Mild Nature of SARS-CoV-2 Breakthrough Infections in Healthcare Workers in India

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ABSTRACT

The vaccine breakthrough infections (BTI) among healthcare workers (HCWs) in various hospital networks in India have been studied. Apollo Hospital, PGIMER, Medanta, Civil Hospital, Park Hospital, Max, Fortis, Narayana, and Maulana Azad hospitals were included in the study. During the Delta variant surge, the BTI were reported in the range of 6-25%. By comparing the BTI rates during the severe Delta variant wave and less severe Original (Wuhan, Alpha, Beta, and Gamma) strain wave, it was worked out that the BTI were more among HCWs who were exposed to high viral load. In the initial days of the pandemic in the first wave when the total active cases were less, the rates of BTI were in the range of 1.6-2.6%. When the viral load increased in the second deadly Delta wave, the BTI rose to 6-25%. The real-time data collected has established that the vaccination gave a protective shield against the novel coronavirus infection. Though the BTI were reported but the severity of the infection remained mild with a low hospitalisation rate and oxygen support requirement. No BTI infected HCWs succumbed to the SARS-CoV-2 infections.

Keywords: Breakthrough infections (BTI), Delta variant, Healthcare workers (HCWs), Severity of infection, Omicron variant.

I. INTRODUCTION

COVID-19 pandemic is doing more damage than it was thought earlier. The study conducted [1], [2] by a research team at Leicester University (UK) found that less than one-third of hospitalised COVID-19 patients fully recovered after one year of their treatment. The low recovery rate even after one year of the onset of the symptoms is a big worry and concern as it is causing a huge financial burden on the governments and individuals along with the loss of working hours. The study related to the follow up of hospitalised patients revealed that women had 33% poorer recovery rate than men. Obesity caused a reduction in the recovery rate by half. The patients who were on ventilator support were 58% less likely to recover. The recovery of 807 patients discharged from 39 British hospitals was assessed between March 2020-April 2021 for five months and again after one year. After five months only 26% fully recovered and one year later...
recovery rate was found to increase slightly to 28.9%. The study was published in the journal Lancet Respiratory Medicine. The symptoms that remained even after one year of infection were: fatigue, muscle pain, poor sleep, physical slow down, and breathlessness. Not fully recovering the hospitalised patients even after one year of infection is the warning that “long COVID” or “post-COVID” could become a common condition. There is a need to develop ways to tackle this disease. The legacy of COVID-19 disease is going to be huge given that in the UK alone 750,000 patients were hospitalised with COVID-19 infection in last two years alone. An effective treatment strategy must be made to solve this “long COVID” condition. The number of people affected by the COVID-19 pandemic is huge. Between April 27, 2020 and February 11, 2022, more than 7 in 10 persons in the UK were already infected with the virus which is 71% of the UK population. More people will be infected if more contagious strains of the virus kept emerging in the future. Therefore, a robust strategy to prevent new infections and treatment of long-COVID patients is needed. On the severity of COVID-19 virus infection, the research showed that the hospitalised COVID-19 patients were three times more likely to die than those admitted with influenza flu though the former were younger and had less comorbidity. A study conducted [3], [4] at the Hospital del Mar in Barcelona (Spain) found that COVID-19 patients were three times more likely to die within 30 and 90 days of hospitalisation than influenza patients. The time spent in the hospital was more with COVID-19 patients than the patients suffering from influenza. The COVID-19 group’s critical care cost was double the cost of the influenza group and pharmacy bills and testing costs were also higher for the former group.

Coming to the treatment front, the COVID-19 treatment pill S-217622 prepared by Shionogi & Co. Ltd (Japan) showed the rapid clearance of the SARS-CoV-2 virus in Phase II/III clinical trial [5]. The new antiviral pill may have a global market which the Japanese regulators are evaluating. The company is planning to produce 10 million doses a year. The other COVID-19 antiviral drug, the oral pill Paxlovid (Pfizer) is also being prescribed. The drug is 90% effective in preventing hospitalisation or death in high risk SARS-CoV-2 patients. A 5-day course is recommended at the onset of the symptoms. However, the drug has failed in a trial [6], [7] to prevent cross-infection in household contacts. The trial was conducted on 3,000 adults. The individuals who took a 5-day course of Paxlovid were 32% less likely to catch the infection from a household infected member and a 10-day course reduced the chances of catching the infection by 37%. This efficacy was not significant and might have resulted by chance. Therefore, the research to develop a credible drug that can prevent severe illness and stop the virus transmission must be continued.

