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Original Article

Anaesthesia Section

Comparison of Wilson's Score and Intubation Prediction Score for Prediction of Difficult Endotracheal Intubation: A Prospective Observational Analytical Study

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ABSTRACT

Introduction: Prediction of a difficult airway is of utmost importance, as an unanticipated difficult airway can lead to severe adverse events. Clinically, prediction is done using independent bedside tests; however, these often lack accuracy. Moreover, most airway assessment scores are cumbersome and subject to interobserver variability because of subjective parameters. Wilson's Score and the Intubation Prediction Score (IPS) are commonly used scoring systems for preoperative airway evaluation.

Aim: To determine the diagnostic accuracy of the Wilson Score and IPS in predicting difficult airways.

Materials and Methods: This prospective, observational, analytical, single-blind study was conducted among 120 patients aged 18 to 70 years who underwent surgeries requiring endotracheal intubation. All patients underwent airway assessment using both the Wilson Score and IPS. General anaesthesia with endotracheal intubation was performed by an anaesthesiologist who was unaware of the patients' scores. The ease of laryngoscopy and intubation was assessed using the Intubation Difficulty Scale (IDS), where an IDS score greater than 5 indicated a difficult airway. Sensitivity, specificity, Positive Predictive Value (PPV), Negative Predictive Value (NPV), and overall accuracy of both scoring systems were calculated. McNemar's test was used to compare diagnostic performance, with p-value <0.05 considered statistically significant.

Results: A total of 120 patients were assessed, of whom 58 (48.33%) were male and 62 (51.67%) were female. The mean age and weight of the patients were 40.47±12.14 years and 70.53±13.76 kg, respectively. Sixty-six (55%) patients belonged to American Society of Anaesthesiologists (ASA) Grade I, and 54 (45%) to ASA Grade II. The actual incidence of difficult airway was 11.67%. Wilson's Score showed a sensitivity of 21.43%, specificity of 93.40%, PPV of 30.00%, NPV of 90.00%, and accuracy of 85.00%. IPS demonstrated significantly better sensitivity (71.43%; p-value=0.014), PPV (83.33%; p-value=0.023), and overall accuracy (95.00%; p-value=0.012). Both systems showed high specificity (IPS: 98.11%; Wilson's: 93.40%; p-value=0.172), while NPV was higher for IPS (96.30% vs. 90.00%; p-value=0.057).

Conclusion: The IPS outperforms Wilson's Score in predicting difficult endotracheal intubation, particularly in terms of sensitivity, PPV, and overall accuracy. Incorporating IPS into routine preoperative assessment may enhance patient safety. Therefore, it can be preferred as a simple and accurate bedside tool for predicting difficult airways in patients undergoing endotracheal intubation under general anaesthesia.

Keywords: Airway assessment, Intubation difficulty score, Laryngoscopy

INTRODUCTION

As an anaesthesiologist, while administering general anaesthesia, the primary goal is to mitigate adverse effects on the respiratory system, which include loss of airway patency and protective reflexes. This is achieved through proper airway management. Mask ventilation, laryngeal mask airways, and other newer devices are regularly used for airway management; however, the gold standard for a safe and definitive method of airway management during surgeries requiring general anaesthesia remains tracheal intubation [1]. The ASA defines difficult endotracheal intubation as requiring three attempts with an average laryngoscope or when endotracheal intubation takes 10 minutes or more [2]. According to the ASA closed claims study, 17% of intraoperative respiratory complications are due to unanticipated difficult airways, and 85% of these patients either die or suffer from hypoxic brain injury along with several other morbidities [3]. Therefore, predicting the possibility of failed endotracheal intubation is crucial, as foreseeing this complication allows for better preparedness and mitigation.

