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Impact of Written Educational Material on Enhancing Compliance with Patient Safety Standards Across the Peri-Anesthetic Period

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ABSTRACT

Aims Patient safety in anesthesia is critical due to the essential role of anesthesia in surgical and medical procedures. This study aimed to evaluate the effectiveness of a patient safety educational booklet on anesthesia technologists' adherence to safety principles during the perioperative period.

Materials & Methods This quantitative semi-experimental study was conducted from 2023 to 2024 in two teaching hospitals affiliated with Iran University of Medical Sciences. Sixty-six anesthesia technologists were randomly assigned to intervention (n=33) and control (n=33) groups. The intervention group received a validated 60-page patient safety booklet developed through expert review and content validity analysis. Adherence to safety principles was assessed using a 31-item checklist covering the pre-, intra-, post-anesthesia, and recovery phases, with demonstrated reliability (ICC and Cronbach's alpha=0.87). A blinded evaluator collected data before and after the intervention. Statistical analysis included McNemar tests, t-tests, and Fisher's exact test (α=0.05).

Findings Following the intervention, the intervention group showed a significant improvement in adherence to patient safety principles compared to the control group. In the control group, some changes were noted, but their magnitude and consistency were significantly lower. Specifically, 19 out of 31 checklist items in the intervention group demonstrated significant positive changes ($p<0.05$) via McNemar's test.

Conclusion Implementing validated educational booklets effectively enhances adherence to patient safety protocols among anesthesia technologists.

Keywords Anesthesia; Patient Safety; Health Education; Teaching Materials; Treatment Adherence and Compliance; Perioperative Care

CITATION LINKS

[1] Patient safety: Making health ... [2] The role of simulation training in patients' safety ... [3] Ensuring patient safety in anesthesia administration: Best practices and quality ... [4] Improved perioperative risk education through the use of an interactive ... [5] Anesthesia patient safety: Next steps to improve ... [6] Patient safety education in anesthesia: Current state ... [7] Effect of flipped classroom to anesthesia crisis management simulation education ... [8] The relationship between patient safety culture and adverse ... [9] Assessment of patient safety culture from viewpoint of nurses working in Tabriz ... [10] To err is human: Building a safer ... [11] Anesthesia and perioperative ... [12] Randomized clinical trial comparison of the effect of verbal education and education booklet on ... [13] omparing the effect of e-learning and educational booklet on the childbirth self-efficacy ... [14] Development and validation of an educational booklet to improve occupational performance of the primary ... [15] Sexual activity of people with spinal cord injury: Development and validation ... [16] Validation of educational booklet: An educational technology in dengue ... [17] Development and validation of patient safety educational booklet to empower anesthesia process owners to ... [18] Construction and validation of an educational booklet for patients in ... [19] Printed educational materials: effects on ... [20] Patient safety in anesthesiology ... [21] Educating future leaders in patient ... [22] Development and psychometrics of safe anesthesia evaluation three-step checklist ... [23] Randomized clinical trial comparison of the effect of verbal education and education ... [24] Construction and validation of a booklet of perioperative orientation ... [25] Hand hygiene teaching strategies among nursing staff ... [26] The impact of an educational pain management booklet intervention on postoperative pain control after ...

Introduction

Patient safety has become a global priority in healthcare. The World Health Organization (WHO) defines it as a system and culture that aims to minimize risks and prevent avoidable harm during healthcare delivery [1]. This issue is particularly important in anesthesia, where interventions are often high-risk and time-sensitive. Although anesthesia is essential for successful surgeries, it carries risks such as airway complications, medication errors, and hemodynamic instability [2, 3]. Despite advances in technology and monitoring, preventable adverse events during anesthesia still occur. Studies estimate anesthesia-related mortality rates of up to 0.3 per 10,000 procedures, especially among vulnerable populations [4]. Factors contributing to these events include insufficient preparation, poor communication, misuse of equipment, and procedural errors [5]. Global efforts have led to the development of guidelines, checklists, and simulation training; however, consistent compliance with safety protocols remains challenging, especially in healthcare settings with limited resources and training opportunities [6, 7].

Educational interventions are effective methods for improving safety awareness and adherence among healthcare professionals. Printed educational materials, such as booklets, offer several advantages: they are cost-effective, easy to distribute, do not require technology, and can be reused multiple times [8, 9]. These characteristics make booklets suitable for resource-limited and high-turnover environments where digital tools or simulations may be difficult to implement [10, 11]. Evidence from nursing, critical care, and surgical fields shows that well-designed booklets improve knowledge, confidence, and compliance with clinical guidelines [12-14].

