

Manual vs. Mechanical Mask Ventilation during Induction of General Anesthesia

—A Practice Changing Retrospective Study

Omar Alwahoush¹, Ghanem Al-Amry¹, Rafik Banoub¹, Ahmed Eldemerdash¹, Alya Ali¹,
Mohammad Khalil², Meera Alblooshi¹

¹Anesthesiology Institute, Cleveland Clinic Abu Dhabi, Abu Dhabi, United Arab Emirates

²School of Medicine and Surgery, Royal College of Surgeons in Ireland-Medical University of Bahrain, Busaiteen, Bahrain

Email: alwahoo@clevelandclinicabudhabi.ae

How to cite this paper: Alwahoush, O., Al-Amry, G., Banoub, R., Eldemerdash, A., Ali, A., Khalil, M. and Alblooshi, M. (2025) Manual vs. Mechanical Mask Ventilation during Induction of General Anesthesia. *Open Journal of Anesthesiology*, 15, 264-272.

<https://doi.org/10.4236/ojanes.2025.1511021>

Received: October 18, 2025

Accepted: November 16, 2025

Published: November 19, 2025

Copyright © 2025 by author(s) and Scientific Research Publishing Inc.

This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

Abstract

Background: Effective ventilation during the induction of anesthesia is crucial for patient safety, yet the comparative effectiveness of mechanical versus manual ventilation techniques remains inadequately explored. This study evaluates whether mechanical mask ventilation yields lower peak inspiratory pressures (PIP) than traditional manual ventilation, and discusses the science of effective and safe methods of mask ventilation. **Methods:** A retrospective cohort analysis was conducted at a tertiary hospital in the United Arab Emirates, reviewing anesthetic charts from 104 patients who underwent general anesthesia with endotracheal intubation. After excluding 9 cases due to insufficient data, 95 patients were analyzed. Data on peak inspiratory pressures, ventilation techniques, and patient demographics were extracted and compared statistically. Additionally, a clinical survey was distributed to anesthesiologists to gather qualitative insights on their experiences and preferences regarding both ventilation methods. **Results:** The mechanical mask ventilation group (n = 8) exhibited a mean PIP of 16.75 cm H₂O, significantly lower than the 23.76 cm H₂O in the manual group (n = 87). Notably, only 25% of mechanical cases exceeded 20 cm H₂O compared to 79.3% in the manual group, underscoring the mechanical method's superior control over airway pressures. Survey responses indicated that 66% of anesthesiologists preferred manual ventilation due to familiarity and perceived reliability, while 34% favored mechanical ventilation for its consistency and reduced physical effort. **Conclusion:** This study demonstrates that mechanical mask ventilation results in lower peak inspiratory pressures compared to manual techniques, potentially enhancing patient safety during anesthesia induction. Despite this, a significant preference for manual ventilation persists among anesthesiologists, highlighting the need for

balanced training in both techniques. These findings contribute valuable insights for optimizing ventilation practices in clinical anesthesia.

Keywords

Mask Ventilation, Mechanical, Manual, Peak Inspiratory Pressure, Gastric Insufflation, Debate

1. Introduction

Effective ventilation during the induction of anesthesia is crucial for ensuring adequate oxygenation and minimizing complications. Traditionally, manual ventilation using a reservoir bag and an adjustable pressure-limiting (APL) valve has been the standard approach in many anesthetic practices [1]. This technique relies on the operator's ability to consistently deliver appropriate tidal volumes and manage peak inspiratory pressures. However, variability in these parameters can lead to unpredictable outcomes, including the risk of gastric insufflation and suboptimal ventilation [2].

In recent years, mechanical ventilators have been increasingly utilized in anesthesia practice, offering a more controlled approach to ventilation. Mechanical ventilators allow for precise regulation of tidal volumes, inspiratory pressures, and respiratory rates. This could potentially address some of the limitations associated with manual ventilation by providing more consistent and predictable ventilation parameters [3]. Despite these theoretical advantages, the comparative effectiveness of mechanical versus manual ventilation in real-world clinical settings has not been thoroughly investigated.