Prediction of a difficult airway is a routine and important step during preanaesthetic evaluation at the bedside. Several independent bedside tests exist for this purpose, including the Mallampati score and its Samsoon-Young modification [4,5], sternomental distance [6], upper lip bite test [7], and mouth opening assessment; however, these tests lack consistent accuracy in predicting difficult airways [8]. Several studies and a recent Cochrane review have concluded that none of the independent bedside screening tests are sufficiently reliable for detecting unanticipated difficult airways [8-11]. A combination of independent tests, however, may predict a difficult airway with better accuracy and consistency. Several multivariate scoring systems have been proposed, such as the Wilson Score [12], El-Ganzouri Multivariate Risk Index [13], Arne's Simplified Score Model [14], Intubation Prediction Score (IPS) [15], and the LEMON score [16]. The Wilson Score, developed in 1988, represents one of the earliest multivariate scoring systems for predicting difficult intubation [17]. It incorporates five parameters: weight, head and neck movement, jaw movement, receding mandible, and buck teeth [18]. The IPS, on the other hand, is a relatively new and easy-to-perform bedside scoring system that combines high-yield objective parameters for airway assessment, including Mallampati grading, atlanto-occipital joint extension, and mandibular space evaluation [15].

In search of a simple and objective scoring system, the present study compared the Wilson Score with the IPS to assess the accuracy and consistency of both scores and to determine whether they can be used in routine bedside preanaesthetic evaluation. The primary outcome measures were the sensitivity and specificity of the two tests, while the secondary outcome measures included the PPV, NPV, and overall accuracy of the two tests.

MATERIALS AND METHODS

This prospective, observational, analytical, single-blind study was conducted in the Department of Anaesthesiology at Dhiraj Hospital, SBKS Medical Institute and Research Centre Vadodara, Gujarat, India, between September 2023 and May 2025, after obtaining approval from the Institutional Ethics Committee (Ref. No. SVIEC/ON/MEDI/BNPG22/Aug/23/26). The study was registered with the Clinical Trials Registry-India (CTRI) under the registration number CTRI/2024/12/078532. The purpose of the study was explained to all participants, and written informed consent was obtained from each patient.

Inclusion criteria: Patients aged between 18 and 70 years, belonging to ASA physical status I or II, scheduled for elective surgery under general anaesthesia requiring endotracheal intubation, and willing to participate in the study were included in the study.

Exclusion criteria: Patients unwilling to participate, those with head or neck pathology, unstable cervical spine, or requiring emergency surgery were excluded from the study, as these factors could interfere with airway assessment or management.

Sample size calculation: Sample size was calculated using the formula: $n= (Z^2\alpha /2 \cdot p \cdot q)/d^2$

- $Z\alpha/2=1.96$ (for 95% CI)
- p= 0.085 (8.5% incidence of difficult intubation in the general population) [19]
- q= 1−p =0.915
- d allowable error (usually expressed as a proportion, e.g., 5% → 0.05)

With a power of the study as 80% the calculated sample size comes to be of 120.

Study Procedure

A standard preanaesthetic evaluation with a detailed airway assessment was performed for all patients using the Wilson's Score [12] [Table/Fig-1] and IPS [15] [Table/Fig-2]. The total score for each system was calculated, and the airway was graded as easy, moderately difficult, or difficult according to the respective scoring criteria.

Risk	Score	Level
Weight (kg)	0	<90
	1	90-110
	2	>110
Head and neck movement (°)	0	Above 90
	1	About 90
	2	Below 90
Jaw movement	0	IG>5 or SLux>0
	1	IG<5 or SLux=0
	2	IG<5 or SLux<0
Receding mandible	0	Normal
	1	Moderate
	2	Severe
Buck teeth	0	Normal
	1	Moderate
	2	Severe
Prediction	Easy intubation: Score ≤2 Moderately difficult intubation: Score 3-7 Difficult intubation: Score≥8	

[Table/Fig-1]: Wilson's score.
IG: Inter incisor gap; Slux: Subluxation

Parameter	Grade	Score
Mallampati test	1	1
	2	2
	3	3
	4	4
Atlanto-occipital joint extension	1	1
	2	2
	3	3
	4	4
Mandibular space	1	1
	2	2
	3	3
	4	4
Grade 1: (3-4 points); easy intubation	Grade 2: (5-8 points); moderately difficult intubation	Grade 3: (9-12 points); difficult intubation

[Table/Fig-2]: Intubation Prediction Score (IPS).

