

Management of Tracheal Intubation in the Respiratory Intensive Care Unit by Pulmonary Physicians

Andrea MA Vianello MD, Giovanna ME Arcaro MD, Fausto S Braccioni MD,
Federico Gallan MD, Chiara M Greggio MD, Anna Marangoni MD, Carlo Ori MD,
and Michele Minuzzo MD

BACKGROUND: Expert management of tracheal intubation has become fundamental to the routine practice of pulmonary physicians who work in respiratory intensive care units (ICUs). In Italy, tracheal intubation is not included as part of the training in respiratory medicine, and pulmonary physicians are usually dissuaded from managing intubations. **METHODS:** We prospectively studied the intubation success rate in 46 consecutive respiratory ICU patients who required either emergency or urgent intubation, conducted by 3 intubation-trained pulmonary physicians in our respiratory ICU. Intubation success was defined as successful tracheal intubation without any of 7 pre-defined complications. **RESULTS:** There were 17 emergency intubations and 29 urgent intubations. Intubation was successful in 43 of the 46 intubation attempts. Complications occurred in 3 cases: 2 patients needed to be intubated by an anesthesiologist, and 1 patient received fiberoptic intubation. **CONCLUSIONS:** Pulmonary physicians trained in tracheal intubation can have a high success rate in performing intubation in the respiratory ICU. Collaborative efforts between anesthesiologists and pulmonary physicians are necessary to optimize the training, skill-retention, and back-up for advanced airway management in the respiratory ICU. *Key words:* tracheal intubation, training, respiratory, intensive care unit. [Respir Care 2007;52(1):26–30. © 2007 Daedalus Enterprises]

Introduction

Unlike in the United States, respiratory intensive care units (RICUs) have been developed in Europe only in the last 15 years. In Italy these RICUs, which provide most types of mechanical ventilatory support, were created to

spare critical care beds in the other ICUs. RICUs have produced promising results as a cost-saving alternative to ICUs, with a cost reduction of 20–60%.¹

SEE THE RELATED EDITORIAL ON PAGE 21

Andrea MA Vianello MD, Giovanna ME Arcaro MD, Fausto S Braccioni MD, Federico Gallan MD, Chiara M Greggio MD, Anna Marangoni MD, and Michele Minuzzo are affiliated with the Unità di Terapia Intensiva Respiratoria, Azienda Ospedaliera di Padova, Padova, Italy. Carlo Ori MD is affiliated with the Dipartimento di Farmacologia ed Anestesiologia, Università di Padova, Padova, Italy.

Andrea MA Vianello MD presented a version of this paper at the 38th Congresso Nazionale of the Associazione Italiana Pneumologi Ospedalieri, held October 25–28, 2005, in Venice, Italy.

The authors report no conflicts of interest related to the content of this paper.

Correspondence: Andrea MA Vianello MD, Unità Operativa Fisiopatologia Respiratoria, Azienda Ospedaliera di Padova, Via Giustiniani 3, 35128 Padova, Italy. E-mail: avianello@qubisoft.it.

Pulmonary physicians managing critically ill patients in the RICU should be competent in tracheal intubation, comparable to other physicians with acute care responsibilities. In fact, although the widespread use of noninvasive positive-pressure ventilation (NPPV) has reduced the need for invasive mechanical ventilation, tracheal intubation and invasive mechanical ventilation remain standard treatment when NPPV is contraindicated or fails.^{2–4}

Although Italy is the European country with the largest number of RICUs run by pulmonary physicians,⁵ specific training in acute airway management, and in particular tracheal intubation, is not part of the standard training in respiratory medicine, so Italian pulmonary physicians have usually been dissuaded from the routine practice of tracheal intubation, which is generally carried out by anes-

thesiologists. However, as anesthesiologists are not always available for intubation in the RICU, we believe that intubation should be within the respiratory physician's scope of practice and that intubation in the RICU should routinely be performed by pulmonary physicians, with appropriate training and skill maintenance.

Based on these considerations and on the observation that nonanesthesiologists perform a substantial proportion of the acute airway management activities outside the operating theater in other countries,^{6,7} we evaluated the success of RICU intubation by intubation-trained pulmonary physicians.

Methods

This was a prospective observational study of the intubation success/failure in 46 consecutive RICU patients who underwent tracheal intubation conducted by 3 pulmonary physicians in our RICU. The study was approved by our institutional review committee.

