A standardized rapid sequence intubation protocol facilitates airway management in critically injured patients

Shana L. Ballow, DO, Krista L. Kaups, MD, Staci Anderson, PharmD, *and* **Michelle Chang, PharmD,** *Fresno, California*

BACKGROUND: In the emergency department (ED) of a teaching hospital, rapid sequence intubation (RSI) is performed by physicians with a wide range of experience. A variety of medications have been used for RSI, with potential for inadequate or excessive dosing as well as complications including hypotension and the need for redosing. We hypothesized that the use of a standardized RSI medication protocol has facilitated endotracheal intubation requiring less medication redosing and less medication-related hypotension.

METHODS: An RSI medication protocol (ketamine 2 mg/kg intravenously administered and rocuronium 1 mg/kg intravenously administered, or succinylcholine 1.5 mg/kg intravenously administered) was implemented for all trauma patients undergoing ED intubation at a Level I trauma center. We retrospectively reviewed patients for the 1-year period before (PRE) and after (KET) the protocol was instituted. Data collected included age, sex, Injury Severity Score (ISS), Abbreviated Injury Scale (AIS) score of the head/face, AIS score of the chest, RSI drugs, need for redosing, time to intubation, indication for RSI, and number of RSI attempts.

RESULTS: During the study period, 439 patients met inclusion criteria; 266 without protocol (PRE) and 173 with protocol (KET). Patients were severely injured with a mean ISS of 24 and median AIS score of the head/face of 3. Dosing in the KET group was appropriate with a mean dose of 1.9-mg/kg ketamine administered. Compliance after KET introduction approached 90%. Fifteen patients in the PRE group required redosing of medication versus three in the KET group ($p < 0.05$, χ^2). For patients younger than 14 years, (26 in PRE and 10 in KET), 2 patients in the PRE group required redosing and none in the KET group (not significant). In all patients, mean time from drug administration to intubation decreased from 4 minutes to 3 minutes.

CONCLUSION: A standardized medication protocol simplifies RSI and allows efficient airway management of critically injured trauma patients in the ED of a teaching hospital. Incorporation of ketamine avoids potential complications of other commonly used RSI medications. (*J Trauma Acute Care Surg*. 2012;73: 1401–1405. Copyright © 2012 by Lippincott Williams & Wilkins)

LEVEL OF EVIDENCE: Therapeutic study, level IV.

KEY WORDS: Ketamine; airway protocol; trauma patient.

Airway control is the first priority in the initial resuscitation and management of the patient with significant traumatic injury. Many of these patients require endotracheal intubation for definitive airway management. While some patients are intubated in the field before hospital arrival or at transferring institutions, a significant proportion are intubated in the emergency department (ED) on arrival. This task is often challenging in a patient who may have agitation, unconsciousness, hypotension, cervical spine injury, or an obstructed airway. Rapid sequence intubation (RSI) is ideally suited for the management of acutely injured patient. The benefits of RSI include rapidity of airway control, decreased pulmonary aspiration, and a high success rate.[1]

RSI includes the use of an induction agent followed by a paralytic agent to achieve optimal conditions for intubation. This drug regimen should produce sedation, neuromuscular paralysis, maintain hemodynamic stability, and prevent vomiting and intraocular content extrusion.[2] Numerous medications have been used to facilitate intubation. The ideal medication is one that has a short onset and duration of action as well as minimal immediate or delayed adverse effects and can be used for most patients. Commonly used premedications and induction agents include fentanyl, midazolam, etomidate, ketamine, thiopental, and propofol. Each of these have advantages and potential adverse effects.

The procedure of RSI requires quick decision making as to which medications and doses are to be used. Selection of agents can be difficult because of the many medications and combinations of medications available, which can delay and complicate treatment. In addition, inadequate sedation and relaxation may lead to multiple or unsuccessful intubation attempts, resultant hypoxia, and potential aspiration. The use of a simplified algorithm can potentially address this problem. The purpose of this study was to examine ED intubation of trauma patients before and after implementation of an RSI protocol. We hypothesized that the use of a standardized protocol using ketamine for induction in combination with a paralytic agent has facilitated endotracheal intubation requiring fewer attempts, less redosing of medication, and a decreased incidence of hypotension.

