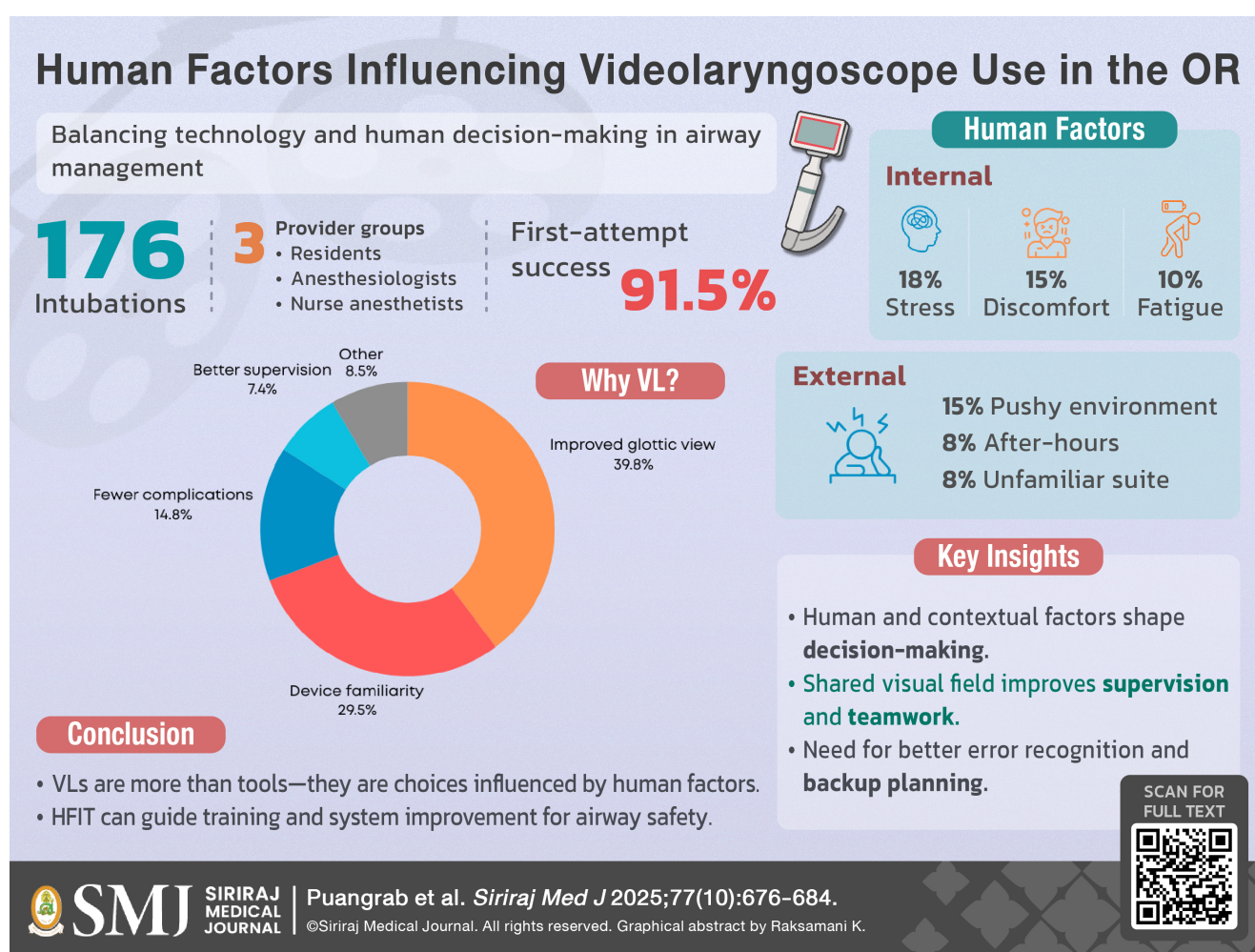


Human Factors Influencing the Decision to Use Videolaryngoscopes for Intubation in the Operating Room

Siwatus Puangrab, M.D.^{1,2}, Atip Youngyoodee, M.D.^{1,3}, Tachawan Jirativanont, M.D.¹, Kasana Raksamani, M.D.^{1,*}

¹Department of Anesthesiology, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand, ²Department of Anesthesiology, School of Medicine, Walailak University, Nakhon Si Thammarat, Thailand, ³Department of Anesthesiology, Nakhonpathom Hospital, Nakhon Pathom, Thailand.



