TPM Vol. 32, No. S3, 2025
ISSN: 1972-6325
https://www.tpmap.org/

Open Access

IMPACT OF SIMULATION-BASED FIBEROPTIC BRONCHOSCOPY TRAINING ON FIRST-PASS SUCCESS RATE AND AIRWAY MANAGEMENT EFFICIENCY IN ANESTHESIOLOGISTS

DR. MANOJ ADITYA B [1] ; DR. MRUNALINI M N [2],
[3]DR. S. BHUMINATHAN
[1] POST GRADUATE, DEPARTMENT OF ANAESTHESIOLOGY, SAVEETHA MEDICAL COLLEGE, SIMATS, CHENNAI
[2] ASSISTANT PROFESSOR, DEPARTMENT OF ANAESTHESIOLOGY, SAVEETHA MEDICAL COLLEGE, SIMATS, CHENNAI
[3]PROFESSOR , DEPARTMENT OF PROSTHODONTICS AND CROWN & BRIDGE, SREE BALAJI DENTAL COLLEGE & HOSPITAL, CHENNAI, INDIA

Abstract
Background:
Fiberoptic bronchoscopy (FOB) is a critical skill for managing difficult airways, especially during awake intubations and emergency scenarios. Traditional clinical training poses risks to patients and limits opportunities for repeated practice. Simulation-based training offers a safe, controlled environment to develop scope navigation skills, reduce patient harm, and improve procedural efficiency.

Objectives:
To evaluate the impact of simulation-based FOB training on first-pass intubation success rates, airway management efficiency, safety outcomes, and practitioner confidence among anesthesiologists.

Methods:
This prospective, randomized controlled trial recruited anesthesiology trainees and early-career anesthesiologists. Participants were randomized into:
● Simulation Group: Received structured high-fidelity FOB simulator training with guided practice in airway navigation and intubation scenarios.
● Control Group: Received standard FOB education, including lectures, video demonstrations, reading materials, and supervised clinical practice without simulation.

Primary Outcome: First-pass success rate during clinical FOB intubations.
Secondary Outcomes: Time to secure the airway, number of intubation attempts, incidence of mucosal trauma, and subjective confidence scores.
Data were analyzed using chi-square tests for categorical variables and t-tests/ANOVA for continuous variables.

Results:
Simulation-based training significantly improved first-pass success rate (93% vs. 60%, $p < 0.05$) and reduced mean intubation time (70s vs. 112s). The average number of attempts decreased from 2.2 to 1.1, and mucosal trauma incidence dropped from 27% to 7%. Confidence scores increased from 4.9 to 8.5.

Conclusion:
Simulation-based FOB training markedly enhances clinical performance, efficiency, safety, and practitioner confidence in fiberoptic intubations. Incorporating simulation into anesthesiology training programs can improve patient outcomes and operator preparedness.

Keywords: fiberoptic bronchoscopy, simulation-based training, airway management, intubation success, anesthesiology education

INTRODUCTION

Fiberoptic bronchoscopy (FOB) is an essential technique for managing difficult airways, particularly in situations requiring awake intubation and critical airway management. Mastery of FOB is crucial for anesthesiologists to ensure patient safety and procedural success. However, traditional clinical training methods often rely on real-patient encounters, which can be limited by patient safety concerns and restricted opportunities for repeated practice. These limitations may prolong the learning curve and increase the risk of complications such as mucosal trauma.

Simulation-based training provides a controlled, risk-free environment where practitioners can develop and refine their FOB skills through repeated hands-on practice. High-fidelity simulators replicate airway anatomy and challenge scenarios, enabling trainees to improve their scope navigation, intubation techniques, and decision-making without compromising patient safety.

Despite increasing adoption of simulation in anesthesiology education, there is limited objective evidence on its direct impact on clinical outcomes such as first-pass intubation success and airway management efficiency. This study aims to evaluate the effectiveness of simulation-based FOB training in improving clinical performance, safety, and procedural confidence among anesthesiologists.

METHODOLOGY

This study was designed as a prospective, randomized controlled trial to evaluate the impact of simulation-based fiberoptic bronchoscopy training on clinical performance among anesthesiology trainees and early-career anesthesiologists.