Head and neck movement: To assess cervical mobility, each patient was instructed to fully extend the head and neck. A pencil was placed vertically against the forehead and aligned parallel to a distant window frame. While maintaining the pencil in a fixed position, the patient was then asked to fully flex the head and neck. The angular displacement of the pencil relative to the horizontal window frame was used to estimate whether the movement exceeded or approximated 90° [12].

Mouth opening (Inter-Incisor Gap): Mouth opening was evaluated by asking patients to open their mouths as widely as possible. The distance between the upper and lower incisors was measured using a ruler. In edentulous patients, the measurement was taken between the upper and lower alveolar ridges (gingiva) [12].

Mandibular subluxation: For assessment of mandibular subluxation, patients were asked to protrude the lower jaw (mandible) as far forward as possible. The degree of anterior mandibular movement was graded as follows [12]:

Grade 1: Lower incisors protruded anterior to the upper incisors.

Grade 2: Lower incisors aligned with the upper incisors.

Grade 3: Lower incisors failed to reach the upper incisors and remained posterior.

Receding mandible: The presence of a receding mandible was subjectively assessed and graded on a three-point scale [12]:

0=Normal

1=Moderate

2=Severe

Buck teeth: The prominence of buck teeth (protruding upper incisors) was evaluated and categorised using a three-point scale [12]:

0=Normal

1=Moderate

2=Severe

Mallampati grading: The patient was asked to sit upright, open the mouth fully, and protrude the tongue maximally [4].

Grade 1: Soft palate, fauces, uvula, and anterior and posterior tonsillar pillars visible (1 point)

Grade 2: Soft palate, fauces, and uvula visible (2 points)

Grade 3: Soft palate and base of the uvula visible (3 points)

Grade 4: Only the hard palate visible; soft palate not visible (4 points)

Atlanto-Occipital Joint Extension (AOJE): A goniometer was used to measure the angle traversed by the occlusal surfaces of the maxillary teeth as the atlanto-occipital joint was extended from complete flexion to the sniffing position [15].

Grade 1: AOJE ≥ 35° (1 point);

Grade 2: AOJE ≥ 22° and < 35° (2 point);

Grade 3: AOJE ≥ 13° and < 22° (3 point);

Grade 4: AOJE < 13° (4 point).

Mandibular space: This included the Thyromental Distance (TMD) and the horizontal Length of the Mandible (LM). To measure the TMD, each patient was asked to extend the head and neck as far as possible with the mouth closed. The straight distance from the inside of the mentum to the thyroid notch was measured. The LM was measured from the angle of the mandible to the mentum [15].

Grade 1: TMD ≥ 6 cm and LM ≥ 9 cm (1 point)

Grade 2: TMD ≥ 6 cm and LM < 9 cm (2 points)

Grade 3: TMD < 6 cm and LM ≥ 9 cm (3 points)

Grade 4: TMD < 6 cm and LM < 9 cm (4 points)

After transferring the patient to the operating room, standard monitors were attached, including Electrocardiogram (ECG), Non Invasive Blood Pressure (NIBP), and pulse oximetry. Preoxygenation with 100% oxygen via an anatomical face mask was performed for 3-5 minutes. Premedication was administered as per routine, with glycopyrrolate 0.004 mg/kg and ondansetron 0.1 mg/kg intravenously. General anaesthesia was induced using propofol 2 mg/kg, and a short-acting muscle relaxant, succinylcholine 2 mg/kg IV, was administered considering the possibility of difficult endotracheal intubation. All endotracheal intubations were performed by anaesthesiologists with more than two years of experience, who were blinded to the patient's airway assessment scores.

Laryngoscopy Grading (Cormack-Lehane Classification):

The laryngoscopic view was graded as follows:

Grade 1: Vocal cords completely visible

Grade 2: Only arytenoids visible

Grade 3: Only epiglottis visible

Grade 4: Epiglottis not visible

The difficulty of endotracheal intubation was assessed using the IDS [20]. The intubating anaesthesiologist was asked to complete a seven-point questionnaire to evaluate and grade the actual difficulty of intubation. If the total IDS score (sum of the seven variables) was 0, the intubation was considered easy. If the score ranged from 1-5, it was classified as slightly difficult, and if the score was greater than 5, it was considered moderate-to-difficult. In this study, an IDS score of more than 5 (i.e., moderate-to-severe difficulty) was considered indicative of a difficult intubation.

