Attempts at Emergent Tracheal Intubation of Inpatients: A Retrospective Practice Analysis Comparing Adjunct Sedation With or Without Neuromuscular Blockade

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Abstract

As part of emergency airway management, anesthesia personnel are frequently responsible for the emergent tracheal intubation of inpatients. The purpose of this retrospective analysis was to examine the number of attempts necessary for a successful emergent inpatient tracheal intubation. All intubation attempts had utilized adjunct sedation. Patient age, gender, and the use of neuromuscular blockade (NMB) were also investigated.

Overall, 73.1% of all intubations, were reported as successful, having used only adjunct sedation and without the use of NMB ($P<0.001$). This was regardless of the number of attempts reported for each intubation.

Furthermore, 54.9% of all intubations had been reported as successful, on the first attempt, without NMB ($P<0.001$).

An association, between tracheal intubation attempts and the use of NMB, had also been retrospectively observed. NMB, when used, was found to have been associated with a greater number of intubation attempts ($P<0.0001$). NMB was also noted to have been used more often with younger inpatients ($P<0.001$) and males ($P<0.01$).

The probability, of a successful emergent inpatient tracheal intubation attempt, was found to have been associated with only NMB use ($P<0.001$). This was accomplished using a logistic regression model. Using this model, neither age nor gender were determined to have been factors for multiple intubation attempts.

Based on this retrospective analysis, it appears that NMB does not need to be used, on a routine basis, for emergent inpatient tracheal intubations.

Key words: Intubation, Emergency, Neuromuscular Blockade.

Purpose

Neuromuscular blockade (NMB) is used almost routinely for tracheal intubations within the operating room. Trauma and emergency department patients are frequently intubated with NMB. Airway management has been described as being more difficult, in that patient population, without NMB.[1] The percentage of successful tracheal intubations, facilitated with NMB within pre-hospital emergency situations, has been reported as high as 96%.[2], [3]

Yet, “intubating” doses of NMB will uniformly lead to apnea. NMB is frequently used within floor and intensive care units, where additional trained personnel and equipment may not be available. This could lead to unmanageable airway-related hypoxia.

The purpose of this practice analysis was to retrospectively assess the use of NMB during the emergent tracheal intubation of inpatients who had received adjunct sedation. The number of intubation attempts was also examined with respect to the use of NMB, age, and gender.

Multiple emergent tracheal intubations attempts can result from either an anatomic inability to visualize the glottis or from difficulty sedating patients adequately for laryngoscopy. Multiple tracheal intubation attempts can also lead to increased salivation, bleeding, and airway edema. These can further deteriorate tracheal intubation ability.

Tracheal intubation attempts also have significant physiologic consequences. Laryngoscopy is frequently associated with reflex increases in heart rate and blood pressure. These are mediated primarily by the sympathetic nervous system.[4] Laryngoscopy is also associated with increases in intercranial pressure.[5] Aspiration, bleeding, airway obstruction, pneumonia, and dental injury are other potential complications. For these reasons, the fewest tracheal intubation attempts would pose the least physiologic insult to a patient.

Age-related increases in cervical and temporomandibular arthritis, as well as body fat, can be associated with tracheal intubation difficulty.[6] Because of the higher incidence of cardiac and cerebrovascular disease in this population, the number of tracheal intubation attempts should be minimized.

An assessment of these intubations, based on age and gender, was also made. A logistic regression model was then constructed to retrospectively examine the use of NMB, age, and gender, on the number of emergent inpatient tracheal intubation attempts.

Methods

This retrospective observational analysis was from a data base of 1695 emergent tracheal intubations, consisting of both medical and surgical floor and ICU patients, done at Hartford Hospital from 1990 to 1997. IRB approval, for the initial data collection, had been obtained and specific patient consent had been deemed unnecessary due to the observational nature of the data collection. Tracheal intubations had been accomplished by either attending anesthesiologists or supervised residents. Only those tracheal intubations, which had been facilitated with sedation, were included in this retrospective analysis. Morphine, methohexital, midazolam, diazepam, etomidate, sodium thiopental, or propofol had been used, either alone or in combination, for sedation.

