanterior chest radiograph of the patient.

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Task 1

Analyse the chest radiograph.

Task 2

Analyse the chest HRCT.

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An interesting case of respiratory failure secondary to occupational exposure in a 28-year-old male

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Figure 2 Chest HRCT of the patient.

Answer 1

A diffuse mixed interstitial and airspace nodular pattern with a predominantly perihilar distribution can be seen.

Answer 2

Diffuse alveolar ground-glass opacities are seen with areas of consolidation posteriorly, along with regions of septal thickening.

This patient was started empirically on broad-spectrum antibiotics (piperacillin-tazobactam, 3.375 g every 6 h, and trimethoprim/sulfamethoxazole, two double-strength tablets three times a day) to cover potential infectious aetiologies. Due to severe hypoxaemia, a trial of high-dose (500 mg·day⁻¹ methylprednisolone) pulse corticosteroids was also given, without clinical improvement.

Task 3

What is your differential diagnosis?

Task 4

What is the next most appropriate diagnosis step?

- Bronchoscopy
- Repeat HRCT with inspiratory and expiratory views
- Lung biopsy
- Positron emission tomography scan

Answer 3

The differential diagnosis at the present time included infectious aetiologies (bacterial, mycobacterial, viral or fungal), acute hypersensitivity pneumonitis, pulmonary alveolar proteinosis, sarcoidosis and occupational lung injury.

Answer 4

a. Bronchoscopy

Bronchoscopy was completed showing mild inflammation diffusely with dense mucous plugging in the lower lobes and no evidence of haemorrhage. Bronchial toileting was performed and copious amounts of dark mucous was cleared. Washings were sent for extensive microbiology testing (viruses, bacteriology, and fungal and mycobacterial cultures) and cytology. All infectious workup returned negative. Cytological analysis showed:

- abundant amorphous and finely granular proteinaceous material, scattered macrophages, degenerated epithelial cells and few groups of cells with regenerative atypia
- scattered birefringent material noted under polarised microscopy consistent with silicates
- periodic acid-Schiff (PAS) and PAS-diastase positive staining (figure 3)

Task 5

What is the most likely diagnosis?

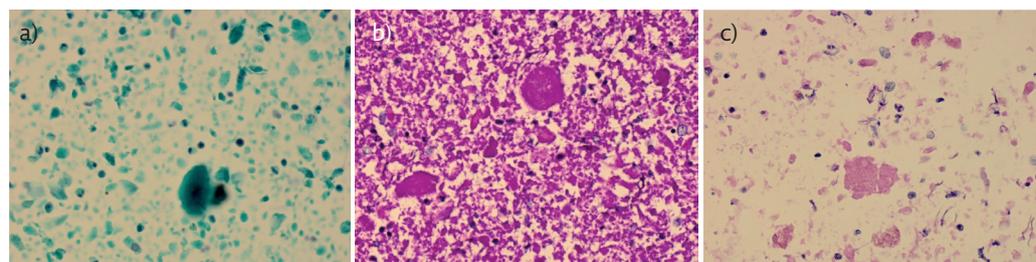


Figure 3 Cytology from bronchoalveolar lavage showing: a) surfactant material lipoprotein material within the alveoli; b) positive PAS stain; and c) positive PAS-diastase stain.

Answer 5

The most likely diagnosis is acute silicoproteinosis from occupational exposure.

The overall clinical picture was suggestive of acute silicoproteinosis. At this point, it was decided to proceed with whole-lung lavage. The thoracic surgery department was consulted, with the cardiovascular surgery department on standby in case extracorporeal membrane oxygenation (ECMO) was needed. The patient was brought to the operating room and his left lung was lavaged with a total of 22 L normal saline. The returning fluid was dark and turbid in appearance (figure 4) but progressively cleared with each irrigation. The patient remained haemodynamically stable throughout the procedure, and was transferred back to the ICU intubated and ventilated. He was extubated the following day to 40% high-flow oxygen.

A follow-up HRCT chest was completed 4 days post-whole lung lavage, which showed some improvement in his airspace disease, with increased dependent consolidations that were felt to be related to retained lavage fluid. Recovery was gradual and by post-procedure day 17, he required 6 L oxygen *via* nasal cannula. At this point, it was decided to proceed with lavage of the right lung, which was completed with 20 L normal saline. Once again, the patient tolerated the procedure extremely well. Recovery was more rapid thereafter and over the next few days, he was weaned to room air and discharged home in stable condition. Follow up HRCT of the chest 6 months later showed a marked improvement in airspace disease, with residual centrilobular ground-glass nodules (figure 5).