*Corresponding author: Kasana Raksamani

E-mail: kasana.rak@mahidol.edu

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ORCID ID: <http://orcid.org/0000-0003-4524-4781>

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ABSTRACT

Objective: This study aimed to explore (1) the human factors influencing the decision to use videolaryngoscopes (VLs) instead of conventional Macintosh blades for intubation in operating room settings, and (2) the reasons anesthesia providers report for selecting VLs in clinical practice.

Materials and Methods: A prospective observational study was conducted from September 2020 to June 2021 among anesthesia personnel at Siriraj Hospital. Eligible participants included anesthesiologists, anesthesia residents, and nurse anesthetists who used a VL for intubating adult patients under general anesthesia. Participants completed a structured questionnaire based on the Human Factors Investigation Tool (HFIT) model, which captured internal and external human factors, device selection rationale, and self-assessed performance. Data were analyzed using descriptive and inferential statistics.

Results: A total of 176 VL intubation events were analyzed. Internal human factors such as stress (18.2%), discomfort (15.3%), and fatigue (10.2%), along with external factors like a pushy environment (15.3%) and after-hours work (7.9%), influenced VL use. The most cited reasons for choosing VLs included improved glottic visualization (39.8%), device familiarity (29.5%), fewer complications (14.8%), and better supervision (7.4%). These findings align with key domains of the HFIT model, including situational awareness, decision-making, and environmental conditions.

Conclusion: This study demonstrates that the decision to use VLs is shaped not only by technical considerations but also by a range of human and contextual factors. The HFIT model provided a valuable framework for understanding how providers navigate complex clinical environments. These insights support targeted interventions in training and workplace design to enhance decision-making and airway safety.

Keywords: Videolaryngoscopes; human factors; airway management (Siriraj Med J 2025; 77: 676-684)

INTRODUCTION

Videolaryngoscopes (VL) have demonstrated superiority over traditional direct laryngoscopy in both anticipated and unanticipated difficult airways by increasing first-attempt success rates and reducing airway trauma.¹⁻⁵ Their ability to provide an enhanced glottic view without requiring alignment of the oral, pharyngeal, and laryngeal axes makes them especially useful for patients with restricted neck movement or limited mouth opening.⁶ Additionally, VLs reduce the physical force needed during intubation, which minimizes upper airway injuries and improves safety, particularly in patients with fragile airway conditions.³⁻⁵

Beyond their utility in difficult airway scenarios, VLs are increasingly used in patients with normal airway anatomy due to their benefits in reducing soft tissue trauma, improving visualization, and facilitating teaching and supervision.^{1,6} Studies have shown that VLs can reduce intubation time and post-procedural complications such as sore throat or hoarseness.⁷

Their widespread use in routine cases may also enhance familiarity with the device, better preparing providers for high-stakes or emergency situations.^{6,7}

Using VL can enhance human factors, including non-technical aspects of airway management, especially during difficult laryngoscopy and intubation.⁸⁻¹⁰ Teamwork, communication, and overall team performance can be

improved by providing a shared visual of the airway.⁹⁻¹²

Human factors play a critical role in airway management and have been implicated in 40% of adverse outcomes related to difficult airway complications, as highlighted in the NAP4 report.¹³ To prevent such complications, anesthesia providers must be proficient not only in clinical skills but also in understanding and managing human factors at both individual and systemic levels.¹⁴ A recent multicenter study reported that airway and respiratory complications occurred in 9.6% of obese patients undergoing general anesthesia, with pregnancy, obesity class, and high Mallampati score being significant risk factors.¹⁵ Non-technical skills are increasingly recognized as a complementary and independent area of competence in anesthesiology.^{16,17} To address these concerns, *Flin et al.* developed the Simplified Human Factors Investigation Tool (HFIT) model to investigate difficult airway events.¹⁸ This study aims to identify the human factors, using the HFIT framework, that influence the decision to use VLs as intubation devices instead of conventional Macintosh blades in operating room settings.

