ORIGINAL ARTICLE

Evaluation of MACOCHA Score for Predicting Difficult Intubation in Critically Ill Cancer Patients: A Prospective Observational Study

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Abstract

Introduction: Tracheal intubation (TI) is often needed in the intensive care unit (ICU) but can have disastrous consequences. The MACOCHA score was developed for prediction of difficult intubation (DI) in critically ill.

Material and methods: After Institutional Ethics Committee approval, we conducted this prospective, single-center observational study. Evaluated the ability of MACOCHA score to predict difficult intubation in our ICU. We included 500 adults undergoing TI in our ICU. We collected the demographic data, details of ICU admission, and intubation-related data for calculating MACOCHA score. We used Statistical Package for the Social Sciences (version 21) for analysis. The accuracy of MACOCHA score for predicting DI was determined by area under the receiver operating characteristic (AUROC) curve. The Hosmer–Lemeshow goodness-of-fit statistics was used to determine calibration.

Results: Since complete dataset was available for 449/500 patients, we analyzed their data. Acute renal failure and shock were the most frequent reasons for TI. Ketamine and rocuronium were most commonly used drugs for TI. The incidence of DI was 13.5% (60/449). There were 30 patients whose Mallampati score was either III and IV, while 84 and 45 patients had severe hypoxemia and coma before TI, respectively. The AUROC curve for the MACOCHA score was 0.659 (confidence interval, 0.574–0.743), suggesting a moderate discrimination. The Hosmer–Lemeshow goodness-of-fit test showed moderate calibration ($\chi^2 = 3.142$, with $p = 0.208$). One hundred and seventy-one (26.5%) complications occurred in the entire cohort. Some patients had multiple complications.

Conclusion: The MACOCHA score showed moderate discrimination and calibration in predicting DI in our study.

Keywords: Critically ill patients, Difficult intubation, Hypoxia, MACOCHA score, Severe cardiovascular collapse.

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Highlights

- In this large cohort study of critically ill cancer patients, utility of the entire MACOCHA score for predicting difficult intubation showed moderate discriminative ability and calibration.
- The incidence of peri-intubation complications was much lower in our study. Importantly, severe cardiovascular collapse and severe hypoxia incidence were much lower.

Introduction

Tracheal intubation (TI) is frequently required in the critically ill, for initiating mechanical ventilation, protecting the airway and for tracheobronchial toilet. Although a simple procedure in healthy patients, TI can have disastrous consequences in the critically ill, such as severe hypoxemia, cardiovascular collapse, cardiac arrest, and death.[1,2] Tracheal intubation in critically ill differs in many ways from the TI performed in the operating rooms, but mainly in that the patients undergoing elective surgeries are healthier and fully optimized, as compared with the critically ill.[3] Critically ill patients may have anatomically challenging airway and many certainly have physiologically difficult airway.[4] The NAP4 audit found that 25% of complications related to airway management occurred outside the operating room, i.e., in the emergency department (ED) and intensive care units (ICUs).[5] In the ICUs, the junior staff may be from different disciplines, many from nonanesthesiology background. During emergency TIs in ICUs, the junior staff is often unsupervised. It is to be expected, therefore, that TI in the critically ill may lead to many complications. Airway assessment to predict likely difficult laryngoscopy and/or TI allows adequate preparation, planning, and enables us to arrange for presence of experienced assistance in advance, to prevent adverse events. A detailed airway

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assessment performed by anesthetists for elective surgeries is elaborate and time consuming, and is not practical in the critically ill, due to need for urgent TI. However, a known difficult airway can be managed better than when being caught unprepared. De Jong et al. described the MACOCHA score, a simple, pragmatic score which incorporates parameters that are easily and quickly obtained at the bedside.[6] In their study, MACOCHA score had a high negative predictive value (NPV) (98%), and acceptable sensitivity (73%) and specificity (89%), though a low positive predictive value (PPV) (36%). This score has not been validated externally in its entirety (i.e., the full score including all parameters) in the critically ill. We, therefore, decided to evaluate the utility of MACOCHA score for predicting difficult intubation (DI) in our ICUs in premier cancer institute.

Material and Methods

This prospective, observational, single-center study was conducted after obtaining Institutional Ethics Committee (IEC) approval (IEC/0414/1298/001) and Clinical Trials Registry (CTRI) registration (CTRI/2017/09/009950). The IEC waived off the need for consent. We had decided to include 500 critically ill cancer patients (age > 18 years), whose trachea was intubated during their ICU stay. This was because, after development of the MACOCHA score, in the study by Jaber et al., the validation cohort size was 400 patients. Our 23-bedded ICU is manned by eight residents, from varying backgrounds, though majority are DM critical care trainees and anesthetic senior residents, round the clock, with two senior intensivists, who are present during the day and are available during night for consult. We excluded pregnant patients and those patients in whom intubation was required during cardiopulmonary resuscitation. We collected the demographic data, details of ICU admission, presence of comorbidities such as, chronic obstructive pulmonary disease (COPD), cancer therapy, metastatic cancer, hematologic cancer, diabetes mellitus, heart failure NYHA III and IV, chronic renal failure, human immunodeficiency virus (HIV) infection, cirrhosis, immunosuppression and steroid therapy, and others if any.