Submitted: March 8, 2012, Revised: June 5, 2012, Accepted: July 6, 2012.
From the University of California, San Francisco-Fresno, Fresno, California.
This study was presented at the 42nd annual meeting of the Western Trauma Association, February 26–March 2, 2012, in Vail, Colorado.
Address for reprints: Krista L. Kaups, MD, Department of Surgery, Community Regional Medical Center, First Floor, 2823 Fresno St, Fresno, CA 93721; email: kkaups@fresno.ucsf.edu.

DOI: 10.1097/TA.0b013e318270dcf5

Copyright © 2012 Lippincott Williams & Wilkins. Unauthorized reproduction of this article is prohibited.

PATIENTS AND METHODS

Community Regional Medical Center (CRMC) is a 650-bed Level 1 trauma center with approximately 3,200 patients added to the trauma registry annually. CRMC is also the main teaching hospital for the University of California, San Francisco-Fresno's Emergency Medicine (EM) and General Surgery (GS) Residency programs. ED intubation of trauma patients is typically performed by either EM and GS second-year or greater residents with guidance from EM and trauma attending physicians as needed. Residents are required to complete advanced trauma life support training as well as an anesthesia rotation before managing critically injured patients.

An RSI protocol was developed by a committee of EM and GS faculty and CRMC clinical pharmacists. The CRMC Trauma Audit Committee, including members from EM, ED nursing, respiratory therapy, anesthesia, neurosurgery, and trauma surgery subsequently approved the use of the protocol for all trauma patients including pediatrics. Implementation began in early 2010. Before this, the individual physicians performing the RSI determined medications and doses used during RSI on a case-to-case basis.

The RSI protocol consisted of preoxygenation with 100% oxygen via a non-rebreather mask followed by induction with ketamine 2 mg/kg intravenously administered, then paralysis with either succinylcholine 1.5 mg/kg intravenously administered or rocuronium 1 mg/kg intravenously administered. Age or head injury were not contraindications to receiving this protocol. Alternative medications were available if the physician thought they were needed for a specific patient. Laryngoscopy and intubation proceeded in standard fashion. Residents performed essentially all intubations with supervision and assistance as needed from attending physicians.

A retrospective chart review was conducted of all trauma patients, identified from the CRMC trauma registry, who were intubated in the ED between January 1, 2009, and April 1, 2011. The RSI protocol was implemented and used for trauma patients intubated from January 17, 2010, to March 3, 2011; patients intubated between January 1, 2009, and January 10, 2010, did not receive the RSI protocol and constituted the comparison group. The CRMC/University of California, San Francisco-Fresno Institutional Review Board approved the study. A standardized data sheet was created and used to collect data points, which include the following: name, medical record number, age, weight, sex, date, mechanism of injury, Injury Severity Score (ISS); Abbreviated Injury Scale (AIS) score for head and chest; drugs and doses used for RSI as well as reason and medications used for redosing; indication for RSI, number of RSI attempts, and the need for more experienced physician to intubate; need for surgical airway; and pre-RSI and post-RSI vials including heart rate, systolic blood pressure, oxygen saturation, as well as the use of cervical spine immobilization. The reason for redosing of medications was inferred or directly obtained from nursing documentation.

Prehospital care is provided by essentially a single emergency medical service (EMS) agency where cervical spine immobilization has been the standard of care. It is institutional practice at CRMC to maintain in-line cervical stabilization during intubation of all trauma patients who have not had cervical spine clearance (in this case, essentially all the patients). The use of cervical spine immobilization is documented in the EMS "run sheet" and in the ED nursing charting.