MATERIALS AND METHODS

This observational study was conducted in the Department of Anesthesiology at Siriraj Hospital, Faculty of Medicine Mahidol University, from September 2020 to June 2021. The primary aim was to identify the human

factors influencing the decision to use VLs for intubation instead of conventional Macintosh blades in the operating rooms. This study received approval from The Siriraj Institutional Review Board (COA no Si 679/2020).

Eligible participants included attending anesthesiologists, anesthesia residents, and certified registered nurse anesthetists from the Department of Anesthesiology, Faculty of Medicine Siriraj Hospital, who performed tracheal intubation using VLs for adult patients (>18 years) undergoing general anesthesia. To ensure homogeneity of clinical context and reduce confounding variables, data from pediatric, trauma, obstetric, and COVID-19-related patients were excluded. These patient groups often require distinct airway management protocols, equipment, or infection control measures that differ significantly from routine adult elective and emergency surgical cases. This exclusion helped maintain consistency in evaluating human factors specific to standard operating room settings. Eligible participants volunteered to take part in the study and were asked to complete a structured questionnaire immediately following the intubation event.

To systematically assess human factors, we developed the “Human Factors Analysis Form” based on the Human Factors Investigation Tool (HFIT) model proposed by Flin et al.¹⁸ The HFIT framework is designed to investigate the role of non-technical skills and contextual factors in clinical decision-making. The form was translated and validated in Thai and structured to collect detailed information across four key domains: user demographics, patient characteristics, airway device details, and a self-assessment of the intubation event ([Supplemental File 1](#)). The self-assessment section was the core component reflecting the HFIT model, designed to evaluate five domains of human performance—situational awareness, decision-making, task management, teamwork, and environmental conditions. Each domain was assessed through targeted questions that captured internal factors such as stress, fatigue, and discomfort, as well as external factors like operating room conditions, time pressure, and unfamiliar settings. Among the environmental factors assessed were noise, lighting, temperature, unfamiliar operating environments, and what was defined in this study as a “*pushy environment*”. This term referred to clinical settings where participants felt under increased pressure to perform rapidly or precisely due to perceived urgency, hierarchical dynamics, or expectations conveyed by surgical teams, supervisors, or the overall pace of the operating room. This operational definition helped capture the subjective experience of performance pressure that may influence decision-making in real-time clinical scenarios.

To quantify the likelihood of a difficult airway, a scoring system was used based on seven established predictors: limited mouth opening (<3 cm), limited neck movement, reduced thyromental distance (<6 cm), presence of a receding mandible, prominent upper incisors, Mallampati classification III or IV, and history of difficult intubation. Each positive predictor was assigned 1 point, resulting in a total difficulty score ranging from 0 to 7, with higher scores indicating increased risk of intubation difficulty. Moreover, a difficult airway was operationally defined as a failed intubation using conventional direct laryngoscopy, followed by a request to use a VL as a rescue device.

The questionnaire underwent expert validation by two independent anesthesiologists with expertise in airway management and human factors. Both experts assessed the content for relevance, clarity, and representativeness. The calculated Content Validity Index (CVI) was 0.96, indicating a high level of agreement and excellent content validity.

The HFIT-based questionnaire was administered immediately after each intubation event to capture the provider’s reflections on the decision-making process, human factors, and contextual influences while the experience was still fresh and accurately recalled. Participants were asked to reflect on the specific conditions under which they chose to use a VL, providing insights into both conscious and contextual influences on their clinical choices. The questionnaire also included space for free-text responses to allow further elaboration beyond the structured items.

