Comparison of COVID-19 Infection in Operating Room Staff During Two COVID-19 Waves Using Different Preventive Strategies in a Tertiary Care Hospital in Pakistan

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ABSTRACT

Objective: To assess if limiting elective surgeries during specific pandemic phases significantly affected COVID-19 incidence among operating room (OR) staff.

Study Design: Retrospective cohort study.

Place and Duration of the Study: Operation Theatre (OT), The Aga Khan University Hospital, Karachi, Pakistan, from May 2020 to 2021.

Methodology: This retrospective study compared two pandemic waves: Wave 1, during which elective surgeries were restricted (REL), and Wave 2, during which elective surgeries were continued routinely (EL). Exposure levels were measured based on OR activity. Incidence rates were calculated per 100 OR staff, per 100 ORs, and per 100 surgeries for both Groups.

Results: No statistically significant difference emerged in COVID-19 incidence among OR staff between REL (13.8 per 100 staff) and EL (14.4 per 100 staff) Groups ($p = 0.825$). However, the EL Group exhibited a significantly lower incidence risk per running OR (5.6 per 100 ORs *vs*. REL's 12 per 100 ORs, $p < 0.001$). Additionally, the EL Group showed a lower incidence per 100 surgeries (1.5 *vs*. REL's 2.9, $p < 0.002$).

Conclusion: Restricting elective surgeries during the early pandemic phase did not significantly reduce COVID-19 incidence among OR staff. Infections were primarily linked to interactions with colleagues and the community, emphasising the need for a balanced pandemic response considering patient care and the consequences of surgery restrictions.

Key Words: *COVID-19 infection, Operating room staff, COVID-19 waves, COVID-19 transmission, Hospital epidemiology, Pandemic response.*

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INTRODUCTION

Pakistan is a low-middle-income country and significantly lags in key healthcare indicators. Its population is more than 200 million, and healthcare expenditure is consistently lower than 3% of the GDP.[1] Pakistan has very fragile healthcare, which was not prepared to face a pandemic of such magnitude. Private and not-for-profit trust hospitals are at the forefront of healthcare in the country. The Aga Khan University Hospital (AKUH) is a JCIA-accredited tertiary care academic medical centre which has 23 operating rooms (ORs) and performs more than 100 surgeries daily.

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In response to the COVID-19 pandemic, Pakistan imposed a nationwide lockdown on 24th March 2020. The ensuing healthcare crisis in the worst-hit European countries had a domino effect. Everything was shut down, even the hospital's elective surgical work per Guidelines and Recommendations from International Surgical Societies.[2-4] ORs were considered high-risk areas and the strategy aimed to prevent COVID-19 infection transmission to the healthcare providers and patients.[5] Consequently, due to this strategy, there was an unprecedented drop in surgical volumes. It was very distressing for patients who had to face unprecedented delays in surgical treatments. Another undesired consequence of this strategy was a huge financial impact on private hospitals, where revenues depend on patient volumes.[6] The restriction of elective surgical work seemed logical at that time because of the presumed risk of transmission of infection in the OR staff.[5] However, during the subsequent COVID-19 waves, elective surgical work was not restricted in many centres including the AKUH. This time elective surgical work continued, but specific precautionary measures were undertaken like preoperative COVID-19 testing, wearing personal protective equipment (PPE), and desig-

nating separate areas for COVID-19 positives or suspects in the OR. This method further enabled the examination of how various approaches affect healthcare outcomes. Since the risk of COVID-19 transmission and infection among the OR staff was one of the intended beneficial effects of these strategies, studying the incidence of COVID-19 infection during these waves can provide valuable insights about these strategies. Since OR staff are a high-risk category, comparing COVID-19 infection rates during subsequent waves in this high-risk Group will tell whether continuing work with precautions increased the incidence of COVID-19 infections among healthcare workers.

This study aimed to investigate the rates of COVID-19 infection among OR staff during two time periods: One when elective surgeries were restricted and another during which elective surgeries were continued.

METHODOLOGY

This retrospective cohort study was conducted among the staff working in the ORs of AKUH, Karachi, from May 2020 to 2021. AKUH is a tertiary care centre with a total of 23 ORs (14 main OR suites, three orthopaedic OR suites, from four daycare OR suites, and two labour room OR suites).

