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The Intubation Difficulty Scale (IDS)

Proposal and Evaluation of a New Score Characterizing the Complexity of Endotracheal Intubation

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Background: **A quantitative scale of intubation difficulty would be useful for objectively comparing the complexity of endotracheal intubations. The authors have developed a quantitative score that can be used to evaluate intubating conditions and techniques with the aim of determining the relative values of predictive factors of intubation difficulty and of the techniques used to decrease such difficulties.**

Methods: **An Intubation Difficulty Scale (IDS) was developed, based on parameters known to be associated with difficult intubation. It was then evaluated prospectively in a group of 311 consecutive prehospital intubations and 315 intubations in an operating room. In the operating room, the IDS was compared with two other parameters: the time to completion of intubation and the visual analog scale (VAS). Time was measured by an independent observer. Operators in both groups completed a checklist regarding the conditions of intubation.**

Results: **There is a good correlation between the IDS scale and the VAS assessment of difficulty and time to completion of intubation. VAS and time to completion have a significant but lesser correlation to each other. Comparison of IDS with operator-assessed subjective categorical impression of difficulty by Kruskall-Wallis was statistically significant.**

Conclusions: **The IDS correlates with but is less subjective than the VAS and categorical classification. IDS correlates with time to intubation, but it offers details regarding the difficulty encountered that time alone does not. This score may not only aid in evaluation of factors linked to difficult intubations, but it may provide a uniform approach to comparing studies related to this subject. (Key words: Intubation Difficulty Score. Difficult intubation. Endotracheal intubation.)**

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DIFFICULT tracheal intubation can be a major source of morbidity and mortality in clinical practice, particularly in emergency situations. The complexity of intubation is often referred to in the literature, but unfortunately, no uniform method of description of the "difficult intubation" exists. Because of the lack of a standard definition of difficult intubation, the incidence and factors associated with difficult intubation vary drastically from one institution or time period to another and are virtually impossible to compare directly.[1–3] An objective scoring system might serve as reproducible quantitative means of overcoming some of these limitations. We thus propose an Intubation Difficulty Scale (IDS) score, which is a function of seven parameters, resulting in a progressive, quantitative determination of intubation complexity. This score may be calculated by the operator or an independent observer immediately after intubation. The score might then be used to compare difficulty of intubation under varying circumstances by isolating variables of interest. It was with this objective in mind that we undertook a prospective study to evaluate the IDS score in varying clinical situations, comparing it with previously described evaluation tools.

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Methods

Our hypothesis is that intubation difficulty may be defined as a measure of the degree of divergence from a predefined "ideal" intubation, *i.e.*, one performed without effort, on the first attempt, practiced by one operator, using one technique, with full visualization of the laryngeal aperture and vocal cords abducted. Such an intubation is accorded an IDS value of 0. Each variation from this defined "ideal" intubation increases the degree of difficulty, the overall score being the sum of all variations from this definition. Impossible intubation is defined by infinity (IDS = ∞). The seven variables are as follows:

N_1—The number of supplementary attempts, an attempt defined as one advancement of the tube in the direction of the glottis during direct laryngoscopy or one like advancement of the tube in the case of a blind intubation trial.

N_2—The number of supplementary operators; N_2 represents the number of additional persons directly attempting (*i.e.*, not assisting) intubation.

N_3—The number of alternative techniques used. For example, changing from an oral intubation to blind nasotracheal intubation or from a curved blade to straight blade increases N_3 by 1 point. The various techniques used should be noted in chronological order, so that subsequent identification of techniques ineffective in a particular case (or series) may be undertaken.

N_4—Glottic exposure as defined by the Cormack grade[4] minus one; grade I ($N_4 = 0$) on this scale corresponds to complete visualization of the vocal cords, grade II ($N_4 = 1$) to visualization of the inferior portion of the glottis, grade III ($N_4 = 2$) to visualization of only the epiglottis, and grade IV ($N_4 = 3$) to a nonvisualized epiglottis. Glottic exposure is evaluated during the first attempt by the first operator. In case of successful intubation after blind nasotracheal intubation, $N_4 = 0$. If the blind attempt(s) fail, glottic exposure is evaluated during the first subsequent alternative visualized laryngoscopic attempt.

