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Original Article

Correlation Analysis of Lemon, Ids, and Wilson Score in Evaluating Intubation Difficulty in Patients With General Anesthesia

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Abstract

Introduction: Difficult and failed intubation are the major causes of morbidity and mortality. The complications can be evaluated by different instruments, such as Look-Evaluate-Mallampati-Obstrucion-Neck mobility (LEMON), Intubation Difficulty Scale (IDS), and Wilson scores. Therefore, this study aimed to analyze the correlation between LEMON, IDS, and Wilson scores in evaluating intubation difficulty in patients with general anesthesia.

Methods: A cross-sectional observational analytic design was adopted and the data were analyzed using Pearson correlation or the Spearmann test. The data on patients with general anesthesia were obtained at Adam Malik General Hospital from April to July 2023.

Results: In this study, a cohort of 76 patients (65.8% female) was included. The mean age of the population was 43.41 ± 14.59 years. Successful intubation was achieved on the first attempt in 61 patients, representing a success rate of 80.3%. Data analysis between pre and post-intubation found significant differences in systole, diastole, mean arterial pressure (MAP), and HR ($P<0.001$). However, there were no significant differences in SpO2 ($P=0.802$) and body temperature ($P=0.902$). The Spearman test showed that there was a significant correlation between all data with each other ($P<0.001$). A high correlation also existed between LEMON and IDS (r = 0.702), LEMON, and Wilson (r = 0.773), as well as IDS and Wilson (r = 0.796).

Conclusion: There was a correlation between LEMON, IDS, and Wilson scores in evaluating intubation difficulty in patients with general anesthesia. The use of multiple scoring systems to identify intubation difficulty is more specific and targeted due to several advantages.

Introduction

General anesthesia is the process used to prevent patients from experiencing verbal, tactile, and painful stimulation. Upper airway obstruction during the process requires the placement of a laryngeal mask airway (LMA) or endotracheal tube (ETT) to maintain patency. The spontaneous ventilation of patients is often inadequate and needs partial or complete mechanical support with positive pressure ventilation.[1] The major problem in anesthesia delivery and implementation of safety is difficult airway management.[2] ETT intubation is used because the process is considered safer for controlling ventilation than an LMA.[3]

The American Society of Anesthesiologists (ASA) Task Force on Difficult Airway Management defines a difficult airway as a clinical situation in which a well-trained anesthesiologist has a problem with mask ventilation upper airway management, intubation, or both.[4] Insufficient airway clearance can lead to brain damage and death. The main factor contributing to the difficulty of tracheal intubation is visualizing the larynx with a laryngoscope.[5] Difficult endotracheal intubation may occur in patients with tumors, infections, congenital anomalies, foreign body aspiration, trauma, inadequate neck extension, and anatomical variations.[6] Elderly patients, due to degenerative processes such as tooth loss as well as head and neck joint changes, obstructive sleep apnea (OSA), and obese patients also make intubation more complicated.[7,8]

According to data from Bendan Regional General Hospital, approximately 15-18% of patients intubated with an ETT are classified as difficult intubation patients as assessed using the Mallampati classification.[9] Complications due to intubation difficulty include airway trauma, laryngospasm, hypoxia, aspiration, esophageal intubation, emergency surgical airway, cardiovascular instability, cardiac arrhythmias, ischemic encephalopathy, and death.[7,10] Difficult intubation can be anticipated and prepared for by identifying relevant anatomical and

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physiological risk factors and potential complications.[11] There are several tools adopted to assess intubation difficulty, including the Look-Assess-Mallampati-Obstruction-Neck Mobility (LEMON), Intubation Difficulty Scale (IDS), and Wilson score.

