

# Comparison of sensitivity, specificity, and accuracy of Wilson's score and intubation prediction score for prediction of difficult airway in an eastern Indian population—A prospective single-blind study

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## ABSTRACT

**Introduction:** Unidentified difficult airway leads to significant adverse events and therefore prediction of a difficult airway is of importance. Independent bedside tests for the prediction of a difficult airway have poor accuracy. The airway assessment scores have not gained popularity as they are cumbersome to perform at the bedside. They also have a varying degree of interobserver variability because of their subjective parameters. Therefore, there is a need to search for a simple score with objective parameters that can be performed at the bedside. **Aim:** To determine the diagnostic accuracy of the Wilson score and Intubation prediction score for predicting difficult airway in the Eastern Indian population. **Material and Method:** A prospective single-blind study was done including 150 consecutive patients, ASA grade I and II between the ages of 18 and 70 years, undergoing surgery requiring general anesthesia with endotracheal intubation. Preoperatively, the airway was assessed in all patients using Wilson Score and Intubation Prediction Score. General anesthesia with endotracheal intubation was done in all patients. The airway was assessed for ease laryngoscopy and intubation using the Intubation Difficulty Scale. An IDS >5 was taken as difficult airway. The sensitivity, specificity, PPV, NPV, and accuracy of the two predictive tests to predict a difficult airway was calculated. **Results:** The sensitivity, positive predictive value and accuracy of Intubation Prediction Score was 77.8%, 58.3% and 90.7% respectively as compared to 38.9%, 25.95% and 78.33% respectively of Wilson's score. **Conclusion:** Intubation Prediction score with its objective parameters can be preferred as a simple and accurate bedside test to predict a difficult airway in an Eastern Indian population.

**Keywords:** Difficult airway, intubation difficulty scale, intubation prediction score, sensitivity, specificity, Wilson's score

## Clinical Significance

Assessment of airway for predicting difficult laryngoscopy and intubation is important for primary care physician in order to avoid catastrophic airway related accidents.

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## Introduction

Laryngoscopy and intubation is the most important manoeuvre in the practice of anaesthesiology. An ASA closed claim study has reported 17 percent adverse respiratory events occurring due to difficult intubation and 85 percent of these cases either died or suffered brain damage.<sup>[1]</sup> Apart from this several morbid nonfatal events have also been reported during laryngoscopy and intubation. Therefore, predicting a difficult

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airway is an important step during a pre-anaesthetic check-up at the bedside.

Several independent bedside tests have been described to predict a difficult airway. This include Mallampatti Samson Young classification,<sup>[2,3]</sup> Sternomental distance,<sup>[4]</sup> Upper-lip bite test,<sup>[5]</sup> mouth opening etc., But none of the independent tests have been able to predict the difficult airway with consistent accuracy.<sup>[6]</sup> A recent Cochrane review concluded that none of the common bedside screening tests were well suited for detecting unanticipated difficult airway.<sup>[7]</sup> Several scores, which are a combination of the independent tests, have been described to assess the airway. But the scores have not gained popularity as bedside tests because they have been perceived to be cumbersome to perform at the bedside. Also, studies have proved that there is varying degree of inter-observer variability in pre-operative airway tests.

Therefore, search continues for a simple score with objective parameters which will adequately predict a difficult airway with consistency and accuracy. The Wilson score<sup>[8]</sup> is one such score which has gained some popularity. However, it has many subjective parameters. The Intubation Prediction score<sup>[9,10]</sup> is easy to perform at bedside and its parameters are objective.

## Aim

To determine the diagnostic accuracy of Wilson score and Intubation prediction score for predicting difficult airway in Eastern Indian population.

## Methodology

A prospective single blind study was done including 150 consecutive patients, ASA grade I and II between ages of 18-70 years, undergoing surgery requiring general anaesthesia with endotracheal intubation. The study was conducted at Tata main Hospital, Jamshedpur between November 2016 and October 2017. Patients with unstable cervical spine, patients with gross abnormality of head and neck and patients undergoing emergency surgery were excluded from the surgery. Ethical approval from institutional ethical committee and informed consent of all the patients included in the study was taken, date of approval 12.01.17. A thorough pre- anaesthesia check-up including weight and height and the requisite investigations was done for all patients. The airway was examined for predicting a difficult airway using Wilson's Score and Intubation Prediction Score by an anaesthesiologist not involved in the study. The following parameters were measured.