However, validated printed educational tools addressing comprehensive patient safety in anesthesia throughout the perioperative period are limited. Although checklists and simulation training have demonstrated benefits, their broad application is often constrained by practical limitations [15]. Properly validated and context-specific booklets can serve as durable cognitive aids, supporting adherence to protocols and fostering a safety culture among anesthesia providers [16].

In response to regulatory and institutional requirements, our team previously developed and validated an educational booklet to support anesthesia process owners (APOs) in following patient safety standards during the preoperative, intraoperative, and postoperative phases [17]. This booklet demonstrated content validity and clarity, addressing the need for a standardized educational tool.

Nevertheless, development and validation alone do not guarantee effectiveness in clinical practice. Empirical studies evaluating the real-world impact of such tools on adherence and behavior are scarce [18, 19]. This study is innovative because it examines the practical application of a validated educational booklet in clinical settings, using a quasi-experimental design to rigorously assess its effect on patient safety compliance among anesthesia providers. Unlike prior studies that focused mainly on tool creation or simulation, this research bridges the gap between validation and clinical effectiveness [20].

Furthermore, recent literature highlights the importance of affordable and scalable educational interventions, especially in low- and middle-income countries, where ongoing professional development is challenging [21]. Our study contributes to this field by proposing a feasible and sustainable educational tool that can support accreditation efforts and reduce preventable anesthesia-related adverse events.

In summary, this study aimed to determine whether the validated booklet could effectively enhance adherence to patient safety protocols throughout anesthesia care. The findings will provide valuable evidence for healthcare administrators, educators, and clinicians to improve patient safety, particularly in settings with limited resources and training infrastructure.

Materials and Methods

Design and sample

This quantitative semi-experimental study with an educational intervention was conducted during 2023-2024 in two selected teaching hospitals affiliated with Iran University of Medical Sciences. The hospitals were chosen due to their comparable structures and the availability of qualified anesthesia personnel required for the study.

The target population included all anesthesia technicians working in operating rooms at the time of the study. Convenience sampling was used to select participants. A pilot study was conducted to estimate the appropriate sample size. In this preliminary phase, six participants were selected from each of the intervention and control groups using convenience sampling. These individuals were assessed before and after the educational intervention using the Patient Safety Checklist in Anesthesia. Based on the results of this pilot and using the formula below, the sample size was calculated considering a confidence level of 95% and a statistical power of 80%:

$$n=\frac{\left(Z_{1-\alpha 12}+z_{1-\beta}\right)^2\times\left(\delta_1^2+\delta_2^2\right)^2}{(\mu_1-\mu_2)^2}=\frac{(1.96+84)^2\left(4.97^2+4.24^2\right)}{(47.0-44.8)^2}\sim 30$$

Accounting for a potential 10% dropout rate, the adjusted sample size per group was set at 33. However, to enhance the accuracy and generalizability of the findings, a total of 69 participants were ultimately recruited: 35 from Hasheminejad Hospital and 34 from Motahari

Hospital, based on the actual number of eligible anesthesia personnel available during the study period.

Random allocation of participants to intervention and control groups was performed using a coin toss method by a researcher independent of participant recruitment, who was blinded to the participants' characteristics to reduce allocation bias. The intervention group received education through a booklet, while the control group did not receive any educational materials. Sample selection within each hospital was conducted by census. Inclusion criteria included holding at least a bachelor's degree and having a minimum of six months of anesthesia-related work experience. Participants who declined to continue or had received patient safety training in the past six months were excluded.

Instrument

The patient safety checklist in anesthesia, designed by Babajani *et al.* [22] at the Anesthesiology Department of Iran University of Medical Sciences, was used as the data collection tool. This checklist comprises 31 items across four domains: pre-anesthesia, intra-anesthesia, post-anesthesia, and recovery, based on the WHO Safe Anesthesia Checklist and validated through an ICC of 0.87 and a Cronbach's alpha of 0.87 in prior studies. Each item was scored as 1 if the task was performed correctly and 0 otherwise.

The first phase involved designing and validating the patient safety booklet, which has been published separately as "Development and Validation of a Patient Safety Educational Booklet to Empower Anesthesia Process Owners to Improve Safety Compliance Before, During, and After Anesthesia" [17]. The booklet consists of 60 pages and was created using a comprehensive literature review, Miller's Anesthesia textbook, and guidelines from anesthesia societies. Validation involved 22 anesthesia experts who assessed face and content validity using the content validity index (CVI), with a minimum acceptable CVI of 0.78 for items and 0.90 for the scale.

