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Original Article

Knowledge and Attitude of Anesthesia Technologist About Infection Control Practices in OR

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ABSTRACT

Background: Infection prevention is essential in operating rooms because anesthesia personnel frequently handle airway devices, anesthesia equipment, medications, invasive devices, and high-touch surfaces that may facilitate cross-contamination. Objective: To assess the knowledge, attitudes, and self-reported infection-control practices of anesthesia technologists working in selected hospitals in Lahore, Pakistan. Methods: A descriptive cross-sectional study included 57 practicing anesthesia technologists recruited through purposive sampling from three hospitals. Data were collected using a structured electronic questionnaire covering demographic characteristics, knowledge, attitudes, and self-reported practices. Categorical data were analysed using IBM SPSS Statistics version 27.0 and presented as frequencies and percentages. Results: Understanding of infection control was reported by 98.2% of participants, awareness of surgical-site infection guidelines by 96.5%, and knowledge of proper hand hygiene by 89.5%. Although 98.2% considered infection-control practices important, only 49.1% agreed that hand hygiene reduces cross-contamination, while 47.4% disagreed. Equipment cleaning after each procedure was reported by 91.2%, sterile technique by 89.5%, and proper medical-waste disposal by 89.5%. Reporting infection-control breaches was the least favourably endorsed practice at 70.2%. Conclusion: Participants reported strong awareness of several infection-control principles, but important gaps remained in understanding hand hygiene and reporting breaches. Targeted training and direct clinical auditing are needed. Keywords: Anesthesia technologists; Cross-contamination; Hand hygiene; Infection prevention and control; Operating room; Patient safety; Personal protective equipment

INTRODUCTION

Healthcare-associated infections are infections acquired by patients while receiving care for conditions unrelated to the infection itself. They remain an important cause of avoidable morbidity, prolonged hospitalization, increased healthcare expenditure, and preventable mortality. The burden is particularly important in surgical environments, where invasive procedures, frequent contact with biological materials, repeated handling of medical equipment, and breaches in aseptic technique may facilitate the transmission of microorganisms. Effective infection prevention and control programmes, supported by trained healthcare personnel and institutional monitoring, are therefore essential for reducing healthcare-associated infections and improving patient safety (1).

The operating room is a highly controlled but inherently high-risk clinical environment. Patients undergoing surgical and diagnostic procedures may be exposed to infection through contaminated hands, inadequately disinfected surfaces, reusable equipment, invasive devices, medications, and breaches in sterile technique. During anesthesia care, healthcare personnel frequently handle airway devices, breathing circuits, intravenous equipment, medication-delivery systems, monitoring devices, and anesthesia workstations. These activities may create opportunities for cross-contamination when

appropriate hand hygiene, equipment disinfection, personal protective equipment, and aseptic procedures are not consistently applied (2).

Anesthesia technologists contribute directly to perioperative patient safety by preparing and maintaining anesthesia equipment, assisting during anesthesia procedures, supporting sterile handling, managing reusable devices, and ensuring the appropriate disposal of contaminated materials. Their responsibilities place them in frequent contact with patients, healthcare workers, potentially infectious material, and high-touch clinical surfaces. Adequate knowledge of infection-control principles is therefore necessary to identify potential hazards and apply appropriate preventive measures. However, knowledge alone may not ensure consistent compliance unless it is accompanied by favourable attitudes, adequate institutional resources, effective training, and a strong culture of patient safety and professional accountability (3).

Hand hygiene is one of the most important measures for preventing cross-transmission in healthcare settings. Appropriate use of personal protective equipment, cleaning and disinfection of anesthesia machines and reusable equipment, maintenance of aseptic technique, safe waste disposal, and prompt reporting of infection-control breaches are also fundamental components of perioperative infection prevention. Failure to apply these measures consistently may expose patients and healthcare personnel to preventable infection risks (4). In resource-constrained healthcare systems, compliance may be further influenced by limited supplies, variable institutional protocols, inadequate refresher training, workload pressures, and insufficient monitoring of infection-control practices (5).

