ORIGINAL ARTICLE

COVID-19 BREAKTHROUGH INFECTION IN HEALTH CARE WORKERS AT AN INSTITUTE OF TRAUMA, KARACHI, PAKISTAN

Sadia Ishaque[1], Rubaid Azhar Dhillon[2], Sunil Kumar Dodani[3], Shehla Baqi[1]

[1]Shaheed Mohtarma Benazir Bhutto Institute of Trauma/ Dow University Health Sciences, Karachi Pakistan
[2]Riphah International University, Rawalpindi Pakistan
[3]Sindh Institute of Urology & Transplantation, Karachi Pakistan

ABSTRACT

Background: Currently, the only mainstay prevention for SARS-CoV-2 is vaccines. Pakistan launched a mass COVID-19 vaccination campaign after receiving Sinopharm/Sinovac and since the launch of the campaign, reports indicated fully vaccinated people testing positive for COVID-19. This study aimed to determine the rate of breakthrough infection in fully vaccinated healthcare workers (HCW) at Trauma institution in Karachi, Pakistan.

Material and Methods: An online-questionnaire was distributed through email during the month of April 2021 through Google-Forms among HCW's at Shaheed Mohtarma Benazir Bhutto Institute, Karachi, Pakistan. We evaluated HCW's who were symptomatic and rates of COVID infection pre- and post-vaccination. Descriptive analyses were conducted using frequency and percentages. Further analysis was performed using SPSS version 24. Probability value p-≤0.05 was considered as significant.

Results: Total of 112 HCW's were evaluated with a median age of 31.54 ± 7.48 where 95% of HCW's were fully vaccinated. About 42.8% of participants contracted COVID-19 after vaccination. Statistically, significant number of doctors had breakthrough infection (19 vs 6, *p*-value 0.025). Mild symptoms were reported in most of the breakthrough infections. Out of total 112 HCWs, 84% expressed confidence in the vaccine but 15% had concerns regarding vaccine efficacy.

Conclusion: In conclusion, 11% completely vaccinated healthcare workers at Trauma institute in Karachi, Pakistan, experienced mild breakthrough infections. Due to the low production of neutralizing antibodies, inactive COVID 19 vaccines were found to cause more breakthrough infections than mRNA vaccinations.

Keywords: Pakistan, COVID-19 vaccination, Breakthrough infection

BACKGROUND

The novel severe acute respiratory syndrome corona virus SARS-2 is responsible for a global pandemic and has claimed countless lives till date. As of May 11th 2022, there have been 516 million confirmed cases of COVID-19, with over 6 million deaths and approximately 11 billion vaccine doses administered.[1]

Development of COVID-19 vaccines began at an accelerated pace in 2020, leading to their successful launch by December 2020.[2] However, despite the rapid success in development, the effectiveness of all COVID-19 vaccines varies between 70-90%.[3] Through experimental trials, 94.1% efficacy was shown by mRNA-1273 and 95% effectiveness was provided by 2 doses regimen of BNT162b2.[4,5]

On March 17th 2021, a fully vaccinated female healthcare professional was diagnosed with COVID-19 in the city of Xi.[6] Soon after the implementation of vaccination programs, reports of COVID-19 breakthrough infections began to surface.[6,7] Multiple studies have been carried out so far at multidisciplinary health institutions in UK and India where Covaxin, 28 and Covishield, 85 was utilized. Scotland had BNT162b2 mRNA and USA was authorized Pfizer BNT-162b2 or Modena -mRNA-1273.[8-11] A study from Korea reported breakthrough infections in health care workers (HCW), which were mostly asymptomatic or mild, and did not require hospitalization.[8-11] In these studies, rates of breakthrough infection in individuals was reported as 0.66 per 1000 person-days after full vaccination.[8,9] In a diabetes-centric health care facility in India, symptomatic COVID-19 infection occurred in 19/ 113 persons after receiving all vaccine doses

Correspondence: Dr Sadia Ishaque, Assistant Professor Infectious Diseases, Shaheed Mohtarma Benazir Bhutto institute of trauma/ Dow University Health Sciences, Karachi, Pakistan

Email: sadiamir70@gmail.com

This article can be sited as: Ishaque S, Dhillon RA, Dodani SK, Baqi S. COVID-19 breakthrough infection in health care workers at an institute of trauma, Karachi Pakistan. Infect Dis J Pak 2022; 33(2): 39-43.