This study aims to explore whether mechanical mask ventilation results in lower peak inspiratory pressures compared to traditional manual ventilation methods. By analyzing anesthetic charts from 104 patients who underwent general anesthesia with endotracheal intubation, this study will evaluate differences in peak inspiratory pressures between the two ventilation techniques. Additionally, a clinical survey of anesthesiologists will be conducted to gather insights into their experiences and opinions regarding both methods. The goal is to provide an unbiased comparison of the two approaches, contributing valuable information to guide clinical practice and improve patient safety.

2. Methods

This study was designed as a retrospective cohort analysis conducted at a tertiary hospital in the United Arab Emirates over a two-week period. The study was approved by CCAD's Institutional Review Board (IRB), and the requirement for written informed consent was waived by the board (Research Ethical Committee, REC). All procedures adhered to the institution's data protection policies, ensuring that the study was conducted with the utmost respect for patient privacy and

ethical standards. Written informed consent was obtained. Given the retrospective nature of the study, it was exempt from obtaining informed consent from individual patients.

We reviewed the anesthetic charts of 104 patients who underwent general anesthesia with endotracheal intubation. The primary objective was to compare the peak inspiratory pressures achieved with mechanical mask ventilation to those achieved with manual ventilation using a reservoir bag and an adjustable pressure-limiting (APL) valve.

Patients included in the study were those who underwent elective or emergency procedures under general anesthesia with endotracheal intubation. Exclusion criteria encompassed patients with incomplete anesthetic records, significant pre-existing conditions that could impact ventilation, Rapid Sequence Inductions (RSI) without mask ventilation, or cases where the method of ventilation could not be clearly determined.

Anesthetic charts were meticulously reviewed to extract key data, including peak inspiratory pressures recorded during the induction phase of anesthesia. The charts also provided information on the ventilation technique used—whether mechanical or manual—as well as patient demographics, such as age, sex, and body mass index (BMI), and details about the surgical procedures, including type and duration.

For patients who received mechanical ventilation, data were collected on the specific settings used, such as tidal volume, inspiratory pressure, and respiratory rate. For those who underwent manual ventilation, we examined the characteristics of the manual ventilation technique, including the use of the reservoir bag and APL valve settings. The peak inspiratory pressures for both groups were documented and compared.

Statistical analysis was performed manually to evaluate differences in peak inspiratory pressures between the two ventilation methods. Descriptive statistics were used to summarize patient demographics and procedural details, while comparative analyses were conducted with a significance level of $p < 0.05$ established for the analysis.

In addition to the chart review, a clinical survey was distributed to the anesthesiologists at the hospital. The survey sought to capture their opinions on the effectiveness of mechanical versus manual ventilation, practical considerations, and patient safety concerns. Specifically, anesthesiologists were asked to provide feedback on the ease of use, reliability, and any challenges encountered with each ventilation method. They were also invited to share their observations regarding patient outcomes and their overall preferences for one method over the other.

The survey responses were analyzed qualitatively to identify common themes and perspectives, providing contextual understanding to complement the quantitative findings from the chart review. This approach allowed for a comprehensive evaluation of the ventilation techniques from both clinical and practical viewpoints.

By combining quantitative data with qualitative feedback, this study aims to offer

a balanced assessment of mechanical and manual ventilation methods, contributing to a better understanding of their respective advantages and limitations in anesthesia practice.

3. Results

Out of the initial 104 patients studied, 9 were excluded due to insufficient data or the absence of mask ventilation attempts, resulting in a total of 95 patients for analysis. The demographic breakdown of these patients revealed that 51 were male (53.7%) and 44 were female (46.3%). Among them, 19 patients had a BMI greater than 35 (20.0%), and 18 patients had a BMI between 30 and 34.9 (18.9%), leading to a total of 37 patients (38.9%) classified as obese.