The primary outcome was the successful intubation using a VL. In cases of unanticipated difficult airway—defined as failed intubation using conventional direct laryngoscopy followed by a request for VL—success was defined as successful endotracheal intubation on the first attempt with VL.

The sample size was calculated to estimate the proportion of anesthesia providers whose decision to use VLs is influenced by human factors, assuming a prevalence of 70% based on prior observational studies.¹³ Using a 95% confidence level and a precision of $\pm 7\%$, the required sample size was 165.

All questionnaire items were optional, and participants were allowed to skip questions without penalty. Missing responses were treated as missing completely at random and were excluded from item-level percentage calculations without imputation. No statistical adjustments were made for missing data, in keeping with the exploratory nature of the study. For data analysis, descriptive statistics such as means and standard deviations (SDs) were used

to describe continuous data, while frequencies and percentages were used to analyze categorical data. For inferential statistics, the Chi-square test was employed to compare two independent proportions for categorical endpoints. A p-value of < 0.05 was considered statistically significant. All statistical analyses were conducted using SPSS software version 29.0 (SPSS Inc., Chicago, USA).

RESULTS

A total of 176 intubation events using videolaryngoscopes in anesthesia settings were recorded from September 2020 to June 2021. Among the respondents who opted to use VLs, 111 (63.1%) were anesthesia residents, 33 (18.8%) were attending anesthesiologists, and 32 (18.2%) were certified registered nurse anesthetists. The respondents included 50 males (28.4%) and 126 females (71.6%), with a mean age of 32.4 ± 9.6 years (Table 1).

Successful intubation on the first attempt was achieved in 161 cases (91.5%), while 15 cases (8.5%) were unsuccessful. Among the 176 patients, 97 (55.1%) were male and 79 (44.9%) were female, with a mean age of 57.6 ± 19.5 years. Emergency cases accounted for 21 (11.9%) of the total. The distribution by service units included 18 (10.2%) in cardiovascular and thoracic surgery, 54 (30.7%) in otorhinolaryngologic surgery, 27 (15.3%) in general surgery, 19 (10.8%) in neurosurgery, 28 (15.9%) in orthopedic surgery, and 30 (17.1%) in other units.

Across 176 events, the chosen VLs were Macintosh blade VLs in 116 cases (65.9%) and angulated blade VLs in 60 cases (34.1%). Participants reported various internal human factors affecting their decision to request VLs: stress in 32 cases (18.2%), discomfort in 27 cases (15.3%), fatigue in 18 cases (10.2%), and hunger in 8 cases (4.5%), while 120 participants (68.2%) reported no internal factors. External factors influencing the decision included a pushy environment in 27 cases (15.3%), after-hours situations in 14 cases (7.9%), unfamiliar suites in 14 cases (7.9%), too many people involved in 14 cases (7.9%), extreme temperature conditions (too hot or too cold) in 10 cases (5.7%), noisy conditions in 8 cases (4.5%), and improper lighting in 8 cases (4.5%) (Table 2). Meanwhile, 120 participants reported no external factors. A human factors analysis of both successful and unsuccessful first-attempt intubations revealed no significant differences between the groups, as demonstrated in Table 3. The primary reasons participants cited for selecting VLs were improved glottic visualization (70 cases, 39.8%), familiarity with the devices (52 cases, 29.5%), confidence that VL would result in fewer complications (26 cases, 14.8%), reduced intubation time (13 cases, 7.4%), and better supervision (13 cases, 7.4%).

The decision to request alternative airway devices was made in the operating theaters before induction in 88 cases (50.0%), during preanesthetic visits in 74 cases

TABLE 1. Demographic data of respondents.

