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Effects of Supervision by Attending Anesthesiologists on Complications of Emergency Tracheal Intubation

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Background: **Emergent intubation is associated with a high complication rate. These intubations are often performed by resident physicians in teaching hospitals. The authors evaluated whether supervision by an anesthesia-trained intensivist decreases complications of emergent intubations.**

Methods: **The authors performed a prospective cohort study in an Academic Tertiary Care Hospital. They enrolled 322 consecutive patients who required emergent intubation between November 1, 2006, and April 15, 2008. Emergency intubations are performed by anesthesia residents during their surgical intensive care unit rotation. An attending anesthesiologist was assigned to supervise these intubations at predetermined periods. A respiratory therapist assisted with airway management and ventilation. Information related to the intubation, detailing patient demographics, indication for intubation, attending anesthesiologist presence, medications used, and immediate complications, was recorded. Disposition and duration of mechanical ventilation were also recorded.**

Results: **There were no differences in demographics, clinical characteristics, or illness severity among patients intubated with and without attending supervision. Attending physician supervision was associated with a significant decrease in complications (6.1% *vs.* 21.7%; $P = 0.0001$). There was no difference in ventilator-free days or 30-day mortality.**

Conclusion: **Supervision by an attending anesthesiologist was associated with a decreased incidence of complications during emergent intubations.**

URGENT or emergent tracheal intubation is often performed for treatment of respiratory failure or cardiopulmonary resuscitation. Under elective conditions in the operating room, the complication rate of intubation is low.[1] In contrast, urgent or emergent intubations outside the operating room are associated with a complication rate of more than 20%.[2–5] This complication rate remains high despite the introduction of the American Society of Anesthesiologists difficult airway algorithm.[6] One possible reason for this high complication rate could be operator experience. In the operating room, all intubations are supervised by an attending anesthesiologist. Emergency intubations reported in studies outside the operating room have been generally performed by resident physicians. It is unknown whether supervision by an attending anesthesiologist decreases complications associated with emergent intubations outside the operating room. We designed a prospective observational study to evaluate whether supervision by an attending anesthesiologist decreases complications of emergent intubations.

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Materials and Methods

Emergency intubations of adult patients outside the operating room and emergency department are performed by anesthesia residents from the surgical intensive care unit at the Massachusetts General Hospital, Boston, Massachusetts. These residents have a minimum of 6 months of anesthesia experience. They performed a mean of 220 (range, 162–344) intubations before they performed emergent intubations outside the operating room. A small group of attending anesthesiologists, all subspecialized in critical care medicine, were assigned to supervise these residents. The attending anesthesiologist was actively supporting the residents with these emergent intubations. A registered respiratory therapist assisted with airway management and ventilation whether the attending anesthesiologist was present or not. That respiratory therapist prospectively recorded data from emergent intubations from November 1, 2006, to July 31, 2007. These data included the reason for intubation, ease of intubation, identification of the first intubator, presence or absence of the attending anesthesiologist, medications used to facilitate intubation, and immediate complications. Data were recorded on a standardized data collection form. Based on our previous study,[4] these complications were predefined as esophageal intubation, traumatic intubation, aspiration, dental injury, and endobronchial intubation. Our initial data focused on the relation between attending physician supervision and complications. To allow for an analysis of potential confounders, we added prospectively collected data from an additional 172 emergent intubations (December 1, 2007, to April 15, 2008). The initial and

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Table 1. Comparison of Demographics in Initial and Additional Data Sets