We recorded the APACHE II score in first 24 hours, indications for and details of TI. History of previous documented DI, if present, was noted. In all patients, electrocardiogram, pulse oximetry, and automated noninvasive blood pressure (or invasive blood pressure) were monitored continuously. The standard unit protocol was followed for TI during the study. This consists of fluid loading or vasopressor infusion if needed, preoxygenation with bag and mask or noninvasive ventilation (NIV) in the form of pressure support ventilation or high-flow nasal cannula (depending on the oxygenation status of the patient), presence of two operators, modified rapid sequence induction and intubation, and confirmation of TI with capnography. We recorded the number of attempts at laryngoscopy and TI. We recorded other details related to TI, such as need for use of nasal or oral airways for mask ventilation, other airway adjuncts, need for use of external laryngeal manipulation, indication for intubation, method of preoxygenation, and drugs (induction and neuromuscular blocking agents) used. We also noted the use of and need to release the Sellick maneuver, need for Backward, Upward, Rightward Pressure maneuver, use of stylet and bougie. The MACOCHA score was calculated before intubation for all patients from the combination of the Mallampati score, mouth opening (≥3 cm), reduced mobility of cervical spine, obstructive sleep apnea syndrome history, presence of coma (Glasgow Coma Scale score < 8) or severe hypoxia ($SpO_2 \leq 80\%$), and the specialty of person performing TI. The major complications occurring during and immediately after TI were recorded. Major complications we recorded were: severe hypoxemia (lowest $SpO_2 < 80\%$, or drop in saturation > 10%, when SpO_2 was already <90%), severe cardiovascular collapse (systolic blood pressure (SBP) < 65 mm Hg at least once or <90 mm Hg prolonged 30 minutes despite infusion of 500–1,000 mL of crystalloids, or fall in SBP > 20% if it was above 65 mm Hg before TI, or need to add vasopressors or increase in ongoing vasopressor by >30%, cardiac arrest, and death during or immediately following TI). We used the definition of difficult airway as described by American Society of Anesthesiologists, in 2022 (see Supplement 1), number of attempts at laryngoscopy ≥ 2, or at intubation ≥ 2 or difficult mask ventilation.[7]

Statistics

Our initial convenience sample size was 500 patients. The data was recorded in Microsoft Excel and later Statistical Package for the Social Sciences software version 21 (SPSS-21; IBM, Chicago, USA) was used for statistical analysis. We present the data here as mean [±standard deviation (SD)], when indicated. The *p*-value of less than 0.05 was considered as statistically significant. The ability and accuracy of the MACOCHA score for predicting DI was determined by plotting the area under the receiver operating characteristic (AUROC) curve. The Hosmer–Lemeshow goodness-of-fit statistics was used to determine calibration.

Results

In this prospective study was conducted over a period of 16 months. Though we had decided on a convenience sample of 500 patients, complete dataset was available for 449 patients and we, therefore, analyzed their data. The mean (±SD) age of patients was 51 (±14.31) years, the mean (±SD) APACHE II score was 16.49 (±3.45). Commonest comorbidities were diabetes, hypertension, and cancer therapy, and the commonest reasons for ICU admission were severe sepsis/septic shock and pneumonia (Table 1). Acute respiratory failure requiring invasive mechanical ventilation and shock were the most frequent reasons for TI (Table 2). One hundred and sixty patients were receiving vasopressor infusion at the time of TI. Most intubation procedures (342) were supervised, and ketamine was the most commonly used induction agent. While 184 TIs were performed without a muscle relaxant, rocuronium was the most commonly used muscle relaxant in the remaining patients.

External laryngeal manipulation to improve glottic view was needed in 125 patients, while bougie or stylet was used for TI in 160 patients (Table 3). The incidence of DI was 13.5% (60/449). In 33 instances, TI was performed by nonanesthesiologists. There were 30 patients whose Mallampati score was either III and IV, while 84 and 45 patients had severe hypoxemia and coma before TI, respectively (Table 4 and Fig. 1).

One hundred and seventy-one (26.5%) complications occurred in the entire cohort. Some patients suffered more than one complication. Sixty-one patients had severe cardiovascular collapse in the peri-intubation period, while 8 patients died within 24 hours of intubation. Nineteen patients had severe hypoxemia during TI (Table 5).