Hypotension was defined as systolic blood pressure less than 90 mm Hg, tachycardia greater than 100 beats per minute, and bradycardia less than 60 beats per minute. The Broselow tape was used to define normal vital signs in pediatric patients based on age. Redosing of medications was defined as the need to redose an induction agent or muscle relaxant to accomplish the task of intubation. The time from ED arrival to RSI was considered "pre-RSI," while "post-RSI" was considered within 30 minutes after intubation. Statistical analysis of data was performed using the Student's t test and χ^2 analysis, with significance attributed to $p < 0.05$.

RESULTS

During the 27-month study period, 326 patients presented to CRMC already intubated, either by EMS personnel or at transferring facilities. These patients were not included in the study. A total of 563 patients were reviewed, of whom 439 patients met inclusion criteria. One hundred four patients were excluded because they were either without vital signs on arrival or intubated without the need for medications. An additional 20 patients were excluded: 7 were intubated before arrival at CRMC, 3 were not trauma patients, 6 were not intubated in the ED, and 4 had insufficient medical records or chart availability. Two hundred sixty-six patients were intubated before the RSI protocol (PRE) implementation and 173 patients were intubated using the protocol (KET).

Overall, the mean patient age was 40 years with a range of 1 year to 91 years; 341(77.7%) were male. Patients were severely injured, with a mean ISS of 24, and the median AIS score for the head/face was 3. The PRE and KET groups did not differ from each other with respect to age, ISS, or AIS score. Most of the patients (396, 90%) had sustained blunt trauma, with similar percentages between groups. Of the patients, 237 (89.1%) in the PRE group and 164 (94.8%) in the KET group had cervical spine precautions maintained during RSI (Table 1). Indications for intubation included the following: altered metal status, respiratory distress, airway protection, hemodynamic instability, and other (Table 2).

In the PRE group, 26 patients (9.7%) were younger than 14 years, while 10 patients (5.8%) in the KET group were younger than 14 years. In children younger than 14 years, two

TABLE 1. Comparison of Demographics Between Preprotocol and Ketamine Protocol Groups

Patient Demographics	PRE (n = 266)	KET (n = 173)	p
Age, mean, y	41	40	NS
Age < 14 y, %	9.7	5.8	NS
Mean ISS	24	24	NS
AIS score of the head, median	3	3	NS
Blunt trauma, n (%)	237 (89)	159 (92)	NS
Cervical spine precautions, n (%)	237 (89)	164 (95)	NS

© 2012 Lippincott Williams & Wilkins

Copyright © 2012 Lippincott Williams & Wilkins. Unauthorized reproduction of this article is prohibited.

TABLE 2. Comparison of the Indications for Intubation Between the Pre-Protocol and Ketamine protocol Groups

Indication for Intubation	PRE (n = 266)	KET (n = 173)
Altered mental status, n (%)	188 (70.7)	112 (64.7)
Respiratory distress, n (%)	48 (18)	31 (17.9)
Airway protection, n (%)	17 (6.4)	9 (5.2)
Hemodynamic instability, n (%)	11 (4.1)	18 (10.4)
Other, n (%)	2 (0.8)	3 (1.7)

patients in the PRE and no patients in the KET group required redosing of medications (not significant [NS]).

Medications administered in the PRE group included midazolam, etomidate, or fentanyl combined with succinylcholine, rocuronium, or vecuronium. Once the ketamine protocol was instituted, compliance was nearly 90%, with a mean ketamine dose of 1.9 mg/kg and a range of 1.0 mg/kg to 3.0 mg/kg. Fifteen adult patients in the PRE group and three adult patients in the KET group, ($p < 0.05$, χ^2) required redosing of medications to complete intubation. The time from medication administration to RSI decreased from 4 minutes to 3 minutes (t test, $p < 0.05$). Sixteen patients (6%) in the PRE group and six (3.6%) patients in the KET group had hypotension within 30 minutes of RSI; however this was not statistically significant. No patient in either group required a surgical airway.