N_5—The lifting force applied during laryngoscopy; $N_5 = 0$ if little effort is necessary, and $N_5 = 1$ if subjectively increased lifting force is necessary. This notion is based on the operator's impression that an abnormal amount of force was used compared with routine practice.

N_6—The necessity of applied external laryngeal pressure for optimized the glottic exposure; $N_6 = 0$ if no external pressure is applied. $N_6 = 1$ if external laryngeal pressure is necessary. Application of the Sellick Maneuver[5] is intended to inhibit aspiration of gastric contents and does not alter the score.

N_7—Position of vocal cords; $N_7 = 0$ if vocal cords are in abduction. $N_7 = 1$ if the vocal cords are in adduction, presenting an impediment to tube passage. If the vocal cords are not visualized, $N_7 = 0$ by default.

IDS is represented in figure 1. In a manner analogous to the Glasgow Coma Scale score, the values of the individual components may be documented to offer detail of the difficulties encountered, then a composite score is summed to provide an overall assessment of difficulty. Each of these parameters has been demonstrated to contribute to the degree of difficulty of airway management by endotracheal intubation.[1,6]

We evaluated the IDS in a prospective investigation in operating room (OR) and prehospital settings. This study received Institutional Review Board approval.

Operating Room Series

In the OR, to avoid inducing any change in intubating habits on the part of the anesthetists, but at the same time to be able to compare a "standardized intubation," we observed *all* intubations during the period of evaluation, rejecting those which did not meet the following conditions of evaluation, which were selected *a priori:* (1) intubation performed by a certified anesthesiologist or certified nurse anesthetist with 2 or more yr of experience in the OR; (2) selected patients were intubated for routine (nonemergent) surgical procedures after induction of anesthesia and neuromuscular blockade (*i.e.*, all patients were pharmacologically paralyzed); (3) in each case, the first used technique was an orotracheal route using a Macintosh #3 blade, without stylet or Magill forceps. This standardization of intubating conditions was designed to limit the number of variables that might affect perceived or actual difficulty on the part of the operators.

The intubation was timed by an independent observer from the instant that the laryngoscope blade touched the patient to the moment that the endotracheal tube cuff was inflated. The time was validated when endotracheal placement was clinically verified. In the case of an accidental esophageal intubation, the chronometer continued to run until a successful intubation was confirmed. The independent observer noted the number of attempts and techniques used by the operator and

Intubation Difficulty Scale

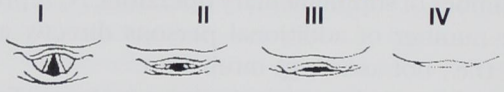
Parameter	Score
Number of Attempts >1	N_1
Number of Operators >1	N_2
Number of Alternative Techniques	N_3
Cormack Grade - 1	N_4
Lifting Force Required	
Normal	$N_5=0$
Increased	$N_5=1$
Laryngeal Pressure	
Not applied	$N_6=0$
Applied	$N_6=1$
Vocal Cord Mobility	
Abduction	$N_7=0$
Adduction	$N_7=1$
TOTAL: IDS = SUM OF SCORES	N_1-N_7

IDS Score	Degree of Difficulty
0	Easy
0 < IDS ≤5	Slight Difficulty
5 < IDS	Moderate to Major Difficulty
IDS = ∞	Impossible intubation

Rules for Calculating IDS Score:

N_1	Every additional attempt adds 1 pt.
N_2	Each additional operator adds 1 pt.
N_3	Each alternative technique adds 1 point: Repositioning of the patient, change of materials (blade, ET tube, addition of a stylette), change in approache (nasotracheal/orotracheal) or use of another technique (fibroscopy, intubation through a laryngeal mask).
N_4	Apply Cormack grade for 1st oral attempt. For successful blind intubation $N_4 = 0$.
N_6	Sellick's maneuver adds no points.
Impossible intubation: IDS takes the value attained before abandonment of intubation attempts.	