IDS Components:

- N1: Number of additional intubation attempts - 1 point each
- N2: Number of additional operators - 1 point each
- N3: Number of alternative intubation techniques used - 1 point each
- N4: Laryngoscopic view (Cormack-Lehane grade minus 1) - 0 to 3 points
- N5: Lifting force applied during laryngoscopy - Normal=0 point; Increased=1 point
- N6: External laryngeal pressure - None=0 point; Applied=1 point
- N7: Vocal cord mobility - Abduction=0 point; Adduction=1 point

Anaesthesia was maintained with oxygen and nitrous oxide in a 1:1 ratio, along with isoflurane using a circle system. Intravenous atracurium was administered as a loading dose of 0.5 mg/kg, followed by maintenance doses of 0.1 mg/kg as required.

Patients were mechanically ventilated in volume-control mode, with ventilator settings adjusted to maintain end-tidal CO_2 ($EtCO_2$) between 35 and 45 mmHg. At the end of surgery, neuromuscular blockade was reversed using intravenous neostigmine (0.05 mg/kg) and glycopyrrolate (0.008 mg/kg), following which patients were extubated after regaining adequate spontaneous ventilation.

STATISTICAL ANALYSIS

Data analysis was performed using Statistical Package for the Social Sciences (SPSS) version 25.0. Numerical variables were presented as Mean±Standard Deviation (SD), while categorical variables were described using frequency and percentage. Sensitivity, specificity, PPV and NPV of the two scores were calculated for predicting difficult airways. Comparison between the two tests was done using McNemar's test. A p-value <0.05 was considered statistically significant, while p<0.001 was considered highly significant.

RESULTS

Demographic parameters are presented in [Table/Fig-3]. Patients were aged between 18 and 70 years, with a mean age of 40.47±12.14 years. Among the 120 participants, 58 (48.33%) were male and 62 (51.67%) were female. The mean weight was 70.53±13.76 kg (range: 45-92 kg). Sixty-six (55%) patients belonged to ASA Grade I, and 54 (45%) to ASA Grade II.

Variable		Value
Age (years)	Mean±SD	40.47±12.14
	Median (IQR)	38.0 (29.0-48.0)
	Range	18-70
Sex	Male, n (%)	58 (48.33%)
	Female, n (%)	62 (51.67%)
Weight (kg)	Mean±SD	70.53±13.76
	Median (IQR)	68.0 (61.0-78.0)
	Range	45-92
ASA grade	I	66 (55%)
	II	54 (45%)

[Table/Fig-3]: Demographic parameters.
(SD- Standard deviation, IQR- Inter Quartile Range, n=Number).

The actual incidence of difficult airway (IDS >5) was 11.67% (14/120). The Wilson's Score predicted a difficult airway in 8.33% (10/120) of patients, underestimating the true incidence. The IPS predicted a difficult airway in 10.00% (12/120) of patients, which more closely approximated the actual incidence but still represented a slight underestimation. This comparison indicated that both scoring systems had limited predictive accuracy, with IPS performing marginally better than the Wilson's Score [Table/Fig-4,5].

The diagnostic performance metrics of the Wilson's Score and IPS are shown in [Table/Fig-6]. IPS demonstrated significantly higher sensitivity, PPV, and overall accuracy compared to the Wilson's Score. Although IPS also showed higher specificity and NPV, these differences were not statistically significant.

Measure	Wilson's score	IPS
Easy intubation	110 (91.67%) (score<2)	108 (90%) (score 3-4)
Moderately difficult intubation	9 (7.5%) (score 3-7)	9 (7.5%) (score5-8)
Difficult intubation	1 (0.83%) (score ≥8)	3 (2.5%) (score 9-12)

[Table/Fig-4]: Percentage of predicted difficult intubation by Wilson's score and IPS.

Measure	Count (n)	Percentage
Easy Intubation (score=0)	98	81.66%
Slight difficult (score <5)	8	6.67%
Moderate to severe difficult (score >5)	14	11.67%

[Table/Fig-5]: Actual difficult airway by Intubation Difficulty Scale (IDS).

