Original Article

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Post-Vaccination COVID-19 Transmission among Healthcare Workers in a Tertiary Level Hospital in Nepal

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Abstract

Background: Frontline healthcare workers have faced an increased risk of contracting COVID-19 since the beginning of the pandemic. Nurses, in particular, faced a substantial risk compared to doctors, possibly due to their prolonged exposure to patients. Despite the vaccine coverage to healthcare workers before the second wave of the pandemic, breakthrough infection was unavoidable.

Methods: This observational study was conducted at Shahid Gangalal National Heart Center, Kathmandu, Nepal, during the second wave of the COVID-19 pandemic. The study aimed to investigate COVID-19 infections among nursing staff, focusing on the number of infections, severity, the relationship between infections and time spent in the COVID ward, the comparison of infections among vaccinated and unvaccinated staff, and the effectiveness of infection control measures.

Results: Among the 132 nursing staff, the overall positive rate after vaccination was 15.15%. Significant differences were observed in age and prior infection. However, no significant differences were observed among the type of family, education level, work experience, wards, total duty hours, level of PPE used, mask type, or mask reuse.

Conclusion: Vaccines reduce the severity of infections but do not eliminate the risk, especially in high-exposure settings like healthcare facilities.

Keywords: COVID-19, Nurses, Vaccination

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Introduction

Healthcare workers (HCWs) at the frontline are at high risk of getting COVID-19 infection from the very beginning of the pandemic[1,2,3]. In a study from Wuhan China, the case infection rate of COVID-19 among HCWs was 2.10%, much higher than that of non-HCWs (0.43%)[4]. Among the HCWs, nurses face a substantial risk (52.06%) compared to doctors (33.62%)[4]. In Nepal, COVID-19 vaccination with COVISHIELD (Oxford AstraZeneca COVID-19 vaccine) began on 27th February 2021, with most frontline workers fully vaccinated by April 2021, just before the second wave.[5] The government of Nepal also approved China's Sinopharm BIBP vaccine (VERO-CELL) for emergency use around the same period.[6] However, Nepal has reported a 10-fold rise in case fatality rate between the first and second waves.[7] Despite high vaccination coverage, breakthrough infections have been reported, defined as positive SARS-CoV-2 RNA or antigen post-vaccination.[8,9] In a study from USA, overall breakthrough infection was low (3.8%).[10] A study in New Delhi's healthcare facility showed a much higher incidence (13.3%).[11] This raises concerns about vaccine effectiveness, particularly against new variants. The research hypothesis was that COVID-19 transmission was minimal among vaccinated healthcare workers. The study aimed to investigate COVID-19 infections among nursing staff in a healthcare setting, specifically focusing on the number of infections, the severity of infections, the relationship between infections and time spent in the COVID ward, comparison of infections among vaccinated and unvaccinated staff, and overall effectiveness of infection control measures.

Methods

The study was an observational study conducted at Shahid Gangalal National Heart Center over two months (May and June) during the second wave of the COVID–19 pandemic in 2021 at Shahid Gangalal National Heart Center, Kathmandu, Nepal. Inclusion criteria comprised nursing staff directly involved in COVID-19 patient care, while nursing supervisors and transiently visiting doctors were excluded from the study. Two hundred nursing staff working full time inwards, HDU, ICU, or emergency departments for the care of COVID patients were included. The study protocol was reviewed and approved by the Institutional Review Board (IRB) of Shahid Gangalal National Heart Center, Kathmandu. Participants were assured of the confidentiality of their data and their right to withdraw from the study at any time without any consequences. Informed consent from each participant was obtained. A structured questionnaire was used to collect data on demographic variables (age, sex, education level, employment status), vaccination status, PPEs (personal protective equipment), and COVID-19 infections. A pilot study was done among the 10 participants to ensure clarity of the questionnaire. Then questionnaires were distributed via email. Responses were later verified with the ward in-charge and records. Missing values, outliers, and inconsistencies were checked and addressed. Categorical variables (e.g., vaccination status, and job role) were then encoded appropriately for analysis. SPSS (Statistical Package for the Social Sciences) version 25.0 was used for the analysis. The analysis included one hundred and thirty-two staff who provided complete responses. Frequencies and percentages were calculated for categorical variables. Means and standard deviations were calculated for continuous variables. Appropriate analytical tests were used for the analysis.

Results

In a group of 132 patients, 63 had tested positive for COVID-19 before vaccination. The case infection rate (CIR) of COVID-19 among nursing staff was 47.7%. Among them, 17 experienced a recurrence of COVID-19 after vaccination. Meanwhile, 69 patients hadn't contracted COVID-19 before vaccination, but three of them tested positive after vaccination. Overall, 20 patients, which is 15.15% of the total, tested positive for COVID-19 post-vaccination, with five cases after the first dose and 15 after the second dose.