Knowledge, attitude, and practice assessments are commonly used to identify educational and behavioural gaps among healthcare professionals. Knowledge reflects awareness and understanding of infection-control principles, attitudes represent beliefs and perceptions regarding their importance, and practices describe the reported application of preventive measures in clinical work. Examining these domains separately is important because healthcare professionals may demonstrate adequate theoretical knowledge while reporting inconsistent application of infection-control procedures (5-8).

Although infection prevention among operating-room personnel has received increasing attention, evidence specifically concerning anesthesia technologists in Pakistan remains limited. Their infection-control responsibilities differ from those of surgeons, nurses, and other operating-room personnel, and their professional practices require focused evaluation. Identifying areas of strength and deficiency may assist hospitals in developing targeted training, reinforcing institutional protocols, and improving perioperative safety. Therefore, this study aimed to assess the knowledge, attitudes, and self-reported infection-control practices of anesthesia technologists working in operating rooms at selected hospitals in Lahore, Pakistan (7).

MATERIALS AND METHODS

A quantitative descriptive cross-sectional study was conducted over a four-month period to assess the knowledge, attitudes, and self-reported infection-control practices of anesthesia technologists working in operating rooms. The study was undertaken at the University of Lahore Teaching Hospital, Mayo Hospital, and Sir Ganga Ram Hospital in Lahore, Pakistan. These institutions were selected to obtain responses from anesthesia technologists working in different hospital environments.

The target population comprised practicing anesthesia technologists assigned to operating-room services at the selected hospitals. Participants were recruited using a non-probability purposive sampling technique. Anesthesia technologists were eligible if they were currently working in an operating room, had more than one year of professional experience, and voluntarily agreed to participate. Students of anesthesia technology, student trainees, personnel who were not currently practicing, and staff members who were not assigned to operating-room services were excluded.

A total of 57 anesthesia technologists were included. The sample size was determined using a finite-population sample-size approach applied during the planning stage of the study. Eligible participants were approached electronically, and access to the survey was provided through professional communication channels, including WhatsApp and other electronic platforms. Participation was voluntary, and only responses submitted by individuals meeting the eligibility criteria were included in the analysis.

Data were collected using a structured, self-administered questionnaire developed after reviewing the relevant literature and considering the objectives of the study. The questionnaire comprised four components. The first component collected demographic and professional information, including age, gender, educational qualification, professional experience, hospital category, previous formal infection-control training, attendance at infection-control workshops, and average daily working hours. The remaining components assessed knowledge, attitudes, and self-reported practices related to infection prevention and control in the operating room.

Knowledge items assessed participants' awareness of the concept of infection control, guidelines for preventing surgical-site infections, appropriate use of personal protective equipment, proper hand hygiene, recommended hand-scrubbing duration, risks associated with contaminated anesthesia equipment, the role of anesthesia technologists in infection prevention, and cleaning of anesthesia machines. Knowledge responses were recorded as yes or no.

Attitude items examined participants' perceptions regarding the importance of infection-control practices, the role of anesthesia technologists in preventing infection, the contribution of hand hygiene to reducing cross-contamination, the effect of infection-control guidelines on patient safety, the need for professional training, the importance of sterile handling, adherence to infection-control protocols, and the use of personal protective equipment during procedures. Responses to attitude items were recorded as agree, neutral, or disagree.

Self-reported practice items evaluated glove use during procedures, disinfection of anesthesia equipment, changing gloves between procedures, maintenance of sterile technique while assisting with anesthesia, appropriate disposal of medical waste, use of face masks during procedures, cleaning of equipment after each procedure, reporting of infection-control breaches, and participation in infection-control training. Practice responses were recorded as yes, maybe, or no. Because the study relied on participant responses rather than direct clinical observation, these variables were interpreted as self-reported practices and not as independently verified compliance with infection-control standards.

Completed electronic questionnaires were reviewed for eligibility and completeness before analysis. Responses were coded and entered into IBM SPSS Statistics version 27.0. Categorical variables were summarized using frequencies and percentages. All analyses were descriptive, and no causal relationships or associations between participant characteristics and infection-control outcomes were inferred.

The study was initiated after clearance from the relevant departmental research committee. Participation was voluntary, and confidentiality was maintained by analysing responses in aggregate form without presenting personally identifiable information. The research procedures were conducted in accordance with applicable institutional principles for ethical research involving human participants.