Figure 2 shows the ROC for the MACOCHA score for our study. The AUROC was 0.659 (confidence interval (CI), 0.574–0.743) suggesting a moderate discrimination. The Hosmer–Lemeshow goodness-of-fit test showed moderate calibration ($\chi^2 = 3.142$, with $p = 0.208$). The MACOCHA score showed sensitivity of 98.5%, specificity of 20%, PPV of 66.7%, and NPV of 88.9%.

Table 1: Demographics, comorbidities, and ICU admission diagnosis ($N = 449$)

Demographics	
Age (years)	51 ± 14.31
M:F	253:196
Weight (kg, mean ± SD)	53 ± 20.89
Height (cm, mean ± SD)	158 ± 17.68
APACHE II score (mean ± SD)	16.49 ± 3.45
Comorbidities	
Diabetes mellitus	131
Hypertension	111
Cancer therapy	140
Metastatic cancer	41
Hematologic cancer	35
COPD	20
Heart failure NYHA III and IV	6
HIV infection	4
Chronic renal failure	4
Cirrhosis	9
ICU admission diagnosis	*No. of patients*
Severe sepsis and septic shock	133
Pneumonia	112
Cardiac failure	32
Enterocolitis	38
Neutropenia	40
Dyselectrolytemia	62
Others	32

Table 2: Indications for intubation

Indications	*No. of patients (N = 449)*
Invasive mechanical ventilation for ARF	256
Shock	112
Coma	61
Others	20

ARF, acute respiratory failure; Of the 449 TIs, 20 were reintubations

On analyzing for predictors of DI, we found that the supervision by consultant ($p = 0.045$) and need for use of stylet ($p = 0.026$) were significant on univariate analysis but not on multivariate analysis. On multivariate analysis, only need for use of stylet (odds ratio (OR) = 3.594, 95% CI: 1.165–11.086, $p = 0.028$) was found to be significant (Table 6).

Discussion

In this prospective observational study, we found that the MACOCHA score had moderate discriminative ability to predict DI in critically ill patients, with good sensitivity and NPV. However, we found that its MACOCHA score had poor calibration.

In comparison, De Jong et al., found good discrimination (AUROC 0.89; 95% CI, 0.85–0.94) and calibration in their development cohort (1,000 patients) of MACOCHA score, where the incidence of DI was 11.3%.[6] In the validation cohort (400 patients), where the incidence

Table 3: Intubation details ($N = 449$)

Preoxygenation technique	*n (%)*
Noninvasive ventilation*	210 (46.77)
With O_2 mask	239 (53.22)
Drugs used for hypnosis/induction	*n (%)*
Ketamine	388 (86.41)
Etomidate	11 (2.44)
Fentanyl + midazolam	50 (11.13)
Muscle relaxants used for TI	*n (%)*
Suxamethonium	87 (19.37)
Rocuronium	143 (31.84)
Vecuronium	35 (7.79)
None	184 (40.97)
Adjuncts used for intubation	*n (%)*
Stylet	106 (23.6)
Bougie	54 (12.02)
External laryngeal manipulation (BURP)	125 (27.83)
Others	
Supervised	342 (76.17)
Unsupervised	107 (23.83)
Sellick's maneuver	160 (35.63)
Vasopressors infusion ongoing at the time of intubation	168 (37.41)
Difficult intubations	60 (13.36)
No. of attempts at laryngoscopy[$]	*n (%)*
One	355 (79.06)
Two	40 (8.9)
Three	26 (5.79)
Four	12 (2.67)
No. of attempts at intubation[$]	*n (%)*
One	352 (78.39)
Two	56 (12.47)
Three	19 (4.23)
Four	3 (0.66)
Difficult mask ventilation[$]	6 (1.33)

BURP, backward upward rightward pressure; *As per unit protocol, FiO_2 1.0, positive end-expiratory pressure 5 cm H_2O, and pressure support ventilation 5–10 cm H_2O, to obtain a tidal volume of 6 mL/kg predicted body weight; [$]One patient may have more than one attempt at laryngoscopy as well as intubation

Table 4: The MACOCHA score components

Component factors (points assigned)	*No. of patients (%)*
Factors related to patient	
Mallampati score III and IV (5)	30 (6.6)
Obstructive sleep apnea syndrome (2)	18 (4)
Reduced mobility of cervical spine (1)	13 (2.8)
Mouth opening < 3 cm (1)	30 (6.6)
Factors related to pathology	
Coma (1)	45 (10.02)
Severe hypoxemia (1)	84 (18.7)
Factors related to operator	
Nonanesthesiologists (1)	25 (5.56)