	Attending Supervision			No Attending Supervision		
	Initial, n = 60	Additional, n = 55	*P* Value	Initial, n = 90	Additional, n = 117	*P* Value
Demographics						
Female, n (%)	24 (40.0)	18 (32.7)	0.54	35 (38.9)	43 (36.8)	0.87
Age, mean ± SD, yr	63.8 ± 15.0	62.4 ± 15.6	0.62	68.7 ± 17.6	66.9 ± 15.7	0.44
BMI, mean ± SD, kg/m^2	26.7 ± 6.1	26.5 ± 6.3	0.86	27.5 ± 5.6	28.0 ± 9.5	0.67
APACHE II score, median (IQR)	17.5 (14.5–25)	18.5 (15–26)	0.53	18 (12.5–25)	20 (16–25)	0.35
ASA physical status, median (IQR)	3 (2–3)	3 (3–4)	0.06	3 (2–3)	4 (3–4)	0.14
ICU, n (%)	41 (68.3)	32 (58.2)	0.35	59 (65.5)	44 (37.6)	0.001
Medical patient, n (%)	35 (58.3)	44 (80)	0.02	52 (57.8)	82 (70.1)	0.09
Surgical patient, n (%)	18 (30)	4 (7.3)	0.005	21 (23.3)	12 (10.3)	0.02
Neurologic patient, n (%)	7 (11.6)	7 (12.7)	0.92	17 (18.8)	17 (14.5)	0.52
Reason for intubation, n (%)						
Respiratory emergency	34 (57)	32 (58.2)	0.95	55 (61.1)	88 (75.2)	0.04
Cardiac arrest	6 (10)	5 (9.1)	0.88	12 (13.3)	17 (14.5)	0.96
Airway protection	14 (23.3)	8 (14.5)	0.34	12 (13.3)	7 (6.0)	0.12
CNS event	1 (1.6)	0	0.93	7 (7.8)	0	0.01
Other	4 (6.7)	10 (18.2)	0.11	5 (5.6)	5 (4.3)	0.92
Medication, n (%)						
Paralytic	21 (35.0)	32 (58.2)	0.02	12 (13.3)	26 (22.2)	0.15
Propofol	41 (68.3)	41 (74.5)	0.54	59 (65.6)	84 (71.8)	0.45
Etomidate	11 (18.3)	4 (7.3)	0.10	17 (18.9)	10 (8.5)	0.04
Fentanyl	23 (38.3)	32 (58.2)	0.04	14 (15.6)	54 (46.2)	0.001
Benzodiazepine	3 (5.0)	9 (16.4)	0.07	1 (1.1)	17 (14.5)	0.001

P values obtained as appropriate with *t* test and chi-square test or Mann–Whitney test.

APACHE = Acute Physiologic and Chronic Health Evaluation; ASA = American Society of Anesthesiologists; BMI = body mass index; CNS = central nervous system; ICU = intensive care unit; IQR = intraquartile range.

the additional data sets were similar regarding patient characteristics and intubation procedure (table 1).

Age and sex were identified from the medical record. Acute Physiologic and Chronic Health Evaluation II score of surviving patients on admission to the intensive care unit,[7] body mass index, and American Society of Anesthesiologists physical status classification[8] were calculated. Patient outcomes were extracted from the medical records. The study was approved by the institutional review board of the Massachusetts General Hospital.

Statistical Analysis

All data analysis was performed using Stata 10 (StataCorp LP, College Station, TX). Continuous variables with a normal distribution are expressed as mean ± SD. Ordinal variables are expressed as median and interquartile range. Baseline characteristics, intubation data, and outcomes of the two groups were compared by unpaired *t* test for normally distributed variables and by Wilcoxon rank sum test for variables that were not normally distributed. The chi-square test was used to compare absolute numbers and proportions. The Spearman rank correlation coefficient was used to measure the strength of association between nonnormally distributed variables. *P* values of baseline characteristics, intubation data, complications, and outcomes were calculated using two-sided analysis, and the level of significance was set at less than 0.05. A multiple logistic regression analysis was performed to control for potential confounding variables in the association between complications and attending supervision. Opioid and muscle relaxant use was chosen for the model because use of different medication has been clinically attributed to different outcomes[9] and because of differences in frequency of use in the initial data set.

Results

Of the 322 patients enrolled in the study, 115 were intubated with attending anesthesiologist supervision, whereas 207 where intubated by anesthesia residents in the absence of an attending anesthesiologist. Approximately half (n = 176, 54.6%) were intubated in intensive care units. More than half were medical patients (n = 219, 66%), and the others were surgical patients (n = 55, 17%) or neurologic patients (n = 48, 15%). There was no difference between groups (with or without an attending intensivist) for sex, Acute Physiologic and Chronic Health Evaluation II score, American Society of Anesthesiologists physical status classification, body mass index, or patient type (medical, surgical, or neurologic). Patients intubated with attending presence were slightly younger and were more likely to be located in the intensive care unit rather then the ward compared with patients intubated without an attending present (table 2).