Tracheal intubations, which had been done without sedation, or those in which only topical anesthesia had been used, were excluded from this current analysis. Patients, who had not received sedation, were presumed to have had greater coexisting morbidity or to have had a more depressed mental status. Thus, they were assumed to have represented a different population than those studied. In addition, failed tracheal intubations, requiring surgical intervention, were also excluded. For the purpose of this retrospective analysis, the depth of sedation, for all patients, whether they had received NMB or not, was assumed to have been clinically equivalent. Neuromuscular blocking agents, when used, included succinylcholine or vecuronium.

Documentation, of the number of tracheal intubation attempts, age, gender, use of NMB, and use of sedation, was done after each tracheal intubation. This information had been included in the original data base.

Intubation reports were subdivided into two groups: “sedation only” and “sedation with NMB.” Intubation reports were further categorized as: “successful first attempt” or those which had required “2 or more attempts.”

Where appropriate, data have been analyzed using chi-square, Student’s t-test, or logistic regression.

Results

Of the total 1695 emergent tracheal intubations, 1232 met inclusion criteria for this retrospective analysis. All intubation reports were categorized into one of two groups: “sedation only” or “sedation with NMB.” With respect to the number of intubation attempts, reports were classified as: “successful first attempt” or “successful after two or more attempts.”

As shown in Figure 1, 900 (73.1%) of emergent inpatient tracheal intubations were reported as having been successfully accomplished with sedation only. The remaining 332 (26.9%) were reported as successfully accomplished having used sedation with NMB ($P<0.001$). This was regardless of the number of attempts reported for each intubation.

Over half (54.9%) of all intubations were reported as having been successful, on the first attempt, with sedation only ($P<0.001$). This is summarized in Figure 2.

Tables 1A and 1B, as well as Figure 2, show the distribution, on an absolute and percentage basis, of the intubation reports.

Successful first-attempt intubations were noted to have been reported more frequently in the “sedation only” group. With sedation only, 75.1% of the intubations, in this group, were reported to have been successful on the first attempt.

When sedation with NMB had been used, the percentage of successful first-attempt tracheal intubations was reported to have been only 59.6%.

This decreased first-attempt tracheal intubation success rate, associated with the use of NMB, was found to have been significant based upon a chi-square analysis ($P<0.0001$). These results are summarized in Table 2.

Table 3 documents the distribution of inpatient age and gender. These were noted to have been different between the "sedation with NMB" and "sedation only" groups. Those inpatients, who had received NMB, were found to have been significantly younger, with an average age of 58.96 years. Whereas the group that had received only sedation had an average age of 64.88 years ($P<0.001$). In addition, a significantly greater percentage of inpatients, who had received NMB for emergent tracheal intubation, were male ($P<0.01$).

A logistic regression model was utilized to retrospectively assess the influence of age, gender, and NMB, on the observed probability of a successful emergent inpatient tracheal intubation:[7]

$$P_2 = \frac{1}{1 + \exp -(b_0 + b_1 x_1 + b_2 x_2 + b_3 x_3)} \quad (1)$$

$$P_1 = 1 - P_2 \quad (2)$$

Where P_1 is the probability that the emergent inpatient tracheal intubation had been reported as successful on the first attempt. P_2 is the probability it had been reported as successful after two or more attempts. The remaining coefficients and variables, after logistic regression modeling, are shown in Table 4.

Using the statistically-derived data from Table 4, equation 1 can then be expressed as:

$$P_2 = \frac{1}{1 + \exp[-(-1.1075 + 0.7096 x_1)]} = \frac{1}{1 + \exp(1.1075 - 0.7096 x_1)} \quad (3)$$

Where $x_1 = 0$ when NMB was not used and $x_1 = 1$ when NMB was used. The results of this model are shown in Table 5 and can be compared to the reported data in Table 2 (odds ratio = 2.03 for a 95% confidence interval of 1.57-2.67).