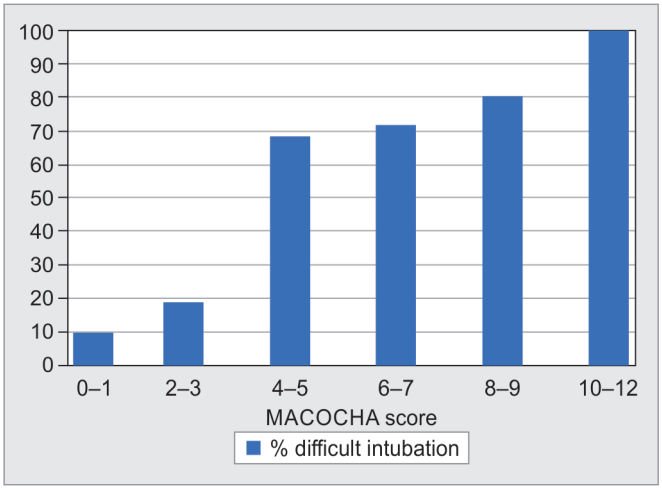

Fig. 1: The MACOCHA score and incidence of DI

Table 5: Immediate peri-intubation complications

Complications	*No. of patients (N = 449), n (%)*
Severe cardiovascular collapse	61 (13.6)
Cardiac arrest	11 (2.4)
Death	8 (1.7)
Severe hypoxemia	19 (4.2)
Esophageal intubation	4 (0.8)
Aspiration of gastric content	9 (2)
Arrhythmias	3 (0.6)
Dangerous agitation	3 (0.6)
Airway injury	2 (0.4)

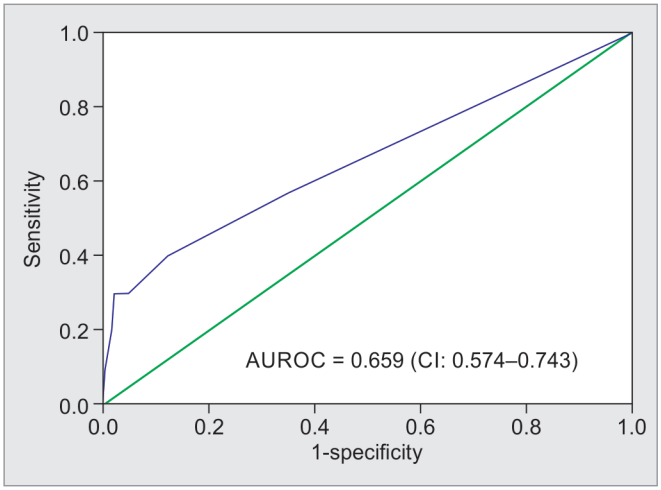

Fig. 2: The ROC curve for MACOCHA score

of DI was 8%, the AUROC for the score was 0.86 (95% CI: 0.76–0.96). The sensitivity was 73%, while the specificity was 89%. They found high NPV of 98%, but quite low PPV (38%).[6]

The MACOCHA score has not been validated extensively; in fact, only one study has attempted to validate this score in the critically ill.[8] Luedike et al. used a truncated MACOCHA score to assess performance of nonanesthesiology trainees while intubating patients ($n = 134$) in their medical ICU. The score was truncated to 9 (instead of 12) due to the following reasons: all operators were nonanesthesiologist trainees; Mallampati score was collected, but not mouth opening in centimeters; and cervical spine mobility was not assessed. They found that at a MACOCHA score > 8 (13 patients in their cohort met this criteria), TI failed at the hands of their nonanesthesiology trainees. Of the total 134 TIs, in 47 (35.1%) patients TI required either more than three attempts, senior physician support, larynx tube, fiberoptic endotracheal tube, anesthesia support, or ENT support. In our study, the incidence of difficult TI was 13.1%. There were no failed intubations, and none of our patient required creation of surgical airway. The incidence of difficult TI in critically ill patients ranges from 8 to 20%.

Table 6: Univariate and multivariate analyses for the predictors of difficult intubation

Variable	*Odds ratio*	*95% CI*	*p*
Univariate analysis			
Obstructive sleep apnea syndrome	0.803	0.186–3.70	0.807
Reduced cervical spine mobility	0.87	0.84–0.903	0.166
Coma before TI	0.454	0.136–1.51	0.189
Severe hypoxia before intubation	0.920	0.443–1.9	0.822
Mallampati score III and IV	0.649	0.247–1.70	0.912
Supervision by consultant	1.387	0.586–3.281	0.045*
Use of muscle relaxant	1.311	0.72–2.31	0.351
Need for use of stylet	1.92	1.07–3.44	0.026*
Multivariate analysis			
Use of bougie	0.649	0.247–1.70	0.376
Need for use of stylet	3.594	1.165–11.086	0.028*

*Statistically significant

The difficulty in intubation and resultant complications can be attributed to various factors – anatomy of the airway, patient's physiological status at the time of TI, urgency in securing the airway and operator background, operator experience, and thereby skills. Patient factors such as limited mouth opening, reduced intraoral space, and various other anatomical factors are known to reduce the ability to expose the glottis completely on direct laryngoscopy.

