Intracuff Pressures of Endotracheal Tubes in the Management of Airway Emergencies: The Need for Pressure Monitoring

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Study objective: Excessive pressure exerted on the tracheal mucosa is an avoidable factor implicated as a cause of damage after intubation of the trachea with cuffed tubes. Many patients are intubated in the out-of-hospital setting by emergency medical teams. The time spent in the out-of-hospital setting could very well be long enough for tracheal mucosal damage to occur if cuff pressure is not controlled. The objective of this study is to assess the incidence of intracuff excessive pressure in the out-of-hospital setting.

Methods: We performed an observational prospective study. Every patient who required tracheal intubation was included in the study, regardless of indication. When the patient was stabilized, the cuff was connected to a manometer, and pressure was systematically recorded. Corrections to inflation were performed if necessary to achieve a cuff pressure of 14 to 27 cm H2O.

Results: One hundred seven patients were included. Eighty-five were out-of-hospital patients and 22 were transfers between 2 hospitals who had been previously intubated when the mobile intensive care unit team arrived. The first recorded cuff pressures were greater than 27 cm H2O among 79% of patients (85/107), with a mean pressure of 56 cm H2O (SD=34 cm H2O) in out-of-hospital patients and 69 cm H2O (SD=37 cm H2O) for transferred patients. Pressure correction was made in 72% of patients (77/107). There were corrections in 69% (59/85) of out-of-hospital patients and 82% (18/22) of transferred patients.

Conclusion: This study revealed that the majority of cuff pressures exceeded safe pressure and required correction. Frequent measurement and adjustment of cuff pressure has been recommended, but this method requires a specific manometer. [Ann Emerg Med. 2006;47:545-547.]

INTRODUCTION

The endotracheal tube’s inflatable cuff should seal the airway, thus preventing aspiration of pharyngeal contents into the trachea, and it should ensure that there are no leaks past the cuff during positive pressure ventilation. At the same time, the pressure exerted by the inflated cuff on the trachea should not be so high that capillary circulation is compromised. Excessive pressure exerted on the tracheal mucosa is an avoidable factor that has been implicated as a cause of damage after intubation of trachea with cuffed tubes.1 Although the exact pathophysiology of postintubation airway symptoms is not fully elucidated, mucosal damage occurring at the cuff level is thought to be an important causative factor for tracheal morbidity.2 A cuff pressure greater than 30 cm H2O for 15 minutes was sufficient to induce histological evidence of tracheal mucosal lesions,3-5 which is probably the first step in development of mucosal damage or immediate complications such as tracheal rupture.6 Many patients are intubated in the out-of-hospital setting by emergency medical teams for respiratory distress. The time spent in the out-of-hospital setting may very well be long enough for tracheal mucosal damage to occur if cuff pressure is not controlled.

The objective of this study is to assess the incidence of cuff excessive pressure in the out-of-hospital setting.

MATERIALS AND METHODS

We performed an observational prospective study. This study was performed according to French ethics law (Loi Huriet), and because the procedure did not vary in any case...
what is already known on this topic
Elevated tracheal tube cuff pressures can cause mucosal injury within 15 minutes and may be associated with substantial morbidity.

what question this study addressed
The incidence of elevated tracheal tube cuff pressures in 107 French emergency medical services patients.

what this study adds to our knowledge
Seventy-eight percent of patients had tracheal tube cuff pressures above recommended values.

how this might change clinical practice
This study suggests that standard cuff inflation with 10 mL of air produces unduly high cuff pressures. If that finding is confirmed, recommendations about cuff inflation volume may require revision, or routine measurement of cuff pressure may be advantageous.

from our standard clinical practice, neither specific informed consent nor ethics committee approval was required. One out-of-hospital emergency service using mobile intensive care units and located in an urban area participated in this study. In France, management of out-of-hospital medical emergencies is the responsibility of the Service d’Aide Médicale Urgente. Mobile intensive care units are staffed by an attending emergency physician, a nurse anesthetist, and an emergency medical technician.

Every patient who required tracheal intubation was included in the study, regardless of indication.

In accordance with our standard practice, after preoxygenation for at least 3 minutes, anesthesia was induced with etomidate (0.2 mg/kg body weight) and succinylcholine (1 mg/kg body weight) (rapid sequence induction), except for patients in cardiac arrest, who were intubated without sedation. Sedation was maintained with midazolam (bolus of 30 μg/kg body weight intravenously followed by infusion of 20 to 80 μg/kg body weight per hour) and fentanyl (bolus of 1 μg/kg body weight intravenously followed by infusion of 1 to 2 μg/kg body weight per hour). Intubations were performed by an emergency physician or nurse anesthetist.

After tracheal intubation, the endotracheal cuff was inflated with air through a 10-mL syringe, but the providers performing intubations were not given instructions about how much air to use. After this, mechanical ventilation was controlled and adapted to patient demand. When the patient was stabilized, the cuff was connected to a manometer (Portex, Smiths Medical Inc, London, UK). An initial pressure during apnea was recorded in the field, and then a correction was performed if necessary to achieve a cuff pressure of 14 to 27 cm H₂O (manufacturer instructions). The use of the manometer was simple, and no specific training was necessary.