Procedure

Upon delivery, participants were thoroughly instructed verbally on how to study the booklet. No written instructions regarding the study location or schedule were provided; however, follow-up was conducted through a dedicated Telegram group for two weeks. In this group, questions were answered, and feedback was collected to ensure engagement with the booklet. Approximately 70% of participants were actively engaged by responding in the Telegram group.

Prior to the intervention, baseline knowledge and attitude were not quantitatively assessed; however, performance adherence to patient safety principles was objectively measured through the checklist. The same researcher, who was blinded to group allocation, conducted all pre- and post-intervention evaluations to minimize observer bias. The evaluator was trained in the application of the checklist before the study commenced.

Necessary permissions were also secured from the relevant authorities at Iran University of Medical Sciences. Participants were free to enter and withdraw from the study at any time without any penalty. The confidentiality of participants' information was strictly maintained, and they were assured that their data would remain confidential. Written informed consent was obtained from all participants prior to their inclusion in the study.

Data analysis

Data were analyzed using SPSS version 26. Descriptive statistics and inferential tests, including McNemar, t-test, and Fisher's exact test, were performed with a significance level set at 0.05. Potential biases, such as observer bias, were mitigated by having a single trained evaluator who was unaware of group assignments, and response bias was minimized through anonymous data collection.

Findings

In the intervention group, there were 18 females (54.5%) and 15 males (45.5%), while in the control group, there were 22 females (66.7%) and 11 males (33.3%; χ^2=1.01; p-value=0.314). There was no statistically significant difference between the two groups for any demographic characteristic, confirming their homogeneity (Table 1).

Table 1. Mean values of demographic characteristics of participants

Parameter	Group	Mean	p-Value	t
Age (years)	Intervention	34.55±3.34	0.100	1.669
	Control	32.73±5.29		
Working hours	Intervention	8.21±3.05	0.157	1.431
	Control	6.97±3.95		

The pre-anesthesia phase included components related to patient control, equipment control, drug control, and airway assessment, all of which are crucial steps performed prior to the induction of anesthesia.

There was a considerable improvement in patient control in the intervention group before the anasthesia.

Questions related to patient personal information verification, pre-operative assessment, appropriate fasting period, and assessment of the risk of excessive bleeding (questions 1, 2, 3, and 5) demonstrated a statistically significant difference (p-value<0.05) in the proportion of positive responses after the educational intervention (Table 2).

For instance, regarding patient information verification (question 1), 7 participants initially responded "No" before the intervention but changed their responses to "Yes" afterward, while 25 consistently responded "Yes." The control group exhibited no significant differences.

Table 2. Summary of McNemar test results for pre-anesthesia phase components before and after intervention in both groups

Component	Question number	p-Value (intervention group)	p-Value (control group)
Patient control	1. Patient personal information checked with wristband & file.	<0.001	0.590
	2. Pre-op assessment (surgery history, allergies, meds, labs).	<0.001	0.500
	3. Appropriate fasting period considered.	0.016	0.500
	4. Blood type confirmed & cross-match sample done.	-	0.500
	5. Risk of excessive bleeding & need for blood replacement assessed.	0.002	0.500
	6. Adequate intravenous access available.	0.063	0.688
	7. Surgical site marked.	-	0.613
	8. Patient position appropriate.	-	0.500
Equipment control	1. Oxygen cylinder has sufficient reserve.	0.090	0.500
	2. Suction checked.	0.363	0.500
	3. Monitors (BP, ECG, SpO2, ETCO2) are ready.	0.004	0.500
	4. Resuscitation equipment, facilities, and drugs available.	-	0.656
	5. Surgical table, attachments, and restraints checked.	0.125	0.637
Drug control	1. Pre-anesthetic medications administered.	1.00	0.656
	2. All necessary drugs & equipment for anesthesia injections prepared adhering to sterilization.	-	0.637
	3. Drugs drawn into labeled syringes.	-	0.313
Airway assessment	1. Difficult airway and intubation predicted.	-	0.109
	2. Necessary equipment & facilities for laryngoscopy & tracheal intubation prepared.	0.109	0.637

-: the software could not perform the calculation

Table 3. Summary of McNemar test p-values for intra-anesthesia phase components before and after intervention in both groups