This study considered the normal continuation of elective surgery as an exposure. In the first COVID-19 wave, elective surgeries were restricted and later started gradually in phases. In the second COVID-19 wave, elective surgeries were not restricted, and the OR worked as usual. The exposed Group EL was the staff working when elective surgeries were continued. The unexposed Group REL was the staff working in the OR when elective surgeries were restricted. The staff who tested positive for COVID-19 before the second study period were excluded from the study, as they must have developed some immunity and were no longer at risk. This study also quantified the degree of exposure during both study periods. The total number of ORs running in each Group and the total surgeries performed in each group were counted.

Regional data for COVID-19-positivity was obtained from the website http://covid.gov.pk. The study periods were identified as follows: The 7-day moving average (MA) of the general population was highest on 14th June 2020. Four weeks before that and four weeks after that were considered as the first period of study REL. During the second wave, the 7-day MA was highest on 17th April 2021. Four weeks before that and four weeks after that were considered the second study period EL.

All OR staff including the entire anaesthesia team (doctors and technicians), surgical technicians, OR nurses, recovery room nurses, and healthcare assistants were studied. The surgery team (residents and consultants), were excluded from the study.

The outcome of interest was COVID-19 infection as confirmed by COVID-19 PCR testing. All the staff who were tested negative or never reported symptoms or contact were considered COVID-19 negative.

OR staff were under surveillance for COVID-19 during the study period. Mechanism for COVID-19 reporting, contact tracing, testing, and quarantine was in place. An application named was *Sehat* developed, and all the staff were required to install it on their smartphones. Each day, the staff had to answer a few questions about having any symptoms or contact with COVID-19-positive case. Answering negative to those questions resulted in the creation of a green day pass which was required to enter the hospital each day. In case of any positive response, the line managers were alerted who would call the staff for a detailed interview and would recommend COVID-19 testing. Contact tracing was also performed and all those staff who were exposed were also tested at 48 hours and 5th day of exposure. In this manner, the COVID-19-positive data of staff were maintained in the OR.

Data were analysed using RStudio version 4.2.1 (R Foundation for Statistical Computing, Vienna, Austria). Descriptive statistics in terms of frequency and proportion were computed for qualitative variables namely designation, department, test result, final status, and the nature of exposure. A proportional Z-test was applied to compare the REL and EL Groups. Incidence risk analysis was performed to compare COVID-19 positives and exposed status (REL and EL Groups) and reported the incidence risk ratio with 95% confidence intervals. A value of $p < 0.05$ was considered a statistically significant level.

RESULTS

The total number of staff at risk in the REL Group was 362, out of which 50 (13.8%) became COVID-19 positive. After excluding the staff who turned COVID-19 positive before the second study wave, 312 OR staff were at risk in the EL Group, out of which 45 (14.4%) became COVID-19 positive. The incidence rate of COVID-19 infection in the REL Group was 13.8 per 100 OR staff and 14.4 per 100 OR staff in the EL Group. The incidence risk ratio was 1.04 (CL 0.72-1.52), which was not statistically significant ($p = 0.825$), as shown in Table I.

In the REL Group, the total number of ORs running was 373, and total surgeries performed were 1,519. In the EL Group, the total number of ORs running was 888 and 3,219 surgeries were performed. The incidence risk was 13.4 per 100 ORs in the REL Group and 5.1 per 100 ORs in the EL Group, showing a statistically significant decreased incidence in the EL Group ($p < 0.001$, Table I). Regarding COVID-19 positivity in relation to the total number of surgeries performed, the incidence risk was 3.3 per 100 surgeries in the REL Group and 1.4 per 100 surgeries in the EL Group, also showing a statistically significant decreased incidence in the EL Group ($p < 0.002$, Table I).

Nature of exposure in the REL Group was from the community in 25 cases (50%), followed by healthcare worker (HCW) to HCW transmission in 16 cases (32%) as shown in Table II. Interestingly, only one person (2%) reported the exposure from the patient. In the EL Group, everyone reported the nature of exposure to be unknown (Table II).

