agent is known to be dependent upon potassium concentration for its effect. Since both the electrocardiographic and hemodynamic alterations promptly responded to corrections of the hypokalemia, we suggest that disopyramide toxicity may be seriously enhanced by high serum potassium. In such circumstances, disopyramide toxicity may be reversed by lowering the serum potassium. We believe this patient is the first documented example of the toxic synergistic action between potassium and disopyramide in man.

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Pneumocephalus*

A Complication of Continuous Positive Airway Pressure after Trauma

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We report an uncommon and potentially dangerous complication of continuous positive airway pressure (CPAP) applied during spontaneous respiration. A patient with multiple fractures and recurrent atelectasis developed pneumocephalus on the seventh day of respiratory therapy with CPAP via a face mask. A fracture of the base of the skull, not recognized despite neurologic and radiologic evaluation at admission, was at the origin of this complication.

Respiratory therapy with overall intermittent positive-pressure breathing and continuous positive airway pressure (CPAP) during spontaneous breathing is used frequently for the treatment of postoperative and post-traumatic pulmonary complications, especially atelectasis.1-4 These techniques can provide efficient therapy without requiring endotracheal intubation.5 In this re-

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FIGURE 1. Chest x-ray film obtained at admission to intensive care unit, showing atelectasis of right upper lobe.

CASE REPORT

A 30-year-old man was admitted to the emergency room after an automobile accident. At admission, he had an areactive coma, general areflexia, bilateral miosis, and isocoria. The blood pressure was 70/40 mm Hg, and the heart rate was 130 beats per minute. A right clavicular fracture, a large wound of the right elbow, and an otorrhagia on the right side were diagnosed. Roentgenograms of the skull did not reveal any fracture. Decreased breath sounds were noted over the

FIGURE 2. Roentgenogram obtained on sixth day of hospitalization. Right upper lobe is normally ventilated, but small area of atelectasis is visible in right lower pulmonary field. Right clavicular fracture is evident.
right upper pulmonary field. The emergency management included orotracheal intubation, mechanical ventilation with 100 percent oxygen, rapid infusion of blood and Ringer's lactate solution, and intravenous administration of 50 mg of dexamethasone. The persisting otorrhagia was considered by an ear, nose, and throat specialist as a lesion of the external ear and was treated with an occlusive dressing. Two hours after admission, the patient began to react to noxious stimuli. All vital signs returned rapidly to normal, and the patient was extubated.

On arrival in the surgical intensive care unit, we did not note any neurologic deficit. The chest roentgenogram revealed atelectasis of the right upper lobe (Fig 1). Clots of blood were aspirated from the right lung by a fiberoptic bronchoscopic procedure. After a transient amelioration, atelectasis recurred, and a second fiberoptic bronchoscopic procedure was performed. At the same time, we began intermittent chest physiotherapy with CPAP via a face mask, which was continued for several days (ten minutes every one to two hours with a CPAP of 10 cm H2O during the day and less frequently during the night). The findings on the chest roentgenogram improved slowly (Fig 2).

On the third day of hospitalization, the patient complained of diplopia. We diagnosed paresis of the right nervus abducens. On the seventh day of hospitalization, a massive rhinorrhea developed on the right side, accompanied by headache. A roentgenogram showed free air within the ventricles of the cerebrum and between the cerebrum and the skull (Fig 3). Tomograms revealed a longitudinal fracture of the os temporale, reaching the right petrous bone. The computerized axial tomographic study and the surgical exploration demonstrated a cerebrospinal liquid fistula between the floor of the sella turcica and the sinus sphenoidalis. Surgical closure of the dural defect was performed. The postoperative course was uneventful. The patient left the hospital ten days after the operation. The neurologic status was normal, except for persisting paresis of the right nervus abducens and repeated episodes of headache.

**DISCUSSION**

Continuous positive airway pressure is a simple, inexpensive, and efficient therapy for the management of atelectasis in nonintubated patients; however, this technique has several potential side effects. Increased intrathoracic pressure produced by CPAP can decrease venous return and cardiac output, but this effect is not found constantly. The impedance to venous return can produce an increase in intracranial pressure; and together with a lowered cardiac output, this may dramatically decrease the cerebral blood flow. Increased airway pressure also produces a higher risk of pneumothorax, pneumomediastinum, and subcutaneous emphysema. Aerophagia and gastric distention are often noted in patients receiving CPAP via a face mask.

Pneumocephalus as a consequence of therapy with CPAP has so far not been reported. Recently, this complication has been described in a victim of trauma during resuscitation by mechanical ventilation via a face mask, with an acute onset of neurologic symptoms. The described case of pneumocephalus after CPAP led us to more caution when we prescribe this treatment for pulmonary complications in nonintubated victims of trauma. A fracture of the base of the skull can not be excluded in these patients, and close monitoring of clinical status and neurologic function is mandatory when CPAP is applied.

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