RESULTS

All 57 anesthesia technologists included in the study provided responses to the demographic, knowledge, attitude, and self-reported practice items. The findings are presented descriptively as frequencies and percentages.

The largest age group was 25–28 years, comprising 32 participants (56.1%). Most participants were male (70.2%), held a bachelor's degree (91.2%), and had 1–3 years of professional experience (73.7%). Government hospitals accounted for the largest proportion of participants (47.4%). Formal infection-control training had been received by 36 participants (63.2%), while 35 (61.4%) had attended an infection-control workshop. Most participants worked 8-hour shifts (80.7%).

Table 1. Demographic and Professional Characteristics of Participants (N = 57)

Characteristic	Category	n (%)
Age, years	20–24	19 (33.3)
	25–28	32 (56.1)
	29–31	6 (10.5)
Gender	Male	40 (70.2)
	Female	17 (29.8)
Educational qualification	Bachelor's degree	52 (91.2)
	Master's degree	5 (8.8)
Professional experience	1–3 years	42 (73.7)
	4–6 years	11 (19.3)
	More than 6 years	4 (7.0)
Hospital category	Government hospital	27 (47.4)
	Private hospital	19 (33.3)
	Teaching hospital	11 (19.3)
Formal infection-control training	Yes	36 (63.2)
	No	21 (36.8)
Attendance at infection-control workshop	Yes	35 (61.4)
	No	22 (38.6)
Daily working hours	8 hours	46 (80.7)
	9–10 hours	6 (10.5)
	More than 10 hours	5 (8.8)

Table 2. Knowledge of Infection-Control Practices Among Anesthesia Technologists (N = 57)

Knowledge item	Yes, n (%)	No, n (%)
Understanding of the concept of infection control	56 (98.2)	1 (1.8)
Awareness of guidelines for preventing surgical-site infection	55 (96.5)	2 (3.5)
Knowledge of personal protective equipment	54 (94.7)	3 (5.3)
Knowledge of proper hand hygiene	51 (89.5)	6 (10.5)
Knowledge of the recommended hand-scrubbing duration	55 (96.5)	2 (3.5)
Awareness of risks associated with contaminated anesthesia equipment	53 (93.0)	4 (7.0)
Awareness of the anesthesia technologist's role in infection control	55 (96.5)	2 (3.5)
Knowledge of cleaning anesthesia machines	51 (89.5)	6 (10.5)

Knowledge responses were generally favourable across the assessed items. Understanding of the concept of infection control was reported by 56 participants (98.2%). Awareness of surgical-site infection prevention guidelines, the recommended duration of hand scrubbing, and the role of anesthesia technologists in infection control was reported by 55 participants (96.5%) for each item. Knowledge was comparatively lower for proper hand hygiene and cleaning of anesthesia machines, although both were still reported by 51 participants (89.5%).

Table 3. Attitudes Toward Infection-Control Practices Among Anesthesia Technologists (N = 57)

Attitude item	Agree, n (%)	Neutral, n (%)	Disagree, n (%)
Infection-control practices are important	56 (98.2)	0 (0.0)	1 (1.8)
Anesthesia technologists have an important role in preventing infection	44 (77.2)	8 (14.0)	5 (8.8)
Hand hygiene reduces cross-contamination	28 (49.1)	2 (3.5)	27 (47.4)
Infection-control guidelines improve patient safety	37 (64.9)	8 (14.0)	12 (21.1)
Infection-control training is necessary for anesthesia technologists	52 (91.2)	3 (5.3)	2 (3.5)
Sterile handling helps prevent infection	53 (93.0)	3 (5.3)	1 (1.8)
Infection-control protocols should be followed strictly	53 (93.0)	4 (7.0)	0 (0.0)
Personal protective equipment should be used during procedures	50 (87.7)	6 (10.5)	1 (1.8)

Most participants agreed that infection-control practices were important (98.2%), sterile handling helped prevent infection (93.0%), and infection-control protocols should be followed strictly (93.0%). Similarly,

52 participants (91.2%) agreed that infection-control training was necessary, and 50 (87.7%) supported the use of personal protective equipment during procedures. Responses were less favourable for two items. Only 37 participants (64.9%) agreed that infection-control guidelines improve patient safety, while 12 (21.1%) disagreed. The greatest attitudinal inconsistency concerned hand hygiene: 28 participants (49.1%) agreed that hand hygiene reduces cross-contamination, whereas 27 (47.4%) disagreed and 2 (3.5%) remained neutral.