This study examines variables related to COVID-19 vaccination and their association with various factors. Out of the total sample of 132 individuals, significant differences were observed in age (mean ± SD: 30.06 ± 4.59 for positive cases vs. 33.20 ± 6.2 for negative cases; p=0.001), education level (p=0.001). However, variables like type of family, wards, total duty hours, level of PPE used, mask type, and mask reuse did not show significant differences between positive and negative cases.

Table 1: Demographic variables

Variables		Total	Tested positive after COVID-19 vaccination N= 20	Not tested positive after COVID-19 vaccination N= 112	p-value
Age (mean ± SD)		30.06 ± 4.59	33.20 ± 6.2	29.50 ± 4.05	0.001[a]
Education	Certificate level	25	5 (20%)	20 (80%)	0.72[b]
	Bachelor level	104	15 (14.4%)	89 (85.6%)	
	Master level	3	0 (0%)	3 (100%)	
Type of family	Nuclear	76	15 (19.7%)	61 (80.3%)	0.269[b]
	Joint	55	5 (9.1%)	50 (90.9%)	
	Extended	1	0 (0%)	1 (100%)	
Work experience	< 1 year	3	0 (0%)	3 (100%)	0.084[b]
	1-5 years	43	3 (7.0%)	40 (93%)	
	5-10 years	45	6 (13.3%)	39 (86.7%)	
	>= 10 years	41	11 (26.8%)	30 (73.2%)	
Wards	ICU	77	15 (19.5%)	62 (80.5%)	0.289[b]
	HDU	25	1 (4.0%)	24 (96%)	
	Isolation ward	19	3 (15.8%)	16 (84.2%)	
	Emergency ward	11	1 (9.1%)	10 (90.0%)	

Table 2: Working hours in COVID ward and PPE

Variables		Total	Tested positive after COVID-19 vaccination N= 20	Not tested positive after COVID-19 vaccination N= 112	p-value
Number of patients cared for per duty by individual nurses: Median (IQR)		3 (2-6)	3 (2-4.75)	3 (2-6)	0.735[c]
Total duty hours in a day Median (IQR)		12 (8-12)	12 (8-12)	12 (8-12)	0.997[c]
Total duty hours in a week Median (IQR)		48 (42-48)	48 (48-48)	48 (36-48)	0.097[c]
Total duty hours in a month Median (IQR)		144 (96-144)	96 (96-144)	144 (96-144)	0.091[c]
Total duty hours in last 2 months Median (IQR)		144 (99-192)	144 (96-192)	144 (144-192)	0.136[c]
Level of PPE used[#]	level II	22	2 (9.1%)	20 (90.9%)	0.308[b]
	level III	110	18 (16.4%)	92 (83.6%)	
Number of times PPE changed per shift	one time	11	2 (18.2%)	9 (81.8%)	0.324[b]
	two times	90	11 (12.2%)	79 (87.8%)	
	three times	28	7 (25.0%)	21 (75%)	
	four times	2	0	2 (100%)	
Mask used	3M N95 mask	18	3 (16.7%)	15 (83.3%)	0.895[b]
	KN 95 mask	64	11 (17.2%)	53 (82.8%)	
	Double mask	39	5 (12.8%)	34 (87.2%)	
	Surgical mask	11	1 (9.1%)	10(90.9%)	
Mask Reused	Yes	67	10 (14.9%)	57 (85.1%)	0.567[b]
	No	65	10 (15.4%)	55 (84.6%)	

[a]Independent sample T-test,[b]Fisher's exact test, [c]Man-Whitney U test,[#]Level two PPE: mask, face shield, gloves, fluid resistance apron. Level three PPE: mask, face shield, two pair of gloves, coverall (head cover, body cover and shoe cover)

Table 3: COVID vaccination

Variables		Total	Tested positive after COVID-19 vaccination N= 20	Not tested positive after COVID-19 vaccination N= 112	p-value
Type of vaccine	COVISHIED	105	18 (17.1%)	87 (82.9%)	0.365[b]
	VEROCELL	27	2 (7.4%)	25 (92.6%)	
Tested positive for COVID-19 before vaccination	Yes	63	17 (27%)	46 (73%)	<0.001[b]
	No	69	3 (4.3%)	66 (95.7%)	

Table 4: Comparison between patients with COVID-19 before and after vaccination.