### Head and neck movement

To measure this patient was asked to fully extend the head and neck while a pencil was placed vertically on the forehead. The orientation of the pencil was adjusted so that it was parallel to a distant window frame. Then while the pencil was held firmly in position, the head and neck was fully flexed and the pencil was

sighted against the horizontal of the window frame to judge if it had moved through 90 degree.

### Mouth opening (Inter incisor gap)

To measure mouth opening, each patient maximally opened his/her mouth and the distance between the upper and lower incisors was measured. In the edentulous patient the distance between upper and lower gingiva was measured.

### Subluxation of the mandible

For subluxation of the mandible, the patient protruded the lower incisors as forward as possible. This assessment was ranked depending upon the amount of anterior mandibular movement; grade 1 if the lower incisors were anterior to the upper incisors; grade 2 if the lower incisors were equal to the upper incisors; and grade 3 if the lower incisors failed to reach the upper incisors and remain posterior.

### Receding mandible

The severity of receding mandible was estimated on subjective three-point scale (0 = normal; 1 = moderate; 2 = severe).

### Buck teeth

The severity of buck teeth (long upper incisors) was also estimated on a subjective three-point scale (0 = normal, 1 = moderate, 2 = severe).

### Mallampatti test

The patient was asked to open his/her mouth and protrude the tongue maximally while in the sitting posture.

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

Grade 2: soft palate, fauces, uvula (2 points); Grade 3: soft palate, base of uvula (3 points);

Grade 4: soft palate not visible at all (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. Grade 1: AOJE  $\geq 35^\circ$  (1 point);

Grade 2: AOJE  $\geq 22^\circ$  and  $< 35^\circ$  (2 points); Grade 3: AOJE  $\geq 13^\circ$  and  $< 22^\circ$  (3 points);

Grade 4: AOJE  $< 13^\circ$  (4 points)

### Mandibular space

It includes the thyromental distance (TMD) and the horizontal length of the mandible (LM). To measure the thyromental distance each patient was asked to extend his/her head and neck

as far as possible with mouth closed. The straight distance from the inside of the mentum to the thyroid notch was measured. Horizontal length of the mandible was measured from angle of the mandible to the mentum.

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).

The examination parameters were computed into the 2 scores i.e. the Wilson's score [Table 1] and the intubation prediction score [Table 2].

### Anaesthesia Technique

After shifting the patient to the operative room, standard monitors were attached which included ECG, Pulse oximeter, and NIBP and the baseline parameters were recorded. The patients IV access was secured with an IV cannula 18G under aseptic precautions and 0.9% Normal Saline was started. Patient was prooxygenated

with 100% oxygen with a Bain's circuit for 5 minutes. Anaesthesia was induced with Fentanyl 2 µgm/kg IV and Propofol 2.5 mg/kg IV slowly over 30 seconds. After confirming loss of response to verbal commands, Vecuronium 0.1 mg/kg IV was given to facilitate intubation. Laryngoscopy was done with Macintosh blade size 3 or 4 after 3 minutes by a single anaesthesiologist with more than 5 years' experience in anaesthesiology. Patients were intubated with appropriate sized cuffed endotracheal tube. After laryngoscopy, the Anaesthetist marked the impression of the view of larynx exposed, on a diagram of the glottis in the Proforma. The other parameters of the intubation difficulty scale were also marked by the intubating anaesthesiologist. Any patient whose trachea could not be intubated was removed from the study (failed intubation). Anaesthesia was maintained with isoflurane 0.5-1% in 50:50 mixture of oxygen and nitrous oxide. After the completion of surgical procedure, the muscle relaxant was reversed with neostigmine (0.5 mg/kg) and glycopyrrolate (0.08 mg/kg). After reversal, the patient was extubated and shifted to recovery room for postoperative monitoring.