In our opinion, the most important reason for the MACOCHA score not being useful in our study for predicting DI is as follows. The tests for assessing the airway for possible difficulty in laryngoscopy and TI try to assess the following components: the ability to position patient, adequacy of mouth opening, likelihood of being able to align oro-pharyngo-tracheal axes in sniff position and availability of space to push the tongue for visualizing the laryngeal opening. An excellent review divided the tests for assessing possible difficult airway using a three-column model: anterior, middle, and posterior.[9] The anterior column tests assess the compliance and volume of the submandibular space, along with stylohyoid ligament flexibility and the degree of motion of temporomandibular joints. Thus, anterior column tests assess the distance from incisors to hyoid, or incisor to temporomandibular joint (TMJ) distance or the distance between two TMJs. The middle column tests assess the path traced by the

endotracheal tube, i.e., passage of the airway for space, which may be reduced by hypertrophy of lingual tonsils or presence of tumors, etc. These tests include physical assessment along with history and imaging of the airway. The tests for third or posterior column assessment include the degree of neck movement, i.e., the ability to extend occipito-atlanto-axial complex. The many tests (such as interincisor gap (IG), TMJ subluxation, upper lip bite test, sternomental distance, etc.) described for predicting DI are not enough on their own for use in all patients, since they assess only one of the components needed for successful laryngoscopy and or intubation. Therefore, a combination of tests may be required, which can be used for all patients, such as Wilson risk sum score, which is a combination of many tests, and thereby assesses many components (obesity (weight), jaw movement, IG, and TMJ subluxation) required for successful laryngoscopy and intubation is in use for many decades now.[10] A recent Indian study compared the Wilson risk sum score with other single-parameter tests and found that the Wilson risk sum score had the highest AUROC (0.990, CI = 0.982–0.999) of all tests and highest strength of agreement with the grade of laryngoscopy (Cohen's kappa 0.925 (0.873–0.976)).[11]

Adnet et al. proposed, developed, and tested the Intubation Difficulty Scale (IDS).[12] It consists of seven parameters, which is similar to Wilson risk sum score, which tests various components (Mallampati classification, thyromental distance, obesity, neck movement, etc.) score required for successful TI. In obese pregnant patients at a cut-off of > 5, the IDS AUROC was 1.0. The MACOCHA score, on the contrary, does not include tests for all essential components needed for successful laryngoscopy and intubation; this may explain its inability to predict DI in all patients.

The location of the patient (operation theater vs other areas) and nonsupervision by experienced personnel also contribute to the difficulty and the incidence of complications. The NAP4 audit reported that of the 184 airway related complications, 51 (27.71%) occurred in ICU and ED.[5] These consisted of mainly tracheostomy-related problems (14), tracheal tube misplacement/displacement (7), failed intubation (7), and cannot intubate cannot ventilate (CICV) (2) of the 36 instances in ICU. While in the ED (15), the incidents were failed intubation (7), aspiration of gastric contents (2), esophageal intubation (2), and CICV (2). Harris and Lockey studied the effect of specialty of personnel intubating the patients, their duration of training, and success in performing rapid sequence intubation in the prehospital setting.[13] The first-pass success rate of TI was higher if the trainees had spent 6–12 months (88.2%) or >12 months (85.5%) in anesthesia as compared with those with experience <6 months (71%). They also found that the laryngeal view (assessed by Cormack Lehane Grading) was significantly better in doctors with an anesthesia training. Bernhard et al. suggested that performing a minimum of 200 TIs was essential to increase first-attempt successful intubation rate to nearly 100% (96%).[14] Apart from higher first-pass success rate, Russotto et al. found that the likelihood of first-pass intubation failure is reduced by nearly 47% (i.e., OR, 0.53; 95% CI, 0.41–0.69), if the primary specialty of the intubator was anesthesiology. Similar reduction occurred in first-pass intubation failure, if the intubating person was consultant vs someone in training (OR, 0.52; 95% CI, 0.40–0.69).[15]

The major peri-intubation complications in our study were severe cardiovascular collapse (13.6%) and severe hypoxia (4.2%). Severe cardiovascular collapse was described in many previous studies, and the incidence of collapse was much higher in these studies.[15–19] There are multiple possibilities as to why severe cardiovascular collapse occurs immediately after TI in the critically ill. The severity of the illness itself, presence of shock at the time of TI, absolute or relative hypovolemia, myocardial depressant and vasodilatory effect of induction agents, sudden decrease in sympathoadrenal output following anesthesia induction, and positive pressure ventilation can all contribute to severe cardiovascular collapse. In the current study, the incidence of cardiovascular collapse was much lower in comparison; this could have been because of the use of ketamine (388) and etomidate (11) for induction of anesthesia in most (89%) of our patients. While both drugs are cardiostable, there is some controversy about which agent is likely to cause hypotension in a larger proportion of patients. However, a recent meta-analysis showed no difference in the incidence of postinduction-hypotension following either ketamine or etomidate.[20] Preintubation fluid loading, which is part of our unit intubation protocol, may also have contributed to lower incidence of hypotension. We are not completely certain about this, since two recent trials found that administration fluid bolus does not prevent peri-intubation hypotension.[21,22] The PrePARE II compared administration of fluid bolus with no bolus for prevention of hypotension in patients undergoing TI in the ICU.[22] There was no significant difference in the two groups in any of the related parameters: incidence of severe cardiovascular collapse (21% vs 18.2%), need for addition of new vasopressors or increase in dose of vasopressors (20.6% vs 17.6%), SBP < 65 mm Hg (3.9% vs 4.2%), cardiac arrest (1.7% vs 1.5%), or death before 28 days (40.5% vs 42.3%).