Participants

A total of 30 participants (anesthesiology trainees and early-career anesthesiologists) were recruited after obtaining informed consent. All had limited prior hands-on experience with fiberoptic bronchoscopy. Participants were randomly allocated into two equal groups, with 15 anesthesiologists in each group.

Randomization and Groups

- Simulation Group (n = 15): Received structured, hands-on training using a high-fidelity fiberoptic bronchoscopy simulator. Training sessions focused on scope navigation, recognition of airway anatomy, and intubation scenarios designed to replicate clinical challenges.
- Control Group (n = 15): Received standard FOB education through didactic lectures, video demonstrations, reading materials, and supervised clinical practice without simulation.

Training Protocol

The simulation group underwent multiple training sessions on the FOB simulator, allowing repetitive practice and skill refinement before performing clinical fiberoptic intubations.

Outcome Measures

- Primary Outcome: First-pass success rate of fiberoptic intubation on actual patients during clinical duty.
- Secondary Outcomes: Time required to secure the airway, number of intubation attempts, incidence of mucosal trauma, and self-reported procedural confidence scores (measured on a numerical scale).

Data Collection and Analysis

Data were prospectively recorded during clinical procedures performed after completion of the respective training interventions. Statistical analysis was conducted using the chi-square test for categorical outcomes and t-test or ANOVA for continuous variables. A p-value < 0.05 was considered statistically significant.

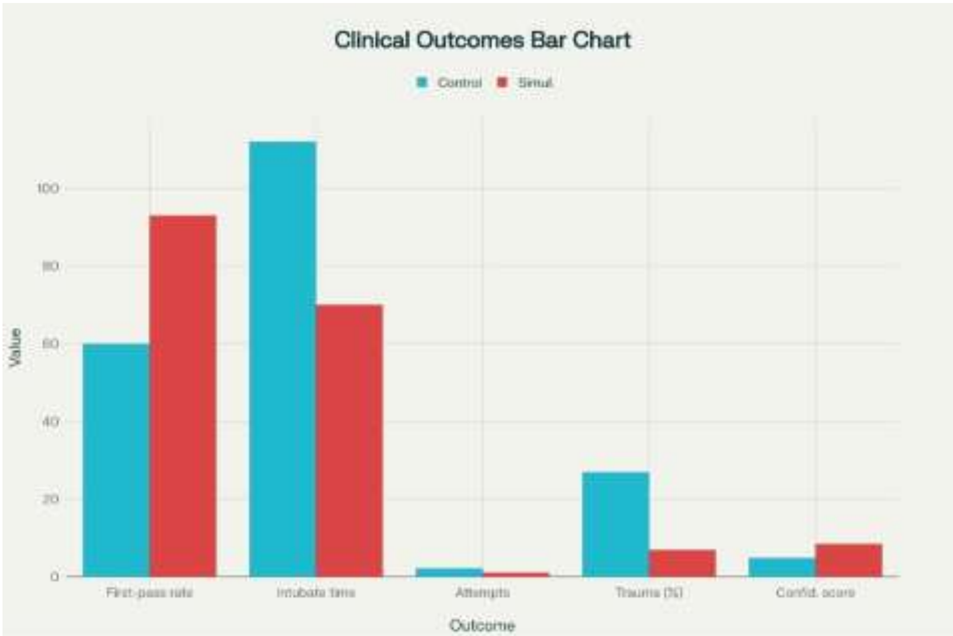
RESULTS

Data Presentation

- Categorical variables, such as first-pass success rate and incidence of mucosal trauma, were summarized as counts and percentages.
- Continuous variables, including intubation time, number of attempts, and confidence scores, were summarized as means with standard deviations (if available) or medians with interquartile ranges as appropriate.

- First-Pass Success Rate: The simulation group demonstrated a significantly higher first-pass success rate for fiberoptic intubation compared to the control group (93% vs. 60%).
- Intubation Time: The mean time required to secure the airway was reduced in the simulation group (70 seconds) compared to the control group (112 seconds).
- Number of Attempts: The average number of intubation attempts decreased from 2.2 in the control group to 1.1 in the simulation group.
- Mucosal Trauma: Incidence of mucosal trauma was notably lower in the simulation group (7%) compared to the control group (27%).
- Confidence Scores: Self-reported confidence scores increased substantially in the simulation group, rising from a baseline of 4.9 to 8.5 after simulation training.