Table 2. Demographic Data

	Attending Supervision, n = 115	No Supervision, n = 207	*P* Value
Female, n (%)	40 (38.6)	80 (34.8)	0.10
Age, mean ± SD, yr	62.5 ± 15.6	67.1 ± 16.8	0.02
BMI, mean ± SD, kg/m^2	28.0 ± 9.6	26.7 ± 6.3	0.30
BMI >30 kg/m^2, n (%)	29 (25.2)	36 (17.5)	0.07
APACHE II score, median (IQR)	18 (15–25)	20 (15–26)	0.13
ASA physical status, median (IQR)	3 (3–4)	3 (3–4)	0.99
ICU, n (%)	73 (63.5)	103 (50)	0.03
Medical patient, n (%)	79 (68.7)	140 (67.6)	0.94
Surgical patient, n (%)	22 (19.1)	33 (15.9)	0.56
Neurologic patient, n (%)	14 (12.2)	34 (16.4)	0.40

APACHE = Acute Physiologic and Chronic Health Evaluation; ASA = American Society of Anesthesiologists; BMI = body mass index; ICU = intensive care unit; IQR = intraquartile range.

Intubation Procedure

Of the 322 patients, 208 (65%) were intubated for respiratory emergency, 40 (12%) for cardiac arrest, 41 (13%) for airway protection, and 8 (2%) for acute neurologic events. More patients intubated for airway protection or for miscellaneous reasons were intubated with attending supervision (table 3). Our residents were instructed in emergent airway management as outlined in the *Critical Care Handbook of the Massachusetts General Hospital*.[10] All patients were intubated orally. Most intubators used a MacIntosh 3 blade. Nearly all patients (95%) were intubated on the first or second attempt. There was no difference in number of intubation attempts between patients intubated with and without attending supervision. The number of attempts was higher in patients who had complications during emergent intubation. Patients intubated without complications required 1 (range, 1–3) intubation attempt, and patients intubated with complications required 2 (range, 1–6) attempts ($P = 0.001$).

Table 3. Intubation Procedure

	Attending Supervision		
	Present, n = 115	Not Present, n = 207	*P* Value
Reason for intubation, n (%)			
Respiratory emergency	66 (57.4)	142 (68.9)	0.05
Cardiac arrest	11 (9.6)	29 (14.1)	0.32
Airway protection	22 (19.1)	19 (9.2)	0.02
CNS event	1 (0.9)	7 (3.4)	0.32
Other	15 (13.0)	10 (4.9)	0.02
Medication, n (%)			
Muscle relaxant	53 (46)	38 (17)	0.001
Propofol	82 (71)	143 (63)	0.80
Etomidate	15 (13)	27 (12)	1.00
Opioids	55 (48)	68 (30)	0.12
Benzodiazepine	12 (10)	18 (8)	0.69
Number of attempts, median (IQR)	1 (1–1)	1 (1–1)	0.34

CNS = central nervous system; IQR = intraquartile range.

Table 4. Intubator Experience

First Intubator	Attending Present	No Attending Present
CA1	5/50 (10.0)	17/67 (25.4)
CA2	1/36 (2.8)	22/113 (19.5)
CA3	0/3 (0)	1/4 (25.0)
Fellow	0	0/1 (0)
Attending	1/13 (7.7)	0
Other	0/13 (0)	5/22 (22.7)
Total	7/115 (6.1)	45/207 (21.7)

Data are presented as number of complications/number of intubations (percentage of complications).

CA1, CA2, CA3 = resident in first, second, or third year of anesthesia training.

Hypnotic, opioid, and muscle relaxant use is shown in table 3. No sedative medications or muscle relaxants were administered during cardiopulmonary resuscitation. There was greater use of muscle relaxants (46% *vs.* 17%; $P = 0.001$) in patients intubated with attending physician supervision.

Complications and Outcomes

Of the 322 patients, 266 (83%) were intubated by first- or second-year anesthesia residents. The remaining patients were intubated by third-year anesthesia residents (n = 7, 2%), anesthesia attending physicians (n = 13, 4%), or other physicians (n = 35, 11%) in the presence of the anesthesia resident. There was no difference in complication rates among first- and second-year anesthesia residents (25.4 *vs.* 19.8%; $P = 0.46$). Table 4 tabulates the complication rates according to intubator experience.