### Observations

1. Demographic parameters
1. Wilson score
2. Intubation Prediction score
- 3 Laryngeal view according to Cormack Lehane grading
4. Intubation Difficulty Scale [Table 3],

#### Cormack Lehane Grading

- Grade 1 – Most of glottic opening is seen.
- Grade 2- Posterior portion of the glottis and arytenoid cartilages are visible.
- Grade 3 – Only epiglottis but no portion of the glottis is visible
- Grade 4 – neither glottis nor epiglottis can be seen

#### Sample size calculation

The sample size was calculated after a pilot study on 30 consecutive patients fulfilling the required eligibility criteria. The incidence of actual difficult airway came to be 10% by using Intubation difficulty scale (IDS > 5). Taking the α (alpha) error at 0.05 and desired power of study as 80% the sample size needed was calculated using following formula. The actual sample size came out to be 138.24. Therefore, total number of patients included in the study were 150 to compensate for dropouts and failed intubation [Figure 1].

$$Sample\ size = \frac{Z^1_{2-\alpha/2} p(1-p)}{d^2}$$

#### Statistical methods

All statistical calculations were done using 'Medcalc' version 19.0.3. Numerical data were expressed as mean and standard deviation and categorical data were expressed as percentages. Sensitivity specificity positive predictive value and negative predictive value of the two scores were calculated in predicting a difficult airway.

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

Parameter	Grade	Score
1. Mallampati Test	1	1
	2	2
	3	3
	4	4
2. Atlanto-Occipital Joint Extension	1	1
	2	2
	3	3
	4	4
3. Mandibular Space	1	1
	2	2
	3	3
	4	4
Grade 1: (3-4 points); easy intubation predicted	Grade 2: (5-8 points); moderately difficult intubation predicted	Grade 3: (9-12 points); difficult intubation predicted

## Results

Demographic parameters are as in Table 4. The percentage of predicted difficult airway was 18% by Wilson's score and 16% by Intubation prediction score. The percentage of the actual difficult airway was 12% (IDS >5).

Table 4: This table represents the demographic profile of the patients included in the study.

Out of total 18 patients who had difficult intubation (IDS >5), Wilson's score had predicted easy intubation in 11 patients (false negative) and 7 patients had predicted difficult intubation (True positive) whereas, only 4 patients (False negative) were predicted to have easy intubation and 14 patients (True positive) were predicted to have difficult intubation by Intubation prediction score. This was statistically significant ( $P < 0.05$ ) (Chi-square test).

The number of false negatives (i.e. patients who were predicted to have an easy intubation but turned out to be difficult intubation) was higher with Wilson's score as compared to the Intubation Prediction Score. (61.1% vs 22.2%, 11 vs 4). ( $P < 0.001$ ).

The ability to predict a difficult airway accurately (i.e. sensitivity) was also higher with Intubation Prediction Score.

Table 5: represents the Total no. and percentage of patients predicted to have a difficult airway by Wilson's score and Intubation Prediction score. Out of 150 patients Wilson's score predicted 18% (27) patients had difficult airway whereas in the same group of patients IPS Predicted 16% (24) of patients had difficult airway.

Table 6 represents the percentage of easy intubation, slight difficult and moderate to severe difficult intubation recorded on the parameters of Intubation difficulty scale. 12% (18) of patients in this study had an Intubation Difficulty Scale of >5 that is moderate to severe difficult intubation. (Actual Difficult Intubation).

The Intubation prediction score had a better sensitivity, specificity, negative and positive predictive value as compared to Wilson's score [Figure 2].

## Discussion

This study was designed to compare the sensitivity, specificity, PPV, NPV and accuracy of Wilson's score and Intubation Prediction Score. The results of the study showed that the Intubation Prediction Score had a better sensitivity, specificity, PPV, NPV and Accuracy as compared to the Wilson's Score in predicting a difficult airway.