DISCUSSION

A major feature of our RSI protocol is the use of ketamine for sedation before neuromuscular blockade. Ketamine is a dissociative medication used for its sedative and anesthetic properties. It inhibits the excitatory effect of glutamate in thalamocortical pathways and the limbic system thereby producing analgesia. It also increases central nervous system sympathetic outflow and decreases reuptake of catecholamines producing an increase in blood pressure, stroke volume, and heart rate while maintaining systemic vascular resistance.[3,4] These effects make it a particularly attractive induction agent in the setting of shock.

A number of other drugs have been used to facilitate intubation, but each has potentially significant drawbacks. Midazolam,[5] propofol, and barbiturates, although frequently used, can each cause hypotension and tachycardia.[6] These are potentially dangerous in trauma patients with hypovolemia and hemodynamic instability.[7] Lidocaine has also been used as an adjunct for endotracheal intubation, particularly for patients with traumatic brain injury; however, there is no evidence to support the use of intravenously administered lidocaine to attenuate a rise in intracranial pressure (ICP) with intubation.[8,9] Etomidate, a sedative-hypnotic is associated with adrenocortical insufficiency, and potentially deleterious effects when used in trauma patients.[10–12] Warner et al.[13] noted an increase in the development of adult respiratory distress syndrome and multiorgan dysfunction in trauma patients who were intubated with etomidate.

Historically however, ketamine was thought to increase ICP, thereby making it contraindicated for patients with traumatic brain injury. The initial reports of increased ICP associated with ketamine use came from small case reports consisting of up to four patients, without acute brain injury published in the early 1970s.[14–16] One study extrapolated ICPs from measuring intrathecal pressure during lumbar puncture.[15] Most of the patients with increased ICP in these early reports had obstructed hydrocephalus or other ventricular obstruction. These studies also failed to measure or discuss any associated changes in blood pressure and central perfusion pressure (CPP) during ketamine administration. In normal cerebral autoregulation, a potential rise in ICP is accompanied by an increase in mean arterial pressure, thereby maintaining CPP, which actually may help prevent secondary brain injury.[17,18] The decrease in reuptake of catacholamines caused by ketamine, which then leads to elevated blood pressure, increases CPP even for patients who have severe brain injury and loss of ability to autoregulate.

More recent prospective trials have demonstrated no significant rise in ICP or decrease in CPP associated with ketamine use.[19–21] Bar-Joseph et al.[19] reported a decrease in ICP of 30% without an accompanying decrease in blood pressure or CPP in 30 mechanically ventilated children with head injuries who had been given ketamine for sedation. Twenty patients who received general anesthesia, undergoing craniotomy, were given ketamine. A small decrease in ICP with no change in mean arterial pressure or CPP was noted.[20] Schmittner et al.[21] compared ketamine to fentanyl in combination with methohexitone for sedation in 24 ventilated intensive care unit patients with traumatic brain injury or aneurysmal subarachnoid hemorrhage. Patients who received ketamine had a tendency to require less norepinepherine to maintain CPP and did not have elevated ICP. Furthermore, head trauma has been eliminated as a contraindication to ketamine use in the recently updated clinical practice guideline for ED ketamine dissociative sedation because of the lack of evidence supporting ketamine as being dangerous in acute brain injury.[22] In a rat model with traumatic brain injury, Ward et al.[23] studied the effects of ketamine on cerebral inflammation and found that even at a doses of 7 mg/kg and 70 mg/kg, ketamine did not increase cerebral edema. Although the anti-inflammatory properties did not decrease cerebral cytokines, it also did not exacerbate cytokine production or increase edema. These help demonstrate the safe and effective use of ketamine especially for patients with traumatic brain injury.