Cormack Grade[1]



[1] Cormack RS, Lehane J. Difficult tracheal intubation in obstetrics. Anaesthesia 1984;39:1105-1111.

Intubation Difficulty Score.

Fig. 1. Intubation Difficulty Scale score. Reproduced with permission from above.

recorded the time required. Immediately after the intubation, the operator was asked to indicate on a visual analog scale (VAS) the difficulty experienced during the intubation. The VAS was graduated on the reverse side (visible only to the independent observer) from 0 (intubation without difficulty) to 100 (maximum difficulty). The operator was asked to place the cursor on the scale to correspond to the subjective difficulty experienced. The reading of the number corresponding to this location on the VAS was then determined and recorded by the observer. The operator thereafter completed a questionnaire regarding the procedure, documenting the number of attempts, number of techniques, Cormack grade,[4] necessity of external laryngeal pressure, use of abnormal traction force, number of operators, and position of the vocal cords, which allowed subsequent calculation of the IDS. The last item on the questionnaire asked for a subjective assessment of the difficulty experienced by category: easy, somewhat difficult, and difficult. The operator was blinded to the construction of the score and to the time consumed in performing the intubation. IDS scores were calculated after the fact by the principal investigator (FA).

Prehospital Series

To assess the IDS under less-controlled conditions, we studied urgent intubations in the prehospital environment, performed by emergency physician members of one of the local emergency medical services units of the French government (SAMU). All physicians had more than 2 yr experience in prehospital care. The difficulty of the procedure was evaluated only by administration of the same questionnaire used in the OR study. This was completed by the physician just after the procedure. As in the OR study, the operators were aware that intubating conditions were under evaluation, but not that a score was being calculated and were blinded to all results. Calculation of IDS was performed by one of the investigators (FA) after completion of the questionnaire.

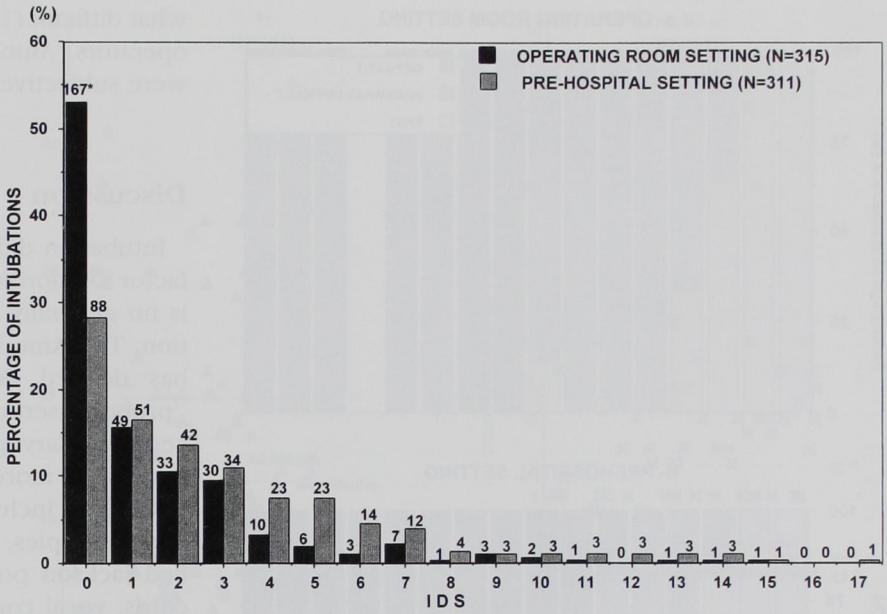


Fig. 2. Comparison of operating room and prehospital Intubation Difficulty Scale distributions. The assigned Intubation Difficulty Scale values are shown on the horizontal axis, whereas the number of patients with each score is shown by the vertical bars. The absolute numbers of patients are shown above each bar.

Statistics

The distribution of the IDS score is non-Gaussian; thus, we used nonparametric tests for comparisons and correlation between the various evaluation techniques. The comparisons between the IDS scores in the OR and prehospital environments were performed using the Mann-Whitney-U test. Comparison of IDS with operator-assessed subjective impression of difficulty was performed using the Kruskall-Wallis analysis of variance (ANOVA). The correlations between the VAS, time to intubate, and IDS were calculated using the Kendall correlation coefficient (τ). All statistics were performed using Stat-View® (Abacus Concepts, Berkeley, CA). A P value < 0.05 was considered statistically significant.

