A 39-year-old man underwent distal gastrectomy and vagotomy for refractory peptic ulcer disease. The surgery and initial postoperative period were uneventful. Forty-eight hours after surgery, he developed progressive respiratory failure and ARDS, necessitating admission to the ICU and mechanical ventilation. Severe hypoxemia persisted despite the use of high ventilatory pressures and a fraction of inspired oxygen of 0.8 to 1.0. A supine anteroposterior chest radiograph was taken later that day (Fig 1).

What is the diagnosis?

Figure 1. Supine anteroposterior chest radiograph demonstrates complete opacification of both lungs, which are hyperinflated.
Diagnosis: Partial liquid ventilation with perflubron

Perflubron is a synthetic liquid ventilation agent used as an adjunct to positive pressure ventilation in selected patients with severe respiratory failure. This radiopaque liquid improves pulmonary gas exchange and lung compliance, and has characteristic and dramatic imaging appearances.

After discontinuation of treatment, perflubron gradually clears from the lungs over several days (Fig 2, 3). An abdominal CT performed 4 days after administration of perflubron demonstrates the markedly hyperattenuating agent in the dependent portions of the lower lobes (Fig 4). The patient’s oxygenation and respiratory failure gradually improved, and after a prolonged hospitalization, he was discharged without supplemental oxygen.

**DISCUSSION**

Despite advances in intensive care medicine, the ARDS carries a significant mortality rate of up to 90% in severely ill patients. Vigorous intensive care treatment regimes and techniques of ventilatory support, including liquid ventilation, are continuing to be developed. Perflubron (perfluoro-octylbromide) is a clear, inert, liquid fluorinated hydrocarbon rendered radiopaque by the presence of a single bromide atom. The oxygen- and carbon dioxide-carrying capacities of perflubron are 20 times and 60 times greater than water, respectively. By displacing the intra-alveolar exudate in patients with ARDS, perflubron aids alveolar recruitment, reduces atelectasis and consolidation, and improves oxygenation of the lung. By reducing alveolar surface tension, perflubron also improves pulmonary compliance. The drug is used to facilitate physiologic gas exchange in patients in whom conventional ventilatory support techniques have failed.

There are currently two methods of liquid ventilation: total and partial. Total liquid ventilation with perflubron-filled lungs is performed with a specialized tidal liquid ventilator. In partial liquid ventila-

![Figure 2](image1.png)
**Figure 2.** Chest radiograph obtained 4 days after administration of perflubron demonstrates clearing of the pulmonary opacification and reduction in lung volumes.

![Figure 3](image2.png)
**Figure 3.** Chest radiograph at 10 days demonstrates further clearing with some residual perflubron distributed in the lower lobes. A left thoracostomy tube was inserted subsequent to the development of a small pneumothorax that was believed to be secondary to positive pressure ventilation.

![Figure 4](image3.png)
**Figure 4.** CT scan 10 days following perflubron administration. Residual agent is present in a symmetric, lower-lobe distribution. The opacified portions of lung parenchyma demonstrated extremely high attenuation values (1,103 Hounsfield units).
tion, perfluorobron is administered in small increments through an endotracheal tube until a meniscus is present in the tube at the level of the sternum with the patient in the supine position. A standard gas ventilator is then used to deliver oxygen to the static liquid column within the lungs.

Following administration of perfluorobron, the lungs are generally rendered completely radiopaque on the frontal chest radiograph. Lack of opacification of a pulmonary lobe is usually due to mucous plugging of a lobar bronchus. The normal distribution of perfluorobron during liquid ventilation is typically symmetrical and gravity dependent. On CT images, perfluorobron is distributed in a dense, homogeneous pattern immediately after administration. Over time, the intra-alveolar deposits become more patchy as the agent begins to vaporize. Clearance of perfluorobron occurs predominantly by evaporation through the endotracheal tube, with minimal systemic absorption or lymphatic uptake. Clearance occurs more rapidly from the anterior portions of the lung with approximately one third of the administered dose remaining after 1 week. A minimal residual is usually detectable by the third week after administration. Failure of perfluorobron to clear from a specific lobe suggests endobronchial obstruction, typically from a mucous plug. Dense extrapulmonary perfluorobron may be seen in mediastinal, supraclavicular, axillary, and retroperitoneal lymph nodes when small amounts of the drug are phagocytosed by the lymphatic system. These lymphatic deposits may persist for months after perfluorobron has cleared from the lungs.

References