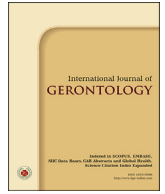


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Original Article

Patient-specific Factors Associated with Difficult Mask Ventilation in the Emergency Department

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SUMMARY

Background: Difficult mask ventilation (DMV) leading to oxygen and ventilation failure can cause complications and fatal consequences in airway management, but has rarely been studied as a primary outcome in the emergency department (ED). This study aimed to determine the incidence and predictors of DMV in the ED.

Methods: A specially designed form recording potential risk factors for DMV was designed and subsequently completed by a research nurse and physicians who had performed the procedure for all mask ventilation attempts over a one-year period in the ED of a large hospital in Taipei, Taiwan. Univariate associations between patient characteristics and DMV were measured, and a risk assessment scale was created according to the independent risk factors for DMV ascertained by adjusted regression models.

Results: One hundred ten mask ventilation attempts were recorded during the study period. DMV occurred frequently in the ED (45.9% of mask ventilation attempts). Significantly elevated rates of DMV were observed in patients aged 65 years or older those lacking teeth, with sunken cheeks, a double chin or a thick short neck. In adjusted analyses, three easily recognizable predictors, namely lack of teeth, sunken cheeks, and a double chin were found to be independent risk factors for DMV, and accordingly a risk assessment scale- LSD method was made.

Conclusion: DMV is a frequent challenge in EDs. An easy-to-use LSD risk scale is created for clinicians to rapidly identify and appropriately manage the risk patients of DMV.

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1. Introduction

Maintenance of sufficient oxygenation and ventilation in patent airways is the primary responsibility of emergency physicians during resuscitation. Mask ventilation and tracheal intubation in

the emergency department (ED) must often be performed urgently in order to save lives. Acute airway management performed in the ED resuscitation room is usually done by ED clinicians rather than anesthetists.¹ At 2%–26%, the incidence of difficult intubation is higher in the ED than in operating rooms, where it is 0.1%–8%.^{2–8} Furthermore, the rate of difficult mask ventilation (DMV) is 0.08–13% in operating rooms^{6,9–11}; however, rates of DMV in the ED have not been reported.^{8,12,13}

In the case of difficult intubation, using a bag-mask breathing system is vital to maintain sufficient ventilation and oxygenation. DMV may result in problems when attempting intubation, and it is one of the major factors underlying morbidity and mortality related

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to anesthesia.^{9,14,15} The risk of DMV should always be evaluated before intubation. Patient age, height, weight, male sex, an elevated Mallampati score, a history of snoring, a lack of teeth, a thick neck, a severely limited jaw protrusion, neck radiation changes, and the presence of a beard are known risk factors for DMV among pre-operative patients.^{9,16–19} However, these risk factors have not been assessed in an ED setting.^{10,11}

An assessment system that objectively measures the factors associated with a DMV in the resuscitation room must be simple to perform, easy to remember, and feasible to perform on obtundent and/or non-compliant patients.²⁰ Rapid evaluation of risk factors using such an assessment system can help emergency physicians avoid a potentially catastrophic sequence of events when DMV is likely. The present study aimed to identify the anatomic characteristics associated with elevated risk of DMV in the ED.

2. Methods

The study was approved by the institutional review board of Mackay Memorial Hospital, Taipei, Taiwan (protocol 11MMHIS064). The study included all adult patients undergoing tracheal intubation in the ED of Mackay Memorial Hospital, Taipei, Taiwan between November 1, 2011 and Aug 31, 2012. After obtaining informed consent from the patients or their legal representative, the physicians performing the tracheal intubation procedure completed a specially designed form (Appendix) to report outcomes. A research nurse reviewed and recorded potential risk factors for DMV on the same form. Elements evaluated to determine risk factors for DMV included general patient and disease characteristics, a standard physical airway examination, physical features that could affect mask fit, and patient history suggesting possible airway anatomy pathology.^{9,10,16,17} All patients except those who were comatose underwent adequate induction anesthesia before the procedures.

DMV was defined as the inability of the emergency physician performing one-person bag-valve-mask ventilation to maintain oxygen saturation above 90% using 100% oxygen and positive pressure ventilation, or inability to prevent or reverse signs of inadequate ventilation within 30 s,^{14,19} when setting up an artificial airway. The primary outcome measured the incidence of DMV in the ED. The secondary was to develop a risk assessment scale for DMV in the ED.