Results

Operating Room Series

Three hundred fifteen intubations met the conditions required for evaluation in the OR. Twenty-six intubations were eliminated from consideration because of nonstandardized conditions. The distribution of IDS scores is represented in figure 2. Median (25th-75th percentiles) IDS value was 0 (range, 0-2). The value IDS = 0 (intubation without difficulty) represents 53.0% (167 of 315) of the number of OR intubations. No intubation was impossible in this series. Nine (4.2%) esophageal intubations, all immediately recognized, were documented. The percentage of intubations with an IDS > 5 (moderate-to-major difficulty of intubation) was 6.3% (20 of 315). The correlation between the subjective difficulty (easy, somewhat difficult, difficult) and the IDS was significant ($P < 0.0001$; Kruskall-Wallis ANOVA; fig. 3A). There was no discrepancy between the number of attempts and alternative techniques reported by the operator and those recorded by the independent observer.

The median (25th-75th percentiles) time of intubation was 22 (25th-75th range, 16-36) s. The time associated with IDS = 0 varied from 6-50 s, with a median (25th-75th percentiles) time of 18 s (25th-75th range, 14-25; fig. 4A). The correlation between the IDS and intubation time was significant ($\tau = 0.48$; $P < 0.0001$). This is shown in figure 5.

The median (25th-75th percentiles) VAS value was 8/100 (25th-75th range, 1/100-20/100). The VAS range associated with IDS = 0 was 0/100- 30/100, with a median (25th-75th percentiles) of 1/100 (25th--75th range, 0/100-7/100; fig. 4B). The correlation between the IDS and VAS was significant ($\tau = 0.63$; $P < 0.0001$; fig. 6). Correlation between VAS and time was significant ($\tau = 0.41$; $P < 0.0001$).

Prehospital Series

Three hundred eleven intubations were performed in the prehospital setting. There was one (0.3%) impossible intubation reported. This intubation was associated

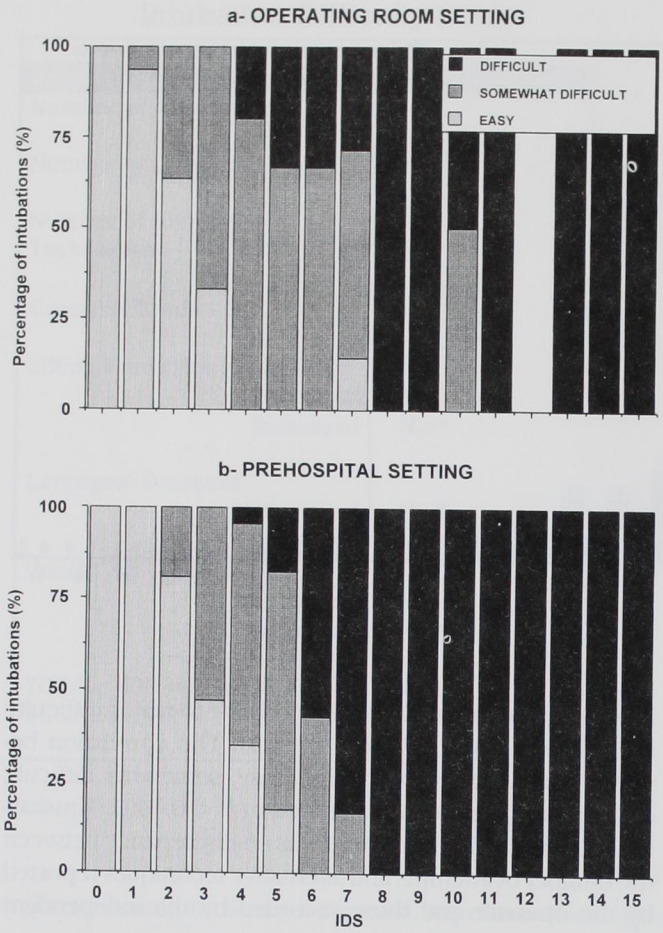


Fig. 3. Comparison of subjective perception of difficulty by operator with Intubation Difficulty Score. Each bar represents 100% of patients assigned to the IDS value. (*A*) Operating room setting. (*B*) Prehospital setting.