Ketamine is also safe to use in pediatric patients as young as 3 months.[12,19,22] Initial studies citing concerns over airway complications have been determined to be too small in size to draw definitive conclusions.[22,24,25] Melendez and Bachur[26] performed a case-control study of 4,252 pediatric patients who had received ketamine for procedural sedation. Serious respiratory complications such as those requiring intubation were rare, occurring in 0.9% of patients.

Ketamine has been known to cause negative psychotropic effects, particularly on emergence; this is usually mitigated with benzodiazepines. We have not noted these effects in trauma patients intubated with ketamine because they are generally not extubated for several hours to days after ketamine administration. In addition, since almost all patients were being continued with mechanical ventilation, continuous administration of sedation was started, most often with midazolam and fentanyl before these effects occurred.

© 2012 Lippincott Williams & Wilkins

Copyright © 2012 Lippincott Williams & Wilkins. Unauthorized reproduction of this article is prohibited.

One of the desired characteristics of a sedative agent in RSI is rapid onset of action. In addition, since patient weight is generally unknown in the emergency setting, dose selection should be as simple as possible, with predictable action in all patients. When used at an intravenously administered dose of 2 mg/kg, ketamine has an onset of action of 30 seconds to 40 seconds. At doses used for anesthesia induction, at a dose of 0.3 mg/kg, etomidate's onset of action is 30 seconds to 60 seconds, and the onset for midazolam is 1 minute to 2.5 minutes.[27] Midazolam also has more variability of dose needed between patients to attain similar sedative effects. In our study, the time to intubate decreased from a mean of 4 minutes to 3 minutes when ketamine was used for induction likely because of the fast onset of action compared with other medications. A decrease in the time from administration of medication to RSI leads to increased efficiency and possibly a decreased perception of difficult intubation.

The KETASED Collaborative Study Group compared critically ill patients using ketamine or etomidate induction for endotracheal intubation in a randomized controlled trial of 655 critically ill patients undergoing emergency intubation. There was no significant difference between the two groups with regard to mortality, intubation difficulty score, or early complications after intubation. The two groups also did not differ with respect to weaning from mechanical ventilation or catecholamines. There were more patients with adrenal insufficiency in the etomidate group having patients with lower basal cortisol levels and more patients who did not respond to an adrenocorticotropin hormone stimulation test.[28]

Some limitations of the present study should be considered. In a retrospective analysis of patient charts, the precise documentation of vital signs at specific times, time from drug administration to endotracheal intubation, or number of attempts at RSI may be difficult to retrieve. Some of the documentation regarding the number of intubation attempts was not always clear. An attempt at RSI was not clearly defined. Some may consider direct laryngoscopy as an attempt, while others may believe that trying to pass an endotracheal tube constitutes an attempt. The number of attempts at intubation were documented by the physician performing RSI and may be underrepresented given differing definitions. Moreover, not surprisingly, all of the patients who were documented as having multiple attempts at intubation were also in cervical spine precautions. Since these limitations were present in both the PRE and KET groups, we believe that they did not contribute to differences between the two.

The main advantage of a defined RSI protocol is the ease of its administration. At a teaching institution, there are many people with varying levels of experience involved in the initial management of trauma patients. The relatively limited experience of residents performing the intubations may contribute to increased difficulty, more attempts, and increased time to intubation. The individual residents rotating in the ED and trauma services change over time; therefore, a standardized approach that is both easy to follow and remember has improved efficiency of RSI. Having a simple approach to RSI has streamlined the procedure. By using only a few medications, physicians, nurses, and pharmacists can have them more readily available at appropriate doses. Once the protocol was implemented, there was a 90% compliance rate. Others have also reported success with a protocol-driven approach to RSI of acutely injured patients.[29,30]

The concept behind protocol driven approaches is that routine clinical care is enhanced when interdisciplinary teams of health professionals use evidence-based protocols to complement their clinical judgment reducing unnecessary variations in practice.[31] Our RSI protocol is a guideline with the intention to streamline intubation of trauma patients with the goal of having mediations readily available, reduce errors in dosing of medications, and achieve safe and efficient intubation. A number of large, randomized, prospective trials have demonstrated that strategies run by health care professionals can not only reduce variation and cost of medicine but also improve morbidity and mortality of critically ill patients.[32]

CONCLUSION

The use of an RSI protocol for intubation of trauma patients in the ED results in an increased efficiency and success. Having a single simple protocol that is appropriate for patients of all ages and types of injuries facilitates correct dosing and ease of drug administration. The use of ketamine as an induction agent is effective in both pediatric and adult trauma patients including those with traumatic brain injury.