Table 4. Self-Reported Infection-Control Practices Among Anesthesia Technologists (N = 57)

Self-reported practice item	Yes, n (%)	Maybe, n (%)	No, n (%)
Wearing gloves during procedures	47 (82.5)	6 (10.5)	4 (7.0)
Disinfecting anesthesia equipment	48 (84.2)	3 (5.3)	6 (10.5)
Changing gloves for each procedure	47 (82.5)	5 (8.8)	5 (8.8)
Maintaining sterile technique while assisting with anesthesia	51 (89.5)	5 (8.8)	1 (1.8)
Properly disposing of medical waste	51 (89.5)	6 (10.5)	0 (0.0)
Wearing a face mask during procedures	46 (80.7)	8 (14.0)	3 (5.3)
Cleaning equipment after each procedure	52 (91.2)	3 (5.3)	2 (3.5)
Reporting breaches in infection-control practices	40 (70.2)	2 (3.5)	15 (26.3)
Participating in infection-control training	44 (77.2)	11 (19.3)	2 (3.5)

The reported responses represent participants' self-reported practices and were not verified through direct clinical observation or audit.

Cleaning equipment after each procedure was the most frequently reported favourable practice, reported by 52 participants (91.2%). Maintaining sterile technique while assisting with anesthesia and properly disposing of medical waste were each reported by 51 participants (89.5%). Disinfection of anesthesia equipment was reported by 48 participants (84.2%), while wearing gloves and changing gloves between procedures were each reported by 47 participants (82.5%).

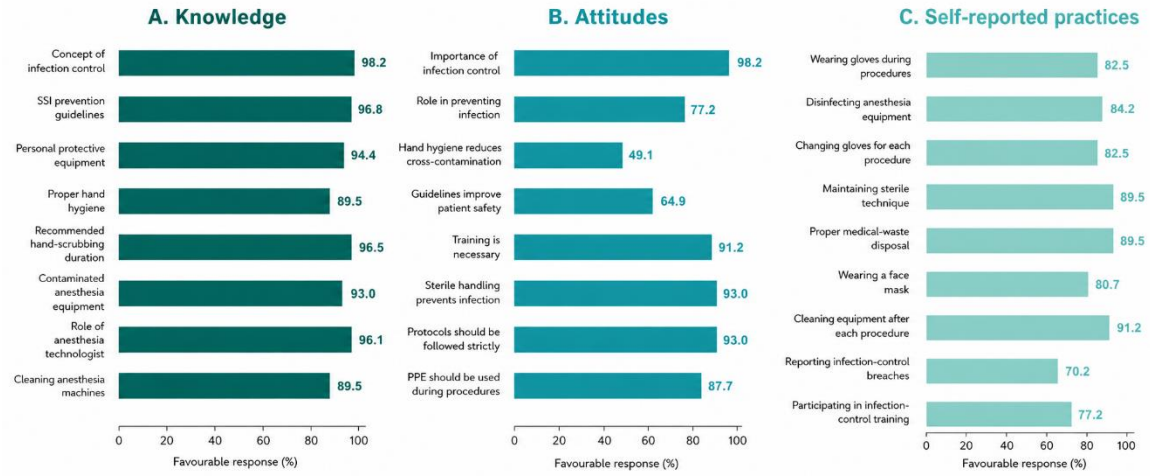

Figure 1. Item-level favourable responses across knowledge, attitude, and self-reported practice domains among anesthesia technologists (N = 57). Panel A presents affirmative knowledge responses, Panel B presents agreement with attitude statements, and Panel C presents affirmative self-reported practice responses. Favourable responses were defined as "Yes" for knowledge and practice items and "Agree" for attitude items. Practice findings were self-reported and were not independently verified through direct observation or clinical audit. Knowledge responses were consistently high, ranging from 89.5% for proper hand hygiene and cleaning of anesthesia machines to 98.2% for understanding the concept of infection control. Attitudes were more variable, with 98.2% recognizing the importance of infection-control practices but only 49.1% agreeing that hand hygiene reduces cross-contamination. Self-reported favourable practices ranged from 70.2% for reporting infection-control breaches to 91.2% for cleaning equipment after each procedure. The figure therefore demonstrates a marked discrepancy between high general infection-control awareness and weaker understanding or application in selected areas, particularly hand-hygiene-related cross-contamination and breach reporting.