with IDS = 17 (value before abandonment of procedure). Median IDS (25th-75th percentiles) value was 2 (25th-75th range, 0-4). The distribution of values of IDS in the prehospital setting, compared with the OR setting is shown in figure 2. The percentage of IDS values >5 was 16.1% (50 of 311) Figure 3B shows the progression in subjective difficulty as a function of increasing IDS. Comparison of subjective categories (easy, somewhat difficult, difficult) to the IDS score by Kruskall-Wallis reveals that the IDS score rankings are significantly different for each of the categories ($P < 0.0001$). The IDS measured in prehospital intubations is significantly greater than those observed in the operating room ($P < 0.0001$). In combining both series, 100% of intubations in which the IDS was > 5 were associated with a subjective perception of being somewhat difficult (16%) or difficult (84%) on the part of the operators. Among intubations with an IDS ≤ 5, 77% were subjectively considered as easy intubations.

Discussion

Intubation difficulty is commonly identified as a risk factor for morbidity and mortality.[7] Unfortunately, there is no generally accepted definition of difficult intubation. The American Society of Anesthesiologists (ASA) has defined difficult tracheal intubation as when "proper insertion of the endotracheal tube with conventional laryngoscopy requires more than three attempts, or more than ten minutes."[8] Other proposed definitions include failure to intubate, more than two laryngoscopies, more than three attempts in the modified Jackson position, poor visualization of the vocal cords, vocal cord movement, perception of jaw relaxation, subjective difficulty on the part of the operator, and combination of subjective evaluation and number of laryngoscopies.[3,4,9-16]

We chose seven factors that have been identified in the literature as associated with difficult intubation.[1] An increased number of attempts (N_1) is the parameter most frequently described as being associated with difficult intubation. Introduction of a second operator (N_2) or abandoning one technique for another (N_3) suggests an encountered difficulty, perhaps more so than a simple additional attempt. As such, changing operators or techniques implies two additional points (one for the change and one for the additional attempt).

The quality of laryngoscopy has been quantified by Cormack,[4] whose score is widely used. IDS is partly influenced by glottic exposure (N_4). However, poor visualization is not always associated with a difficult intubation.[17] In our OR series, 21/34 (61.7%) intubations with a Cormack grade ≥ III were completed on the first attempt. Such an intubation results in an IDS score between 2 and 5, indicating slight difficulty. Conversely, Cormack grade I is not synonymous with an easy intubation.[6] In our combined series, four intubations with Cormack grade I glottic visualization were judged very difficult, subjectively and by IDS (15, 11, 11, and 9). These examples demonstrate that the glottic exposure alone is thus an incomplete reflection of intubation difficulty. On the other hand, it is generally true that in difficult intubations, poor visualization of the glottis is a determining factor. Combining the two patient populations, 50 of 70 (71.4%) intubations of IDS > 5 had a