Supervision of residents by attending anesthesiologists was associated with a significant decrease in complication rate (6.1% *vs.* 21.7%; $P = 0.0001$). Complications of emergent intubations are summarized in table 5. Attending supervision was associated with a decreased complication rate in all categories. Of 13 patients who experienced aspiration, only 4 survived.

Because there was higher use of muscle relaxants ($P = 0.0001$) and a trend for higher use of narcotics ($P = 0.12$) in the patients supervised by an attending anesthesiologist that may have contributed to the observed dif-

Table 5. Complications

Complication	Attending Supervision, n = 115	No Supervision, n = 207	*P* Value
Overall	7 (6.1)	45 (21.7)	0.0001
Esophageal intubation	1 (0.9)	7 (3.4)	0.27
Traumatic intubation	2 (1.7)	14 (6.8)	0.06
Aspiration	1 (0.9)	12 (5.8)	0.037
Dental injury	0	2 (1.0)	0.54
Endobronchial intubation	3 (2.6)	15 (7.2)	0.13

Data are presented as number (percentage).

Table 6. Outcomes

	Attending Supervision		
	Present, n = 115	Not Present, n = 207	*P* Value
Mortality, n (%)	52 (45.2)	97 (46.8)	0.87
Ventilator-free days, mean ± SD	11.3 ± 11.0	11.0 ± 11.1	0.81
Home, n (%)	21 (18.9)	36 (17.8)	0.92
Nursing home or rehabilitation facility, n (%)	29 (26.1)	47 (23.3)	0.67
Hospital, n (%)	9 (8.1)	23 (11.4)	0.46

ferences in complications, we performed a multiple regression analysis. Attending supervision was associated with a decreased rate of complication (odds ratio, 0.52; 95% confidence interval, 0.27–0.99; $P = 0.047$), use of muscle relaxants did not affect complication rate (odds ratio, 0.66; 95% confidence interval, 0.33–1.33; $P = 0.248$), and use of opioids was associated with an increased rate of complications (odds ratio, 2.17; 95% confidence interval, 1.22–3.86; $P = 0.009$).

Of the 322 patients emergently intubated, 54% survived and 18% were discharged home. There was no difference in 28-day mortality, ventilator-free days, or patient disposition whether or not the patients were intubated with attending supervision (table 6).

Discussion

The most important finding of our study is that supervision of emergent intubations by an attending anesthesiologist was associated with a decreased complication rate.

Most of the intubations were performed for respiratory emergencies. The most commonly used sedative was propofol. In other centers, etomidate[5] is the preferred hypnotic agent because of its favorable hemodynamic profile.[11,12] However, reports of adrenal insufficiency associated with the use of etomidate[13] may influence clinicians' choice. Opioids were used in 38% of our patients and were associated with an increased risk for complications. Although this is difficult to explain, opioids have been associated with an increased risk for aspiration and regurgitation.[14] Variable choices of hypnotic agents also reflect the lack of randomized controlled studies evaluating approaches to emergent airway management outside the operating room. Similarly, there is wide variability in the use of muscle relaxants for emergent intubation, ranging between 5%[4] and 80%.[2] The use of muscle relaxants can cause severe hypoxia if the trachea cannot be intubated and the patient cannot be ventilated. In our study, muscle relaxants were used more commonly in the presence of an attending anesthesiologist (46% *vs.* 17%; $P = 0.001$). Perhaps this reflects that attending physicians were more confident in their ability to intubate.

Complication rates for emergent intubations outside the operating room have remained high during the past decade.[2,3,5,15] In our study, the presence of an attending anesthesiologist decreased the complication rate significantly (6.1% *vs.* 21.7%). Similarly, multivariate analysis of an observational study of complications of emergent intubations of intensive care unit patients revealed that supervision by a senior intensivist may decrease the risk of complications.[5] It is unknown whether this decrease in complication rate was due to the experience of the supervising anesthesiologist or the result of additional help by the anesthesiologist. In our institution, the resident physician performing the intubation has assistance from an experienced senior respiratory therapist assisting with airway management.[4] Schwartz *et al.*[2] reported that the experience of the physician performing the intubation did not influence the complication rate for emergent intubation. In contrast, Tayal *et al.*[16] reported that success of intubation by emergency medicine residents increased with experience. In our study, the majority of intubations were performed by first- and second-year residents. Only a few patients (n = 20) were intubated by third-year anesthesia residents or attending physicians as first intubators. Residents for the first time involved in emergent airway management had an average experience of 220 intubations. This is higher than the published learning curves for orotracheal intubations, which report between 19 and 57 orotracheal intubations to reach good success.[17–19] There was no difference in complication rate between first-year anesthesia residents and the more experienced second-year residents. Based on this, we do not know how many emergent intubations residents need to perform to reach competency.