Reporting breaches in infection-control practices was the least frequently endorsed practice. Only 40 participants (70.2%) reported that breaches should be reported, while 15 (26.3%) responded negatively. Participation in infection-control training was reported by 44 participants (77.2%), although 11 (19.3%)

selected "maybe." Face-mask use during procedures was reported by 46 participants (80.7%), with 8 (14.0%) expressing uncertainty.

Overall, the item-level findings demonstrated high reported knowledge of several fundamental infection-control principles and favourable attitudes toward training, sterile handling, protocol adherence, and personal protective equipment. However, the near-equal division of responses regarding whether hand hygiene reduces cross-contamination represented an important inconsistency. The self-reported practice findings also indicated comparatively weaker responses regarding the reporting of infection-control breaches and participation in infection-control training. Because no validated composite scoring procedure was reported, participants were not classified into overall categories of adequate knowledge, positive attitude, or satisfactory practice.

DISCUSSION

This descriptive cross-sectional study assessed the knowledge, attitudes, and self-reported infection-control practices of 57 anesthesia technologists working in selected hospitals in Lahore. Participants generally reported strong awareness of fundamental infection-control principles, including the concept of infection control, surgical-site infection prevention guidelines, personal protective equipment, recommended hand-scrubbing duration, contaminated anesthesia equipment, and the role of anesthesia technologists in infection prevention. Favourable responses were also observed for several attitude and self-reported practice items, particularly the importance of infection control, sterile handling, strict adherence to protocols, equipment cleaning, aseptic technique, and medical-waste disposal. Nevertheless, important inconsistencies were identified in understanding the role of hand hygiene in preventing cross-contamination and in the reporting of infection-control breaches.

The high level of reported knowledge regarding infection prevention was consistent with evidence showing that healthcare personnel working in operating rooms frequently demonstrate awareness of core infection-control procedures. Structured institutional protocols, repeated exposure to aseptic procedures, and routine participation in perioperative care may contribute to familiarity with infection prevention measures. Operating-room personnel are expected to understand surgical-site infection prevention, hand hygiene, personal protective equipment, sterile technique, and equipment decontamination because these practices are integral to patient safety in invasive clinical environments (1,2). Anesthesia technologists also interact closely with airway equipment, anesthesia machines, breathing circuits, monitoring devices, medications, and high-touch surfaces, making infection-control knowledge particularly relevant to their professional responsibilities (3,4).

Although knowledge responses were generally favourable, knowledge was not uniformly distributed across all items. Knowledge of proper hand hygiene and cleaning of anesthesia machines was reported by 89.5% of participants, which was lower than awareness of the general concept of infection control at 98.2% and awareness of surgical-site infection guidelines at 96.5%. This difference suggests that general familiarity with infection-control principles may not always translate into equally strong understanding of procedure-specific requirements. Theoretical and evidence-based infection-control guidance in anesthesia emphasizes that contamination may occur through equipment, environmental surfaces, medication handling, airway procedures, and inadequate hand hygiene, requiring consistent application of multiple preventive measures rather than reliance on general awareness alone (2).

The most important inconsistency concerned the relationship between hand hygiene and cross-contamination. Although 89.5% of participants reported knowledge of proper hand hygiene, only 49.1% agreed that hand hygiene reduces cross-contamination, while 47.4% disagreed. This near-equal division may indicate a conceptual misunderstanding, ambiguity in questionnaire wording, or limitations in the validity of the attitude item. Hand hygiene is a central component of perioperative infection prevention because the hands of healthcare personnel may facilitate transmission between patients, equipment, medications, environmental surfaces, and invasive devices (4). The finding therefore identifies an

educational priority, but it should be interpreted cautiously because the questionnaire's psychometric properties and item-validation procedures were not reported.