When compared with both age and gender, this model has shown that NMB use had been the only significant factor associated with multiple emergent inpatient tracheal intubation attempts ($P<0.001$).

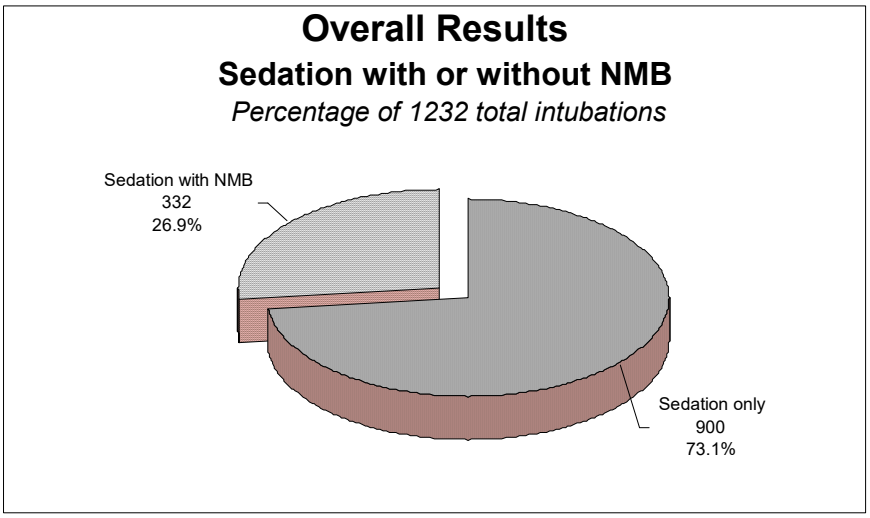

Figure 1. *Over 73% of emergent inpatient tracheal intubations had been reported, as successfully accomplished, with sedation only ($P<0.001$). This was regardless of the number of attempts reported for each intubation. All 1232 intubations had utilized adjunct sedation.*

Group: **sedation only**	Intubations	Percentage of total	Percentage of group
Sedation only with a successful first attempt	676	54.9%	75.1%
Sedation only requiring 2 or more attempts	224	18.2%	24.9%
Group total: sedation only	900	73.1%	100%

Table 1A.

Group: **sedation with NMB**	Intubations	Percentage of total	Percentage of group
Sedation with NMB with a successful first attempt	198	16.07%	59.6%
Sedation with NMB requiring 2 or more attempts	134	10.88%	40.4%
Group total: sedation with NMB	332	26.9%	100%

Table 1B.

Tables 1A and 1B. *Intubation reports were categorized into two groups: "sedation only" and "sedation with NMB." Intubation attempts were classified as: "successful first attempt" or those which had been reported as "successful after two or more attempts."*