In terms of ventilation techniques, 8 patients (8.4%) were ventilated mechanically, while the majority, 87 patients (91.6%), received manual ventilation. The mean PIP in the mechanical mask ventilation group was 16.75 cm H₂O, compared to 23.76 cm H₂O in the manual mask ventilation group. Notably, in the mechanical mask ventilation group, PIP exceeded 20 cm H₂O on two occasions (25%), with the maximum recorded value reaching 22 cm H₂O. In contrast, the manual mask ventilation group experienced PIP exceeding 20 cm H₂O on 69 occasions (79.3%), exceeding 25 cm H₂O on 34 occasions (39.0%), and exceeding 30 cm H₂O on 11 occasions (12.6%), with a maximum recorded PIP of 50 cm H₂O (**Figure 1** and **Figure 2**).

Using Fisher's Exact Test, these findings indicate a statistically significant difference in peak inspiratory pressures between the two ventilation methods, with mechanical mask ventilation resulting in lower PIPs.

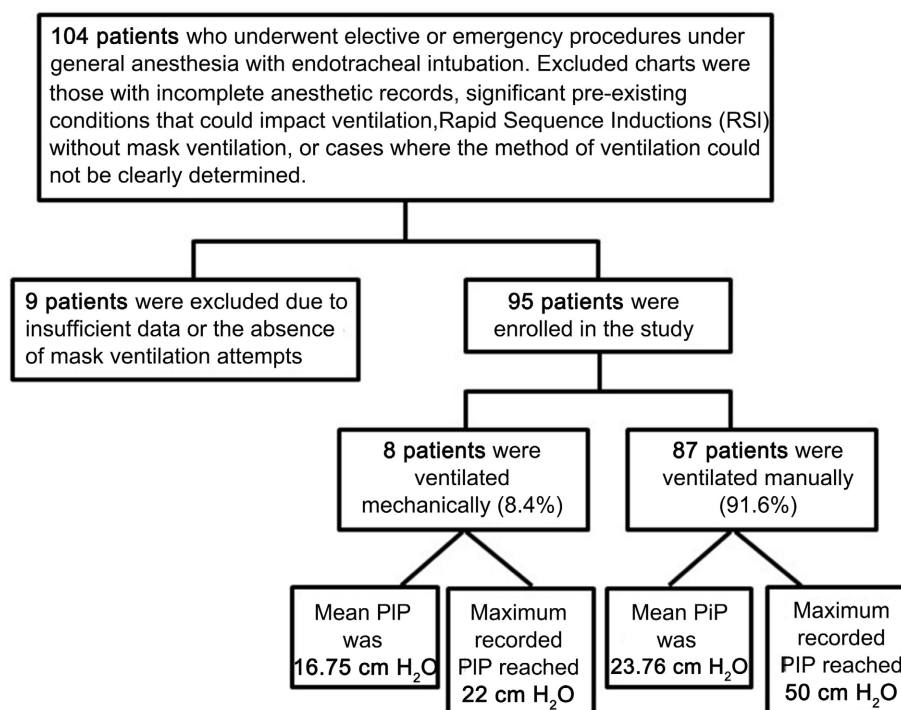


Figure 1. A flowchart summarizing the design of the study.

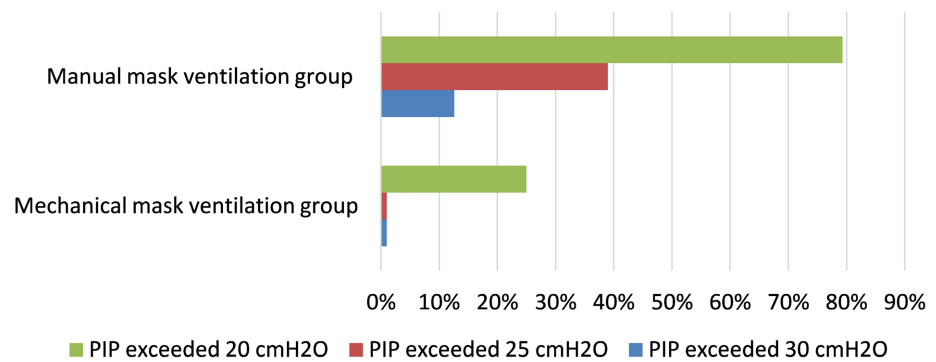


Figure 2. The distribution of the PIP limits exceeded.