Variable	Successful intubation on the first attempt (n=161)	Unsuccessful intubation on the first attempt (n=15)	p value
Sex (Male), n (%)	41 (25.5)	6 (40.0)	0.36
Age (year), mean (SD)	32.0 (8.5)	31.9 (8.4)	0.97
Type of respondent, n (%)			0.33
Attending anesthesiologist	34 (21.1)	2 (13.3)	
Anesthesia resident	98 (60.9)	8 (53.3)	
Certified register nurse anesthetist	29 (18.0)	5 (33.3)	
Experience of respondent, n (%)			0.53
0-5 years	129 (80.1)	13 (86.7)	
5-10 years	4 (2.5)	1 (6.7)	
10-15 years	15 (9.3)	1 (6.7)	
More than 15 years	13 (8.1)	0 (0.0)	

TABLE 2. Human Factors Reported to Influence the Decision to Use Videolaryngoscopes (n=176).

Category	Factor	Number of Cases	Percentage (%)
Internal Factors	Stress	32	18.2
	Discomfort	27	15.3
	Fatigue	18	10.2
	Hunger	8	4.5
External Factors	Pushy environment	27	15.3
	After-hours situations	14	7.9
	Unfamiliar suite	14	7.9
	Too many people involved	14	7.9
	Extreme temperature	10	5.7
	Noisy conditions	8	4.5
	Improper lighting	8	4.5
Technical Considerations	Improved glottic view	70	39.8
	Familiarity with device	52	29.5
	Fewer complications expected	26	14.8
	Better supervision	13	7.4

TABLE 3. Participant responses to non-technical skill statements adapted from the Human Factors Investigation Tool (HFIT) framework, targeting domains such as decision-making, teamwork, and situational awareness. These human factors were analyzed in relation to successful and unsuccessful first-attempt intubations.

Category	Question	Success in the first attempt (n=161)	Unsuccess in first attempt (n=15)	p
Task management	Do you know how to assess difficult airways?	161 (100%)	15 (100%)	0.186
	Did you notice the personnel action error?	15 (9.3%)	3 (20.0%)	
	Are you aware of the difficult airway management guideline?	158 (98.1%)	15 (100%)	
	Did you follow the difficult airway management guideline?	151 (93.8%)	14 (93.3%)	
Teamworking	Did your team have a clear role?	160 (99.4%)	15 (100%)	1.00
	Did the assigned role appropriate to the team member?	161 (100%)	15 (100%)	0.16
	Did your teamwork collaborate?	160 (99.4%)	14 (93.3%)	
	Did the information exchange appropriately?	150 (93.2%)	14 (93.3%)	
	Did your team encourage each other?	148 (91.9%)	14 (93.3%)	1.00
Situation awareness	Did you notice the difficult airway beforehand?	155 (96.3%)	13 (86.7%)	0.14
	Did you plan for alternative airway instruments in advance?	149 (92.5%)	13 (86.7%)	0.34
Decision making	Did you aware of the pros and cons of the instrument chosen?	139 (86.3%)	10 (66.7%)	0.58
	Did you have another backup plan?	109 (67.7%)	10 (66.7%)	1.00

(42.0%), and after failed intubation with a Macintosh blade #3 in 12 unanticipated difficult airway cases (6.8%). The success rate of VLs in unanticipated difficult airway cases, defined as successful intubation on the first attempt using VL, was 10 out of 12 (83.3%). The mean intubation difficulty score was 2.03 (± 1.6), and there was no significant difference between the success and unsuccessful groups.

DISCUSSION

This study demonstrated a high first-attempt intubation success rate (91.5%) using videolaryngoscopes (VL) in anesthesia settings. The primary reasons for selecting VL included improved glottic visualization, device familiarity, reduced complications, and enhanced supervision. Both internal (e.g., stress, discomfort) and external (e.g., pushy environment, after-hours situations) factors influenced the decision to use VL.

