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Clinical Communication

Difficult mask ventilation: An objective criterion

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ABSTRACT

Effective mask ventilation plays a critical role in safe management of airway before intubation or after failed intubation. Mask ventilation (MV) is the primary technique of ventilation before tracheal intubation or insertion of any airway device. Its most unique role however, is as a rescue technique for ventilation should tracheal intubation fail or prove difficult. The ability to establish adequate MV has, therefore, become a major branch point in any difficult airway algorithm. Despite it being an important skill, MV has received little attention in the extensive body of literature and book chapters addressing airway management when compared to laryngoscopy and intubation. At present, there is no standard definition for Difficult Mask Ventilation (DMV) that is based on precise and objective criterion. The authors propose a simple objective criterion to categorize difficult mask ventilation based on the best monitoring parameters.

1. Introduction

Effective mask ventilation plays a critical role in safe management of airway before intubation or after failed intubation.[1] Mask ventilation (MV) is the primary technique of ventilation before tracheal intubation or insertion of any airway device. Its most unique role however, is as a rescue technique for ventilation should tracheal intubation fail or prove difficult. The ability to establish adequate MV has, therefore, become a major branch point in any difficult airway algorithm.

Despite it being an important skill, MV has received little attention in the extensive body of literature and book chapters addressing airway management when compared to laryngoscopy and intubation. At present, there is no standard definition for Difficult Mask Ventilation (DMV) that is based on precise and objective criteria. Han's scale has been frequently used in various studies to define and evaluate DMV.[2–6] However, it is still not validated, may not be reproducible or sensitive enough when used for data comparisons and/or research purposes.[7]

Warters et al[8] in 2011 described scale to assess mask ventilation difficulty after administering neuromuscular blocker rocuronium and assigning points based on escalating levels of intervention necessary to ventilate the lungs such as use of an airway device, increased inspiratory pressure and two-person ventilation with an aim to achieve a standardized tidal volume using bag mask ventilation. It also has limitation of being subjective in nature and the need for an objective measurement, such as a tidal volume with controlled airway pressure, has been suggested to provide more reliable and quantitative outcome than the Warters scale.[9]

The attempts to define difficult mask ventilation have taken a paradigm shift from being purely defined in terms of oxygenation,[10] inability to mask ventilate in terms of inadequate mask seal,[11] excessive gas leak,[1,11,12] excessive resistance to the ingress or egress of gas,[11] inadequate chest movements,[1,11,12] need of using airway adjuncts,[3] use of both hands,[1] change in operator[1] or need for two

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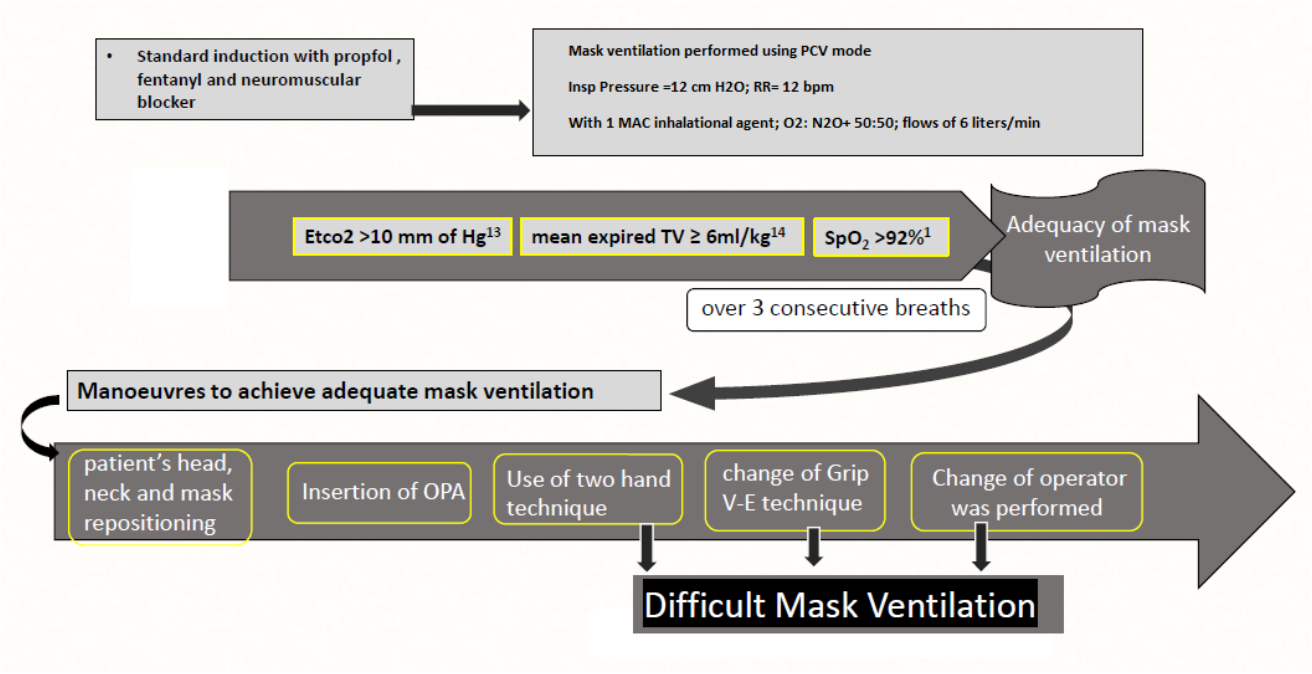