In the presence of an attending anesthesiologist, a significantly higher percentage of patients received muscle relaxants. The supervising attending anesthesiologist was actively involved in the care of the patient, bringing his expertise as a consultant to the bedside. This includes appropriate use of medications. The multiregression analysis revealed that attending presence was associated with a decreased rate of complications after controlling for the effects of muscle relaxants and opioids. In the emergency department, rapid sequence intubation has decreased the complication rate of emergency intubation and is considered safe.[9,16,20] In addition, the use of muscle relaxants was associated with a lower complication rate of tracheal intubation in critically ill patients.[5] To our knowledge, there is no published study testing the safety and efficacy of muscle relaxations for emergent intubations of hospitalized patients.

Our observed mortality of 46% is comparable to that in previous reports of patients requiring urgent and emergent intubation.[4,21–23] Despite a decrease in complications, there was no difference in mortality whether pa-

tients were intubated in the presence or absence of an attending anesthesiologist.

Study Limitations

This was a single-center study in an academic tertiary care center, which limits the ability to generalize the findings to different settings. For example, emergent intubations in hospital wards in the United States are often performed by nonanesthesia care providers such as respiratory therapists.[24]

The study design as a prospective observational study limits the ability to control variables of the study. The attending was actively involved in planning and performing these intubations and may have introduced different techniques and drugs that influenced the complication rate. Although this decreases the ability to detect advantages or disadvantages of different approaches to emergent airway management, it reflects the reality of emergent intubations.

In our study, the supervising attending physicians were anesthesia trained. It is not known whether similar results would have been achieved with different training backgrounds of the supervising attending physicians. Jaber *et al.*[5] reported no difference in complications of emergent intubations whether the supervising attending physician was an anesthesiologist or not. Similarly, Bushra *et al.*[25] reported no difference in success and complications whether emergent intubations were supervised by attending anesthesiologists or attending emergency physicians.

In our study, complications were limited to predefined categories that could be reliably charted by an observer who did not perform the intubation. We cannot exclude observer bias. However, there were more than 100 residents and respiratory therapists who took part in the study, and the respiratory therapists charted objective endpoints limiting potential bias. For practical reasons, following our previous study[4] we concentrated on four complications that our respiratory therapists have the expertise to report. Emergent intubations may lead to many more complications that may cause unfortunate outcomes.[5,14,26] The current study was not intended or powered to address outcomes of patients with complications. We can only assume but do not know that attending presence decreased other complications as well.

The number of patients enrolled (n = 322) was too small to detect differences in mortality between patients intubated in the presence or absence of an attending anesthesiologist. A large multicenter trial might be necessary to assess the impact on survival.

Conclusions

Emergent intubation is associated with a high complication rate. Supervision of anesthesia residents by an attending anesthesiologist is associated with a decreased incidence of complications during emergent intubations.