4. Discussion

4.1. Importance of Monitoring the Peak Inspiratory Pressure Limits during Mask Ventilation

During mask ventilation in general anesthesia, peak inspiratory pressures (PIP) above 20 - 25 cm H₂O are known to increase the risk of gastric insufflation, potentially leading to aspiration [4] [5]. Excessive pressure can force air into the stomach, causing distension and increasing the likelihood of regurgitation. Maintaining PIP within recommended limits is crucial to minimize this risk [6]. Clinicians should monitor pressures closely and adjust ventilation techniques to ensure safe airway management and reduce complications associated with aspiration.

4.2. Interpretation of the Study Results

The findings of our study indicate that mechanical mask ventilation offers better control over peak inspiratory pressures compared to manual ventilation techniques. Specifically, the significantly lower mean PIP observed in the mechanical ventilation group suggests a more consistent and reliable approach to airway management during anesthesia induction. By maintaining peak inspiratory pressures within safer limits, mechanical mask ventilation may help reduce the risk of complications associated with gastric insufflation, such as aspiration and regurgitation. This enhanced control is particularly critical in clinical settings, where fluctuations in airway pressures can lead to adverse outcomes. Overall, our results support the integration of mechanical ventilation into standard anesthetic practice as a means to improve patient safety and optimize ventilation management.

4.3. Overview of Survey Results

In addition to our primary investigation comparing mask ventilation using a ventilator versus manual bag ventilation, we conducted a survey among anesthesiologists within our department to explore their preferences for these techniques and the reasons behind these preferences. The survey results provide a comprehensive view of the current practices and attitudes towards these ventilation methods [7] [8].

4.4. Anesthesiologist Preferences and Rationale

➤ **Manual Bag Mask Ventilation:**

The survey revealed that 66% of anesthesiologists preferred using the manual bag technique for mask ventilation. This preference was driven by several key factors:

1) Baseline Familiarity with Airway Resistance: A predominant reason cited by the majority was the ability to gauge and become familiar with the patient's airway resistance. Anesthesiologists value the tactile feedback provided by manual bag ventilation, which helps establish a baseline for the airway's resistance and compliance. This immediate sensory input is considered crucial for assessing and managing ventilation effectively, especially in varying clinical scenarios.

2) Mastery of One-Handed Technique: Another significant reason for preferring manual bag ventilation was the desire to master the one-handed mask ventilation technique. This skill is deemed essential for handling non-ideal situations, such as emergency intubation in confined or challenging environments where another person might not be available to help with squeezing the bag.

3) Scepticism of Mechanical Ventilator Reliability: A notable proportion of anesthesiologists expressed concerns about the reliability and accuracy of mechanical ventilators. They highlighted that mechanical systems might not always function as expected, and thus, relying solely on these devices could pose risks if they malfunction or fail. This scepticism underscores a preference for manual techniques where the anesthesiologist retains direct control.

4) Perceived Limitations of Mechanical Ventilation: Some respondents indicated that mechanical ventilation might be perceived as a less appropriate practice in certain situations. They argued that manual techniques could offer more flexibility and adaptability in dynamic clinical scenarios.

5) Familiarity and Training: Many anesthesiologists favored manual bag ventilation due to their greater familiarity with this technique. This familiarity extends to the training of residents, where teaching the one-handed technique is considered an important aspect of their education. The traditional approach remains entrenched in practice, contributing to its continued preference.