The "LEMON" method is a structured method used to evaluate the difficulty of airway management utilized to assess airway management. Each component of the LEMON assessment helps to identify and anticipate potential challenges in managing a patient's airway, thereby guiding the clinician in preparation and technique selection. The LEMON scoring system has components of 1) Look: visual inspection for external signs of potential airway difficulties; 2) Evaluate: a systematic assessment using the 3-3-2 rule; 3) Mallampati Score: a classification based on the visibility of the structures in the oral cavity, which has four classes; 4) Obstruction/Obesity: assessment of any condition that might obstruct the airway or increase difficulty due to obesity; 5) Neck Mobility: evaluation of the patient's ability to move their neck. Minimal and maximal scores of LEMON are 0 and 10, respectively.[12,13]

IDS scoring system is a scoring system used to quantify the difficulty of intubation, which has 7 of variables. The components of the IDS scoring system are the number of attempts, number of operators, number of alternative techniques used, glottis exposure (Cormack-Lehane grade), lifting force required, external laryngeal pressure, and position of vocal cords. If the total IDS score from the seven measurement variables is 0 points, it is considered an easy endotracheal intubation. A score of 1-5 points indicates a somewhat difficult intubation, while a score of more than five points is considered a moderately to severely difficult intubation.[14]

Wilson score assesses and provides a total score based on five physical characteristics to predict the difficulty of endotracheal intubation. Each factor is scored zero, one, or two points, with the total score ranging from zero to 10. A higher total score indicates a higher likelihood of difficult endotracheal intubation. A score of 10 suggests a significant risk of intubation difficulty. These characteristics are weight, head and neck movement, jaw movement, receding mandible, and prominent upper incisors.[15]

The LEMON method includes assessment, and is a quick and easy method to assess the airway of patients in an emergency.[16] This method can be used in emergency settings, including both difficult and routine intubation, by visually assessing anatomical landmarks and using finger measurements to estimate the required length without the need for specialized instruments.[17] IDS is a function of seven parameters, allowing for a progressive and quantitative determination of the complexity of intubation.[14] Wilson score is used for routine assessment based on criteria assessing physical characteristics, such as body weight, mobility of the cervical spine and jaw, posterior teeth, and shape of the incisors.[18,19]

A study by Ji et al. reviewed 114 adult trauma patients who were subjected to emergency surgery under general anesthesia.[16] The airways of patients were assessed using the modified LEMON method before anesthesia and after intubation, and physicians reported IDS scores. The difficult intubation group was defined as patients with IDS score > 5. The results showed that the LEMON score was significantly correlated with the IDS score ($P < 0.001$) in adult trauma patients subjected to emergency surgery. Difficult intubation showed a higher score than the non-difficult group ($P = 0.017$).[16]

Domi's study of 426 patients undergoing endotracheal intubation found that 40 experienced difficult intubation, of whom 33 had been correctly predicted by the Wilson score. The specificity and sensitivity of the Wilson score were 78.5 and 7.8, respectively. This study also found that the Wilson score was the best predictive test of intubation difficulty compared to others.[20]

To our knowledge, the correlation between the LEMON, IDS, and Wilson scores in predicting intubation difficulty has not been investigated yet. Therefore, this study was designed to investigate the correlation between the LEMON score, IDS score, and Wilson score in predicting intubation difficulty in general anesthesia patients.

Methods

Study Design

This study utilized a cross-sectional observational analytic design at the General Hospital of Adam Malik, Medan. Patients aged 18 to 64 years who underwent elective surgery with general anesthesia and ETT, with ASA physical status scores of 1 to 3, and who provided informed consent, were included in the study conducted between April 2023 and July 2023. The exclusion criteria for this study were as follows: patients who refused to participate, those with decreased consciousness, individuals intubated before the induction of anesthesia, and patients who underwent surgical procedures with regional anesthesia.

Ethical Considerations

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Health Research Ethics Committee of the Faculty of Medicine, University of Sumatera Utara (No.: 235), and informed consent was obtained from all individual participants.

Data Collection

After obtaining ethical approval, the process of data collection was initiated. Patients scheduled for general anesthesia (GA) ETT who met the inclusion criteria and did not meet any exclusion criteria were given an explanation of the study procedures and asked to provide informed consent. The anesthesiologists (5th-year residents and above) on duty were provided with a patient observation sheet after the pre-operative examination for GA-ETT. The patient observation sheet included patient data, pre-intubation, and post-intubation hemodynamic data, and intubation success. The principal investigator observes patients based on LEMON, IDS, and Wilson scores when admitted to the handover room.