In general, the emergency physician chief residents or certified registered nurses present in the room initially attempted both mask ventilation and intubation, and the attending staff made all clinical decisions regarding airway management (i.e., patient position, mask size, direct laryngoscope blade, use of cricoid pressure). Mask ventilation was performed using an advanced silicon rubber reusable Half Mask Face Piece (Teleflex Medical Inc., Research Triangle Park, NC).

2.1. Statistical analysis

Data management and statistical analysis were performed using SPSS version 17.0 (SPSS Inc., Chicago, IL). Categorical variables were described using frequency distributions and reported as n (%), and continuous variables were reported as mean \pm standard deviation. Univariate analyses of associations between patient characteristics and DMV were performed using Pearson's chi-squared test or Fisher's exact test for categorical variables and student's *t*-tests for continuous variables. Statistical significance was set according to an alpha level of 0.05.

To assess independent risk factors for DMV, logistic regression was then used to compute odds ratios (ORs) and 95% confidence intervals (CIs) for individual patient characteristics. All individual

risk factors significantly associated with DMV in the univariate analysis were included in a multivariate binary logistic regression model. Finally, a weighted prediction score based on the β coefficient of the independent predictors was derived from the results of the logistic regression model. Prediction scores were calculated by dividing the β coefficient of each independent predictor by the lowest significant β coefficient of all the independent predictors, multiplying the result by two, and rounding to the nearest integer.

3. Results

A total of 110 consecutive adult patients (66 men and 44 women) were enrolled in the study. The age of the patients was ranged from 21 to 96 years. Only 6.3% of patients had a clear consciousness level before induction anesthesia, and more than 25% required cardiorespiratory resuscitation before setting up the airway (Table 1).

DMV was encountered in 51 patients (45.9%, Table 2). No patients reported snoring in the study. Observed signs of inadequate mask ventilation included gas flow leak around the mask, poor chest movement, and oxygen desaturation. When DMV occurred with one-person mask ventilation, it was resolved using a two-handed, two-person mask ventilation mask ventilation technique or by changing the mask ventilation. DMV was significantly associated with patient age, lack of teeth, sunken cheeks, a double chin and a thick short neck. In contrast, sex, height, weight, body mass index, consciousness level before induction anesthesia, mouth opening, thyromental distance, sternomental distance, thyrosternal distance, and airway impaction by sputum or food were not significantly associated with DMV (Table 2).

Table 3 shows univariate ORs predicting DMV. Elevated odds of DMV were found for patients who were greater than 65 years of age (OR, 5.0; 95% CI, 2.0–12.6), were lacking teeth (OR, 3.4; 95% CI, 1.5–8.0), had sunken cheeks (OR, 7.7; 95% CI, 2.1–28.7), a double chin (OR, 21.9; 95% CI, 2.7–173.9) or a thick short neck (OR, 11.8; 95% CI, 2.5–55.0). Patients who were both lacking teeth and had sunken cheeks had elevated odds of DMV compared to those with

Table 1
Demographic characteristics of the study sample.

Variable	Mean \pm SD ^a , or n [#] (%)	Minimum	Maximum
Difficult mask ventilation	51 (45.9%)		
Age (year)	69.3 \pm 16.5	21	96
Sex (male/female)	66 (59.5%)/44 (40.5%)		
Height (cm)	165.3 \pm 8.0	150	180
Weight (kg)	64.2 \pm 13.7	35	100
BMI [#] (kg/m ²)	23.4 \pm 4.4	14.5	44.4
Consciousness level before induction anesthesia			
Clear	7 (6.3%)		
Obtundent	53 (47.7%)		
Coma	50 (46%)		
Cause of intubation			
Sepsis	9 (8.1%)		
Lung diseases [*]	20 (18%)		
Heart diseases [*]	20 (18%)		
Renal diseases [*]	1 (0.9%)		
In-hospital cardiac arrest	2 (1.8%)		
Dead on arrival	27 (24.3%)		
Cerebrovascular insult [*]	11 (9.9%)		
Trauma	1 (0.9%)		
Others [*]	19 (17.1%)		

BMI: body mass index, n: case number, SD: standard deviation, * Lung diseases: chronic obstructive pulmonary disease, or pneumonia; heart diseases: heart failure, pulmonary edema; or renal disease: uremia; cerebrovascular insult: ischemic or hemorrhagic stroke; others: gastric ulcer bleeding, esophageal varices bleeding, nitrogen oxide intoxication, alcoholic coma, drug abuse, or diabetic ketoacidosis.

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