Setting

The study was carried out in our 4-bed adult RICU, which is in a university-affiliated, acute care regional hospital with more than 1,500 beds. We receive patients from the emergency department, acute medical wards, and intensive care. Treatment may be based on monitoring, NPPV, or weaning from invasive mechanical ventilation. Our RICU is fully equipped for invasive and noninvasive ventilation and monitoring. The RICU staff includes 3 pulmonary physicians, 4 anesthesiology residents (available only at night), 2 physical therapists, and 8 nurses. There is always at least one physician present in the RICU.

Patients

From March 1, 2003, to February 28, 2005, 46 of 240 consecutive patients admitted to our RICU required tracheal intubation and were recruited into the study. The baseline diagnosis groups were: exacerbation of chronic obstructive pulmonary disease (diagnosis based on medical history and functional data); other acute respiratory disease (eg, pneumonia or pulmonary embolism); respiratory failure related to a neuromuscular or chest wall disease; and postoperative respiratory failure.

Intubation Training

The pulmonary physicians underwent an individualized intubation course with an anesthesiologist. This was an in-depth, hands-on, 3-month course that explored different airway techniques, drugs, and cases based in the operating theater. The pulmonary physicians were assigned to pa-

tients for the entire duration of the patient's surgery and recovery room stay. Each pulmonary physician was expected to intubate approximately 40 patients, under the supervision of an anesthesiologist, and each was instructed about the use of sedative drugs and neuromuscular blocking agents. The following skills were required at the end of the course: bag and face mask ventilation, application of cricoid pressure (Sellick's maneuver), tracheal intubation using a Macintosh blade, administration of sedative drugs, neuromuscular blocking agents, and hemodynamic drugs. The pulmonary physicians were required to maintain their airway skills by performing a minimum of 15 intubations per year in the operating theater.

Intubation Protocol

A 2-level response system for intubation of critically ill patients was adopted in our RICU. Need for tracheal intubation was defined as "emergency" if intubation was required in < 5 min or "urgent" if a > 5-min delay was acceptable. The emergency requirement was usually indicated by cardiorespiratory arrest; urgent need was suggested by altered level of consciousness and a need to control the airway, respiratory distress, or failure of medical therapy and NPPV.

Under this system, intubations were performed by the pulmonary physician on duty, with an anesthesiologist available for back-up telephone consultation in emergency intubation situations, or with an anesthesiologist from the emergency department present as a back-up provider in urgent intubation situations. The pulmonary physician was allowed to perform a number of intubation attempts, at the discretion of the attending anesthesiologist. If both the pulmonary physician and the back-up anesthesiologist failed in their attempts, immediate access to a flexible fiberoptic scope, as an alternative airway device for difficult intubation, was planned.

The intubation protocol we adopted in our RICU is based on the use of sedation without neuromuscular blocking agents (a system called "intubation minus paralysis").⁸ Unless completely obtunded, the patient received sedation to reduce the distress associated with laryngoscopy. Sedation was achieved with propofol, 1–1.5 mg/kg, administered intravenously. Neuromuscular blocking agents were not used. Both the pulmonary physician and anesthesiologist used a German designed, bulb-illuminated Macintosh blade for intubation; usually there was no stylet or bougie inserted in the endotracheal tube. Sellick's maneuver was usually performed by paramedical personnel familiar with the maneuver: a light cricoid pressure was exerted while the patient was drowsy, and a firm pressure (approximately 20–30 N) when the patient became unconscious. Pressure was maintained until intubation and in-

MANAGEMENT OF TRACHEAL INTUBATION IN THE RESPIRATORY ICU

Table 1. Protocol for Intubation Minus Paralysis

Time (min)	Procedure(s)
0–5	Pre-oxygenate; continue oxygenating until intubated Assemble drugs and prepare for intubation
5.0–5.5	Administer sedation (intravenous propofol, 1–1.5 mg/kg) Allow 1–2 min for sedation to take effect
7	Perform Sellick's maneuver (cricoid pressure) Intubate

flation of the endotracheal tube cuff was complete. Table 1 summarizes the intubation protocol.

Data Collection

The following data were collected: anthropometrics, baseline condition, location prior to RICU admission, criteria for admission, indication for intubation, and whether the intubation was emergency or urgent. The number of intubation attempts and immediate complications were prospectively monitored.