In our study, the rate of laryngoscopy and intubation during the first attempt was nearly 80%, and there was no correlation between number of attempts at TI and peri-intubation complications, as described in other studies. While 4.2% of our patients developed severe hypoxemia after intubation, 18.7% patients had hypoxia before intubation. The incidence of severe hypoxia was much higher in other studies (Table 7). This may have been because a large proportion (46.77%) of our patients were preoxygenated using NIV. Mort showed that in critically ill patients requiring TI, preoxygenation using bag and mask led to only a marginal improvement in PaO_2.[23] In most patients, this increase was less than 5%, and only 6% patients had an increase in PaO_2 > 50 mm Hg. An elegant study compared preoxygenation with high FiO_2 mask and NIV (using pressure support ventilation) in critically ill patients.[24] Patients preoxygenated with NIV showed a significant improvement in the PaO_2 in the NIV group [203 (116–276) vs 97 (66–163) mm Hg, $p = 0.01$].

The rate of other immediate peri-intubation complications in our study are similar to those described in several previous studies in the critically ill patients (Table 7).

The strength of our study is that it was performed in a single center, which is often stated to be a limitation. However, this is advantageous since we have trainees in critical care for many years now and we have well-established protocols in place for many decades. The ICU is manned mainly by DM trainees in critical care and anesthesia senior residents, around the clock. The other important aspect of our study is that this is the first study to use the full MACOCHA score during validation, in a very large cohort of critically ill patients; in fact our cohort is larger than the validation cohort of the original study.[25–30]

We must also understand the limitations of our study and their implications. This was a single-center study, and our practices,

Table 7: Incidence of major peri-intubation complications in critically ill patients

Study, year	*DI**	*Hypoxia*	*Profound hypotension*	*Esophageal intubation*	*Aspiration*	*Cardiac arrest*
Schwartz et al.,[25] 1995	8	NA	NA	8	4	3
Mort,[23] 2005	10	4.7	NA	9.7	2.1	1.8
Jaber et al.,[16] 2006	12	26	25	4.6	2	2
Griesdale et al.,[26] 2008	13.2	19.1	9.6	7.4	5.9	
Jaber et al.,[17] 2010*	12	25	27	5	3	3
Jaber et al.,[17] 2010*	8	10	15	5	1	2
Martin et al.,[27] 2011	10.3	NA	NA	1.3	2.8	NA
Mayo et al.,[28] 2011	20	14	6	11		
Simpson et al.[29] 2012	0.26	22	20	2	2	NA
Corl et al.,[30] 2018*	17.5	14.6	5.1	6.6	2.9	1.5
Corl et al.,[30] 2018*	10.9	9.4	3.6	4.3	5.8	0.7
Russotto et al.,[15] 2021	4.7	9.3	42.6	5.6	3.9	3.1
Prabhu et al.,[18] 2022	3.7	5.7	40.5	1.9	1.3	1.3
Ghosh et al.,[19] 2022[$]	9.8	24.5	29.5	0	0	3.28
Ghosh et al.,[19] 2022[$]	9.6	12.7	14.2	2	0	4.76
Current study	13.1	4.2	13.6	0.8	2	2.4

NA, not available; *Two-phase studies, complications occurring during the control and interventions period; [$]Comparative study, two arms

protocols, and personnel manning the ICU may be different from other units in India. The difficulty in visualization of larynx and in TI was reported by the person intubating the patient, and this apart from being subjective, obviously depends on the experience and skill level of the person. The level of seniority of intubating person was variable. While a large proportion (76.1%) of TIs were supervised, we were unable to find a correlation between supervision or lack thereof, and difficulty in intubation. We need to keep in mind that most of the TIs in our study were performed by trainees in DM in Critical Care Medicine, who have finished their postgraduate training or senior residents in anesthesia. This means that they had already worked in their respective specialties for at least for 3 years. Our ICU is manned by these residents round the clock, who are adept at performing TI. It is unlikely that many ICUs in India have such experienced trainees in their units, through 24 hours. Most of the ICUs are manned by less-experienced personnel during after-hours, who may not have a similar degree of training, with expertise that is available in our unit. Therefore, findings of our study may not be extrapolatable to other centers.