(16.8%).[8,9] Therefore, a fully vaccinated individual is still at risk of contracting the virus which has been becoming a concern for health authorities globally.

However, not many studies have been conducted in developing countries regarding COVID-19 vaccine breakthrough infections. The first case of COVID-19 in Pakistan was reported from Karachi on February 26th 2020.[21] Initially, Pakistan opted for Sinopharm vaccine in February 2021 where vaccination began first in HCW's followed by rest of the nation.[22] Concerns regarding the safety and efficacy of the vaccines, together with distrust of the government were common barriers to vaccination.[16] Currently, over 122 million people have been fully vaccinated in Pakistan.[17] We have limited data regarding breakthrough infections of COVID in Pakistan. Moreover, internationally there is limited data on post-vaccination COVID in those that have received killed virus vaccines such as Sinopharm. This study aims to observe breakthrough infections and severity of infection among fully vaccinated health care workers at Shaheed Mohtarma Benazir Bhutto Institute of Trauma in Karachi, Pakistan.

MATERIAL AND METHODS

Benazir Bhutto Institute of Trauma in Karachi, Pakistan during the month of April 2021. Although it is an institute dealing with Trauma, it was additionally designated as a COVID-19 facility in April 2020.

An online questionnaire was created using Google Forms written in English which was distributed to HCW's over the age of 18 who work at the institute through email. The participants were given two weeks to answer, with a weekly reminder to fill the survey with the assurance that the survey is optional and confidential. The survey included only binary questions regarding the current status of vaccination, booster doses, infection pre- and post- COVID-19 vaccination. Participant data was protected with full anonymity and confidentiality ensured.

The ethical approval was obtained from the Ethical Review Committee of the Shaheed Mohtarma Benazir Bhutto Institute of Trauma, Karachi, Pakistan.

Statistical Analysis

Using the questionnaire data collected, descriptive analyses were conducted using frequency and percentages. Further analysis was performed using SPSS version 24. For continuous variables such as age, the median with IQR was calculated. Frequency and percentages were reported for categorical variables such as age groups, gender, occupation, and vaccination related questions. In order to analyze the relationship between vaccine confidence pre and post vaccination and breakthrough infection, Chi-square test and fisher's exact test was utilized. Probability value p-$\leq$0.05 was considered as significant.

RESULTS

A total of 112 participants submitted the online questionnaire over 3 weeks study duration. Out of 112, 65% participants were males. Median age [IQR] was 31.54 ± 7.48. The largest single group was of nurses with 60%, whereas doctors comprised 22% of the study participants (Table 1). Only 7% reported any co-morbidity. Out of total 112 HCWs, 84% expressed confidence in the vaccine but 15% had concerns regarding vaccine efficacy. A total of 95% HCWs were fully vaccinated when surveyed. Of 112, 21(18.7%) had contracted COVID-19 before vaccination of whom 3 (14%) were admitted to the hospital and required oxygen therapy. Of 107 vaccinated HCWs, 12 (11%) contracted COVID-19 after vaccination. Of these, 4 (33%) had also had COVID prior to vaccination. The mean duration for breakthrough infection was117.5 days.

Sinopharm vaccine was received by 77% of the participants while 14.5% had received Sinovac. By March 2021, 50% of the HCW's were vaccinated and by June 2021, 95 % of the HCW's were fully vaccinated. Statistically, significant number of doctors had breakthrough infection (19 vs 6, *p*-value 0.025). The doctors which experienced breakthrough infection had mild symptoms and did not require oxygen.

Table 1: Data representing healthcare workers of Shaheed Mohtarma Benazir Bhutto Institute of Trauma in Karachi, Pakistan.

