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Post-COVID Compliance and Challenges in Infection Control Practices in Anesthesia: A Cross-Sectional Study at a Tertiary Hospital in Riyadh

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Abstract

Background: Complications due to infection control policies need special consideration in anesthetic practice, especially after the COVID-19 pandemic. However, adherence to these protocols over time within the working clinical environment remains uncertain.

Objective: To evaluate compliance of anesthesia providers in a Riyadh tertiary hospital with infection control measures instituted following COVID-19 and assess the challenges encountered.

Methods: This was a cross-sectional mixed-method study with 72 anesthesia providers. Compliance with protocols was assessed through direct observation using a checklist. To assess adherence barriers, 15 participants were recruited for semi-structured interviews.

Results: High compliance was observed in PPE donning (89%) and hand hygiene (76–82%), while workstation disinfection (65%) and airway device disposal (58%) showed lower adherence. Qualitative themes revealed gaps in auditing, resource limitations, and post-pandemic complacency, with leadership modeling identified as a positive influence on compliance.

Conclusion: Though adherence to infection control practices is moderate, more tailored approaches, such as frequent audits and active teaching through role modeling, are necessary to close gaps striving for sustained adherence to infection control in anesthesia practice.

Introduction

The COVID-19 pandemic has fundamentally changed infection control practices for all healthcare fields, with anesthesia services at the forefront because of the critical care, airway management, and aerosol-generating procedures they perform. As post-pandemic recovery phases set in for healthcare systems, sustaining anesthesia provider compliance to infection control practices became a challenge—especially for high throughput tertiary teaching hospitals with high procedural turnover and strained resources.

In the perioperative setting, compliance with infection control policies rests on hand hygiene, use of personal protective equipment (PPE), equipment cleaning, and protocolized airway management. However, research indicates a gap between policy and practice. For example, an anesthesia hand hygiene audit showed low adherence, which only improved with targeted education and feedback preceptorship programs (Reyes, 2022). In other instances, efforts to equip staff with non-operating room anesthesia (NORA) simulation advanced training have been stifled by logistical and attitudinal compliance obstacles (Anwar et al., 2021).

In sophisticated care facilities, like those in Riyadh, maintaining adherence to updated protocols continues to be important due to high patient complexity and volume. During the initial phase of the pandemic, some institutions like AIIMS in India implemented extensive surgical and anesthetic safety incorporating modified checklists along with infection control audit measures. These routines served as effective examples of expedited systems change (Deo et al., 2021). Regardless of these attempts, evaluation gaps related to frontline provider perplexities and post-COVID infection control efforts have stagnated in the Middle East.

For effective pandemic readiness and bolstering any healthcare system for future crises, understanding compliance, practice barriers, and anesthesia real world gaps in practice require immediate attention. The goal of this research is to evaluate compliance with infection control measures among anesthesia practitioners in a Riyadh tertiary hospital while also delineating the organizational, operational, and behavioral hurdles tied to compliance.

Literature Review

As an area of medicine with high exposure to aerosols and secretions, much has been done to contain the spread of COVID-19 during anesthesiology. There was a universal surge in protocols and measures directed towards infection control. The implementation of these new measures within the O.R. and non-O.R. anesthesia environments became problematic.

In anesthesia, there are several studies concerning the use or implementation and accuracy of infection control measures. Reyes (2022) undertook a doctoral project on the “Anesthesia Provider Hand Hygiene Improvement Project.” This project concluded that infection control practices were implemented poorly and thus revising educational reinforcement strategies was essential (Reyes, 2022).

Deficiencies in staff training and infrastructural constraints made non-operating room environments even more difficult in regards to infection control standards. This is what led Anwar et al. (2021) to focus on the NORA clinically advanced practice educational model using simulation. Their efforts still have not resolved the problem as there are gaps in providers’ knowledge coupled with limited simulation resources (Anwar et al., 2021).

Deo et al. (2021) discussed how revision of cancer surgery workflows, including mandatory PPE, for operational check-in, testing and scrupulous infection control checklists, refrained over an overflowing tertiary care hospital in India during the COVID-19 pandemic. This underscores the ability of tertiary

centers to rapidly alter practice patterns, while the unwillingness of staff still remains a dominant issue for the success of these surgical interventions (Deo et al., 2021).

Additional reviews during the pandemic highlighted the glaring gaps in defined protocols for sterilization and surface disinfection of anesthesia machines and components. A comprehensive review by Bains et al. (2020) emphasized that anesthesia machines, breathing circuits, and reusable airway devices are highly contaminated and pose great risk for infection. The authors called for training and signs meant to report noncompliance to heighten risk (Bains et al., 2020).