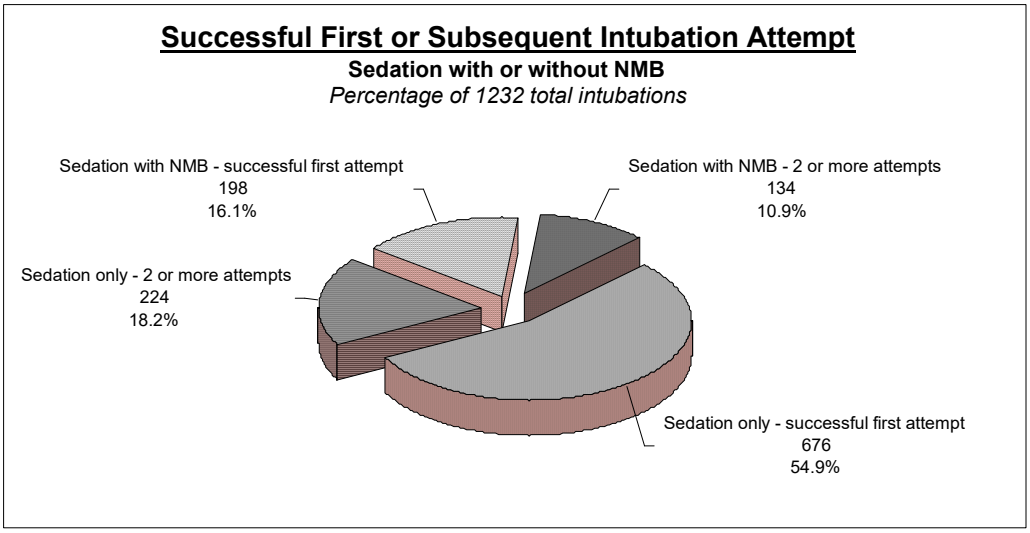

Figure 2. *54.9% of all emergent inpatient tracheal intubations had been reported as successful, on the first attempt, without NMB (P<0.001).*

Those intubations, which had utilized only sedation and had required two or more attempts, as well as all intubations in which NMB had been given, accounted for the remaining 45.1% of the total.

Group	Successful first tracheal intubation attempt	Tracheal intubation successful after 2 or more attempts	Total tracheal intubations
Sedation only	676 (75.1%)	224 (24.9%)	900
Sedation with NMB	198 (59.6%)	134 (40.4%)	332

Table 2. *A comparison between the reported number of emergent inpatient tracheal intubation attempts, with sedation, with or without the use of neuromuscular blockade (NMB). First-attempt emergent tracheal intubations were found to have been associated with a higher success rate when NMB had not been used (P<0.0001). Percentages are based upon group totals.*

Group	Mean Age (years) ± SEM	Gender
Sedation only	64.88 ± 0.55	Male: 492 (54.8%) Female: 406 (45.2%)
Sedation with NMB	58.96 ± 1.03	Male: 210 (63.4%) Female: 121 (36.6%)

Table 3. *Those inpatients, who had received sedation with NMB for emergent tracheal intubation, tended to have been younger (P<0.001) and male (P<0.01). Percentages are based upon group totals.*

	b value	Significance	*x* value
Intercept (b_0)	-1.1075	P<0.001	None
NMB not used/NMB used (b_1)	0.7096	P<0.001	0 or 1
Age (years) (b_2)	Negligible	N.S.	Years
Gender (b_3)	Negligible	N.S.	Male = 1 Female = 2

Table 4. *A summary of x and derived b values for equation 1. Only the intercept (P<0.001) and the use of NMB (P<0.001) were found to have been significant. N.S.= not significant.*

Group	P_1 Predicted successful first tracheal intubation attempt	P_2 Predicted successful tracheal intubation after 2 or more attempts
Sedation only	75.17%	24.83%
Sedation with NMB	59.82%	40.18%

Table 5. *The probability for a successful emergent inpatient tracheal intubation, was accurately modeled based only upon the reported use, or nonuse, of NMB (P<0.001). This model was derived by assessing the intubation reports with logistic regression*.

Discussion

Multiple series have previously shown that emergent tracheal intubations, of trauma and emergency department patients, are frequently facilitated with neuromuscular blockade.[8], [9], [10], [11], [12], [13], [14], [15] High failure rates have been reported when NMB was not used in this particular patient population. In addition, use of a "rapid sequence intubation" technique, in which NMB is routinely used, has also been recommended for airway management in emergency and trauma situations.[12] Yet, 73.1% of all emergent intubations, in this retrospective analysis, had been done without NMB. Furthermore, 54.9% of all intubations had been successfully done, on the first attempt, without NMB.