An "intubation attempt" was defined as placement of the laryngoscope into the patient's mouth, even if no attempt was made to insert an endotracheal tube.⁹ Intubation complications were defined as:

1. Greater than 3 intubation attempts
2. Intubation by the anesthesiologist
3. Need for fiberoptic intubation
4. Cardiovascular compromise, defined as hypotension (blood pressure < 80 mm Hg), bradycardia (heart rate < 55 beats/min), or desaturation (oximetry-measured saturation < 90%) during intubation
5. Patient resistance or movement
6. Esophageal intubation
7. Regurgitation and/or aspiration

Outcome Measure and Statistical Analysis

The only outcome measure was successful intubation, defined as success without any of the defined complications.

Our sample size was calculated with Simon's 2-stage optimal design. Considering that the success rate for tracheal intubation performed without neuromuscular blocking agent outside the operating theater in hospitals is around 70–90% among nonanesthesiologists and 95–98% among anesthesiologists,^{6,7} the lower success level (p₀) was set at 0.80 and the target success level (p₁) of interest was set at 0.95. The α and β error levels were set at 0.05 and 0.1, respectively. We planned to stop the study if ≤ 17 intubations in 19 eligible cases were successful and to reject the adoption of tracheal intubation by pulmonary physi-

Table 2. Patient Anthropometric and Clinical and Data at Study Entry^a

Age (mean \pm SD y)	75.5 \pm 13.5
Sex (M/F)	32/14
Baseline condition (number of patients)	
COPD exacerbation	24
Other acute respiratory disease	11
Neuromuscular or chest wall disease	9
Postoperative respiratory failure	2
Location prior to ICU admission (number of patients)	
Emergency department	26
Acute medical ward	11
ICU	9
Criteria for admission (number of patients)	
NPPV	25
Monitoring	17
Weaning	4
Urgency of intubation (number of patients)	
Urgent	29
Emergency	17

^a46 intubations

COPD = chronic obstructive pulmonary disease

ICU = intensive care unit

NPPV = noninvasive positive-pressure ventilation

cians if ≤ 38 intubations in 42 eligible cases were successful.

Mean and standard deviations were used for discrete and continuous variables.

Results

Over a 2-year period, 46 patients were recruited to the study. Table 2 shows the cumulative anthropometric and clinical data at study entry. The majority of RICU patients (24/46) who required tracheal intubation had exacerbations of chronic obstructive pulmonary disease. Twenty-five of the 46 initially underwent NPPV for acute respiratory failure refractory to medical therapy.

Intubation was emergent in 17 cases and urgent in 29 cases. The indication for emergency intubation was cardiorespiratory arrest in all cases. The indications for urgent intubation were respiratory distress or failure of medical therapy and NPPV in 15 cases, and altered level of consciousness with a need to control the airway in 14 cases.

Propofol was administered intravenously to 21 of the 26 urgently intubated patients. No emergency-intubated patient was given drugs. The number of intubations performed by the 3 pulmonary physicians in our RICU were 20, 14, and 12, respectively.

Intubation was successful in 18 of the first 19 eligible cases, 39 of the first 42 eligible cases, and 43 of the total 46 cases (93.5%, 95% confidence interval 86.4–100). The success/failure rates for the individual pulmonary physi-

Table 3. Anthropometric and Clinical Data From the Unsuccessful Intubations

	Patient 1	Patient 2	Patient 3
Age (y)	74	81	78
Sex	M	M	F
Baseline condition	Fibrothorax, obesity	Fibrothorax, phrenic nerve paralysis	Amyotrophic lateral sclerosis
Location prior to ICU admission	ED	ED	ICU
Criteria for admission	NPPV	NPPV	Weaning
Urgency of tracheal intubation	Urgent	Urgent	Urgent
Reason for tracheal intubation	Need to protect the airway	Need to protect the airway	Respiratory distress
Complication	Intubation by the anesthesiologist	Intubation by the anesthesiologist	Need for fiberoptic intubation

ICU = intensive care unit

ED = emergency department

NPPV = noninvasive positive-pressure ventilation

cians were 18/20, 14/14, and 11/12, with a mean number of attempts of 1.5, 1.3, and 2.0, respectively. Complications were documented in 3 patients (6.5%, 95% confidence interval 0–13.6), all of whom suffered from neuromuscular or chest wall disease. Table 3 summarizes the unsuccessful intubations. Two of these patients were intubated in the second attempt by the back-up anesthesiologist. The other patient underwent fiberoptic intubation after several unsuccessful attempts by the anesthesiologist. There was no difference in complication rate between the individual pulmonary physicians.