There are several tests to predict a difficult airway. These include single independent bedside tests as well as group indices. The single tests which are most frequently used as predictors of

difficult airway are Modified Malampatti Score,<sup>[2,3]</sup> upper lip bite test,<sup>[5]</sup> Thyromental distance,<sup>[12]</sup> sternomental distance,<sup>[5]</sup> neck circumference, neck length<sup>[13]</sup> etc., The group indices include Wilson's Score,<sup>[8]</sup> Arnie Score,<sup>[14]</sup> El Ghanzouri 7 parameter score,<sup>[6]</sup> Naguib Score,<sup>[15]</sup> Intubation Prediction Score<sup>[9-10]</sup> etc., Several studies have found that the independent bedside tests have poor discriminative power when used alone as compared to the combination of tests<sup>[16,17]</sup> and have recommended that a combination of tests should be used to predict a difficult airway.<sup>[18]</sup>

**Table 3: Intubation difficulty Scale<sup>[11]</sup>**

Score	Description
N1	The number of supplementary attempts, an attempt defined as one advancement of the tube in the direction of glottis during direct laryngoscopy or one like advancement of the tube in case of blind intubation trial.
N2	The number of supplementary operators, it represented the number of additional persons directly attempting intubation
N3	The number of alternative techniques used
N4	Glottic exposure as defined by the Cormack Lehane grade minus one; grade I (N4=0) on this scale corresponded to complete visualization of the vocal cords, grade II (N4=1) to visualization of the inferior portion of the glottis, grade III (N4=2) to visualization of only the epiglottis and grade IV (N4=3) to a non-visualized epiglottis
N5	The lifting force applied during laryngoscopy; N5=0 if little effort was necessary and N5=1 if subjectively increased lifting force was necessary
N6	The necessity of applied external laryngeal pressure to optimized the glottis exposure; N6=0 if no external pressure was applied. N6=1 if external laryngeal pressure was necessary
N7	Position of the vocal cords; N7=0 if vocal cords were in abduction and N7=1 if vocal cords were in adduction, presenting an impediment to tube passage
IDS Score 0=Easy	
IDS Score less than 5=Slight difficulty	
IDS Score more than 5=Moderate to major difficulty	
Difficult airway – IDS>5	

**Table 4: Demographic parameters**

Parameters	Mean +/- S.D	Range and %
Age in yrs.	49.81±13.34	18-70
Weight in Kg	64.70±14.99	40-112
Sex (F: M)	99:51	66.0%:34.0%
ASA (I: II)	35:115	23.3%:76.7%

**Table 5: % of Predicted difficult airway**

Score	Frequency	%
Wilson's Score	27.0	18%
IPS	24.0	16%

**Table 6: % Actual difficult airway**

IDS	Frequency	%
Easy (Score=0)	51	34.0%
Slight Difficult (Score <5)	81	54.0%
Moderate Severe (Score >5)	18	12.0%

The group indices have never gained popularity as bedside tests as they have many parameters and are cumbersome to perform at bedside.<sup>[6,14,15]</sup> Some of them also have radiological parameters and therefore cannot be used as bedside tests.<sup>[15]</sup> Of the group indices, the Wilson score is simple and easy to perform at bedside. But its parameters are subjective and are likely to be affected by some degree of inter-observer variability.<sup>[19]</sup> Therefore, there is the need to search for a simple score with objective parameters and lesser degree of interobserver variability which is easy to perform at bedside. The Intubation Prediction Score is one such Score and therefore we chose to compare this score with Wilson's Score for predicting a difficult airway.

The incidence of difficult airway in this study was 12% in this study. The reported incidence of difficult airway in Indian population ranges from 3.3% to 14.4%.<sup>[17,18,20,21]</sup> This is nearly the same as that of Dhanger *et al.*<sup>[18]</sup> and Basuniya Sandip *et al.*<sup>[17]</sup> who reported an incidence of 13% and 13.3% respectively. While IDS >5 was used as the diagnostic criteria in the present study and by Dhanger *et al.*, Basuniya Sandip *et al.* used the Cormack Lehane grading and the ease of intubation score as the diagnostic criteria. The IDS<sup>[8]</sup> offers an advantage because a single score can be used to evaluate both laryngoscopy and intubation parameters.