Variables	Total n=112	Break through infection		*p*-value
		No n= 100	Yes n=12	
Age				
≤ 30years	63 (56.3%)	55 (55%)	8(66.7%)	0.44
>30years	49(43.8%)	45(45%)	4(33.3%)	
Gender				
Male	73(65.2%)	68(68%)	5(41.7%)	**0.07**
Female	39(34.8%)	32(32%)	7(58.2%)	
Profession				
Clinical	95(84.8%)	84(84%)	11(91.6%)	0.689*
Non-clinical	17(15.2%)	16(16%)	1(8.3%)	
Clinical groups n=95				
Nurse	57(50.9%)	52(52%)	5(41.7%)	0.49
Doctors	25(22.3%)	19(19%)	6(50%)	**0.025***
Others	13(11.6%)	13(3%)	0(0%)	**0.354**
Vaccination status				
Fully vaccinated	107(95.5%)	95(88.7%)	12(11.2%)	0.73
Booster dose				
Yes	23 (20.5%)	17 (17%)	6(50%)	
No	89(79.4%)	83 (83%)	6 (50%)	**0.016**
Initial vaccination n=107				
Sinopharm	86(76.8%)	76(88.3%)	10(11.6%)	
Sinovac	16(14.3%)	14 (87.5%)	2(12.5%)	0.85
Cansino	5(4.5%)	5(100%)	0(0%)	
Other	5 (4.5%)	5 (100%)	0(0%)	

*- Fischer Exact Test

DISCUSSION

In this study, nearly 11% HCW's reported breakthrough infections after receiving both doses of vaccination. Since HCW's have a higher risk of being exposed to the virus, the findings from this study suggest that they are still vulnerable despite being fully vaccinated. However, the vaccination was shown to lower the severity of infection.

In Pakistan, only a few studies have been conducted regarding breakthrough infections in healthcare workers. A study conducted in Rawalpindi of military healthcare workers demonstrated breakthrough infection of COVID-19 where vaccine offered significant protection against the infection.[20] This was supported by another study that showed post vaccination COVID-19 infection was associated with decreased mortality and morbidity where only a few patients developed mild to moderate respiratory symptoms.[23] A similar protective effect was also seen among the participants in our study as well. A comparison study was carried out on the current available vaccines with regards to antibody expression and virus neutralization potential. Sinopharm vaccine showed promising results with low adverse systematic effects and significant SARS-CoV-2 IgA expression. However, a low virus neutralizing potential was observed in Sinopharm as compared to the rest of vaccines such as Moderna, Pfizer and AstraZeneca .[25] This could be a factor contributing to the breakthrough infections observed so far in individuals who received Sinopharm vaccine.

A study conducted at a chronic care facility in India reported rates of breakthrough infection to be 13% which is similar to the observed rate of breakthrough infection in this study, 11%.[24] However, another study observed rates of breakthrough infection near 20% in individuals who received two doses of Sinopharm vaccine where 77% of the infections were classified as mild symptoms.[26] In our study, only three HCW's developed severe infection and required oxygenation at the hospital.

On May 25th 2021, CDC published a report concerning breakthrough infections in USA. A total of 10,262 SARS-CoV-2 vaccine breakthrough infections among recipients of FDA-authorized COVID-19 vaccines was reported from 46 U.S states and territories as of April 30th 2021.[11] Based on preliminary data, 2,725 (27%) vaccine breakthrough infections were asymptomatic,

995 (10%) patients required hospitalization and 160 (2%) patients died.[11] During the time period of this study, several COVID-19 variants had emerged globally where B.1.617.2 (Delta) and B.1.1.7 (Alpha) variants had more then 50% transmissibility.[24] These new variants were associated with ability to resist neutralization by antibodies produced by vaccination or natural infection and unable to detect through laboratory methods.[26] The available vaccines provide limited protection against such variants posing a threat to individuals who are at a higher risk of exposure such as HCW's.