Conclusion

MACOCHA score in adult critically ill cancer patients showed moderate discriminative ability in predicting DI in our study. The incidence of peri-intubation complications was lower as compared with previous studies. Further studies are warranted to confirm the utility of MACOCHA score in critically ill patients for predicting DI, and also so that it can modified to increase its predictive ability.

Supplementary Materials

All the supplementary materials are available on the website www.ijccm.com

Author Contributions

Conceptualization: APK and SB; Data curation: APK, SC, KK, and AS; Formal analysis: APK, SB, and MG; Methodology: APK and SB; Project administration: APK; Resources: APK and SB; Supervision: APK and SB; Validation: APK and SB; Writing – original draft, review, and editing: APK and SB.

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References

1. Smischney NJ, Khanna AK, Brauer E, Morrow LE, Ofoma UR, Kaufman DA, et al. Risk factors for and outcomes associated with peri-intubation hypoxemia: A multicenter prospective cohort study. J Intensive Care Med 2021;36(12):1466–1474. DOI: 10.1177/0885066620962445.
2. De Jong A, Rolle A, Molinari N, Paugam-Burtz C, Constantin JM, Lefrant JY, et al. Cardiac arrest and mortality related to intubation procedure in critically ill adult patients: A multicenter cohort study. Crit Care Med 2018;46(4):532–539. DOI: 10.1097/CCM.0000000000002925.
3. Nolan JP, Kelly FE. Airway challenges in critical care. Anaesthesia 2011;66(Suppl 2):81–92. DOI: 10.1111/j.1365-2044.2011.06937.x.
4. Mosier JM, Joshi R, Hypes C, Pacheco G, Valenzuela T, Sakles JC. The physiologically difficult airway. West J Emerg Med 2015;16(7):1109–1117. DOI: 10.5811/westjem.2015.8.27467.
5. Cook TM, Woodall N, Harper J, Benger J, Fourth National Audit Project. Major complications of airway management in the UK: Results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society. Part 2: Intensive care and emergency departments. Br J Anaesth 2011;106(5):632–642. DOI: 10.1093/bja/aer059.