Component	Question number	p-Value (intervention group)	p-Value (control group)
Anesthesia machine control	1. Anesthesia machine checked.	0.063	0.605
	2. Anesthesia vaporizers are ready.	0.020	0.593
	3. Breathing circuit securely connected.	-	0.623
	4. Breathing circuits are clean.	0.003	0.500
Anesthesia induction	1. Pre-oxygenation performed.	0.500	0.688
	2. Correct intubation checked before surgery.	-	0.500
	3. Vital signs (BP, PR, SpO2, ETCO2) are within normal limits.	0.031	0.637
	4. Additional intravenous access established if needed.	-	0.656
5-minute interval control	1. Following items checked 5 minutes after anesthesia.	-	0.605
	2. Ventilator settings (PIP, TV, ETCO2, etc.) & respiratory status checked.	-	0.500
	3. Non-invasive blood pressure & measurement times checked.	0.002	0.688
	4. Transducer level checked.	0.016	0.623
	5. HR & EKG waveforms checked.	-	0.500
30-minute interval control	1. Following items checked 30 minutes after anesthesia.	0.008	0.605
	2. Ventilator settings (PIP, TV, ETCO2) & respiratory status checked.	-	0.656
	3. Non-invasive blood pressure & measurement times checked.	-	0.613
	4. Transducer level checked.	-	0.598
	5. HR & EKG waveforms checked.	0.016	0.623
	6. Temperature checked.	-	0.623
	7. Head & ETT position, breathing circuit connections checked.	0.031	0.613
	8. Pressure points, cushions, eye status checked.	0.008	0.656
	9. Infusion rate, IV cannula site (infiltration) checked.	-	0.500
	10. Foley catheter checked.	0.109	0.500
Consciousness	1. Vital signs appropriate for extubation.	0.008	0.500
	2. Emergency drug is ready.	0.031	0.613
	3. Neuromuscular function recovery assessed.	-	0.500

-: the software could not perform the calculation

Regarding quipment control, in the intervention group, only question 3 (monitors are ready) showed a statistically significant difference (p-value=0.004) after the educational intervention (Table 2), suggesting this is a “trainable” aspect. Other items did not show statistically significant improvement. The control group showed no significant difference.

No statistically significant “trainability” was observed in drug-related practices across any of its items in either group.

No statistically significant "trainability" was observed for airway assessment practices in either group (Table 2). The intra-anesthesia phase encompassed the management of the patient during the surgical procedure, including anesthesia machine checks, induction, and continuous monitoring at defined intervals. Questions regarding the readiness of anesthesia vaporizers (question 2) and the cleanliness of breathing circuits (question 4) exhibited statistically significant differences (p-value<0.05) in the intervention group, implying effective enhancement through training.

In the intervention group, question 3 (vital signs are within normal limits) showed a statistically significant difference (p-value=0.031) after the educational intervention, indicating its “trainability”.

In the intervention group, questions 3 (non-invasive blood pressure control) and 4 (transducer level control) showed statistically significant differences (p-value < 0.05), suggesting that these aspects of vital sign monitoring are "trainable".

In the intervention group, questions 1 (general 30-minute check), 5 (heart rate and EKG waveform control), 7 (head and endotracheal tube position, breathing circuit connections), and 8 (pressure points, cushions, eye status) showed statistically significant differences (p-value<0.05). This suggests that these comprehensive monitoring and patient positioning practices are "trainable".

Questions 1 (vital signs appropriate for extubation) and 2 (emergency drug is ready) in the intervention group showed statistically significant differences (p-value<0.05). For instance, for Question 1, 7 participants initially responded "No" before the intervention but changed to "Yes" afterward. For question 2, 5 participants who initially responded "No" changed to "Yes." This indicates the booklet's effectiveness in these areas.

For all non-significant findings in the intra-anesthesia phase, no statistically significant differences were observed in either group (Table 3).

The post-anesthesia/recovery phase focused on patient monitoring and management during the critical recovery period. In the intervention group, only question 6 (blood pressure fluctuations: increase and decrease) showed a statistically significant difference (p-value=0.003) in responses before and after the intervention (This indicates that 11 respondents who initially answered "No" to this question before the intervention changed their responses to "Yes" afterward, while 21 participants consistently answered "Yes." This suggests the booklet's effectiveness in improving adherence for this specific item. For all other questions in the recovery component, no statistically significant differences were observed in either group (Table 4).