Regarding the vaccination update in Japan, more than 50% population has been inoculated [8] with the third dose. The rate of vaccination among the elderly population (65 and above) was as high as 86.9% as on April 25, 2022. On the other hand, the inoculation rate for the third booster dose among the younger people in their 20s and 30s remained low at 30.1% and 33.2%, respectively. The data showed that the robust vaccination drive in Japan has controlled the spread of the Omicron variant. The infection rate per 100,000 among the cohort in 20s for the period April 4-10 was 766 cases as reported among the unvaccinated individuals which dropped to 306 for two-shot recipients and further reduced to 141 infections among individuals who had their third shot. The study conducted at Nagasaki University (Japan) has found that among 16-64 years cohort, the booster shot prevented Omicron variant infection by 69% compared with 43% among those who took a two-dose regimen. Since the booster shot is effective in preventing infection, the fourth round of vaccination for the elderly and people with comorbid conditions has been approved by the health experts in Japan. The gap between the two booster doses will be five months, one month shorter than the current gap of 6 months for the third shot. In Israel, Britain, France, and the US, the fourth dose inoculation has already begun in HCWs, people with pre-existing conditions, and elderly people.

The data analysis of 37 hospitals covered under the National Clinical Registry of COVID-19 an affiliate of the Indian Council of Medical Research (ICMR), was conducted for the period November 2021-January 2022 (Delta and Omicron waves) [9]. The analysis of the result showed that the vaccination significantly reduced the deaths from COVID-19 infections. A death rate of 10% was reported among the hospitalised patients who were fully vaccinated whereas it was higher at 21.8% among unvaccinated or partially vaccinated individuals. Though, among the fully vaccinated patients, the patients with comorbidities were more (91%) than the unvaccinated individuals where only 83% individuals had comorbid conditions. Among the fully vaccinated hospitalised patients only 36% required oxygen whereas 45.5% of partially or unvaccinated individuals needed oxygen support. Mechanical ventilation support was needed in 5.4% of fully vaccinated patients whereas for unvaccinated or partially vaccinated individuals it was 11.2%. During the third Omicron wave the average age of patients who needed hospitalisation reduced to 44 years compared to 55 years in the earlier waves. This was due to the lower per cent of vaccinated younger population as compared to the elderly population. Currently, 96% of India’s eligible population has been partially vaccinated and 76% have received both doses. Also, 13 million Indians have received a booster dose till February 3, 2022. Age-wise vaccination status shows that 40% of 12-15 years age cohort and 79% of 15-18 years age group have received their first doses and 8% of 12-15 years and 57% of 15-18 years were fully vaccinated as on April 28, 2022 [10]. The population of the above age group is just about 15% of the total adult population. As on April 28, 2022, the vaccination rate was 1.98 million doses per day. This was much less than between the period of late July 2021-mid-February 2022 when the 7-day average of daily doses was about 4 million. The booster shot inoculation among the population of cohort 45-60 years and 60-plus in India was just 0.2% and 10.7%, as on April 28.

The real-time data showed that the vaccination is lifesaving. Vaccination, not only reduces the risk of developing severe illness but also reduces the chances of household transmission of the virus thus controls the spread of the disease. A study conducted by Public Health England (PHE) has shown that inoculation of one dose of Pfizer-BioNTech or AstraZeneca vaccine reduces household transmission by up to 50%. The vaccine efficacy is generally
defined and reported in terms of Relative Risk Reduction (RRR). A number of studies showed that vaccination against COVID-19 significantly reduces the risk of infection. In a clinical trial, 95% vaccine efficacy indicates that a vaccinated person will have 95% less chances of getting the infection. If 1% population has infection before the vaccination then after vaccination the rate of infection will reduce to 0.05%.

