

When the air pressure decreased, the low-pressure alarm for compressed air was not connected to the critical care areas or central switchboard, as required by NFPA-56F.⁵ This alarm, along with other medical gas alarms, is being connected to a hospital central alarm system (Johnson Control Alarm System, Model 81). Fortunately, the low air pressure was detected quickly, but not because of an alarm in the critical care areas. This same standard⁵ calls for a refrigerated air dryer when local atmospheric conditions make it necessary. We have installed such a dryer since this episode, but not solely to prevent deterioration of these check valves. It may be noted, however, that whether it is necessary depends among other things on the volume of gas used, ever increasing in our experience.

Although this incident produced no evident injury to patients, owing to its rapid detection, the potential obviously existed for such complications as retro-lental fibroplasia, pulmonary oxygen toxicity, or the

diminution of hypoxic drive to respiration. Prevention depends on thoughtful design of apparatus, adherence to standards, anticipation of modes of failure, and careful checking of equipment before use. Oxygen analyzers of adequate reliability should, however, ultimately be included as integral components of all devices other than the most rudimentary for the respiratory and anesthetic care of patients.

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Use of the Flexible Fiberoptic Bronchoscope to Change Endotracheal Tubes in Critically Ill Patients

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In critically ill patients absolutely dependent upon mechanical ventilatory support safely changing an endotracheal tube can be very difficult, especially in the presence of upper airway edema or anatomic abnormalities. Often these patients cannot tolerate prolonged periods of hypoventilation or loss of positive end-expiratory pressure (PEEP), and they may be impossible to ventilate via a face mask. An endotracheal tube may have to be changed for many reasons, including a leaking cuff and the inability to permit passage of a flexible fiberoptic bronchoscope or suction catheters. The flexible fiberoptic bronchoscope is fre-

quently used to facilitate the placement of endotracheal tubes in spontaneously breathing patients.¹⁻³ We describe here a technique using the flexible fiberoptic bronchoscope to change an endotracheal tube in a critically ill patient while maintaining ventilation and control of a difficult airway.

REPORT OF A CASE

A 44-year-old obese man was scheduled for an elective tonsillectomy. After induction of anesthesia, intubation of the trachea was very difficult because of his short, fat neck and small jaw. Many attempts were necessary before an oral endotracheal tube 8 mm in internal diameter (ID) was successfully passed. Bronchospasm then developed, but resolved with deep halothane anesthesia. The operation proceeded, with the surgeon having some technical difficulty because of tissue swelling and bleeding. At the end of the operation breathing was spontaneous, and the trachea was extubated. Air exchange, however, was not adequate because of upper airway obstruction and recurrent bronchospasm. With considerable difficulty a 7-mm-ID endotracheal tube was passed transnasally, and the patient was transferred to the intensive care unit, where mechanical ventilation was begun. Over the next two days, severe bronchospasm persisted, despite therapy that included sedation with morphine and diazepam, antibiotics, steroids, aminophylline, isoetharine, aerosolized atropine, and careful fluid balance guided by pressures obtained with a pulmonary-artery catheter.

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On the second postoperative day, since radiographic examination of the chest revealed opacification of the entire left lung field, presumably due to a mucous plug, emergency bronchoscopy was indicated. Our flexible fiberoptic bronchoscope (Olympus Corporation, model BF-B3, 5.5 mm OD) could not be passed down the 7-mm-ID nasal endotracheal tube. Examination of the pharynx revealed that there was still considerable tissue swelling. With the surgeons standing by prepared to perform an emergency tracheostomy, we proceeded to change the endotracheal tube.

To change the endotracheal tube without at any time losing control of the airway, we first passed a 9-mm-ID endotracheal tube through the opposite nostril until its tip was in the posterior pharynx. The flexible fiberoptic bronchoscope was passed easily through this larger endotracheal tube and then advanced through the pharynx and *alongside* the already positioned 7-mm-ID endotracheal tube down the trachea until the tip of the flexible fiberoptic bronchoscope was almost at the carina. With the flexible fiberoptic bronchoscope acting as a semirigid stent, the smaller endotracheal tube was pulled out and the larger endotracheal tube advanced over the flexible fiberoptic bronchoscope until it was properly positioned in the trachea. The patient tolerated the procedure very well. Transbronchoscopic suctioning was then used to remove abundant, thick secretions. With the larger endotracheal tube in place, suctioning using standard suction catheters was much easier than before.

Maximal medical therapy was continued, with the bronchospasm resolving by the end of the third postoperative day. Heavy sedation was discontinued, and the patient was easily weaned from the ventilator and his trachea extubated without complication.

DISCUSSION

Flexible fiberoptic bronchoscopy has become a useful and frequent procedure in the respiratory care of endotracheally intubated, critically ill patients.⁴⁻⁶ The endotracheal tube must be large enough not only to allow the passage of the flexible fiberoptic bronchoscope but also to allow adequate ventilation through the tube around the flexible fiberoptic bronchoscope.^{7,8}

When the endotracheal tube is too small to allow the flexible fiberoptic bronchoscope to pass through it safely, an alternative approach for bronchoscopy is to pass the flexible fiberoptic bronchoscope alongside it down the trachea.⁹ However, with the flexible fiberoptic bronchoscope positioned next to the endotracheal tube going past the inflated cuff on the endotracheal tube, there will be a large air leak around the cuff, which would preclude high airway pressures (such as that needed in the present case) or PEEP. Under such conditions, prolonged therapeutic bronchoscopy may be unsafe.

Previous methods used to change an endotracheal tube in a patient with a difficult airway have included the use of a long, soft nasogastric tube passed through the endotracheal tube. The original endotracheal tube is taken out with the nasogastric tube left in place, and then a new endotracheal tube is passed over the naso-

gastric tube. Using this technique, we have sometimes encountered difficulty passing the second endotracheal tube over the nasogastric tube into the trachea. Since the nasogastric tube is very pliable, the new endotracheal tube is not guided directly into the trachea, but instead may get caught at the epiglottis or vocal cords. The advantage of using the flexible fiberoptic bronchoscopy as a stent to guide the passage of an endotracheal tube is that it is rigid enough to insure that the endotracheal tube does not, through its own stiffness, pass in the wrong direction. One must, of course, be certain that the second endotracheal tube is not too large to pass through the patient's vocal cords and larynx.

This technique can be modified for use in other situations as well. For example, if the placement of the second endotracheal tube through the patient's other nostril is impossible, then the procedure using the flexible fiberoptic bronchoscope can be performed via the oral route. This can be generalized into a technique for replacing any nasotracheal tube with an orotracheal tube.

We believe that this technique of using a flexible fiberoptic bronchoscope passed alongside an endotracheal tube already in place as a stent over which a new endotracheal tube can be passed endotracheally is a safe, effective method for changing an endotracheal tube in patients in whom changing an endotracheal tube by extubation and laryngoscopy may be difficult or dangerous.

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