Metrics	Wilson's Score	IPS (95% Confidence interval)	p-value
TP- n (%)	3 (2.50%)	10 (8.33%)	-
TN-n (%)	99 (82.50%)	104 (86.67%)	-
FP-n (%)	7 (5.83%)	2 (1.67%)	-
FN-n (%)	11 (9.17%)	4 (3.33%)	-
Sensitivity (95% CI)	21.43% (7.57-47.59)	71.43% (45.35-88.28)	0.014*
Specificity (95% CI)	93.40% (86.99-96.76)	98.11% (93.38-99.48)	0.172
PPV (95% CI)	30.00% (10.78-60.32)	83.33% (55.20-95.30)	0.023*
NPV (95% CI)	90.00% (82.98-94.32)	96.30% (90.86-98.55)	0.057
Accuracy (95% CI)	85.00% (77.53-90.30)	95.00% (89.52-97.69)	0.012*

[Table/Fig-6]: Comparison between Wilson's score and IPS.
(TP: True positive; TN: True negative; FP: False positive; FN: False negative; PPV: Positive predictive value; NPV: Negative predictive value; n: Number; CI: Confidence interval) (McNemar's test)

IPS exhibited a markedly higher sensitivity, indicating that it identified a greater proportion of patients with actual difficult airways. Both scores demonstrated high specificity, reflecting their strong ability to correctly identify true negatives. The significantly higher PPV of IPS suggests that a positive IPS result was much more likely to correspond to a true difficult airway. Although the NPV was not significantly different between the two tests, both demonstrated a good ability to identify the absence of difficult airways. Overall, IPS showed significantly better accuracy, confirming its superior ability to correctly identify both difficult and non-difficult airways compared to the Wilson's Score.

DISCUSSION

This prospective observational study comparing the IPS and Wilson's Score for predicting difficult endotracheal intubation demonstrates that IPS significantly outperforms Wilson's Score across multiple diagnostic metrics. The actual incidence of difficult airway in present study was 11.67% (14/120), which aligns with the reported incidence of difficult airway in the Indian population, ranging from 3.3% to 14.4% [21-24]. These findings reveal that IPS achieved superior sensitivity (71.43% vs 21.43%, p-value=0.014), PPV (83.33% vs 30.00%, p-value=0.023), and overall accuracy (95.00% vs 85.00%, p-value=0.012) compared to Wilson's Score.

Wilson's Score Performance: The results of this study show that the sensitivity of Wilson's Score (21.43%) was consistent with previous studies reporting variable and often suboptimal performance. In a study by Mathew J and Gvalani SK, comparing the Wilson Score with the Mallampati classification and neck circumference-to-TMD ratio, the sensitivity of the Wilson Score was 25.8% [25]. Detsky ME et al., conducted a systematic review and reported a sensitivity of 43% (95% CI: 26%-62%) [26]. However, Hamid A et al., reported a much higher sensitivity of 84.44% (95% CI: 78.31%-89.41%), indicating significant variability across different populations and study designs [27]. The specificity (93.40%) observed in present study aligns well with the literature. A meta-analysis by Shiga T et al., demonstrated moderate to high specificity ranging from 82-97% [11]. Shelgaonkar VC et al., conducted a study predicting difficult intubation using the Mallampati and Wilson Scores correlated with the Cormack-Lehane grading and reported a specificity of 76.6% [28]. The PPV (30%) observed in present study corresponds with the findings of Vidhya S et al., who reported a PPV of 25.93%, and Shelgaonkar VC et al., who reported 32.25% [18,28].

The NPV (90%) of the Wilson Score in present study also coincides with previous reports. Domi R, found an NPV of 85%, and Kumar D et al., reported 98.3% [6,29]. The accuracy (85%) in present study was comparable with that reported by Vidhya S et al., (79.33%) and Hamid A et al., (85%) [18,27]. The poor sensitivity of the Wilson's Score in the current study, resulting in 11 false negatives (9.17%), highlights a critical limitation consistently reported in the literature. This high false-negative rate poses significant clinical risks, as patients with genuinely difficult airways may not receive appropriate preparation and resources for intubation.