AUTHORSHIP

All authors contributed to this study's design and literature review. S.L.B. and K.L.K. collected the data, which K.L.K. analyzed and interpreted. S.L.B. wrote the manuscript and produced the tables. K.L.K. edited the final article.

DISCLOSURE

The authors declare no conflicts of interest.

REFERENCES

1. Toschlog EA, Sagraves SG, Rotondo MF. Airway control. In: Feleciano DV, Mattox KL, Moore EE. *Trauma*. 6th ed. United States: The McGraw-Hill Companies, Inc.; 2008:185–211.
2. Dunham CM, Barraco RD, Clark DE, Daley BJ, Davis FE, Gibbs MA, Knuth T, Letarte PB, Luchette FA, Omert L, et al. Guidelines for emergency tracheal intubation immediately after traumatic injury. *J Trauma*. 2003;55: 162–179.
3. Cromhout A. Ketamine: its use in the emergency department. *Emerg Med*. 2003;15:155–159.
4. Craven R. Ketamine. *Anaesthesia*. 2007;62(Suppl 1):48:53
5. Reves JG, Fragen RJ, Vinik HR, Greenblatt DJ. Midazolam: pharmacology and uses. *Anesthesiology*. 1985;62:310–324.
6. Reynolds SF, Heffner J. Airway management of the critically ill patient: rapid-sequence intubation. *Chest*. 2005;127:1397–1412.
7. Airway and ventilatory management. In: American College of Surgeons Committee on Trauma. *Advanced Trauma Life Support for Doctors ATLS Student Course Manual*. 8th ed. Chicago, IL: American College of Surgeons; 2008:25–42.
8. Robinsion N, Clancy M. In patients with head injury undergoing rapid sequence intubation, does pretreatment with intravenous lingocane/lidocaine lead to an improved neurological outcome? A review of the literature. *Emerg Med J*. 2001;18:453–457.
9. Butler J, Jackson R. Towards evidence based emergency medicine: best BETs from Manchester Royal Infirmary. Lignocaine premedication before rapid sequence induction in head injuries. *Emerg Med J*. 2002;19:554.

© 2012 Lippincott Williams & Wilkins

Copyright © 2012 Lippincott Williams & Wilkins. Unauthorized reproduction of this article is prohibited.