The anesthesiologists conducted monitoring based on the observation sheet guidelines. The sheet was collected by the principal investigator after completion and the data on LEMON, IDS, and Wilson were recapitulated and evaluated by the principal investigator.

Statistical Analysis

The sample size was calculated using the formula for analytic correlational studies involving numerical data in a single population, with the minimum required sample size for this study being 70 samples. In this study, a non-probability sampling technique was employed, specifically using consecutive sampling. This approach involves selecting samples sequentially according to the inclusion and exclusion criteria until the minimum required sample size is achieved.

To address selection bias, the author ensures the use of clearly defined inclusion and exclusion criteria during the data sampling process, ensuring that all eligible patients during the study period are included. A standardized protocol is established for data collection, which is followed by personnel collecting the data. The sampling process is regularly monitored to ensure that all eligible patients are included. Furthermore, the author ensures transparent reporting of the sampling process. Missing data is managed by following up with participants to complete incomplete data entries and employing imputation techniques to address any remaining missing data.

The data were tabulated and processed using Ms. Excel and SPSS version 26. In quantitative data analysis, the normality of the data was assessed using the Kolmogorov-Smirnov test. Normally distributed data were presented as mean ± standard deviation (SD). Differences between categorical variables were evaluated using the Chi-Square test. For normally distributed quantitative data, a dependent t-test was employed to compare means, whereas the Wilcoxon test was used when the data did not follow a normal distribution. The sensitivity and specificity data were presented along with the area under the curve (AUC). Correlation between variables was examined using either the Pearson correlation or the Spearman test. Statistical significance was determined if the *P* value was less than 0.05.

Results

Characteristic Data Analysis Results

Out of the initial 85 patients assessed, only 76 fulfilled the predetermined inclusion and exclusion criteria. Subsequently, the data on their baseline characteristics were subjected to analysis. The variables included in this baseline were age, gender, mean arterial pressure (MAP), heart rate (HR), American Society of Anesthesiologists physical status (ASA-PS) classification, and the rate of successful intubation on the initial attempt.

In this study, the mean ± standard deviation (SD) age of patients was 43.41 ± 14.59 years old, female gender 50 patients (65.8%), mean height 169.6 ± 11.8 cm, mean weight 26.2 ± 5.3 kg, mean BMI 24.7 ± 5.3 kg/m,^{2} mean initial MAP 89.36 ± 8.61 mmHg, mean initial HR 78.84 ± 9.23 bpm, PS-ASA II in 39 patients (51.3%) with a mean of 2.30 ± 0.63, and success at the first attempt of intubation in 61 patients (80.3%). Based on the normality data, height and weight data were normally distributed while age and gender were not normally distributed (Table 1).

Hemodynamic Status Analysis Results

Hemodynamic status, including systole, diastole, MAP, HR, body temperature, and oxygen saturation (SpO2) is presented in Table 2. The mean ± SD pre and post

Table 1. Characteristic Data Analysis Results

Characteristic	Data	*P* value Normality*
Age (years)		
Mean±SD	43.41±14.59	0.018
Median	45	
Min-Max	18-64	
Sex		
Male	26 (34.2%)	*P*<0.001 (categoric)
Female	50 (65.8%)	
Height (cm)		
Mean±SD	169.6±11.8	0.130
Median	168	
Min-Max	156.8-181.7	
Weight (kg)		
Mean±SD	69.4±6.3	0.370
Median	70	
Min-Max	58.2-98.3	
BMI (kg/m^2)		
Mean±SD	24.7±5.3	0.180
Median	25.1	
Min-Max	18.3-30.3	
MAP (mmHg)		
Mean±SD	89.36±8.61	0.200
Median	90	
Min-Max	63.33-103.33	
HR (beats/minute)		
Mean±SD	78.84±9.23	0.060
Median	80	
Min-Max	62-99	
PS-ASA		
I	7 (9.2%)	
II	39 (51.3%)	
III	30 (39.5%)	*P*<0.001 (categoric)
Mean±SD	2.30±0.63	
Median	2	
Min-Maks	1-3	
First Attempt of Intubation		
Success	61 (80.3%)	*P*<0.001 (categoric)
Unsuccessful	15 (19.7%)	

ASA-PS, American Society of Anesthesiologists Physical Status; BMI, body mass index; HR, heart rate; MAP, mean arterial pressure; Max, maximum; Min, minimum; SD, standard deviation. *Normality was assessed using the Shapiro–Wilk test.