Table I: Incidence of COVID-19 positive in exposed and unexposed cohorts.

Group	COVID +ve	COVID -ve	Total staff	Incidence per staff	Total OR	Incidence per OR	Total cases	Incidence per case
REL	50 (13.81%)	312 (86.19%)	362	13.8/100	373	13.4 / 100	1519	3.3 / 100
EL	45 (14.42%)	267 (85.58%)	312	14.4/100	888	5.1 / 100	3221	1.4 / 100
Incidence risk ratio				1.04 (0.72 - 1.52)		2.65 (1.77 to 3.97)		2.36 (1.58 to 3.55)
p-value				0.825		<0.001*		<0.001*

*OR: Operating room. *Reduced incidence in EL Group.*

Table II: Nature of exposure in both study periods.

Nature of exposure	REL (n = 50)	EL (n = 45)	Total (n = 95)
Community	25 (50%)	0 (0%)	25 (26.33%)
HCW to HCW	16 (32%)	0 (0%)	16 (16.84%)
Multiple	0 (0%)	0 (0%)	0 (0%)
Patient to HCW	1 (2%)	0 (0%)	1 (1.05%)
Unidentified	8 (16%)	45 (100%)	53 (55.79%)

HCW: Healthcare worker.

The highest proportion of COVID-19 positives was from the Department of Anaesthesiology, which was 31.58%, followed by OR technicians (22.1%), and recovery room nurses (21%). Among the COVID-19 positives and within the Department of Anaesthesia, there was no significant difference among technicians, residents, and consultants between both groups. The highest proportion among anaesthesia staff was noted in 15 technicians (50%).

DISCUSSION

The study results indicate that the restriction of elective surgeries did not lead to a significant reduction in the incidence of COVID-19 infection among OR staff. Given that OR staff were regularly tested and their contacts were meticulously traced, they formed an ideal occupational cohort for studying the impact of this policy measure. There is little evidence by scientific societies on the management of elective surgeries during such pandemics; most of it is related to emergency or urgent surgeries.[7] One of the primary goals of restricting elective surgeries during the initial wave of the COVID-19 pandemic was to mitigate the spread of the virus. ORs were considered high-risk due to the increased risk of COVID-19 transmission.[5] The study's results suggest that continuing elective surgeries with the implementation of COVID-19-specific precautions did not result in an increased risk of COVID-19 infections among OR staff.

It is worth noting that despite restrictions, surgeries were performed during the first wave of the pandemic, resulting in exposure for the staff working in the ORs. The number of functional ORs during both study periods was quantified to study the effect of varying degrees of exposure. Interestingly, a lower infection rate was observed when more ORs were operational, both with the number of ORs and the number of cases. This suggests an absence of harmful effects conferred by greater operational capacity. The lack of increased incidence of COVID-19 infection may be because of some ceiling effect of exposure such that any increase after a certain level may not increase the risk any further. Notably, individuals who tested positive for COVID-19 during the first and before the second wave were excluded from the study. But still, asymptomatic COVID-19 positives could have been missed even though the staff who came in contact with a COVID-19-positive case were also tested twice at 48 hours and on the 5th day of the exposure. While one could still make a case for reducing infection rates with the complete suspension of elective surgeries, it is important to acknowledge that in a tertiary care hospital, there will always be situations requiring emergency surgeries. Therefore, the notion of a complete absence of surgeries is not feasible and some degree of exposure is bound to occur.

Interestingly, out of the 95 individuals who tested positive for COVID-19, only one reported exposure from a patient. During no elective surgery period, 50% of staff reported exposure from the community, while 32% reported exposure from another HCW. Much emphasis was given to preventing COVID-19 infection from transmission from patients to healthcare providers.[8] The study's findings indicate that most exposures occurred from co-workers and within the community in the real-world scenario. In the anaesthesia department, only consultants conducted intubations of COVID-19 positive or suspected patients without assistance from residents and technicians. The incidence among consultants was lower than anaesthesia technicians and residents. It is essential to prioritise implementation of social distancing and other transmission-prevention strategies in HCWs and to extend COVID-19 infection control practices to workplace environments adjacent to the ORs, such as hallways, lounges, eating areas, and changing rooms. It can be prevented by scattering mealtimes of the staff instead of one mealtime for everyone, as done in hospitals in Singapore.[9]