Discussion

In Italy, the growing number of RICUs run by pulmonary physicians has prompted discussion regarding who should manage intubation in the RICU. In Italy, intubation is not part of the regular training program in respiratory medicine. Intubation is usually performed by anesthesiologists. However, anesthesiologists are not always available. Under these circumstances, we believe that a pulmonary physician with appropriate training and skill maintenance can be an effective alternative provider.

Although the study design and relatively small number of patients are limitations, our experience provides several elements of information. First of all, it should be emphasized that in 93.5% of the cases in this study, the intubation was effective and safely carried out by the intubation-trained pulmonary physicians, which supports the hypothesis that intubation can be competently conducted by pulmonary physicians in the RICU. This finding is in keeping with several other studies that found that intubation-trained medical and paramedical personnel can perform tracheal intubation outside of the operating theater with a frequency of complications similar to tracheal intubation carried out by anesthesiologists. A success rate of 86–98% has been reported for emergency physicians, depending on which intubation tech-

nique was adopted (rapid-sequence intubation, intubation minus paralysis, or nasotracheal intubation),^{10,11} and 90–100% among respiratory therapists.^{12,13} It should also be emphasized that in a difficult intubation scenario, pulmonary physicians have an advantage over other trained personnel in that they can usually intubate with fiberoptic guidance if direct laryngoscopy fails. Although the amount of training needed to achieve competence in direct laryngoscopy and intubation is debated, reports suggest that 20–60 intubation attempts are required to complete the learning curve experience.^{14,15} Accordingly, in our study we required approximately 40 intubations before assuming competence. Intubation skills can deteriorate over time, so for skill maintenance we required the pulmonary physicians to complete a minimum of 15 intubations every 2 years, with expert feedback, as this is reported to reduce deterioration of skills.^{13,16}

The use of neuromuscular blocking agents in combination with anesthetic drugs significantly reduces complications of tracheal intubation, compared to sedation without paralysis;⁸ nevertheless, our protocol was designed to have intubation performed without any muscle relaxant. This decision was based on reports that acceptable intubating conditions can be provided by anesthetic alone,¹⁷ and on the consideration that, in Italy, it is suggested that neuromuscular blocking agents be regulated by anesthesiologists. We chose propofol as the anesthetic, based on data that propofol combined with opioids may provide better intubating conditions than do other sedatives. Propofol may decrease arterial blood pressure more than do other anesthetics,^{18,19} but we did not observe such hemodynamic effects in our patients, presumably because we used a lower anesthetic dose (1–1.5 mg/kg) than is used in common practice.

The small number of patients in our study prevents us from clearly identifying clinical variables that may influence the success of tracheal intubation. Nevertheless, our results suggest that the chances of successful intubation

are higher in emergency than in urgent conditions: in fact, all nearly or fully arrested patients were successfully intubated, whereas intubation difficulty or failure occurred with 3 patients who were not completely obtunded immediately before the intubation attempt. A failure of 10% in the urgent group is in agreement with other studies, which reported that nonarrested patients are more complex during intubation and usually require a greater number of intubation attempts than do arrested patients,²⁰ which suggests that a different intubation protocol, including the use of muscle relaxants or high-dose opioids, might benefit these patients. Interestingly, we also noted that more patients suffering from neuromuscular or chest wall disease proved difficult to manage during intubation, perhaps because they more commonly present with conditions that cause mechanical impediments to intubation, such as scoliosis of the cervical spine and neck rigidity.²¹ Anesthesiologist assistance could be appropriate with such patients.

Conclusions

We believe our results show that most RICU intubations can be managed by intubation-trained pulmonary physicians. Given the growing number of RICUs run by pulmonary physicians, in our opinion, airway management skills, including tracheal intubation, should be included as part of the program of specialization in respiratory medicine. Collaborative effort between anesthesiologists and pulmonary physicians is fundamental to optimize the training and skill retention for advanced airway management in the RICU.