These data also show a significant association between the use of NMB and a greater number of tracheal intubation attempts. During laryngoscopy without NMB, reflex closing of the vocal cords, jaw clenching, and patient movement may have often

occurred-consequently making tracheal intubation difficult. This could have happened with levels of sedation which, at first, may have seemed adequate. Thus, after initially administering only a sedative, an attempted intubation may have proven unsuccessful. Following this, NMB may have then been used as an additional adjunct. Subsequent intubation attempts would then have been made.

However, NMB may have also lead to intubation-related complications. NMB virtually always causes a cessation of respiration. Breath sounds, heard emanating through a tracheal tube, are therefore lost. This would have lead to the inability to use auscultation of breath sounds as an "intubation guide." The reported increase in tracheal intubation attempts, associated with the use of NMB, may have resulted from clinicians not having had this audible cue.

The emergent inpatient population presented here, while often requiring no NMB for tracheal intubation, may have been significantly different from the reported population of trauma and emergency department patients. The inpatient population, in this study, may have been older, may have had less muscle mass, or had a greater extent of concomitant illness. Overall, these factors may have contributed to a diminished requirement for the reported use of NMB as an intubation adjunct.

Airway-related practice differences, between anesthesia and emergency personnel, are conceivably additional factors for the reported variation in NMB use.

Also observed from this study, NMB use had been associated more often with males and younger inpatients. This is expected as both of these groups have a relatively greater amount of muscle mass. Yet the probability, of a successful emergent inpatient tracheal

intubation attempt, was found to have been statistically a function of only the use of NMB and neither age nor gender.

This study has several limitations which should be addressed. Useful markers for anatomic airway difficulty such as cervical spine mobility, thyro-mental distance, inter-incisor distance,[16] and Mallampati classification[17] had not been recorded. Details, regarding the reasons for multiple tracheal intubation attempts, were not available for review. For the purpose of this retrospective practice-pattern assessment, sedation levels, between patient groups, was assumed to have been equivalent. Furthermore, this study was neither blinded, randomized, nor prospective.

There is a great potential for hypoxia when using NMB for emergent inpatient intubations outside the operating room. Additional personnel and sophisticated airway management devices may not be readily available. Accordingly, clinicians should strive to "keep the patient breathing" and avoid NMB whenever possible in this patient population. This is a long-standing adage of many anesthesia-trained personnel. Based upon the findings of this retrospective practice analysis, this is a frequently obtainable goal.

Conclusions

These data support that the use of NMB is not routinely needed for the emergent tracheal intubation of inpatients who have received adjunct sedation. Emergent inpatient tracheal intubations, in which NMB had been utilized, were associated with a greater number of intubation attempts. The use of NMB, in only a subset of inpatients, may have been due to such issues as agitation, movement, or jaw clenching. These may have

happened even with seemingly adequate levels of sedation. The observed association of NMB, with a greater number of tracheal intubation attempts, may actually have represented the failure to have successfully intubated with the use of sedation alone.

This retrospective analysis has also shown an expected association of NMB use with younger inpatients and males. Yet, the probability, for a successful emergent inpatient tracheal intubation, was mathematically modeled based only upon the use of NMB. Therefore, NMB use appears to have been independent, of both age and gender, regarding its association with multiple emergent inpatient tracheal intubation attempts.

Clinicians need to be aware that the routine use of NMB may not be indicated for emergent tracheal intubations of inpatients who have received sedation. Although uncommon, the use of NMB may lead to catastrophic situations in which the patient can neither be intubated nor ventilated by mask. Additionally, breath sounds, transmitted via the tracheal tube during intubation, are lost with the use of NMB. Therefore, the advantages of intubating a spontaneously breathing patient are readily evident.

There is tremendous potential for hypoxia-related complications from the use of NMB. Consideration should be given to initially attempt those emergent inpatient tracheal intubations, which require sedation, without NMB. This is especially true in situations where additional trained personnel and airway management equipment are not readily available.

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