Attitudes were favourable for several other aspects of infection prevention. Most participants agreed that infection-control practices were important, that training was necessary, that sterile handling helped prevent infection, and that infection-control protocols should be followed strictly. These findings were broadly consistent with previous research among operating-room nurses and anesthesia professionals, in which participants recognized the importance of hand hygiene, personal protective equipment, sterile procedures, and adherence to infection-prevention guidelines (6,7). However, only 64.9% of participants agreed that infection-control guidelines improve patient safety, and 21.1% disagreed. This result suggests that some participants may perceive protocols as administrative requirements rather than as direct patient-safety interventions. Educational programmes should therefore explain not only the required procedures but also the mechanisms through which adherence reduces contamination, surgical-site infections, occupational exposure, and preventable adverse outcomes (8-12).

Self-reported practices were strongest for cleaning equipment after each procedure, maintaining sterile technique while assisting with anesthesia, and properly disposing of medical waste. More than 80% of participants also reported wearing gloves, disinfecting anesthesia equipment, changing gloves between procedures, and wearing face masks. These responses suggest broad acceptance of routine infection-control measures. However, self-reported behaviour should not be interpreted as confirmed compliance because the study did not include direct observation, clinical audit, environmental sampling, or review of institutional records. Self-report surveys are vulnerable to recall bias and social-desirability bias, particularly when respondents are asked about professionally expected behaviours.

Reporting breaches in infection-control practices was the least favourably endorsed practice, with only 70.2% responding positively and 26.3% responding negatively. Failure to report breaches may allow unsafe practices to continue and may weaken institutional learning and accountability. Reluctance to report may be associated with fear of blame, uncertainty regarding reporting pathways, lack of feedback, or inadequate safety culture; however, these potential explanations were not measured in the present study and should not be interpreted as established determinants. Hospitals may benefit from confidential and non-punitive reporting systems, clear escalation procedures, and regular feedback concerning corrective actions.

Formal infection-control training had been received by 63.2% of participants, while 61.4% had attended an infection-control workshop. These findings indicate that a substantial proportion had received some form of structured education, but more than one-third had not received formal training. The study did not examine whether training, professional experience, hospital category, or working hours were associated with more favourable responses. Such analyses would require participant-level data and valid domain scoring. Future studies should evaluate whether structured training is associated with objectively measured compliance and should assess the durability of improvements after refresher education (11-13).

The findings have practical implications for perioperative infection prevention. Training should move beyond general awareness and focus on areas of inconsistency, particularly the role of hand hygiene in interrupting cross-transmission, correct decontamination of anesthesia equipment, reporting of infection-control breaches, and the relationship between institutional guidelines and patient safety. Periodic competency assessments, direct observational audits, accessible written protocols, adequate supplies of personal protective equipment, and feedback-based quality-improvement programmes may provide a more reliable assessment of infection-control performance than self-report alone (14-16).

This study included anesthesia technologists from three hospital settings and assessed several dimensions of infection prevention relevant to their professional role. However, its findings should be interpreted in light of important limitations. The sample was small and selected through non-probability

purposive sampling, limiting generalizability. Data were collected through an electronic self-administered questionnaire and may have been affected by selection, recall, and social-desirability biases. The questionnaire's development, validation, reliability, and scoring procedures were not fully reported. Some items may have assessed beliefs rather than actual practices, and the "maybe" response category did not quantify the frequency of behaviour. The study did not include direct observation or institutional audit, did not investigate associations between participant characteristics and outcomes, and was restricted to anesthesia technologists. The cross-sectional design also prevented assessment of changes over time or the effects of training interventions. Larger multicentre studies using validated instruments, behavioural-frequency response options, direct observation, and analytical comparisons are required to provide stronger evidence regarding infection-control competence and compliance among anesthesia technologists (17).

CONCLUSION

Anesthesia technologists in the selected hospitals generally reported strong knowledge of several fundamental infection-control principles and favourable attitudes toward training, sterile handling, protocol adherence, and personal protective equipment. Self-reported practices were most favourable for equipment cleaning, sterile technique, and medical-waste disposal. However, the marked inconsistency regarding the role of hand hygiene in reducing cross-contamination and the comparatively low endorsement of breach reporting identified important areas for improvement. The findings support targeted education, clearer reporting procedures, competency assessment, and direct clinical auditing to strengthen consistent infection-control practice in operating rooms.

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