Variables		Patients with COVID-19 before vaccination N= 46#	Patients with COVID-19 after vaccination N= 20	P value
Severity of COVID-19	Mild	30 (65.2%)	14 (70%)	0.773[b]
	Moderate	15 (32.6%)	6 (30%)	
	Severe	1 (2.17%)	0 (0%)	
Family member with COVID-19 before COVID-19 infection in participants	Yes	7	3	0.648[b]
	No	39	17	

[#]These patients did not develop COVID-19 after vaccination. The data for severity was missing for 12 patients. [b]Fisher's exact test

COVISHIELD was the predominant vaccine with 105 individuals. Among them, 18 individuals (17.1%) tested positive for COVID-19. Out of 27 individuals receiving the VEROCELL vaccine, two were tested positive (7.4%). There was no significant difference between the two vaccine types in terms of testing positive after vaccination (P- 0.365). Notably, a significant association was found between prior COVID-19 infection and post-vaccination positivity (p<0.001). Among the 46 individuals with previous infection, 17 tested positive post-vaccination, compared to only three among the 69 without prior infection. Additionally, no significant differences were observed in the severity of COVID-19 post-vaccination or having a family member with COVID-19 before infection.

Discussion

Frontline healthcare workers were facing an increased risk of contracting COVID-19 due to their direct exposure to infected patients during the pandemic. Studies, such as one from Wuhan, China, have highlighted significantly higher infection rates among healthcare workers compared to the general population (2.10% vs 0.43%), with nurses at elevated risk compared to doctors (Nurses 52.06% vs doctors 33.62%).[4] In the metanalysis of 28 studies, the proportion of healthcare workers who tested positive for COVID-19 was 51.7%.[12] Nursing staff were chosen as our study group because they played an important role in the transmission processes of COVID-19 for several reasons. Firstly, nurses spend significant time with patients, administering medications, helping them with personal hygiene, and monitoring vital signs. This frequent and close contact leads to a higher risk of getting an infection as compared to other healthcare workers. Secondly, nurses perform a wide range of tasks that require close physical interaction with patients, often involving bodily fluids, which are potential sources of the virus. Nurses also assist with aerosol-generating procedures such as intubation, suctioning, and nebulizer treatments, which can increase the risk of airborne transmission. All these factors together made nursing staff vulnerable to getting infected with COVID-19 within healthcare settings. In our study case, the infection rate among the nursing staff was 47.7%.

Nepal started COVID-19 vaccination in the third week of February 2021, mainly targeting frontline health workers, with most receiving full vaccination coverage by April 2021, just before the second wave.[13] Despite high vaccination rates, breakthrough infections have been reported, raising concerns about vaccine effectiveness, especially against emerging variants.[14] Our study found a noteworthy rate of post-vaccination COVID-19 infections among nursing staff, with some cases even after full vaccination. Case infection rate after vaccination (breakthrough infection) was 4.34% in our study which is a significant drop from the non-vaccinated state of 27% (p<0.001). Younger age was associated with lower infection rates, which could be attributed to better adherence to preventive measures and more updated knowledge of COVID-19 protocols. Our study showed no significant difference in infection rates between the two types of vaccines used (COVISHIELD and VEROCELL). However, there was a significant association between prior COVID-19 infection and post-vaccination positivity. Individuals with a history of COVID-19 had a higher likelihood of testing positive again post-vaccination. This could suggest either a decreasing immunity or potential exposure to new variants not fully covered by the vaccine-induced immunity. These findings emphasize the importance of continued vigilance, even among vaccinated healthcare workers, and highlight potential areas for improving vaccination strategies and infection control measures.

The were no significant differences in infection rates concerning the type of family, total duty hours, level of PPE used, and mask type or reuse. This highlights the fact that while PPE is essential, its effectiveness might be limited by other factors such as the proper usage and disposal practices. The findings suggest the importance of the need for continuous surveillance of COVID-19 infections among healthcare workers, even after vaccination. There should be policies focusing on regular testing, booster vaccinations, especially for those with prior infections, and ensuring high-quality PPE and its proper use.

Limitations

This study has several limitations. The sample size is small and related to a single healthcare center, which may limit the generalizability of the findings. Additionally, the study is an observational study which cannot establish causal relationships between the variables. Further studies with larger sample sizes and multiple centers are recommended to validate these findings.

Conclusion

In conclusion, while vaccination reduces the incidence of transmission of COVID-19 infections among healthcare workers, there is still the probability of breakthrough infections. Continuous monitoring, booster vaccinations, and stringent adherence to PPE protocols are crucial to safeguard this essential workforce.

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