Discussion

Occupational and environmental lung diseases represent a vast spectrum of respiratory pathologies [1]. Exposure to silica from various industrial activities has been associated with silicosis [2]. Silicosis is further divided into chronic and accelerated silicosis, and silicoproteinosis. Chronic silicosis and accelerated silicosis occur 10 years and 5–10 years after exposure, respectively [2, 3]. Acute silicoproteinosis occurs weeks to 5 years after exposure to large quantities of silica and is similar to pulmonary alveolar proteinosis (PAP), with alveolar deposition of lipoproteinaceous material, positive for PAS stain [4]. Current literature divides PAP into three groups: autoimmune, secondary and genetic [5], with autoimmune PAP accounting for ~90% of cases [6]. Silica exposure falls under a secondary (toxic inhalation) cause of PAP. Granulocyte–macrophage colony-stimulating factor (GM-CSF) has been shown to be important in some forms of PAP [7] as antibodies to GM-CSF resulted in dysfunction of alveolar macrophages



Figure 4 Returning whole-lung lavage fluid showing clearance of sediment.

influencing surfactant clearance [8]. On HRCT, the “crazy paving” pattern of ground-glass opacities and interlobular septal thickening is often seen in PAP [9]. Bronchoalveolar lavage in PAP may have a characteristic “milky” appearance due to the surfactant material within the alveoli and the fluid should generally stain positive for PAS [10]. Whole-lung lavage remains the cornerstone of treatment of PAP [11] and has recently been reviewed by GAY *et al.* [12], though GM-CSF replacement [13], immunomodulatory therapy [14] and plasmapheresis [15] have been explored.

Regarding acute silicoproteinosis and whole-lung lavage, few case reports are available to guide treatment. MOREIRA *et al.* [16] described a case of secondary PAP in a 44-year-old male who had a significant exposure to silica, and a past history of both silicosis and treated pulmonary tuberculosis, presenting with hypoxaemic respiratory failure on the background of 4 months of dyspnoea on exertion. The patient was supported on venovenous ECMO and bilateral whole-lung lavage was completed, with favourable outcomes and an improvement in hypoxaemia. HUARINGA *et al.* [17] described a case of a 52-year-old male with significant occupational exposure to silica, without use of personal protective equipment. He presented with exertional dyspnoea over 1.5 years,



Figure 5 Repeat HRCT imaging 5 months from admission showing resolution of pulmonary infiltrates.

with a cough productive of white sputum. Chest imaging showed bilateral infiltrates, and biopsies *via* bronchoscope revealed refringent particles (silica) and PAS-positive lipoproteinaceous material. The patient underwent whole-lung lavage (double-lumen endotracheal tube; dependent lung down) with ~20 L. 1 week later, the second lung was lavaged. Overall, there was significant improvement in symptoms and oxygenation [17]. STAFFORD *et al.* [18] described a case most similar to ours. Their patient was a 32-year-old male presenting with a 9-month history of dyspnoea, cough and fever. He had significant occupational exposure to silica. Through imaging and bronchoscopic evaluation, he was diagnosed with acute silicoproteinosis. Pathology from bronchoscopy showed birefringent crystals compatible with silica. He was originally treated with methylprednisone for 3 days with mild improvement, and discharged on supplemental

oxygen and corticosteroid taper. He re-presented with worsening hypoxaemia. Whole-lung lavage was then completed first in the right lung, followed by the left lung 4 days later. The lavage return was cloudy, and 20 and 30 L were irrigated in the right and left lung, respectively. The patient was able to be weaned to his baseline oxygen requirements of 4 L·min⁻¹ [18].

Crystalline silica dust exposure remains a significant occupational hazard globally, with a spectrum of disease ranging from chronic fibrosis to acute silicoproteinosis, the latter of which can cause hypoxaemic respiratory failure. From our clinical case and the small number of case reports in the literature, it is evident that whole-lung lavage may be a viable treatment option for secondary PAP due to silica inhalation. Large-volume lavage is likely required and subsequent recovery may be gradual. Ongoing research is needed in this field.

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Conflict of interest

None declared

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