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Special Issue

A proposal for a new scoring system to predict difficult ventilation through a supraglottic airway

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Abstract

Background: The aim of this study was to propose and validate a new clinical score to predict difficult ventilation through a supraglottic airway device.

Methods: The score was proposed from our previously reported derivation data, and we prospectively validated the score in 5532 patients from November 2013 to April 2014. Predictive accuracy of the score was compared by the area under the receiver operating characteristic (ROC) curve (AUC). We assigned point values to each of the identified four risk factors: male, age >45 yr, short thyromental distance, and limited neck movement, their sum composing the score. The score ranged between 0 and 7 points. The optimal predictive level of the score was determined using ROC curve analysis.

Results: The AUC of the score was 0.75 (95% CI 0.66 to 0.84) in the validation data set, and was similar to that in the derivation data set (0.80; 95% CI 0.75 to 0.86). In derivation and validation data sets, the incidence of low risk categories (scores 0–3) was 0.42% *vs* 0.32% and of high risk categories (scores 4–7) was 3% *vs* 1.7% respectively. A score 4 or greater is associated with a six to seven fold increased risk of difficult ventilation through a supraglottic airway device.

Conclusions: The new score for prediction of difficult ventilation through a supraglottic airway device is easy to perform and reliable, and could help anaesthetists plan for difficult airway management.

Key words: airway management; predictive values of tests; prospective study

Despite availability of several guidelines for difficult airway management,[1–4] unexpected difficulty in airway management at induction of anaesthesia, remains a major cause of anaesthesia-related death and hypoxic brain damage.[5 6] When facemask ventilation and tracheal intubation prove difficult,[1–4 7] existing guidelines recommend insertion of a supraglottic airway device, such as a laryngeal mask airway. However, insertion of or ventilation through a supraglottic airway device may also fail.[8] Therefore, preoperative assessment of not only difficult mask ventilation and tracheal intubation,[7–14] but also difficult ventilation through a supraglottic airway device may decrease the risk of major airway complication during difficult airway management.

Failure to insert of a supraglottic airway device, or to ventilate through it occurs in 0.5–4.7%.[15–21] Reported causes of difficult insertion of and ventilation through a supraglottic airway device include severe anatomical abnormality, swelling of the upper airway, and bleeding after repeated attempts at tracheal intubation.[8] In a previous study, we identified four risk factors for

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Editor's key points

- The authors have developed a scoring system for difficult ventilation through a supraglottic airway.
- In the current study the predictive value of the score was prospectively validated.
- High scores were associated with an increased risk of difficult ventilation.
- Positive prediction value was however low (many patients had easy ventilation despite a high score).

difficult ventilation through a supraglottic airway device: male, age >45 yr, short thyromental distance, and limited neck movement.[16] The purpose of this study was to propose and validate a new clinical score that predicts difficult ventilation through a supraglottic airway device based on the identified risk factors.

Methods

Institutional review board approval (IRB) approval was obtained for this study. Individual patient informed consent was waived by the IRB as no clinical interventions were made, and no patient identifiable data were used. A score for prediction of difficult ventilation through a supraglottic airway device was proposed from data in our previous study.[16] 14 480 patients, aged ≥18 yr, who underwent general anaesthesia with the use of a supraglottic airway device were studied. We identified 74 (0.5%) patients in whom ventilation through a supraglottic airway device was difficult. Multivariate analysis identified four risk factors for difficult ventilation through a supraglottic airway device: male sex (OR 1.75, 95% CI=1.07–2.86, P=0.02); age >45 yr (OR 1.70, 95% CI=1.01–2.86, P=0.04); short thyromental distance (OR 4.35, 95% CI 2.31–8.17, P<0.001); and limited neck movement (OR 2.75, 95% CI=1.02–7.44, P=0.04).