The 7-day average of the daily new infections in India on April 15, 2022 was 996. It increased to 2,912 cases reported on April 28. Keeping in mind the recent surge in cases, ramping up the booster dose is necessary to stop the virus spread. In Delhi (India), 97% of the total samples collected from those who died of COVID-19 between January–March 2022 had the Omicron variant [11]. Out of 578 samples taken from the deceased, 560 samples had Omicron strain of the novel coronavirus. The rest of the 18 (3%) samples had other variants including Delta and its sub lineages. The Delta variant caused the surge in daily infections resulting in the second wave in April and May 2021. The fifth pandemic (Omicron) wave in Delhi was less virulent as the hospitalisation rate was less compared to the fourth Delta wave. The novel coronavirus infection was not the primary reason for most of the fatalities among the patients who tested positive for the virus and died during the treatment in Delhi. During the Omicron wave, 18% of the COVID-19 beds were occupied in Delhi’s hospitals on January 17, 2022 whereas during the Delta (fourth) wave on May 6, 2021, 92% beds were in use this has justified the less severe nature of the Omicron variant. The less severe nature of the Omicron strain is an indication that COVID-19 may become a curable and less damaging disease.

In this article, the BTI reported in India among HCWs and the general population have been analysed. The results showed that the BTI were proportional to the viral load an individual or HCWs were exposed to. The BTI refer to when fully vaccinated individuals who still got infected with the virus after 14 days of taking the second vaccine dose. The findings of the study are useful to understand the role of vaccines to protect from new infection and developing serious illnesses, and the post vaccination status of the recipients. The results have dispelled the myth related to vaccination. The findings have established the vaccine effectiveness. The robust vaccination drive in India protected the population against the SARS-CoV-2 infections. Fully vaccinated HCWs did not develop severe symptoms requiring ICU care. The vaccination prevented mortalities among the HCWs.

II. Methods

In India, two COVID-19 vaccines were mainly used. The Covishield (ChAdOx1 nCoV-19) (Serum Institute of India, India) and the Covaxin (BBV152) (Bharat Biotech, India), an inactivated whole virion vaccine, were administered. The two doses of vaccine were given at the gap specified by the makers.

III. Results and Discussion

A. BTI in HCWs in the Second Delta Wave (4 Hospitals in Gurugram)

The BTI was studied [13], [14] among the HCWs in hospitals located at Gurugram. The study period was March-May 2021. The period saw the severe fourth Delta wave (second in India) in Gurugram. Total of 9,383 HCWs were covered in the study. The per cent of BTI and other hospital incidence and occurrence have been given in Fig. 1 and Table I. The hospitals selected for the study were Medanta, Park, Narayana, and Civil Hospital. The BTI in the above 4 hospitals were low in the range of 6-7%. Most of the BTI were mild and no patient succumbed to the disease. A very few BTI resulted in moderate or severe symptoms. Hospitalisation or ICU care was not required. BTI infected HCWs had mild symptoms and recovered soon. The analysis of infected individuals was done after 14 days of the administration of the second dose. A person is said to have BTI if he tests positive for the virus after 14 days of taking the second dose of the vaccine. A small percentage of BTI (Fig. 1 and Table I) suggested that the vaccination has given a protective shield against the novel coronavirus infection.

The vaccine is effective in preventing the infection and severity of the disease. In Medanta Hospital, out of 4,000 fully vaccinated HCWs, 250 tested positive for the infection. Further analysis showed that 8 (3%) had moderate symptoms whereas 2 (1%) needed ICU care. Rest 242 (96%) infected HCWs had mild symptoms and recovered soon. At Civil Hospital, 89 (6%) HCWs showed BTI out of total of 1,425 HCWs who had both the vaccine doses. 3 (3%) of them were hospitalised for severe infection. 15 (17%) had moderate symptoms and the remaining 80% were asymptomatic. In Park Hospitals, 206 (6%) HCWs tested positive out of 3,500 fully vaccinated HCWs but none needed hospitalisation. In case of the Narayana Hospital, the BTI infected workers were 34 (7%) out of 458 fully vaccinated HCWs. At the hospital campus, 458 (77%) healthcare staff out of total workers of 597 were fully vaccinated when the study was conducted.