We likewise included intubated patients who were transferred from one hospital to another. In these cases, cuff pressure was recorded and corrected, if necessary, at the beginning of care by the mobile intensive care unit team.

results
One hundred seven patients were included between January 1, 2003, and June 30, 2003. Eighty-five were out-of-hospital patients, and 22 patients were transferred between 2 hospitals and had been previously intubated when the mobile intensive care unit team arrived. Indications for intubation were alteration of consciousness (41%), cardiac arrest (29%), respiratory distress (16%), hemodynamic instability (10%), and other (4%). The first recorded cuff pressures were greater than 27 cm H₂O among 79% of patients (85/107) (Figure), with a mean pressure of 56 cm H₂O (SD ± 34) in out-of-hospital patients and 69 cm H₂O (SD ± 37) for transferred patients. Pressure correction was made in 72% of patients (77/107). There were corrections in 69% (59/85) of out-of-hospital patients and 82% (18/22) of transferred patients.

limitations
This study was not blinded. The operator knew that pressure was measured and knew the result of each pressure; therefore, he could change his procedure about cuff injected volume throughout the survey. This was a bias of this study.

There was no specific manufacturer instruction for calibration of the device. A progressive loss of accuracy of the device was therefore possible.

discussion
This study showed that the majority of cuff pressures exceeded safe pressure and needed correction. Furthermore, this measurement was simple to do in the out-of-hospital setting. Although cuff pressure measurement is recommended in French guidelines about airway management, its use was unusual in our out-of-hospital emergency medical practice before this survey. It has been shown in humans that tracheal...
mucosal blood flow is impaired when cuff pressure increases above 30 cm H₂O.³ Seegobin and van Hasselt⁴ assessed tracheal mucosal blood flow in 40 patients undergoing surgery using an endoscopic photographic technique while varying the cuff inflation pressure. The authors found that obstruction to mucosal blood flow occurs at pressures above 30 cm H₂O, with total occlusion of flow to the mucosa at a pressure of 50 cm H₂O. Combes et al² showed that the incidence and severity of tracheal mucosal lesions, seen with fiberoptic tracheoscopy, was higher in the group with cuff pressure greater than 30 cm H₂O than in the group with cuff pressures controlled between 20 and 30 cm H₂O. The incidence of major tracheal complications and related deaths among ICU patients who required intubation and mechanical ventilation for more than 6 hours decreased sharply after introduction of the controlled pressure tube (2.7% versus 0.3 for major complications; 1.7 versus 0.1% for death because of major tracheal complications).⁸

Several clinical studies have shown that the incidence of postoperative sore throat was significantly decreased when low cuff pressure was maintained during anesthesia, suggesting that for a constant cuff-tracheal surface area, intracuff pressure was the determining factor for postintubation sore throat.⁵,¹⁰ We found no study about the minimum time for mucosal lesions to occur in humans. In out-of-hospital intubations, we do not know whether measurement of cuff pressure on the field is indispensable or not compared with a later hospital measurement. In an animal model, a cuff pressure greater than 30 cm H₂O for 15 minutes was sufficient to induce histologic evidence of tracheal mucosal lesions, which interestingly did not worsen with time beyond 15 minutes.⁵ Furthermore, a case of reported tracheal rupture caused by an overinflated cuff after emergency intubation might have been avoided with immediate measurement.⁶ Unfortunately, there are limited means to ensure that the cuff pressure of the endotracheal tube placed in the field will be rapidly measured on hospital arrival until this becomes standard practice by the receiving medical team. Notwithstanding the limited out-of-hospital period, we would strongly recommend that cuff pressure be measured immediately after intubation by the caregiver performing the intubation.

Prevention of excessive pressure of the endotracheal tube cuff can be achieved by several means. Frequent measurement and adjustment of cuff pressure has been recommended, but this method requires a specific manometer.⁷ This device is not expensive and is a good investment in comparison with expected benefit.

This study revealed that tracheal tube intracuff pressure was too high in the majority of cases in the out-of-hospital setting. Monitoring of this pressure was simple with a manometer and allowed for correction of excessive pressure.

Supervising editors: Richard M. Levitan, MD; Robert K. Knopp, MD
Author contributions: MG and BG conceived the study and designed the survey. FA and FL provided advice on study design. MG analyzed the data. MG and SWB drafted the manuscript. VT and the other authors contributed to its revisions. MG takes responsibility for the paper as a whole.

Funding and support: The authors report this study did not receive any outside funding or support.

Publication dates: Received for publication September 2, 2004. Revisions received April 19, 2005; May 13, 2005; June 7, 2005; and July 21, 2005. Accepted for publication August 3, 2005. Available online October 17, 2005.

Reprints not available from the authors.

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