Point values were assigned to each of the four independent risk factors. The points were weighted according to their parameter estimates with the lowest parameter estimate (Age >45 yr) assigned as 1, and the other factors proportionally allocated their points rounded to the nearest integer: one point for male (1.75/1.70=1.03, and thus the nearest integer (1), two points for limited neck movement (2.75/1.70=1.61, and thus the nearest integer (2) and 3 points for short thyromental distance (<5.5 cm) (4.35/1.70=2.55, and thus the nearest integer (3), giving a range of scores of 0–7 (Table 1). Summation of these points allowed for a single score ranging from 0 to 7 points. From this, we defined two overall risk categories for difficult supraglottic airway ventilation that gave both an adequate number of patients in each category and a distinct difference in rates of difficult supraglottic airway device ventilation.

Table 1 The simplified score to predict difficult ventilation through a supraglottic airway device. The points were weighted according to their parameter estimates with the lowest parameter estimate (Age >45 yr (OR 1.70)) assigned as 1, and the other factors proportionally allocated their points rounded to the nearest integer (see the methods for details).

Perioperative variables	Points
Male	1
Age >45 yr	1
Short thyromental distance	3
Limited neck movements	2

The model was then validated on a subsequent cohort of patients who had a supraglottic airway device insertion attempted as part of their anaesthesia management between November 2013 and April 2014. Similar to the derivation cohort reported previously,[16] only patients who were 18 yr of age or older were included. From a total of 15 865 patients who underwent general anaesthesia during that period, 5532 patients met the inclusion criteria and were used as the validation cohort.

The primary endpoint was difficult ventilation through a supraglottic airway device. The types of supraglottic airway used included LMA Classic™, Proseal™ LMA, LMA Supreme™ (LMA™ North America, Inc, San Diego, CA, USA), I-gel™ (Intersurgical Ltd, Wokingham, Berkshire, UK), and The Fastrach™ Intubation Laryngeal Mask Airway® (Laryngeal Mask Company, Jersey, UK). The definition was namely inability to provide adequate ventilation during induction of anaesthesia, because of one or more of the following problems: inadequate laryngeal mask seal, excessive gas leak, excessive resistance to the ingress or egress of gas.[1] Signs of inadequate ventilation include absent or inadequate chest movement, absent or inadequate breath sound, auscultatory signs of severe obstruction, cyanosis, gastric air entry or dilation, decreasing or inadequate oxygen saturation, absent or inadequate exhaled carbon dioxide, absent or inadequate spirometric measures of exhaled gas flow and haemodynamic changes associated with hypoxemia or hypercarbia.

Statistical analysis

The model was evaluated using the Hosmer-Lemeshow goodness-of-fit test and the area under the ROC curve. To measure and compare the predictive accuracy of the model in the derivation and validation data sets, we generated the receiver operating characteristic (ROC) curve and compared their C-statistics (AUC). The optimal predictive level of the score was determined using ROC curve analysis. The AUC provides a global summary statistic of test accuracy, and guidelines suggest that 0.5<AUC≤0.7 represent low accuracy, 0.7<AUC≤0.9 moderate accuracy, and 0.9<AUC≤1.0 represents high accuracy.[22] Statistical analysis was performed using SPSS version 22 (Armonk, NY, US). A P-value of less than 0.05 was considered statistically significant.

Results

Patients' characteristics are shown in Table 2. ROC curve analysis identified two risk categories; where a score of 0–3 signified low risk, and a score of 4–7 signified high risk, of difficult ventilation through a supraglottic airway device (Table 3).

In the validation cohort of 5532 patients, 22 patients experienced difficult ventilation through a supraglottic airway device. The incidence of difficult ventilation through a supraglottic airway device in validation data set was 0.4%, similar to that of the derivation cohort (0.5%).[16] Patients in the high risk group had approximately a six-fold increased risk of difficult ventilation through a supraglottic airway device as compared with those in the low risk group; a similar quantum of increased risk as was seen in the derivation cohort. The AUC of the score in validation data set was 0.75 (95% CI=0.66–0.84) (Figure 1), similar to derivation data set (0.80, 95% CI=0.75–0.86) (Figure 2). The sensitivity of the risk score is 23%, while the specificity is 95%; giving a negative predictive value of 99.6% (Table 4). The Hosmer-Lemeshow goodness of fit statistic was 0.63.