Table 2. Hemodynamic Status Analysis Results.

Hemodynamic	Pre	Post	*P* value Normality[a]	*P* value
Systole				
Mean ± SD	117.30±9.74	144,95±9.28	Pre: 0.099 Post: 0.021	0.523*
Median	117	144.5		
Min-Maks	100-141	127-162		
Diastole				
Mean ± SD	75.39±9.26	96,09±8.95	*P* < 0.001 0.006	0.415*
Median	78	98		
Min-Maks	45-90	68-112		
MAP				
Mean ± SD	89.36±8.61	112,38±8.43	0.200 0.200	0.471**
Median	90	111.83		
Min-Maks	63.33-103.33	87.67-127.33		
HR				
Mean ± SD	78.84±9.23	97.70±9.19	0.060 0.200	0.802**
Median	80	99.5		
Min-Maks	62-99	80-120		
SpO2				
Mean ± SD	98.37±1.64	98.65±0.86	*P* < 0.001 *P* < 0.001	0.902*
Median	99	99		
Min-Maks	92-99	96-100		
Temperature				
Mean ± SD	37.85±0.66	37.74±0.84	0.047 0.031	0.802*
Median	38.1	38.1		
Min-Maks	36.5-39.1	36-38.9		

* Wilcoxon test
** T-test dependent test
DBP, diastolic blood pressure; HR, heart rate; MAP, mean arterial pressure; Max, maximum; Min, minimum; SBP, systolic blood pressure; SD, standard deviation; SpO_2, peripheral oxygen saturation.

hemodynamic status of this study were [1] systolic pressure of 117.30 ± 9.74 mmHg and 144.95 ± 9.28 mmHg, [2] diastole pressure of 75.39 ± 9.26 mmHg and 96.09 ± 8.95 mmHg, [3] MAP of 89.36 ± 8.61 mmHg and 112.38 ± 8.43 mmHg, [4] HR ofc78.84 ± 9.23 times/min and 97.70 ± 9.19 times/min, [5] SpO2 of 98.37 ± 1.64% and 98.65 ± 0.86%, [6] temperature of 37.85 ± 0.66°C and 37.74 ± 0.84°C.

Based on the normality data test, only MAP and HR were normally distributed. Dependent T-test and Wilcoxon test were performed on normally and non-normally distributed data. It was concluded that there was a difference between groups when a *P* value < 0.05 was found in the data. Based on the results, there were significant differences in systole, diastole, MAP, and HR data between pre and post with a *P* value of *P* < 0.001. Meanwhile, there were no significant differences in SpO2 and temperature data with a *P* value of 0.802 and 0.902.

Sensitivity and Specificity Values of LEMON, IDS, and Wilson Score With Success in the First Attempt

In this study, a receiver operating characteristic (ROC) curve was analyzed to determine the sensitivity, specificity, and cut-off values of LEMON, IDS, and Wilson for success on the first attempt. The first analysis was conducted using the ROC curve in SPSS software and was continued to determine the cut-off value using Ms. Excel software. In this study, cut-offs were used to obtain the risk of mortality events in sepsis patients.

The LEMON score had AUC, sensitivity, and specificity values of 0.985 or 98.5% (*P* < 0.001), 100%, and 95.1%. IDS score had AUC, sensitivity, and specificity values of 0.836 or 83.6% (*P* < 0.001), 86.7% and 67.2%. Furthermore, the Wilson score had AUC, sensitivity, and specificity values of 0.885 or 88.5% (*P* < 0.001), 66.7%, and 93.4% (Figure 1 and Table 3).