The high first-attempt success rate highlights the effectiveness of VL in clinical practice. Our findings align with previous studies reporting high success rates with VL in both difficult and non-difficult airway situations.^{1,7} When comparing success rates of VL and conventional Macintosh laryngoscopes, the literature consistently shows higher first-attempt success rates with VL due to its superior glottic visualization and improved angle of view, which enhances the likelihood of successful intubation on the first attempt, reducing the incidence of failed intubations and associated complications.^{1,3,13}

The study highlights several reasons for selecting VL for intubation, including improved glottic visualization, device familiarity, reduced complications, and better supervision during intubation. VL devices are equipped with video cameras that provide a high-resolution view of the glottis and surrounding structures.^{1,19} This enhanced visualization is particularly beneficial in patients with difficult airways, where direct laryngoscopy often fails to provide a clear view.^{19,20} Studies have shown that VL significantly improves the Cormack-Lehane grade and offers superior visualization compared to Macintosh laryngoscopes, especially in patients with difficult airways.^{2,21} The improved visualization also enhances team coordination by allowing all members to share the visual field and maintain situational awareness during the procedure.²² This shared view enables the team to assist with additional airway maneuvers, such as applying external laryngeal pressure or providing secretion suction when needed. Familiarity with the VL device is another crucial human factor influencing its selection as the first-choice intubation tool.^{14,23} This is particularly important in emergency situations where quick and efficient airway management is critical.^{4,5}

Knowing how to operate and locate the device is vital for effective airway management.^{4,5,9} Another significant reason for choosing VL is the improved supervision and support it offers during intubation, making it valuable in both routine and emergency settings. The shared glottic view allows supervisors to guide the intubation process, provide immediate feedback, and intervene when necessary to prevent complications.²⁴⁻²⁶ Ensuring that practitioners are familiar with VL through regular use can further improve outcomes.

This study examined the influence of human factors, such as stress, pushy environment, discomfort, fatigue/after-hours situations, and hunger, on the decision to use VL for intubation. Anesthesia induction and intubation are high-stakes procedures that demand rapid decision-making and precise clinical skills. Human factors can significantly impact the performance of anesthesia providers during these critical moments.^{11,12,18} Studies have shown that stress/pushy environments can reduce working memory capacity and hinder problem-solving abilities, potentially affecting the choice of intubation device.^{5,13} Stress-induced physiological changes, such as increased heart rate and elevated cortisol levels, can also impair coordination and fine motor skills.⁹ Discomfort, often due to poor ergonomic conditions, can negatively affect concentration and efficiency.⁹ Inadequate workstation setups, improper posture, and prolonged standing may lead to musculoskeletal pain and distraction. Additionally, environmental factors, such as extreme temperatures, noise, and psychological discomfort (i.e., anxiety) in unfamiliar environments can increase cognitive load and reduce situational awareness, complicating decision-making during anesthesia.²⁷ Fatigue also negatively affects cognitive and physical performance, impairing attention, memory, and executive function. It slows reaction times and increases error rates, with performance degradation comparable to alcohol intoxication.²⁷ This is particularly concerning in the high-stakes anesthesia settings. Understanding and addressing human factors such as stress, discomfort and fatigue through targeted interventions can improve clinical performance and patient safety.¹² Strategies like simulation training, ergonomic improvements, fatigue management, and promoting proper nutrition can mitigate the adverse effects of human factors and enhance the overall effectiveness of anesthesia providers in high-pressure situations.

This study employed the HFIT model to create a questionnaire assessing various aspects of intubation practices. The results showed a high proportion of affirmative responses across multiple items in [Table 3](#)—for example, 91.5% reported knowing their roles during

intubation and 89.2% indicated clear communication with team members—indicating general competence and situational awareness among respondents. However, the self-analysis method used to assess human factors presents certain limitations.²⁷ Healthcare providers tend to report their non-technical skills higher than when observed in simulation settings.²⁸ Moreover, the relatively low proportions of respondents who reported having a backup plan (67.7%) or observed errors during intubation (64.2%) are concerning. These findings, as shown in [Table 3](#), may indicate under-preparedness or a tendency to underrecognize or underreport errors during airway management. This finding could imply the need for better education and culture around error reporting and analysis.^{9,18} Similarly, the relatively low score on the backup intubation planning reveals a significant gap in airway management preparedness. Having a comprehensive backup plan is essential, especially in difficult airway scenarios, to ensure prompt, effective, and successful management when unexpected situations arise.^{4,5} These findings emphasize the importance of continued focus on developing and implementing robust backup plans in airway management protocols and training programs.