Several studies have evaluated the sensitivity of the Wilson's score in predicting a difficult airway. It ranged from 40% to 42% which was like the sensitivity in the present study. Naguib *et al.* found that the sensitivity of Wilson's score for predicting a difficult airway was less than Arnie's and Naguib's score. However, these scores are cumbersome to use as bedside tests as they either have too many parameters or require radiological assistance. In our study, we found the Intubation Prediction Score to have a better sensitivity and specificity as compared to the Wilson's Score.

The ideal test for predicting a difficult airway would be one with a high sensitivity and a high specificity. However, for difficult airway prediction sensitivity of the test i.e. its ability to accurately predict the true positives, is most important. This allows the anaesthesiologist to plan for securing the airway safely and to avoid any serious outcomes of unanticipated airway related catastrophe.<sup>[17,21]</sup>

### Conclusion

This study was undertaken with the aim to compare the Wilson score and Intubation prediction score for the assessment of difficult airway in Eastern Indian population. Intubation prediction score has better Sensitivity, Specificity, Positive predictive value, Negative predictive value and accuracy as compared to Wilson's score. Intubation Prediction score with its objective parameters can be preferred as a simple and accurate bedside test to predict a difficult airway in an Eastern Indian population

### Clinical Significance

The Intubation Prediction Score is a simple tool which can be used by primary care physicians at the bedside in order to detect a difficult airway. This will enable the primary care physician to make all necessary preparations to avoid a catastrophic airway associated event and also to make referrals to higher centres whenever required.

### Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have

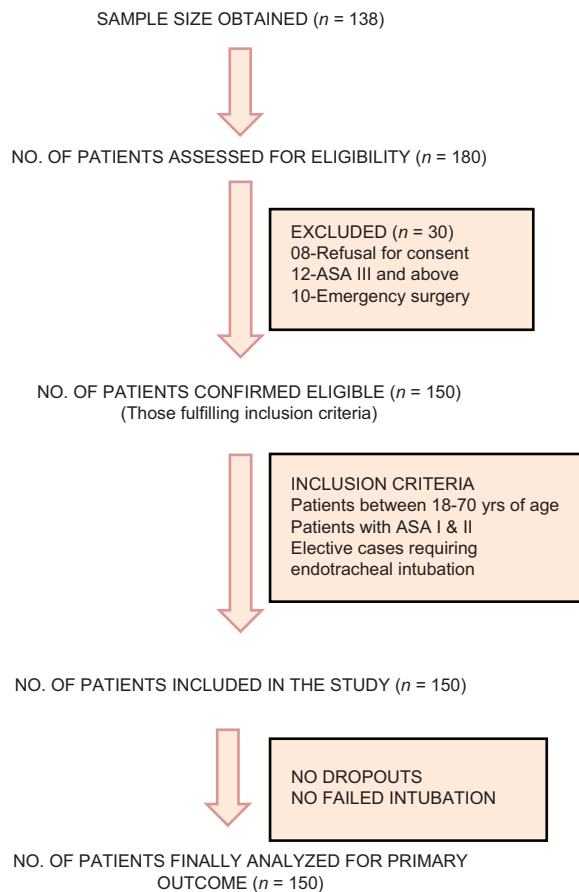


Figure 1: Participant flow diagram

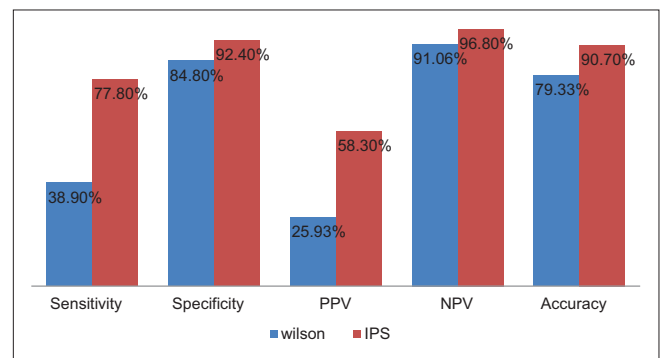


Figure 2: Represents the comparative, sensitivity, specificity, positive predictive value, negative predictive value and accuracy of Wilson's and Intubation prediction score. In this study IPS had a better sensitivity, specificity, NPV, PPV and Accuracy

given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

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