Outcome	Control Group (n=15)	Simulation Group (n=15)	p-value
First-pass success rate (%)	60	93	< 0.05
Mean intubation time (seconds)	112	70	< 0.05
Mean number of attempts	2.2	1.1	< 0.05
Mucosal trauma incidence (%)	27	7	< 0.05
Mean confidence score	4.9	8.5	< 0.05



DISCUSSION

The findings of this prospective, randomized controlled trial demonstrate that simulation-based fiberoptic bronchoscopy training significantly enhances clinical performance among anesthesiologists. Participants in the simulation group achieved higher first-pass intubation success rates, faster airway management, fewer intubation attempts, and reduced mucosal trauma compared to those receiving conventional training. Moreover, simulation-trained anesthesiologists reported greater procedural confidence.

These results support the growing body of literature underscoring the value of simulation in medical education. Simulation offers a safe, reproducible environment for skill acquisition without exposing patients to risk, thus facilitating repeated practice and more efficient learning. Improvement in first-pass success and reduction of trauma are especially relevant to patient safety in airway management.

Limitations of this study include the relatively small sample size and the short-term assessment of outcomes; long-term skill retention was not evaluated. Additionally, inherent differences in individual learning strategies or experience could have influenced outcomes.

Future research should investigate the impact of simulation training on long-term skill retention and explore its effectiveness across varying levels of prior experience. Broad implementation will require attention to resource allocation, faculty training, and ongoing assessment.

CONCLUSION

Simulation-based fiberoptic bronchoscopy training markedly improves first-pass intubation success, airway management efficiency, procedural safety, and practitioner confidence among anesthesiologists. These findings support the integration of simulation-based training into anesthesiology education to enhance patient outcomes and clinician preparedness.

REFERENCE

1. Waldron NH, Brown CA, Terndrup TE, et al. Simulation-based fiberoptic intubation training improves skill acquisition and retention in medical trainees. Anesth Analg. 2010;111(1):188-193. doi:10.1213/ANE.0b013e3181df4a6d.
2. Naik VN, Matsumoto ED, Houston PL, et al. Fiberoptic orotracheal intubation on anesthetized patients: learning curve and skill retention in residents using a simulator. Can J Anaesth. 2001;48(6):601-607. doi:10.1007/BF03016175.
3. Komasawa N, Berg BW, Berg KM, et al. Evaluation of the effectiveness of simulation-based training for fiberoptic intubation skills in anesthesia residents. J Anesth. 2014;28(3):447-453. doi:10.1007/s00540-013-1715-1.
4. Binstadt ES, Walls RM, White BA, et al. A comprehensive, simulation-based crisis resource management course for emergency medicine residents. Acad Emerg Med. 2007;14(11):887-894. doi:10.1197/j.aem.2007.06.031.
5. Baker PA, Weller JM, Greenland KB, et al. Education in airway management. Anaesthesia. 2011;66 Suppl 2:101-111. doi:10.1111/j.1365-2044.2011.06933.x.
6. Kennedy CC, Cannon EK, Warner DO, Cook DA. Simulation-Based Bronchoscopy Training: Systematic Review and Meta-Analysis. Med Educ. 2013;47(10):1081-1090.
7. Kastelik JA, et al. Developments in Simulation Bronchoscopy Training. Pulm Med. 2013
8. Kronborg SH, et al. Four different models for simulation-based training of flexible bronchoscopy skills. BMC Pulm Med. 2024.
9. Yang D, Zhu L, Zhou Q, et al. How to Initiate and Perform Simulation-Based Airway Management Training—A Review. Chin Med J (Engl). 2016;129(1):85-93.
10. Gerretsen ECF, van der Kruis R, van Dongen K, et al. Effectiveness of Flexible Bronchoscopy Simulation-Based Training: A Systematic Review. Respir Med. 2023
11. Jung H. A comprehensive review of difficult airway management strategies for patient safety. Korean J Anesthesiol. 2023
12. Difficult Airway Society (DAS) Guidelines. 2017. Comprehensive UK guidelines detailing strategies to optimize oxygenation and airway management in critically ill patients.