6. De Jong A, Molinari N, Terzi N, Mongardon N, Arnal JM, Guitton C, et al. Early identification of patients at risk for difficult intubation in the intensive care unit: Development and validation of the MACOCHA score in a multicenter cohort study. Am J Respir Crit Care Med 2013;187(8):832–839. DOI: 10.1164/rccm.201210-1851OC.
7. Apfelbaum JL, Hagberg CA, Connis RT, Abdelmalak BB, Agarkar M, Dutton RP, et al. 2022 American Society of Anesthesiologists Practice Guidelines for Management of the Difficult Airway. Anesthesiology 2022;136(1):31–81. DOI: 10.1097/ALN.0000000000004002.
8. Luedike P, Totzeck M, Rammos C, Kindgen-Milles D, Kelm M, Rassaf T. The MACOCHA score is feasible to predict intubation failure of nonanesthesiologist intensive care unit trainees. J Crit Care 2015;30(5):876–880. DOI: 10.1016/j.jcrc.2015.04.118.
9. Greenland KB. Airway assessment based on a three column model of direct laryngoscopy. Anaesth Intensive Care 2010;38(1):14–19. DOI: 10.1177/0310057X1003800104.
10. Wilson ME, Spiegelhalter D, Robertson JA, Lesser P. Predicting difficult intubation. Br J Anaesth 1988;61(2):211–216. DOI: 10.1093/bja/61.2.211.
11. Kumar D, Bhargava S, Sisodiya RS, Tiwari D. A comparison of Wilson risk sum score and combination of modified Mallampati classification, hyomental distance ratio, ratio of height to sternomental and thyromental distances for predicting difficult laryngoscopy in Indian population. J Evid Based Med Healthc 2020;7(50):3038–3045. DOI: 10.18410/jebmh/2020/620.
12. Adnet F, Borron SW, Racine SX, Clemessy JL, Fournier JL, Plaisance P, et al. The intubation difficulty scale (IDS): Proposal and evaluation of a new score characterizing the complexity of endotracheal intubation. Anesthesiology 1997;87(6):1290–1297. DOI: 10.1097/00000542-199712000-00005.
13. Harris T, Lockey D. Success in physician prehospital rapid sequence intubation: What is the effect of base speciality and length of anaesthetic training? Emerg Med J 2011;28(3):225–229. DOI: 10.1136/emj.2009.088302.
14. Bernhard M, Mohr S, Weigand MA, Martin E, Walther A. Developing the skill of endotracheal intubation: Implication for emergency medicine. Acta Anaesthesiol Scand 2012;56(2):164–171. DOI: 10.1111/j.1399-6576.2011.02547.x.
15. Russotto V, Myatra SN, Laffey JG, Tassistro E, Antolini L, Bauer P, et al. Intubation practices and adverse peri-intubation events in critically ill patients from 29 countries. JAMA 2021;325(12):1164–1172. DOI: 10.1001/jama.2021.1727.
16. Jaber S, Amraoui J, Lefrant JY, Arich C, Cohendy R, Landreau L, et al. Clinical practice and risk factors for immediate complications of endotracheal intubation in the intensive care unit: A prospective, multiple-center study. Crit Care Med 2006;34(9):2355–2361. DOI: 10.1097/01.CCM.0000233879.58720.87.
17. Jaber S, Jung B, Corne P, Sebbane M, Muller L, Chanques G, et al. An intervention to decrease complications related to endotracheal intubation in the intensive care unit: A prospective, multiple-center study. Intensive Care Med 2010;36(2):248–255. DOI: 10.1007/s00134-009-1717-8.
18. Prabu NR, Chaudhari HK, Kulkarni AP, Dangi MS, Bhagat V, Siddiqui SS, et al. Compliance with intubation bundle and complications in critically ill patients: A need to revisit the bundle components! Trends Anaesth Crit Care 2022;42(2):26–33. DOI: 10.1016/j.tacc.2021.10.001.
19. Ghosh S, Salhotra R, Arora G, Lyall A, Singh A, Kumar N, et al. Implementation of a revised Montpellier bundle on the outcome of intubation in critically ill patients: A quality improvement project. Indian J Crit Care Med 2022;26(10):1106–1114. DOI: 10.5005/jp-journals-10071-24332.
20. Koroki T, Kotani Y, Yaguchi T, Shibata T, Fujii M, Fresilli S, et al. Ketamine versus etomidate as an induction agent for tracheal intubation in critically ill adults: A Bayesian meta-analysis. Crit Care 2024;28(1):48. DOI: 10.1186/s13054-024-04831-4.
21. Janz DR, Casey JD, Semler MW, Russell DW, Dargin J, Vonderhaar DJ, et al. Effect of a fluid bolus on cardiovascular collapse among critically ill adults undergoing tracheal intubation (PrePARE): A randomised controlled trial. Lancet Respir Med 2019;7(12):1039–1047. DOI: 10.1016/S2213-2600(19)30246-2.
22. Russell DW, Casey JD, Gibbs KW, Ghamande S, Dargin JM, Vonderhaar DJ, et al. Effect of fluid bolus administration on cardiovascular collapse among critically ill patients undergoing tracheal intubation: A randomized clinical trial. JAMA 2022;328(3):270–279. DOI: 10.1001/jama.2022.9792.
23. Mort TC. Preoxygenation in critically ill patients requiring emergency tracheal intubation. Crit Care Med 2005;33(11):2672–2675. DOI: 10.1097/01.ccm.0000187131.67594.9e.
24. Baillard C, Fosse JP, Sebbane M, Chanques G, Vincent F, Courouble P, et al. Noninvasive ventilation improves preoxygenation before intubation of hypoxic patients. Am J Respir Crit Care Med 2006;174(2):171–177. DOI: 10.1164/rccm.200509-1507OC.
25. Schwartz DE, Matthay MA, Cohen NH. Death and other complications of emergency airway management in critically ill adults. A prospective investigation of 297 tracheal intubations. Anesthesiology 1995;82(2):367–376. DOI: 10.1097/00000542-199502000-00007.
26. Griesdale DE, Bosma TL, Kurth T, Isac G, Chittock DR. Complications of endotracheal intubation in the critically ill. Intensive Care Med 2008;34(10):1835–1842. DOI: 10.1007/s00134-008-1205-6.
27. Martin LD, Mhyre JM, Shanks AM, Tremper KK, Kheterpal S. 3,423 emergency tracheal intubations at a university hospital: Airway outcomes and complications. Anesthesiology 2011;114(1):42–48. DOI: 10.1097/ALN.0b013e318201c415.
28. Mayo PH, Hegde A, Eisen LA, Kory P, Doelken P. A program to improve the quality of emergency endotracheal intubation. J Intensive Care Med 2011;26(1):50–56. DOI: 10.1177/0885066610384070.
29. Simpson GD, Ross MJ, McKeown DW, Ray DC. Tracheal intubation in the critically ill: A multi-centre national study of practice and complications. Br J Anaesth 2012;108(5):792–729. DOI: 10.1093/bja/aer504.
30. Corl KA, Dado C, Agarwal A, Azab N, Amass T, Marks SJ, et al. A modified Montpellier protocol for intubating intensive care unit patients is associated with an increase in first-pass intubation success and fewer complications. J Crit Care 2018;44:191–195. DOI: 10.1016/j.jcrc.2017.11.014.