Although the world had not experienced anything of similar magnitude in the past, Pakistan had lessons learned from H1N1 influenza in 2009 that swift actions are critical for ensuring good outcomes for patients and providers.[10] International Society Guidelines recommend limiting or suspending elective surgical work for two reasons. One was cross-infection in hospital workers, which was investigated in this study also. Another reason was allocating resources such as beds, medical supplies, staff, and capacity to manage COVID-19 cases.[11] Elective surgeries typically require PPE, which was in high demand and short supply during the early stages of the pandemic. Furthermore, infected hospital staff could pose a triple-threat by becoming patients themselves, reducing the number of available healthcare providers, and serving as vectors for transmission to other healthcare staff and the

community.[12] Therefore, assessing the overall impact of elective surgery restriction is crucial.

Restricting elective surgeries during the pandemic had several harmful consequences. Pullagura *et al.* reported that it resulted in the progression of cancer stage and increased mortality in patients waiting for cancer surgeries. In benign conditions, there was symptom progression in 45.9% cases, out of which, 5.4% needed emergency surgery.[13] Another study in Palestine concluded that the healthcare system's response to COVID-19 negatively influenced patients physically, financially, and psychologically.[14] The suspension also had significant economic implications for healthcare systems, hospitals, and providers, as many hospitals rely on revenue generated from elective procedures to sustain their operations. The financial strain resulting from the suspension may have led to job cuts, lay-offs, or even the closure of certain healthcare facilities, affecting access to care in the long-term. Hence, it is essential to strike the right balance between addressing the immediate needs of the pandemic and providing essential medical care.

This study had some limitations. It is possible that asymptomatic COVID-19 positives were missed in this study. In a study, conducted on 319 OR and ICU staff in a hospital in Saudi Arabia, 39 had COVID-19 antibodies, out of which only 5 (12.8%) had never experienced any symptoms suggestive of COVID-19.[15] However, any missed asymptomatic COVID-19 positives might have been missed equally in both COVID-19 waves, resulting in non-differential misclassification. Additionally, there is a possibility that staff had exposures but did not report them. This could be due to concerns about repercussions, as observed during the second wave when staff who tested positive did not report their exposure history.

Approximately 50% of staff were tested during each testing period. Given that COVID-19 exposure resulted in quarantine and leave, staff who were exposed were likely to have reported it. Nevertheless, the reliance on self-reported exposure does introduce the possibility of recall bias and the study observed a decrease in exposure reporting during the second study period, highlighting the importance of promoting a culture where staff can report negative events without fear of repercussions.

CONCLUSION

This study suggests that restricting elective surgeries during the COVID-19 pandemic did not significantly reduce the incidence of COVID-19 infection among OR staff. Continuing elective surgeries with appropriate precautions appeared to be safe for this Group of HCWs. However, it is important to recognise that most infections stem from interactions with colleagues and the community, emphasising the need for infection prevention strategies in healthcare settings. Achieving a balance between the pandemic response and the delivery of essential care is crucial, given the economic and healthcare system consequences of surgery suspensions. Despite the study's limitations, its findings underscore the importance of continually evaluating and adapting strategies during infectious disease outbreaks.

ETHICAL APPROVAL:
The study was approved by the Ethics Review Committee of the Agha Khan University Hospital, Karachi, Pakistan (ERC Reference No. 2021-6956-19763, Dated 07-Dec-2021).

PATIENTS' CONSENT:
Informed consent was taken from all the patients, staff members, and HCWs.

COMPETING INTEREST:
The authors declared no conflict of interest.

AUTHORS' CONTRIBUTION:
SAD: Development of the manuscript, study design, interpretation of results, and discussion write-up.
TM: Statistical analysis, preparation of results and the discussion section, reviewing, and manuscript editing.
AAK: Initial draft of the manuscript and critical insights.
SI: Data collection and initial draft preparation.
MNB: Discussion write-up, adding insightful perspectives, and contributing to the clarity of the manuscript.
AL: Discussion write-up and ensuring that the manuscript presented a cohesive narrative.
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