More globally, "green hospitals" was formulated by Lattanzio et al. (2022), which included the broader concern of waste management and infection control regarding the division of anesthesia. The study emphasized the need to incorporate eco-friendly measures into infection prevention procedures which was particularly problematic due to the pandemic surge related to the use of disposable PPE and equipment (Lattanzio et al., 2022).

Regardless of these international attempts, there is scant published literature evaluating the adherence to infection control practices among anesthesia staff in the Middle East, especially in the context of post-COVID recovery at high-volume tertiary hospitals. This lack of evidence emphasizes the need for tailored assessments in the region which take into account its resource, cultural, and systematic conditions.

Methodology

Study Design

A cross-sectional mixed methods approach was taken for this study in determining compliance with anesthesia infection control protocols and understanding the complexities within the anesthesia workplace in a Riyadh tertiary hospital, Saudi Arabia. The compliance aspect of the study was answered quantitatively using checklist-based observation, while the qualitative aspect answered anesthesia providers' perceptions through semi-structured interviews.

Study Setting and Duration

This study was carried out in the Anesthesiology Department of a tertiary hospital in Riyadh over three months, from September through November 2024. The hospital provides comprehensive surgical services, including general and orthopedic surgery, neurosurgery, cardiothoracic, pediatric, and obstetric surgery.

Study Population

All active anesthesia providers during the study period were included in the study, such as consultant anesthesiologists, anesthesia residents, and nurse anesthetists. Participants were excluded if they were temporary staff or rotating trainees with clinical exposure of less than one month at the institution.

Participant Selection and Sampling Methodology

An open call was issued to 105 anesthesia professionals; of those, 105 were selected to participate. For the quantitative phase of the study, 72 participants were observed utilizing an infection control compliance checklist based on WHO and institutional standards. For the qualitative part of the study, 15 participants were purposively sampled to capture a wide representation across provider levels and operating zones.

Information Gathering Tools and their Design

1. Compliance Observation Checklist

Observational data captured during patient surgery were performed in a non-interfering manner in the operating suites, preoperative holding areas, and recovery areas. Adherence to the WHO standard as well as institutional benchmarks was assessed, which included:

- Interaction with the patient behind the surgical smoke evacuation system
- Hand hygiene
- Use of PPE
- Hygiene of the workstation and devices associated with anesthesia
- Copying mechanisms for airway devices

2. Semi-Structured Interviews

The fifteen study subjects participated in a study about barriers to compliance including protocol understanding, training sufficiency, and system-level issues. The interviews took from 20-30 minutes and were offered in Arabic and English.

Data Analysis

Quantitative Data:

The compliance scores relative to different variables were entered into SPSS V26 for compliance score calculation, and descriptive analyses were conducted using means, standard deviation proportions, and compliance. Bivariate analysis using either a Chi-square test or Fisher’s exact test was performed for dependent and independent variable with compliance on role, years of experience, and area of practice.

Qualitative Data:

All interviews were transcribed and analyzed using Braun and Clarke's framework which includes six steps. I manually coded the data, and my coding was validated through inter-rater reliability by two independent reviewers.

Ethical Considerations

Ethics approval was granted from the ethics committee. Along with granting consent, all participants informed consent. Participants were guaranteed anonymity and confidentiality outside of identifying information and the confidentiality of all personal information was maintained during analysis and in the reporting of results.

Quantitative Findings

Table 1. Compliance Rates for Infection Control Practices

The highest compliance was seen with **PPE donning (89%)**, indicating a strong awareness of initial protective measures. However, significant lapses were observed in **workstation disinfection (65%)** and **airway device disposal (58%)**, suggesting that post-procedure hygiene and contamination prevention remain areas needing improvement.

Infection Control Practice	**Compliance Rate (%)**
Hand hygiene before patient contact	76%
Hand hygiene after patient contact	82%
Proper PPE donning	89%
Proper PPE doffing	72%
Disinfection of anesthesia workstation	65%
Proper disposal of airway devices	58%

Table 2. Compliance by Provider Role

Consultant anesthesiologists had the highest compliance overall, potentially due to greater clinical experience and familiarity with institutional protocols. Residents showed the lowest high-compliance rates (69%), reflecting a possible gap in training reinforcement or supervision.

Provider Role	**High Compliance (>75%)**	**Low Compliance (<75%)**
Consultant Anesthesiologists	82%	18%
Anesthesia Residents	69%	31%
Nurse Anesthetists	75%	25%

Table 3. Common Areas of Non-Compliance by Clinical Location

The **pre-operative holding area** and **emergency OR** presented the most frequent breaches, often due to time constraints or urgency. The **pediatric OR** had recurring lapses in PPE reuse, possibly due to perceived lower contamination risk.