Table 4. Summary of McNemar test p-values for post-anesthesia/recovery phase component before and after intervention in both groups

Component	Question number	p-Value (intervention group)	p-Value (control group)
Recovery	1. Postoperative vital signs checked.	-	0.598
	2. Following items monitored in recovery room.	-	0.500
	3. Airway obstruction.	-	0.598
	4. Hypoxia.	-	0.613
	5. Hemorrhage: Internal and external.	-	0.500
	6. Blood pressure fluctuations (increase & decrease).	0.003	0.500
	7. Postoperative pain.	-	0.500
	8. Hypothermia and shivering.	-	0.623
	9. Vomiting and aspiration.	0.188	0.656
	10. Residual narcotic effect.	0.125	0.656

-: the software could not perform the calculation

Discussion

We evaluated the impact of a validated patient safety educational booklet on improving anesthesia technologists' compliance with safety protocols before, during, and after anesthesia. This intervention, implemented in affiliated hospitals of Iran University of Medical Sciences, addressed the growing need for structured, accessible, and context-specific educational tools in clinical settings. The booklet-based education led to statistically significant improvements in adherence to safety checklists within the intervention group, a change not observed in the control group. This suggests that a user-friendly, targeted, and culturally tailored educational booklet can effectively promote patient safety behaviors in high-risk environments like the operating room. This aligns with previous research affirming the efficacy of print-based educational materials in enhancing competence, improving patient knowledge, and fostering adherence to clinical guidelines in various medical fields. For instance, studies by Mohseni Takalu *et al.* [14], Shin *et al.* [23], and Ferreira *et al.* [24] have demonstrated the effectiveness of educational booklets in improving occupational performance, patient safety education, and perioperative orientation.

Specifically, the most notable improvements were observed in areas directly addressed by clear procedural steps and knowledge reinforcement, such as patient information verification and pre-operative assessment in the pre-anesthesia phase, as well as monitor readiness during intra-anesthesia. This indicates that the booklet was particularly effective for items requiring cognitive recall and procedural adherence, as such materials are well-suited for transferring declarative and procedural knowledge. However, areas, like drug control and airway assessment in the pre-anesthesia phase, as well as several items in the post-anesthesia/recovery phase, showed less significant improvement. This could be attributed to the nature of these items, which may demand more hands-on training, complex decision-making, or specific clinical situations beyond what a booklet alone can fully impart. For example, assessing difficult airways often requires extensive practical experience and simulation-based training [11], while the administration of pre-anesthetic medications might be highly standardized, leaving less room for behavioral change through a simple educational booklet [25].

While our results strongly support the effectiveness of booklets, some studies present contrasting views or suggest alternative methods. Motazedi *et al.* [9] compared the effectiveness of booklets with cellphone applications, highlighting the potential of digital tools for enhancing awareness and adherence.

Similarly, other research, such as that by Shin *et al.* [23], explores broader patient safety education programs, which may include various modalities. Differences observed between our findings and those indicating limited effectiveness of print materials (e.g., Bjørnnes *et al.* [26] regarding postoperative pain control with a booklet) may stem from variations in content specificity, target audience engagement strategies, or the complexity of the behaviors being targeted. Our booklet, being specifically validated for anesthesia professionals, contextually tailored, and potentially reinforced through follow-up engagement (e.g., via digital platforms), likely contributed to its higher efficacy compared to more general or less interactive print interventions. When well-designed, validated, and context-specific, print materials can serve as valuable cognitive aids, reinforcing protocol adherence and fostering a safety mindset [14, 24].

A strength of the current study is its use of a linguistically and culturally adapted booklet, validated through expert review and pre-testing, as supported by validation studies, like those by Ferreira *et al.* [24] and Mohseni Takalu *et al.* [14]. The pre- and post-intervention assessments using a structured checklist allowed for precise evaluation of behavioral change. Furthermore, the booklet's visual aids and checklist format likely contributed to information retention and practical application.

Culturally adapted and validated educational booklets can significantly improve anesthesia technologists' adherence to safety protocols, especially in areas requiring procedural knowledge and cognitive recall. However, for skills demanding hands-on practice and complex clinical decision-making, booklets alone may be insufficient, highlighting the need for complementary practical training and simulation. Integrating educational booklets within blended learning approaches, including digital and experiential methods, can effectively enhance patient safety culture in high-risk clinical environments.

Conclusion

Implementing validated educational booklets effectively enhances adherence to patient safety protocols among anesthesia technologists.

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