Analysis of Categorical LEMON, IDS, and Wilson Scores with Success on the First Attempt

The relationship between the categorical LEMON, IDS, and Wilson scores and the success of intubation on the first attempt was analyzed. The statistical results indicate a significant association, with a *P* value of less than 0.001, suggesting that the LEMON, IDS, and Wilson scores are associated with intubation difficulty (Table 4).

Correlation of LEMON, IDS, and Wilson Score

Based on the normality test, LEMON, IDS, and Wilson score data were not normally distributed; hence, non-

Table 3. Sensitivity, Specificity, and Cut-Off values of LEMON, IDS, and Wilson scores

Data	Area	Std Error	*P* value	Se	Sp	*Cut-off*
LEMON	0.985	0.011	$P<0.001$	1.000	0.951	3
IDS	0.836	0.064	$P<0.001$	0.867	0.672	3
Wilson	0.885	0.053	$P<0.001$	0.667	0.934	3

AUC, area under the receiver operating characteristic curve; IDS, Intubation Difficulty Scale; LEMON, Look–Evaluate–Mallampati–Obstruction–Neck mobility; SE, standard error; Se, sensitivity; Sp, specificity.

Table 4. The results of the categorical analysis of the LEMON, IDS, and WILSON score to the success of the first intubation attempt

LEMON Category	First Attempt				Total		*P* value*
	Success		Failure				
	N	%	N	%	N	%	
Easy	61	80.3	10	13.2	71	93.4	$P<0.001$
Difficult	0	0	5	6.6	5	6.6	
Wilson Category	**First Attempt**				**Total**		***P* value***
	Success		**Failure**				
	N	**%**	**N**	**%**	**N**	**%**	
Easy	57	75	5	6.6	62	81.6	$P<0.001$
Difficult	4	5.3	10	13.2	14	18.4	
IDS Category	**First Attempt**				**Total**		***P* value****
	Success		**Failure**				
	N	**%**	**N**	**%**	**N**	**%**	
Easy	2	2.6	0	0	2	2.6	
Difficult	58	76.3	12	15.8	70	92.1	$P<0.001$
Very Difficult	1	1.3	3	3.9	4	5.3	

IDS, Intubation Difficulty Scale; LEMON, Look–Evaluate–Mallampati–Obstruction–Neck mobility; n, number of patients.
*Fisher-Exact test
**Mann-Whitney test

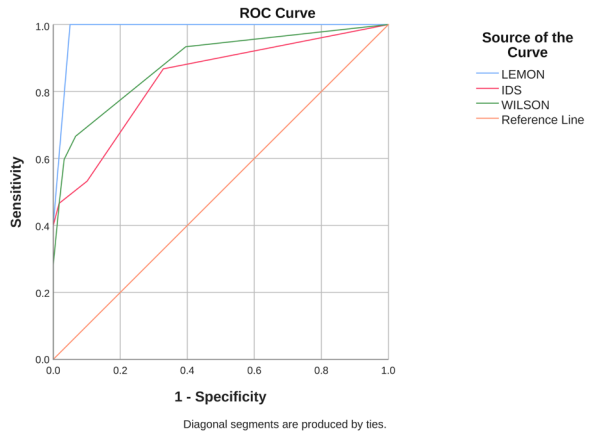


Figure 1. ROC Curve Analysis Results

parametric statistical analysis was carried out using the Spearman correlation test.

The results of the Spearman test showed a significant correlation between all data with each other ($P<0.001$). There was a strong correlation (r = 0.702) between LEMON and IDS(r = 0.702), LEMON and Wilson (r = 0.773), and IDS and Wilson (r = 0.796), as shown in Table 5.

Table 5. Correlation of LEMON, IDS, and Wilson Scores.