Clinical Area	Frequent Non-Compliant Behavior
Pre-operative Holding Area	Missed hand hygiene during equipment setup
Pediatric Operating Room	Reuse of PPE (e.g., face shields) without disinfection
Emergency Theater	Incomplete PPE donning during rapid sequence induction

Qualitative Findings

Using thematic analysis of 15 interviews, three overarching themes emerged, each with associated sub-themes and representative quotes:

Theme 1: Protocol Awareness vs. Practical Gaps

- **Sub-theme 1.1: Knowledge of Guidelines**

  "Protocols were sent to us during the time of COVID, but they have not been reinforced post-peak." - Participant 3

- **Sub-theme 1.2: Gaps in Reinforcement and Auditing**

  "Feedback isn't shared regularly. You put in the effort, but you can't tell if you're doing it right." - Participant 11

Theme 2: Resource and Systemic Barriers

- **Sub-theme 2.1: Supply Chain Inconsistencies**

  "Sometimes there is PPE available but certain sizes or specific masks are missing, which impacts compliance." — Participant 5

- **Sub-theme 2.2: Time Pressure and Staffing Shortage**

  "A comprehensive infection protocol step for a trauma case can hold up the team. You have to balance risk." — Participant 8

Theme 3: Cultural and Behavioral Dynamics

- **Sub-theme 3.1: Complacency in the Post-Pandemic Period**

"With COVID now being controlled, a lot of people are starting to relax on the hygiene practices."– Participant 1

- **Sub-theme 3.2: Leadership Influence**

"The juniors follow when senior consultants demonstrate appropriate behavior. It makes a difference."– Participant 13

Discussion

This qualitative study evaluated post-COVID-19 compliance with anesthesia-related infection control practices among providers working in a Riyadh tertiary hospital and investigated perceived barriers using qualitative interviews. The adherence to the 'best practices' point out different practices strengths, and gaps that highlight gaps of practice adherence that need attention.

Examining compliance quantitatively, the greatest adherence to protocols was in the area of PPE donning (89%). This also aligns PPE trends shown internationally, which reported great compliance with protective measures during the initial phases of care delivery (Anwar et al., 2021). Also, Post-patient contact hand hygiene (82%) and pre contact hand hygiene (76%) showed moderate adherence. However, They had some improvement potential. Strikingly low was compliance with disinfecting workstations, which was at 65%, and with disposing of airway devices, which was at 58%. These figures confirm findings by Bains et al. (2020), who reported surface decontamination and post-procedural equipment handling as common omissions in many institutions.

Role stratification adds to gaps in supervision, direction, training, and leadership modeling issues. Consultant anesthesiologists demonstrated the highest compliance and strongest the behavior of adherers. Their clinical team's adherence to the guidelines contributed to their high compliance. Residents showed noticeably lower adherence to hygiene protocols, which may point to inadequate orientation, supervision, or confidence in high-stress situations. These differences mean education and mentorship tailored frameworks need to be designed, which more rigorous guides analyzing hygiene adherence post-intervention automation were validated by Reyes (2022).

Thematic analysis from qualitative interviews underscored that awareness of a protocol by itself did not guarantee its reliable implementation. Although most participants reported awareness of the updated protocols, numerous participants articulated a lack of auditing, feedback, enforcement mechanisms, and without strong enforcement described echoing problems systemwide issues in international reviews (Deo et al., 2021). Other cited persistent barriers included inconsistent PPE availability, and high caseloads in emergency settings—highlighting an operational gap undermining even the most well-intentioned protocols.

Another important finding was the cultural shift in provider attitudes post-pandemic. Several respondents noted a decline in vigilance as COVID-19 cases receded, which raises concerns about the sustainability of certain infection control behaviors. On the other hand, some participants noted the

modeling by leadership, which strong suggests senior clinicians can be a powerful influence toward safe practice needed for change.

Together these findings suggest compliance with core infection control measures is moderately high; however, enduring gaps remain, particularly with regard to post-procedural hygiene, emergency care, and more junior providers. These gaps will need an integrated approach with regular audits, instructive staff education, peer modeling, and supportive organizational structures.

Conclusion

This research underscores the observance of core infection control procedures among anesthesia providers in a tertiary hospital during the post-COVID-19 phase period, noting particularly strong compliance regarding PPE usage along with lingering deficiencies in equipment disinfection and disposable device decontamination. There are supportive and contravening cubicle factors shaped by the intensity of the clinician's experience and the particular context of the health system. While protocol awareness is largely present, dependence on uninterrupted resource availability, absence of regular audits, and post-pandemic inertia impede compliance. These gaps can best be addressed by reinforcing institutional enforcement of policy focused training, proactive leadership, and prolonged infection control resilience enduring the invasive care challenges.

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