Figure 1: Proposed flowchart to categorize difficult mask ventilation

operators.[3] The current lack of an objective definition creates problems when clinicians attempt to communicate clinical information. It also complicates data interpretation and comparisons when investigators want to study the subject. Conversely, the subjective and operator dependent nature of the ability to perform MV may render establishing such a precise and objective definition an unreachable goal. A definition that uses objective criteria to precisely describe the different stages of the continuum is obviously needed.

Thus, to add objectivity to the definition of DMV, the authors propose criterion based on objective measurement such as tidal volume with controlled airway pressure.

2. Materials and Methods

After induction of anesthesia and administration of muscle relaxant, the ventilator of anesthesia machine to be set on pressure control mode with settings: Inspiratory Pressure of 12 cm H_2O, and rate of 12 breaths per minute. Mask ventilation (MV) to be attempted using the transparent face mask attached to closed circuit. The patients should be ventilated with inhalational agent at 1 MAC and 50% nitrous oxide in oxygen with flows of 6 liters/ min. MV should be considered inadequate if there is no plateau on capnography with $EtCO_2 \leq 10$ mmHg[13] and/or mean expired tidal volume (V_t) < 6 ml/kg[14] and/or inability to maintain saturation (SpO_2) above 92%[1] over 3 consecutive breaths. In such case, the patient's head, neck and mask to be repositioned and ventilation reassessed over next 3 consecutive breaths. If MV still remains inadequate, appropriately sized oropharyngeal airway to be inserted. If this is also not able to maintain adequate MV over next 3 consecutive breaths, two hand technique to be used and if still inadequate change of grip to be performed. Change of operator should be performed if all above mentioned maneuvers fail. The requirement of the above-mentioned rescue maneuvers, if any should be noted.

MV will be noted as Difficult Mask Ventilation (DMV) if there is need for any of the following interventions after one minute of administration of muscle relaxant: two hand technique, change of grip or change of operator (Figure 1). If after all the above interventions, there is inability to mask ventilate the patient (mean V_t<2 ml/kg for 3 consecutive breaths, no $EtCO_2$ or SpO_2< 90%), it should be noted as impossible mask ventilation.

3. Discussion

The above criterion is an attempt to use combination of objective measures (SpO2, capnograph with end tidal CO2 values, standardized tidal volume with a set controlled airway pressure)[1,13,14] to describe mask ventilation. The conclusion of DMV is based not merely on these parameters but only after optimization through interventions (repositioning and use of oropharyngeal airway) fail. The authors have attempted to categorize MV as difficult when it would be difficult for an anaesthesiologist to maintain adequate MV for 3 minutes after administration of muscle relaxant. The estimation after 1 min of neuromuscular blocker allows for proper onset of action to occur and time

for optimization interventions. The use of closed circuit and PCV allows for standardization of effort to ventilate as opposed to bag mask ventilation by hand which can vary with each breath and is non-standardized. In the criterion, inspiratory pressure of 12 cm of H_2O was based on the pilot cases performed to achieve V_t >6ml/kg in normal non-obese adult population at our institution. Also, previous studies have observed pressure <10 cm of H_2O to cause inadequate ventilation and >15 cm of H_2O to cause gastric insufflation.[15] However, pressures of 15-18 cm H_2O may be required in patients with restrictive lung pathologies and obese patients.

Thus, the proposed criterion of defining DMV is based on objective measurements and considering the continuum of maneuvers required to achieve these objectives while ensuring adequate depth of anesthesia and neuromuscular blocker efforts. This is an advantage over previous definitions and grades/scale defined in literature as it takes into account optimal conditions for MV and relies solely on objective measurements; thus removing subjectivity of attempting MV by squeezing of bag by operator. Various studies evaluating DMV have yielded variable results as different authors have used different criterion to define DMV, thus making comparison between studies difficult. Using this standardized criterion of DMV for research would allow comparison between studies reliable and quantifiable.

We used this criterion to categorize DMV in our teaching institution. Retrospective analysis of our case records revealed an incidence of 10.78% DMV in general non-obese population (unpublished results) and 13.8% in COVID induced mucormycosis patients (unpublished results). The various studies evaluating incidence of DMV in our Indian population have revealed similar incidence.[6,16] The similarity of these incidences with ours point to internal clinical validation of these criterion. However, the criterion requires further external validation.

4. Conclusion

In summary, we propose a simple clinical criterion to categorize difficult mask ventilation based on the best monitoring parameters. The resulting criterion of difficult mask ventilation is objective and practical, and internally validated by the close agreement between our incidence data and previous reports. This criterion might help standardize mask ventilation difficulty to allow comparison between various studies reliable and quantifiable.

5. Source of Funding

None.

6. Conflict of Interest

None.

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