References

1. Domino KB, Posner KL, Caplan RA, Cheney FW: Airway injury during anesthesia: A closed claims analysis. ANESTHESIOLOGY 1999; 91:1703–11
2. Schwartz DE, Matthay MA, Cohen NH: Death and other complications of emergency airway management in critically ill adults: A prospective investigation of 297 tracheal intubations. ANESTHESIOLOGY 1995; 82:367–76
3. Mort TC: Emergency tracheal intubation: Complications associated with repeated laryngoscopic attempts. Anesth Analg 2004; 99:607–13
4. Benedetto WJ, Hess DR, Gettings E, Bigatello LM, Toon H, Hurford WE, Schmidt U: Urgent tracheal intubation in general hospital units: An observational study. J Clin Anesth 2007; 19:20–4
5. Jaber S, Amraoui J, Lefrant JY, Arich C, Cohendy R, Landreau L, Calvet Y, Capdevila X, Mahamat A, Eledjam JJ: Clinical practice and risk factors for immediate complications of endotracheal intubation in the intensive care unit: A prospective, multiple-center study. Crit Care Med 2006; 34:2355–61
6. Practice guidelines for management of the difficult airway: A report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. ANESTHESIOLOGY 1993; 78:597–602
7. Knaus WA, Draper EA, Wagner DP, Zimmerman JE: APACHE II: A severity of disease classification system. Crit Care Med 1985; 13:818–29
8. American Society of Anesthesiologists: New classification of physical status. ANESTHESIOLOGY 1963; 24:111
9. 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: 141–3
10. Dunn FP, Goulet LR, Hurford EW: Airway management, Critical Care Handbook of the Massachusetts General Hospital, 4th edition. Edited by Bigatello LM. Philadelphia, Lippincott Williams & Wilkins, 2006, pp 53–86
11. Zed PJ, Abu-Laban RB, Harrison DW: Intubating conditions and hemodynamic effects of etomidate for rapid sequence intubation in the emergency department: An observational cohort study. Acad Emerg Med 2006; 13:378–83
12. Jackson WL Jr: Should we use etomidate as an induction agent for endotracheal intubation in patients with septic shock? A critical appraisal. Chest 2005; 127:1031–8
13. Lundy JB, Slane ML, Frizzi JD: Acute adrenal insufficiency after a single dose of etomidate. J Intensive Care Med 2007; 22:111–7
14. Mort TC: Complications of emergency tracheal intubation: Immediate airway-related consequences—part II. J Intensive Care Med 2007; 22:208–15
15. Bellomo R, Goldsmith D, Uchino S, Buckmaster J, Hart G, Opdam H, Silvester W, Doolan L, Gutteridge G: Prospective controlled trial of effect of medical emergency team on postoperative morbidity and mortality rates. Crit Care Med 2004; 32:916–21
16. Tayal VS, Riggs RW, Marx JA, Tomaszewski CA, Schneider RE: Rapid-sequence intubation at an emergency medicine residency: Success rate and adverse events during a two-year period. Acad Emerg Med 1999; 6:31–7
17. Young A, Miller JP, Azarow K: Establishing learning curves for surgical residents using Cumulative Summation (CUSUM) Analysis. Curr Surg 2005; 62: 330–4
18. Mulcaster JT, Mills J, Hung OR, MacQuarrie K, Law JA, Pytka S, Imrie D, Field C: Laryngoscopic intubation: Learning and performance. ANESTHESIOLOGY 2003; 98:23–7
19. Konrad C, Schupfer G, Wietlisbach M, Gerber H: Learning manual skills in anesthesiology: Is there a recommended number of cases for anesthetic procedures? Anesth Analg 1998; 86:635–9
20. 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; 31:325–32
21. Bushnell CD, Phillips-Bute BG, Laskowitz DT, Lynch JR, Chilukuri V, Borel CO: Survival and outcome after endotracheal intubation for acute stroke. Neurology 1999; 52:1374–81
22. Adnet F, Le Toumelin P, Leberre A, Minadeo J, Lapostolle F, Plaisance P, Cupa M: In-hospital and long-term prognosis of elderly patients requiring endotracheal intubation for life-threatening presentation of cardiogenic pulmonary edema. Crit Care Med 2001; 29:891–5
23. Di Bari M, Chiarlone M, Fumagalli S, Boncinelli L, Tarantini F, Ungar A, Marini M, Masotti G, Marchionni N: Cardiopulmonary resuscitation of older, inhospital patients: Immediate efficacy and long-term outcome. Crit Care Med 2000; 28:2320–5
24. Zyla EL, Carlson J: Respiratory care practitioners as secondary providers of endotracheal intubation: one hospital's experience. Respir Care 1994; 39:30–3
25. Bushra JS, McNeil B, Wald DA, Schwell A, Karras DJ: A comparison of trauma intubations managed by anesthesiologists and emergency physicians. Acad Emerg Med 2004; 11:66–70
26. Mort TC: Complications of emergency tracheal intubation: Hemodynamic alterations—part I. J Intensive Care Med 2007; 22:157–65