Intubation Prediction Score (IPS) Performance: In this study, IPS demonstrated a sensitivity of 71.43%, specificity of 98.11%, PPV of 83.33%, NPV of 96.30%, and overall accuracy of 95.00%. These results are consistent with the findings of Vidhya S et al., who compared the Wilson's Score and IPS for predicting difficult airway in an eastern Indian population [18]. In their study, IPS demonstrated a sensitivity of 77.8%, specificity of 92.40%, NPV of 96.80%, and accuracy of 90.7%, although the PPV (58.3%) was lower. The difference in PPV may be attributed to variations in study population and sample size. Similar results were observed in the study by Tiwari A R et al., who evaluated the IPS for the assessment of difficult intubation. They reported a sensitivity of 78.6%, specificity of 63.2%, PPV of 30.6%, and NPV of 93.5% [30]. The discrepancies in specificity and PPV across studies might be due to differences in population characteristics and sample size.

Comparison between Wilson's score and Intubation Prediction Score (IPS): Upon comparison of the two multivariate indices, IPS was found to be superior in terms of sensitivity (71.43% vs 21.43%; p-value=0.014), PPV (83.33% vs 30.00%; p-value=0.023), and overall accuracy (95.00% vs 85.00%; p-value=0.012), with statistically significant differences. Although specificity and NPV were higher for IPS, the differences were not statistically significant (specificity: 98.11% vs 93.40%, p-value=0.172; NPV: 96.30% vs 90.00%, p-value=0.057). A similar comparison was performed by Vidhya S et al., who also concluded that IPS demonstrated better sensitivity, specificity, PPV, NPV, and accuracy compared to Wilson's Score [18].

The significantly higher sensitivity of IPS has profound clinical implications for patient safety. High sensitivity in airway assessment tools is crucial because failing to identify a potentially difficult airway can lead to catastrophic outcomes, including hypoxemia, aspiration, cardiovascular collapse, and even death [31]. The 50% improvement in sensitivity with IPS means that substantially more patients with genuinely difficult airways can be identified preoperatively, allowing for appropriate preparation such as ensuring the availability of difficult airway equipment, the presence of experienced personnel, consideration of awake fiberoptic intubation, and readiness for surgical airway intervention if needed. Both scoring systems demonstrated high specificity (IPS: 98.11%, Wilson's Score: 93.40%), which is important for avoiding unnecessary resource utilisation and patient anxiety. High specificity ensures that patients with normal airways are not subjected to unnecessary complex airway management procedures. The slightly superior specificity of IPS, combined with its markedly higher sensitivity, makes it a more balanced and clinically useful tool. The superior PPV of IPS (83.33% vs 30.00%) is particularly valuable in clinical decision-making. When IPS predicts a difficult airway, clinicians can have greater confidence in this assessment and prepare accordingly. Conversely, the NPV of 96.30% for IPS provides reassurance that when the score suggests an easy airway, this is likely to be accurate in the vast majority of cases.

Limitation(s)

The results of this study may not be generalisable to other populations or healthcare settings, as it was conducted at a single centre. Furthermore, different studies use varying definitions of difficult intubation, making direct comparisons challenging. The exclusion criteria may also have eliminated some high-risk patients, potentially affecting the true incidence of difficult airways in the general population.

CONCLUSION(S)

This study demonstrated that the IPS significantly outperforms Wilson's Score in predicting difficult endotracheal intubation, with superior sensitivity, PPV, and overall accuracy. The improved sensitivity of IPS has important implications for patient safety, as it identifies a substantially higher proportion of patients with genuinely difficult airways. While both scoring systems showed good specificity, the balanced performance of IPS makes it a more clinically useful tool for routine airway assessment. These findings support the adoption of IPS in clinical practice; however, further multicentre validation studies are warranted to confirm its generalisability across diverse patient populations. Clinicians should remember that no single assessment tool is perfect, and sound clinical judgment, combined with appropriate preparation for difficult airway management, remains paramount to ensuring patient safety during endotracheal intubation..

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