Data	r	*P* value*
LEMON-IDS	0.702	$P<0.001$
LEMON-Wilson	0.773	$P<0.001$
IDS-Wilson	0.796	$P<0.001$

*Spearman test

Discussion

A total of 76 patients were included, with a mean (SD) and a median age of 43.41 ± 14.59 and 45 years. The females were 50 (65.8%), while the males were 26 (34.2%). A study by Domi et al. found that patient characteristics showed the majority were male (62.5%) compared to female (37.5%). In this study, males experienced difficulty during intubation more frequently than females.[20] This is attributed to the fact that endotracheal intubation can be challenging due to anatomical or physiological factors. Anatomically difficult intubation includes challenges in visualizing the vocal cords (difficult laryngoscopy) or inserting the tube into the trachea (difficult endotracheal tube placement). Physiologically difficult intubation comprises cardiopulmonary compromise, manifesting as hypoxemia or hypotension.[21]

In this study, a mean BMI of 24.7 can be considered indicative of overweight status within the Asia-Pacific population.[22] This suggests that the majority of individuals in the study have a higher body weight than what is deemed ideal for their health. In the study conducted by Yakushiji et al, overweight patients exhibited a lower success rate

in the first intubation attempt with an odds ratio (OR) of 0.62 [95% CI 0.49-0.78], $P < 0.001$, compared to lean patients, yet their success rate remained higher compared to obese patients.[23] The meta-analysis study also revealed a relationship between obesity and the risk of intubation difficulty, with a pooled relative risk (RR) of 2.04 [95% CI: 1.16–3.59], $P = 0.01$.[25]

PS-ASA (American Society of Anaesthesiologists Physical Status) is a classification of the general health of patients and is divided into 5 levels, namely I, II, III, IV, and V. The PS-ASA scores of patients were I, II, and III, with 7 (9.2%), 39 (51.3%), and 30 (39.5%) with a mean of 2.30 ± 0.63.[26] Only patients with PS-ASA classification levels I, II, and III were included in this study. The use of classification levels I, II, and III minimized bias related to the patients' diseases. Additionally, patients with PS-ASA grade II accounted for 39 individuals, compared to 7 and 30 patients with PS-ASA grades I and III, respectively.

Preoperative evaluation under anesthesia should begin with a comprehensive medical history, including any previous adverse reactions, an assessment of cardiac and pulmonary function, a history of allergies, and current medications. Preoperative anesthesia evaluation facilitates the acquisition of laboratory tests, imaging procedures, and additional medical consultations. Consequently, the patient's medical conditions are optimized as much as possible before surgery.[25]

In this study, hemodynamic status was assessed in the form of systolic blood pressure, diastolic blood pressure, MAP, HR, and oxygen saturation (SpO2). MAP data in this study had an initial mean of 89.36 ± 8.61 and the mean initial HR of patients was 78.84 ± 9.23 bpm. Success in the first trial was found in 61 patients (80.3%), and the initial mean MAP was 89.36 ± 8.61 above the minimum limit. The definition of MAP is the average arterial pressure throughout one cardiac cycle, systole, and diastole. To perfuse important organs, maintenance of MAP of at least 60 mmHg was required. Manifestations in end organs such as ischemia and infarction may occur when the value falls below this point for a long period.[26]

Sarkar et al. found that the systolic value of patients before and after the action did not increase or decrease significantly.[27] The same result was obtained for the diastolic value of patients, where a significant difference was reported. The difference was also in line with this study, where the increase or decrease of the values impacted the choice of anesthetic drugs. For example, propofol is a phenol agent with rapid onset and short duration of action used for induction, but its dose can cause respiratory depression and maintenance of anesthesia.[6,27,28]

The ASA defines difficult endotracheal intubation as 3 attempts when an average laryngoscope is used. It is an airway patency management that can prevent aspiration and facilitate mechanical ventilation. However, unanticipated difficult endotracheal intubation may be detrimental to patients and cause death.[17]

The study by Ji et al. assessed the use of LEMON scoring in 114 adult trauma patients subjected to emergency surgery using general anesthesia methods. The results showed that the modified LEMON score was significantly correlated with IDS ($P < 0.001$) in adult trauma patients. The difficult intubation group reported a higher score than the non-difficult group ($P = 0.017$).[16] The specificity and sensitivity of the LEMON score had a high level of reliability. This was proven through the LEMON ROC curve which had an AUC value of 0.985 or 98.5% ($P < 0.001$) as well as sensitivity and specificity of 100% and 95.1%. It was concluded that LEMON scoring could be used to identify cases at risk of difficult intubation.