REFERENCES

1. Nava S, Confalonieri M, Rampulla C. Intermediate respiratory intensive care units in Europe: a European perspective. *Thorax* 1998; 53(9):798–802.
2. Brochard L, Mancebo J, Wysocki M, Lofaso F, Conti G, Rauss A, et al. Noninvasive ventilation for acute exacerbations of chronic obstructive pulmonary disease. *N Engl J Med* 1995;333(13):817–822.
3. Celikel T, Sungur M, Ceyhan B, Karakurt S. Comparison of noninvasive positive pressure ventilation with standard medical therapy in hypercapnic acute respiratory failure. *Chest* 1998;114(6):1636–1642.
4. Martin TJ, Hovis JD, Costantino JP, Bierman MI, Donahoe MP, Rogers RM, et al. A randomized, prospective evaluation of noninvasive ventilation for acute respiratory failure. *Am J Respir Crit Care Med* 2000;161(3 Pt 1):807–813.
5. Confalonieri M, Gorini M, Ambrosino N, Mollica C, Corrado A; Scientific Group on Respiratory Intensive Care of the Italian Association of Hospital Pneumologists. Respiratory intensive care units in Italy: a national census and prospective cohort study. *Thorax* 2001;56(5):373–378.
6. Bishop MJ. Who should perform intubation? *Respir Care* 1999;44(7): 750–755.
7. Kovacs G, Law JA, Ross J, Tallon J, MacQuarrie K, Petrie D, et al. Acute airway management in the emergency department by non-anesthesiologists. *Can J Anaesth* 2004;51(2):174–180.
8. Li J, Murphy-Lavoie H, Bugas C, Martinez J, Preston C. Complications of emergency intubation with and without paralysis. *Am J Emerg Med* 1999;17(2):141–143.
9. Marvez E, Weiss SJ, Houry DE, Ernst AA. Predicting adverse outcomes in a diagnosis-based protocol system for rapid sequence intubation. *Am J Emerg Med* 2003;21(1):23–29.
10. Sakles JC, Laurin EG, Rantapaa AA, Panacek EA. Airway management in the emergency department: a one-year study of 610 tracheal intubations. *Ann Emerg Med* 1998;31(3):325–332.
11. Levitan RM, Rosenblatt B, Meiner EM, Reilly PM, Hollander JE. Alternating day emergency medicine and anesthesia resident responsibility for management of the trauma airway: a study of laryngoscopy performance and intubation success. *Ann Emerg Med* 2004; 43(1):48–53.
12. McLaughlin AJ Jr, Scott W. Training and evaluation of respiratory therapists in emergency intubation. *Respir Care* 1981;26(4):333–335.
13. Zyla EL, Carson J. Respiratory care practitioners as secondary providers of endotracheal intubation: one hospital's experience. *Respir Care* 1994;39(1):30–33.
14. Young A, Miller JP, Azarow K. Establishing learning curves for surgical residents using Cumulative Summation (CUSUM) Analysis. *Curr Surg* 2005;62(3):330–334.
15. Konrad C, Schupfer G, Weitlisbach M, Gerber H. Learning manual skills in anesthesiology: is there a recommended number of cases for anesthetic procedures? *Anesth Analg* 1998;86(3):635–639.
16. Kovacs G, Bullock G, Ackroyd-Stolarz S, Cain E, Petrie D. A randomized controlled trial on the effect of educational interventions in promoting airway management skill maintenance. *Ann Emerg Med* 2000;36(4):301–309.
17. Erhan E, Ugur G, Gunusen I, Alper I, Ozyar B. Propofol – not thiopental or etomidate – with remifentanyl provides adequate intubating conditions in the absence of neuromuscular blockade. *Can J Anaesth* 2003;50(2):108–115.
18. Barker P, Langton JA, Wilson IG, Smith G. Movements of the vocal cords on induction of anaesthesia with thiopentone or propofol. *Br J Anaesth* 1992;69(1):23–25.
19. Davidson JAH, Gillespie JA. Tracheal intubation after induction of anaesthesia with propofol, alfentanil and i.v. lignocaine. *Br J Anaesth* 1993;70(2):163–166.
20. Stauffer JL, Olson DE, Petty TL. Complications and consequences of endotracheal intubation and tracheostomy: a prospective study of 150 critically ill adult patients. *Am J Med* 1981;70(1):65–76.
21. Morris P. Duchenne muscular dystrophy: a challenge for the anaesthetist (editorial). *Paediatr Anaesth* 1997;7(1):1–4.