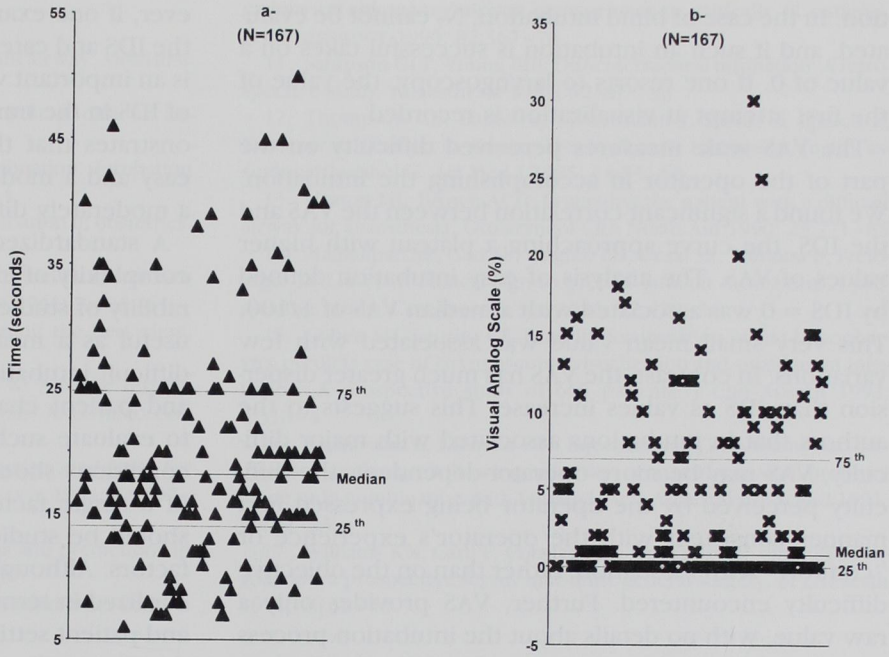


Fig. 4. Time and visual analog scale distributions for Intubation Difficulty Scale = 0. Each triangle or cross symbolizes one patient. (*A*) Time distribution. (*B*) Visual analog scale distribution.

Cormack grade ≥ III. Given these opposing scenarios, it seems appropriate that the influence of glottic visualization on the IDS score is moderate and quickly saturated, the worst case adding only 3 points. Further, in the case of blind intubation, the Cormack grade is meaningless. Thus, laryngoscopic quality alone is not an adequate measure of difficulty, but forms an important component of the IDS score.

Increased lifting force (N_5) and external laryngeal pressure (N_6) are frequently used to improve glottic exposure. The IDS considers these two factors, which tend to further emphasize the importance of quality of glottic visualization.

Finally, the status of the glottic aperture (N_7) will be affected by laryngospasm and cough, both of which have been identified as increasing difficulty of intuba-

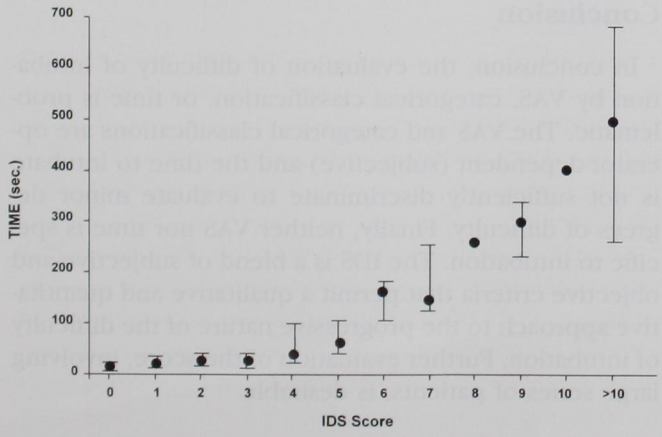


Fig. 5. Correlation between time and Intubation Difficulty Scale values. The assigned Intubation Difficulty Scale values are shown on the horizontal axis. Time (s) is shown on the vertical axis. Each symbol represents the median of patients assigned to the IDS value, with 75th and 25th percentiles.

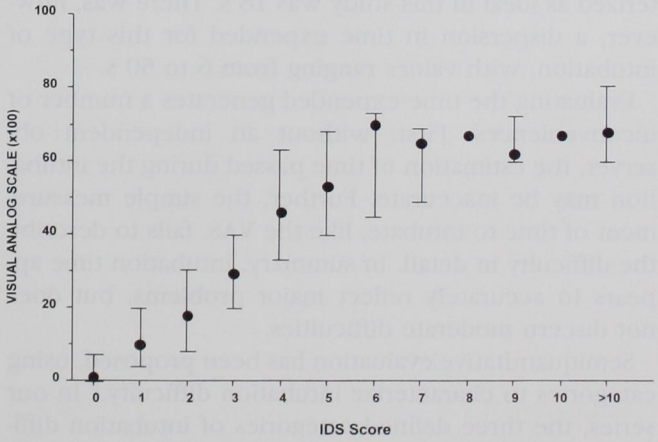


Fig. 6. Correlation between visual analog scale and Intubation Difficulty Scale values. The assigned IDS values are shown on the horizontal axis. Visual analog scale (×100) is shown on the vertical axis. Each symbol represents the median of patients assigned to the IDS value, with 75th and 25th percentiles.

tion. In the case of blind intubation, N_7 cannot be evaluated, and if such an intubation is successful takes on a value of 0. If one resorts to laryngoscopy, the value of the first attempt at visualization is recorded.