10. Fellows IW, Bastow MD, Byrne AJ, Allison SP. Adrenocortical suppression in multiply injured patients: a complication of etomidate treatment. *BMJ*. 1983;287:1835–1837.
11. Cotton BA, Guillamondegui OD, Fleming SB, Carpenter RO, Patel SH, Morris JA, Arbogast PG. Increased risk of adrenal insufficiency following etomidate exposure in critically injured patients. *Arch Surg*. 2008; 143:62–67.
12. Hildreth AN, Mejia VA, Maxwell RA, Smith PW, Dart BW, Barker DE. Adrenal suppression following a single dose of etomidate for rapid sequence induction: a prospective randomized study. *J Trauma*. 2008;65:573–579.
13. Warner KJ, Cuschieri J, Jurkovich GJ. Single-dose etomidate for rapid sequence intubation may impact outcome after severe injury. *J Trauma*. 2009;67:45–50.
14. Wyte SR, Shapiro HM, Turner P. Ketamine-induced intracranial hypertension. *Anesthesiology*. 1972;36:174–176.
15. Evans J, Rosen M, Weeks RD, Wise C. Ketamine in neurosurgical procedures. *Lancet*. 1971;1:40–41.
16. Gardner AE, Dannemiller FJ, Dean D. Intracranial cerebrospinal fluid pressure in man during ketamine anesthesia. *Anesth Analg*. 1972;51:741–745.
17. Sih K, Campbell SG, Tallon JM, Magee K, Zed PJ. Ketamine in adult emergency medicine: controversies and recent advances. *Ann Pharmacother*. 2011;45:1525–1534.
18. Sehdev RS, Symmons DA, Kindl K. Ketamine for rapid sequence induction in patients with head injury in the emergency department. *Emerg Med Australas*. 2006;18:37–44.
19. Bar-Joseph G, Guilburd Y, Tamir A, Guilbard J. Effectiveness of ketamine in decreasing intracranial pressure in children with intracranial hypertension. *J Neurosurg Pediatr*. 2009;4:40–46.
20. Mayberg TS, Lam AM, Matta BF, et al. Ketamine does not increase cerebral blood flow velocity or intracranial pressure during isoflurane/nitrous oxide anesthesia in patients under going craniotomy. *Anesth Analg*. 1995;81:84–89.
21. Schmittner MD, Vajkoczy SL, Horn P, et al. Effects of fentanyl and S(+) ketamine on cerebral hemodynamics, gastrointestinal motility, and need of vasopressors in patients with intracranial pathologies: a pilot study. *J Neurosurg Anesthesiol*. 2007;19:257–262.
22. Green SM, Roback MG, Kennedy RM, Krauss B. Clinical practice guideline for emergency department ketamine dissociative sedation: 2011 Update. *Ann Emerg Med*. 2011;57:449–461.
23. Ward JL, Harting MT, Cox CS, Mercer DW. Effects of ketamine on endotoxin and traumatic brain injury induced cytokine production in the rat. *J Trauma*. 2011;70:1471–1479.
24. Cravero JP, Havidich JE. Pediatric sedation—evolution and revolution. *Pediatr Anesth*. 2011;21:800–809.
25. Green SM, Kennedy RM, Krauss B, Brown L, McGlone RG, Agrawal D, McKee M, Weiss M, Pitetti RD, Hostetler MA. Predictors of airway and respiratory adverse events with ketamine sedation in the emergency department meta-analysis of 8,282 children. *Ann Emerg Med*. 2009;54: 158–168.
26. Melendez E, Bachur R. Serious adverse events during procedural sedation with ketamine. *Pediatr Emerg Care*. 2009;25:325–328.
27. Micromedex 2.0. Ketamine. Etomidate. Midazolam. Available at http://www.thomsonhc.com/home/dispatch. Accessed January 8, 2012.
28. Jabre P, Combes X, Lapostolle F, Dhaovadi M, Ricard-Hibon A, Vivien B, Bertrand L, Beltramini A, Gamand P, Albizzati S, et al. Etomidate versus ketamine for rapid sequence intubation in acutely ill patients: a multicentre randomised controlled trial. *Lancet*. 2009;374:293–300.
29. Casey ZC, Smally AJ, Grant RJ, McQuay J. Trauma intubations: can a protocol-driven approach be successful? *J Trauma*. 2007;63;955–960.
30. Dufour DG, Larose DL, Clement SC. Rapid sequence intubation in the emergency department. *J Emerg Med*. 1995;13:705–710.
31. Meade MO, Ely EW. Protocols to improve the care of critically ill pediatric and adult patients. *JAMA*. 2002;288:2601–2603.
32. Holcomb BW, Wheeler AP, Ely EW. New ways to reduce unnecessary variation and improve outcomes in the intensive care unit. *Curr Opin Crit Care*. 2001;36:366–374.

© 2012 Lippincott Williams & Wilkins

Copyright © 2012 Lippincott Williams & Wilkins. Unauthorized reproduction of this article is prohibited.