➤ **Mechanical Mask Ventilation:**

In contrast, 34% of the anesthesiologists preferred mechanical mask ventilation. Their reasons included:

1) Consistency in Breathing Patterns: One of the main advantages cited was the ability of mechanical ventilation to set and maintain a consistent breathing pattern, including intervals, rate, volumes, and pressures. This precision is particularly valuable for ensuring stable ventilation during induction.

2) Quantification of Airway Pressure: Mechanical ventilation allows for accurate measurement and monitoring of the patient's airway pressures, providing a quantitative baseline that aids in assessing and managing the patient's respiratory status. This data can be crucial for optimizing ventilation and minimizing complications.

3) Reduction of Physical Effort: The use of mechanical ventilation reduces the need for excessive physical effort exerted on one side of the jaw. Specifically, it distributes the force on both sides and, therefore, at least theoretically, could decrease jaw trauma and pain.

4) Avoidance of Airway Adjuncts: Some anesthesiologists preferred mechanical ventilation to avoid the need for additional airway adjuncts, such as oropharyngeal airways. Mechanical systems can sometimes provide adequate ventilation without requiring these supplementary devices, especially when 2 hands are used to open the airway.

5) Freeing Up Manual Tasks: Mechanical ventilation allows the anesthesiologist to free up one hand for other critical tasks, such as administering medications and controlling the monitors. This multi-tasking capability is seen as an advantage in managing complex cases where additional procedures are required simultaneously.

6) Energy Conservation: Mechanical ventilation is also associated with conserving muscle energy, which is particularly beneficial when the same hand is used for both mask ventilation and subsequent intubation. This can prevent fatigue and maintain effectiveness throughout the procedure.

4.5. Implications of Survey Results

The survey results highlight a significant divergence in practice preferences, reflecting broader discussions in the field regarding the balance between manual techniques and mechanical assistance. Understanding these preferences provides insight into clinical decision-making processes and highlights key factors that influence the choice of ventilation method. **Table 1** discusses the reasons provided by the manual mask ventilation group, and how these reasons can be argued scientifically.

4.6. Integration into Practice

The findings suggest that both techniques have their merits and can be appropriate depending on the clinical scenario. It is essential for anesthesiologists to be proficient in both methods and to be able to select the most appropriate technique based on the patient's condition, the complexity of the case, and available resources [9]-[11]. Training programs should continue to emphasize the importance of mastering both manual and mechanical ventilation techniques, ensuring that practitioners are well-prepared for a range of situations.

4.7. Suggested Method of Mechanical Mask Ventilation

After the patient becomes apnoeic due to the induction agents introduced, a proper seal is secured around the mouth and nose of the patient. The mechanical ventilator can now be switched on using the pressure control mode, and this will ensure a set value of PIP, and at the same time, consistent breaths that will keep the patient well oxygenated. Small tidal volumes at this stage will be sufficient to

give the anesthesiologist the important information about the patency of the airway, and will not allow a clinically significant hypercarbia to occur, given the short time of the mask ventilation phase.

Table 1. The scientific discussion of the reasons provided by the manual mask ventilation group

Reason	Discussion
Baseline Familiarity with Airway Resistance	This was the most mentioned reason, which is basically to get a tactile feel of the patient's baseline airway resistance. In fact, mechanical mask ventilation offers a more comprehensive image of that for two reasons: 1) The ventilator will give the anesthesiologist an objective value of the airway resistance, instead of a subjective estimate provided by the tactile feel of the bag. 2) The opportunity of using 2 hands easily in mechanical mask ventilation gives the anesthesiologist higher chances of forming a proper seal around the mouth, and therefore a more accurate representation of the secured airway that the anesthesiologist will insert.
Mastery of One-Handed Technique	The argument here was that manual mask ventilation allows anesthesiologists to master the one-hand technique in preparation for unusual and challenging situations. In reality, mechanical mask ventilation can also be performed using one hand, and it will provide other advantages.
Scepticism of Mechanical Ventilator Reliability	The concern of some anesthesiologists was that ventilators are not reliable all the time, but the counter-argument would be that if the mechanical ventilator does not work, then the whole surgery will be difficult to continue, and the anesthesiologist can always use the manual method in those rare and malfunctioning situations.
Perceived Limitations of Mechanical Ventilation	Technology is now evolving every day and becoming a big part of the healthcare system. This is one example that will allow technology to help anesthesiologists provide safer care to the patients.
Familiarity and Training	As we mentioned before, both techniques should be taught to the residents, and one-hand mask ventilation techniques can still be mastered using mechanical mask ventilation.