The VAS scale measures perceived difficulty on the part of the operator in accomplishing the intubation. We found a significant correlation between the VAS and the IDS, the curve approaching a plateau with higher values of VAS. The analysis of easy intubation defined by IDS = 0 was associated with a median VAS of 1/100. This very small mean value was associated with few variations. In contrast, the VAS has much greater dispersion than IDS as values increase. This suggests to the authors that in intubations associated with major difficulty, VAS may be more operator-dependent, the difficulty perceived by the operator being expressed in a manner consistent with the operator's experience or "comfort" with intubation, rather than on the objective difficulty encountered. Further, VAS provides only a raw value, with no details about the intubation process or techniques used to overcome the difficulty. In contrast, when characterized by its individual components, IDS provides specific information about the intubation.

The time necessary to complete an intubation is an integral part of the consensus definition of the difficult intubation, as defined by the ASA.[8] Clearly, the more difficult an intubation, the greater the time that is necessary for its completion. The curve of time *versus* IDS is biphasic. For values of IDS ≤ 5, time does not vary significantly. On the other hand, when the IDS is > 5, the time increases rapidly in relation to the score (fig. 5). The mean time associated with an intubation characterized as ideal in this study was 18 s. There was, however, a dispersion in time expended for this type of intubation, with values ranging from 6 to 50 s.

Evaluating the time expended generates a number of inconveniences. First, without an independent observer, the estimation of time passed during the intubation may be inaccurate. Further, the simple measurement of time to intubate, like the VAS, fails to describe the difficulty in detail. In summary, intubation time appears to accurately reflect major problems, but does not discern moderate difficulties.

Semiquantitative evaluation has been proposed, using categories to characterize intubation difficulty.[9] In our series, the three defined categories of intubation difficulty correlated significantly with the IDS score. One might argue that if there is a good correlation between the categorical scale and a calculated quantitative scale, that the former is easier, and therefore preferable. However, if one examines figure 3, it is clear that although the IDS and categorical values parallel each other, there is an important variation in perceived difficulty at levels of IDS in the transitional zones (from 2 to 7). This demonstrates that there is no true "border" between an easy and a moderately difficult intubation or between a moderately difficult and a difficult one.

A standardized quantitative scale characterizing the complexity of intubation would permit greater comparability of studies of difficult intubation. IDS may prove useful as a means of evaluating predictive factors of difficult intubation, operator skills, various techniques, and patient characteristics. To use IDS appropriately to evaluate such an array of factors, either intubating conditions should be standardized to allow evaluation of a single factor, or a sufficient number of patients should be studied to permit a multivariate analysis of factors. Although our OR group was more or less standardized in terms of operator training, techniques used and patient setting, our prehospital group was not, rendering any direct comparison of the two groups questionable. That stated, in the prehospital series, the significant influence of cardiac arrest on intubation difficulty is discerned by IDS, patients in cardiac arrest having a median IDS approximately one half that of those patients not in arrest. Additionally, in the OR group, IDS distinguished between Mallampati scores in a significant manner (unpublished data), indicating its potential value in evaluating predictive factors of intubation.

Conclusion

In conclusion, the evaluation of difficulty of intubation by VAS, categorical classification, or time is problematic. The VAS and categorical classifications are operator-dependent (subjective) and the time to intubate is not sufficiently discriminate to evaluate minor degrees of difficulty. Finally, neither VAS nor time is specific to intubation. The IDS is a blend of subjective and objective criteria that permit a qualitative and quantitative approach to the progressive nature of the difficulty of intubation. Further evaluation of the score, involving large series of patients, is desirable.

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