Domi's study on Wilson scoring was conducted on 426 patients with endotracheal intubation. From the 426 patients studied, there were patients with intubation difficulty in the 40 assessed using Wilson scoring. The study states that Wilson's scoring had specificity and sensitivity of 78.5 and 78, respectively. Therefore, Wilson's score was the best predictive test of intubation difficulty compared to others.[20]

The Wilson scores had an AUC value of 0.885 or 88.5% ($P < 0.001$) as well as sensitivity and specificity values of 66.7% and 93.4%. This study disagrees with the selection of Wilson's score as better than others. Based on the results, the LEMON score is the best used to detect difficult intubation. Ji et al also supported this opinion by providing a concrete example where patients with difficult intubation had a higher LEMON score.[16]

IDS is a function of seven parameters, resulting in a progressive and quantitative determination of intubation complexity.[14] The study by Selvi et al. showed sensitivity and specificity values of 86.27% and 71.57%. IDS score had AUC, sensitivity, and specificity values of 0.836 or 83.6% ($P < 0.001$), 86.7% and 67.2%. Selvi et al. and the obtained result were similar in the sensitivity and specificity values obtained. Even though IDS has been used for a long time compared to others, the score cannot be ignored.[29]

There was a strong correlation ($r = 0.702$) between LEMON and IDS ($r = 0.702$), LEMON and Wilson ($r = 0.773$), and IDS and Wilson ($r = 0.796$). The results of statistical analysis using the Spearman test showed a significant correlation between the data with each other ($P < 0.001$). Ji et al. found a significant correlation between LEMON score and IDS ($P < 0.001$).[16] This result proves the reliability of using scores to detect difficult intubation in emergency patients requiring rapid surgery. The use of 2 or more scores to determine the degree of difficulty should be carried out by clinicians. The use of more than 1 score can detect the degree of intubation difficulty more specifically and target it.

Further research investigating the correlation between this score remains limited. The differences in sensitivity and specificity of each scoring system, as well as variations in the number of examination points performed in each scoring system, undoubtedly impact the accuracy of the scoring itself. Research by Iohom et al. substantiates this point by stating that sometimes a single scoring system is insufficient to aid in determining the difficulty level of intubation, thus the use of additional scoring systems

is more beneficial in identifying patients with such tendencies.[30] There are limited studies that discuss the correlation between scores. Differences in the sensitivity and specificity of each score as well as in the number of checkpoints certainly have an impact on accuracy.

In this study, there were limitations regarding the description of comorbidities, anatomical abnormalities, anesthesia-related factors, and the type and duration of surgery in the patient population, which could introduce potential bias and impact the examination results. The absence of a homogeneous gender distribution within the patient population could potentially influence the outcomes as well. The operator's experience is also a determining factor in the success rate of intubation on the first attempt. However, this study successfully showed that the scores studied have adequate sensitivity and specificity levels in clinical aspects. Relying solely on a single scoring system may prove inadequate in identifying the likelihood of difficult intubation. Therefore, the effectiveness of combining with other methods becomes apparent, contributing to a more accurate and comprehensive diagnostic method.

Conclusion

In conclusion, the highest correlation was between IDS and the Wilson score with a strong correlation. However, the best score was LEMON, with the highest AUC, sensitivity, and specificity values, followed by Wilson and IDS.

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None.

Authors' Contribution

Conceptualization: Irsazulharto Mulana Nasution, Andriamuri Primaputra Lubis
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Writing–Review & Editing: Irsazulharto Mulana Nasution, Andriamuri Primaputra Lubis, Dadik Wahyu Wijaya

Competing Interests

The authors do not have any pertinent financial or non-financial conflicts of interest to declare.

Ethical Approval

The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the Health Research Ethics Committee of the Faculty of Medicine, University of Sumatera Utara (No.: 235), and informed consent was obtained from all individual participants.

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Informed Consent

Patients were requested to provide their consent for participation and to sign the informed consent form.

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