5. Conclusion

In conclusion, this study demonstrates that mechanical mask ventilation significantly reduces peak inspiratory pressures compared to traditional manual ventilation techniques during the induction of anesthesia. The findings suggest that mechanical ventilation may offer a more controlled and reliable approach, thereby minimizing risks associated with gastric insufflation and aspiration. Despite the benefits of mechanical ventilation, the survey indicates a strong preference among anesthesiologists for manual techniques, attributed to familiarity and perceived reliability. Ultimately, both ventilation methods possess distinct advantages, emphasizing the importance of proficiency in each technique to ensure optimal patient safety and outcomes in diverse clinical scenarios.

Glossary of Terms

PIP: Peak Inspiratory Pressure;

APL: Adjustable Pressure Limiting.

Consent

REC did not require individual consent due to the retrospective nature of the data.

Authors' Contributions

Alwahoush Omar M.D: This author is the primary author of this paper. He brought up the study's idea and collected the data. He also wrote the paper, did the literature review, did the paper submission work, got the ethical approval from the hospital, and conducted the clinical survey. Al-Amry Ghanem M.D: This author is the first co-author of this paper. He helped with collecting the data and writing the manuscript. Eldemerdash Ahmed: He is an associate staff anesthesiologist in the same hospital. He helped with writing the perioperative anemia protocol. Banoub Rafik: He is an associate staff anesthesiologist in the same hospital. He helped the primary author with the literature review and reviewed the paper after it was written. Ali Alya: She is the second co-author of this paper. She helped with the literature review.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- [1] Tunstall, M.E., Spence, R.K., Lindbergh, P., *et al.* (2016) Manual Ventilation with an Anesthesia Bag: Techniques and Complications. *Anesthesiology*, **125**, 564-572.
- [2] Kheterpal, S., Engelhardt, T., Avidan, M.S., *et al.* (2018) Effect of Manual Ventilation on Peak Airway Pressures: A Retrospective Study. *Anesthesia & Analgesia*, **126**, 1305-1312.
- [3] Ghoneim, M.M., El-Boghdadly, K. and McCluskey, S.A. (2020) The Role of Mechanical Ventilation in Anesthesia: An Evidence-Based Review. *British Journal of Anaesthesia*, **124**, 83.
- [4] Kheterpal, S., *et al.* (2009) Intraoperative Gastric Insufflation and Risk of Aspiration. *Anesthesiology*, **110**, 902-909.
- [5] Arozullah, A.M., *et al.* (2004) Risk Factors for Perioperative Aspiration. *Anesthesiology*, **100**, 1081-1086.
- [6] Fuchs-Buder, T., *et al.* (2005) Anesthesia and Aspiration: A Review of the Literature. *British Journal of Anaesthesia*, **95**, 191-197.
- [7] Miller, R.D. (2020) *Miller's Anesthesia*. 9th Edition, Elsevier.
- [8] Barash, P.G., Cullen, B.F. and Stoelting, R. (2017) *Clinical Anesthesia*. 8th Edition, Wolters Kluwer.
- [9] Kroeger, K. and Nelson, K. (2019) *Anesthesia: A Comprehensive Review*. 2nd Edition, Springer.
- [10] Egan, T.D. and Morgan, G.E. (2019) *Basics of Anesthesia*. 7th Edition, Elsevier.
- [11] Cook, T.M. and Woodall, N. (2019) Major Complications of Airway Management in the United Kingdom: Results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society. *British Journal of Anaesthesia*, **123**, 669-678.