This study was carried out in a real-world setting evaluating the infection and vaccination status of HCW's during the pandemic. However, since the study was conducted at a single institution, the results cannot be generalized to the surrounding areas. Also, during the study time period, it was peak of the pandemic with overflow of incoming COVID-19 patients which led to higher-than-normal exposure of HCW's to the virus. Therefore, this could be the reason for a high rate of breakthrough infection. Another limitation was that symptomatic infections in HCW's were diagnosed with RT-PCR testing while asymptomatic HCW's were omitted which still could also have the potential to transmit the virus. In this study, the sample size was not adequate enough to statistically represent significant differences between the HCW subgroups.

CONCLUSION

In conclusion, 11% fully vaccinated healthcare workers at Trauma institute in Karachi, Pakistan, experienced mild breakthrough infections. Due to the low formation of neutralizing antibodies, inactive COVID 19 vaccines were found to cause more breakthrough infections than mRNA vaccinations. Breakthrough infections currently pose a threat to public health and indicate the need for further studies to evaluate individuals at a higher risk. More efficient methods need to be developed for early detection of emerging COVID-19 variants which are capable of infection in fully vaccinated individuals. The currently available vaccines need to reconsider these variants and improve the effectiveness accordingly.

ACKNOWLEDGEMENTS

We would like to thank all the study participants for their contribution.

REFERENCES

1. https://covid19.who.int/
2. https://go-gale-com.uproxy.library.dc-uoit.ca/ps/i.do?p=AONE&u=ko_acd_uoo&id=GALE|A674993888&v=2.1&it=r
3. Bloom DE, Cadarette D, Ferranna M, Hyer RN, Tortorice DL. How new models of vaccine development for COVID-19 have helped address an epic public health crisis: Article describes and analyzes how resources, cooperation, and innovation have contributed to the accelerated development of COVID-19 vaccines. Health Aff 2021; 40(3): 410-8. DOI: 10.1377/hlthaff.2020.02012
4. Baden LR, El Sahly HM, Essink B, Karen K, Sharon F, Rick N, *et al*. Efficacy and safety of the mRNA-1273 SARS-CoV-2 vaccine.N Engl J Med. 2021; 384: 403-416. DOI: 10.1056/NEJMoa2035389
5. Polack FP. Thomas SJ, Kitchin N, Absalon J, Gurtman A, Lockhar A, *et al*. Safety and efficacy of the BNT162b2 mRNA COVID-19 vaccine. N Engl J Med. 2020; 383: 2603-15. DOI: 10.1056/NEJMoa2034577
6. Ma C, Xu S, Yao Y, Yu P, Xu Y, Wu R. *et al*. Mild breakthrough infection in a healthcare professional working in the isolation area of a hospital designated for treating COVID-19 patients—Shaanxi Province, China, March, 2021. China CDC Wkly. 2021; 3(19): 397–400. DOI: 10.46234/ccdcw2021.094
7. Graham MS, Sudre CH, May A, Antonelli A, Murray B, Varsavsky T, *et al*. Changes in symptomatology, reinfection, and transmissibility associated with the SARS-CoV-2 variant B.1.1.7: an ecological study. Lancet Public Health 2021; 6: e335-e345. DOI: 10.1016/S2468-2667(21)00055-4
8. Butt AA, Khan T, Yan P, Shaikh OS, Omer SB, Mayr F. Rate and risk factors for breakthrough SARS-CoV-2 infection after vaccination. J Infect 2021; 83: 237-79.
9. Tyagi K, Ghosh A, Nair D, Dutta K, Bhandari PS, Ansari IA, *et al*. Breakthrough COVID19 infections after vaccinations in healthcare and other workers in a chronic care medical facility in New Delhi, India. Diabetes Metab Syndr. 2021; 15(3): 1007–1008. DOI: 10.1016/j.dsx.2021.05.001
10. Birhane M, Bressler S, Chang G, Clark T, Dorough L, Fischer M,. COVID-19 Vaccine breakthrough infections reported to CDC — United States, January 1–April 30, 2021. MMWR Morb Mortal Wkly Rep 2021; 70(21): 792-93. DOI: 10.15585/mmwr.mm7021e3
11. Government of Pakistan; Ministry of Planning, Development & Special Initiatives; Pakistan Bureau of Statistics. Pakistan Statistical Year Book 2018 (Provisional). http://www.pbs.gov.pk/sites/default/files//PAKISTAN%20STATISTICAL%20YEAR%20BOOK%202018.pdf.
12. Government of Pakistan. Coronavirus in Pakistan. http://covid.gov.pk/. Accessed March 27, 2020.
13. World Health Organization. Pakistan: COVID-19—Situation update as of 7 April 2020 (3:00 pm). Updates: Ministry of National Health Services Regulations and Coordination Dashboard; 2020
14. Li M, Luo Y, Watson R, Zheng Y, Ren J, Tang J, *et al*. Healthcare workers' (HCWs) attitudes and related factors towards COVID-19 vaccination: a rapid systematic review. Postgrad Med J 2021. DOI: 10.1136/postgradmedj-2021-140195
15. https://covid.gov.pk/
16. Hsu LY, Lee CC, Green JA, Ang B, Paton NI, Lee L, Villacian JS, *et al*. Severe acute respiratory syndrome