Limitations

While this study offers useful insight into the human factors that prompt clinicians to select VLs and highlights the value of backup plans during difficult intubations, several limitations warrant consideration. First, the analysis is inherently subject to selection bias: only intubations in which providers had already chosen a VL were captured, and participation was voluntary. Because no comparison cohort of conventional direct-laryngoscopy cases was included, causal inference regarding device choice cannot be made.²⁹ Second, the observational, single-center design further limits causal interpretation and external validity. Clinical practices, resource availability, and patient characteristics at Siriraj Hospital may differ from those in other institutions or healthcare systems, constraining generalizability. Third, all human-factor data were obtained from immediate post-procedure self-reports. Although this timing minimizes recall decay, it remains vulnerable to recall and social-desirability bias; providers may under- or over-estimate non-technical behaviors such as situational awareness or error recognition.³⁰ Additionally, the study was not powered for inferential subgroup comparisons, and multivariate analysis was not feasible due to the limited number of unsuccessful intubation cases. Finally, unmeasured confounders—including provider experience, institutional culture, and contemporaneous pandemic-related practice changes—

may have influenced both human-factor ratings and intubation outcomes. These limitations underscore that the present findings are exploratory and hypothesis-generating, with the primary aim of informing the design of future studies rather than guiding immediate changes in clinical practice. Future multi-center studies with objective behavioral assessment and a control group of direct-laryngoscopy cases are needed to confirm and extend these observations.

Strengths and implications

Despite these limitations, this study offers several noteworthy strengths. It is among the few to systematically apply the HFIT to explore decision-making in airway management in real-world operating room settings. By capturing responses immediately after intubation, the study provides timely insights into how internal (e.g., stress, fatigue) and external (e.g., time pressure, communication dynamics) human factors influence the choice to use VLs. The inclusion of multiple provider types—attending anesthesiologists, residents, and nurse anesthetists—adds to the contextual relevance of the findings.

Importantly, the study highlights actionable gaps in current practices, particularly in error recognition and backup planning, which are critical to patient safety. Based on our findings, integrating the HFIT model into airway management practice has several potential applications. It can support routine post-intubation debriefings by enabling systematic reflection on technical and non-technical contributors to performance. HFIT domains can also be used to design simulation scenarios that help trainees recognize and manage system-based challenges, such as communication breakdowns or equipment availability. Finally, embedding HFIT principles into formal airway training programs may enhance decision-making, preparedness, and team coordination, ultimately improving safety and efficiency in airway management.

CONCLUSION

This study identified key human factors influencing the decision to use VLs instead of Macintosh blades in the operating room. Internal factors such as stress and fatigue, along with external pressures like time constraints and high-demand environments, played a significant role in decision-making. Participants cited improved glottic visualization, device familiarity, and enhanced supervision as primary reasons for choosing VLs. By applying the HFIT model, this study systematically captured the interplay of cognitive, organizational, and environmental influences on airway management. The

findings underscore the importance of incorporating HFIT-based frameworks into training, debriefing, and system-level strategies to support safe and efficient intubation practices.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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DECLARATIONS

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Conflict of Interest

None declared.

Registration Number of Clinical Trial

The study did not involve any intervention or prospective assignment of participants; therefore, clinical trial registration was not applicable.

Author Contributions

Conceptualization and Methodology: SP, AY, TJ, KR; Literature review, Investigation, Formal analysis and Writing original draft: SP, AY; Writing review & editing, Data interpretation and Supervision: KR, T.J. All the authors read and agreed with the final version of the manuscript.

Use of Artificial Intelligence

Not applicable.

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