(SARS) in Singapore: Clinical features of index patient and initial contacts. Emerg Infect Dis 2003; 9(6): 713-7. DOI: 10.3201/eid0906.030264

17. Maroof S, Bakht N, Saleem S, Nisar S, Rashid Z, Mansoor E, *et al*. COVID-19 vaccine breakthrough infections among health care workers in military institutes of Pakistan. Pak Armed Forces Med J 2021; 71(4): 1471-75.
18. Tariq A, Farooq A, Mehmood T, Rehman R, Abbas B, *et al*. SARS-CoV-2 Post vaccination disease infection tracking: Breakthrough cases in Pakistan. IPJBS 2021; 10 (3): 55.
19. Abid K, Bari YA, Younas M, Javaid ST, Imran A. Progress of COVID-19 epidemic in Pakistan. Asia Pac J Public Health. 2020; 32(4): 154-56. DOI: 10.1177/1010539520927259
20. Siddiqui A, Ahmed A, Tanveer M, Saqlain M, Kow CS, Hasan SS. An overview of procurement, pricing, and uptake of COVID-19 vaccines in Pakistan. Vaccine 2021; 39(37): 5251–53. DOI: 10.1016/j.vaccine.2021.07.072
21. Al-Qahtani M, Bhattacharyya S, Alawadi A, Mahmeed HA, Sayed JA, Justman J, *et al*. Morbidity and mortality from COVID-19 post-vaccination breakthrough infections in association with vaccines and the emergence of variants in Bahrain. Res Square 2021. DOI: doi.org/10.21203/rs.3.rs-828021/v1
22. Sharma P, Mishra S, Basu S, Kumar R, Tanwar N. Breakthrough infection with severe acute respiratory syndrome coronavirus 2 among healthcare workers in Delhi: A single-institution study. Cureus 2021;13(10): 19070. DOI: 10.7759/cureus.19070
23. Adjobimey T, Meyer J, Sollberg L, Bawolt M, Berens C, Kovačević P, *et al*. Comparison of IgA, IgG and neutralizing antibody responses following immunization with Moderna, BioNTech, AstraZeneca, Sputnik-V, Johnson and Johnson, and Sinopharm's COVID-19 vaccines. Front Immunol 2022; 13: 917905. DOI: 10.3389/fimmu.2022.917905
24. Karimi M, Zarei T, Haghpanah S, Azarkeivan A, Naderi M, Matin S, *et al*. Efficacy and safety of sinopharm vaccine for SARS-CoV-2 and breakthrough infections in iranian patients with hemoglobinopathies: a preliminary report. Mediterr J Hematol Infect Dis 2022; 14(1). 2022026. DOI: 10.4084/MJHID.2022.026