Fig. 1. Comparison of BTI in fully vaccinated HCWs in India hospitals during the first and second COVID-19 wave.
TABLE I: ANALYSIS OF BREAKTHROUGH INFECTIONS AMONG HCW, IN DELTA WAVE IN INDIAN HOSPITALS (BLANK SPACES: NOT RECORDED)

| Name of the Hospital | Sample size (HCWs) | Breakthrough infections | Mild symptoms | Moderate symptoms | Hospitalisation | Severe & hospitalisation | Moderate symptoms & needed oxygen support | ICU | ICU & Deaths |
|----------------------|--------------------|-------------------------|---------------|------------------|----------------|------------------------|--------------------------------|-----|-------------|
| Medanta (Gurugram)   | 4,000              | 6%                      | 96%           | 3%               |                |                        |                                | 1%  |             |
| Civil Hospital       | 1,425              | 6%                      | 80%           | 17%              |                |                        |                                | 3%  |             |
| Park Hospital        | 3,500              | 6%                      |               |                  |                |                        |                                |     |             |
| Narayana (Gurugram)  | 458                | 7%                      |               |                  |                |                        |                                |     |             |
| Max Healthcare       | 14,000             | 6%                      | 90%           |                  | 10%            |                        |                                | 0.1%|             |
| Max Healthcare & IGB (Delhi) | 95       | 25%                     |               |                  |                |                        |                                |     |             |
| Fortis Healthcare    | 16,000             | 6%                      | 92%           |                  |                |                        |                                | 1%  |             |
| Fortis Centre of Excellence for Endocrinology (Delhi) | 113 | 13%                     | 93%           |                  | 7%             |                        |                                |     |             |
| Maulana Azad Medical College (Delhi) | 326 | 11%                     | 94%           |                  |                |                        |                                | 6%  |             |

B. BTI in HCWs in Delta Wave in Other Hospitals in India

Apart from Gurugram hospitals, Table I and Fig. 1 also have the BTI data of other Indian hospitals. The data of Max Healthcare Hospital showed that the BTI rate was the same (6%) as reported in the hospitals at Gurugram. The hospital staff of about 14,000 workers in all the hospital network of Max Healthcare received both doses of the vaccine. Among these fully vaccinated HCWs, 6% tested positive for the infection. Out of the total BTI, 90% had mild symptoms and only 10% were hospitalised. All hospitalised HCWs recovered except one elderly clinician staff who was treated in ICU where he succumbed to the infection. The study conducted [15] by Fortis Healthcare (India) showed that after receiving both doses, only 6% of the HCWs were found positive for the virus. Out of this, 92% developed mild infections, 7% developed moderate infections that required hospitalisation, and only 1% developed severe illnesses who were given ventilation support in ICU. The study covered around 16,000 HCWs who were administered both doses of vaccine. The data were collected between January and May 2021, was the period that witnessed the severe Delta wave that hit India when 350,000 to 400,000 cases each day were recorded. HCWs were working round-the-clock treating seriously ill COVID-19 patients and were exposed to the high viral load and thus were at higher risk of infection. Fully vaccinated 113 HCWs at Fortis Centre of Excellence for Diabetes, Metabolic Diseases and Endocrinology (Delhi, India) were followed for developing BTI [16]. The facility had a total of 123 medical staff. Out of 123, 113 (92%) individuals were fully vaccinated. After 14 days of vaccination, 15 (13%) workers were found to be infected with the novel coronavirus. Among the infected individuals, 14 had mild infections (93%) and 1 (7%) was hospitalized. At Maulana Azad Medical College complex (Delhi), out of 326 HCWs who had both the vaccine doses, 36 (11%) were found positive for the virus [17], [18]. Most of the BTI (34 cases; 94%) were mild and did not require hospitalisation. Only 2 (6%) individuals had moderate symptoms that needed oxygen therapy before recovery. The above data were collected in the period April-May 2021. In this set of study, all family members in the household of 20% of BTI patients had COVID-19 infection concurrently and in 45% cases at least one member of the house had infection before the outbreak. In another set of observations, the study conducted [19] jointly by Max Hospitals, Delhi, India and IGB, India, found that the BTI was more at 25% than reported in earlier studies during the Delta variant surge. Such large BTI were reported for the first time. None of the HCWs needed hospitalisation as the severity of the infection remained low due to vaccination. The study was conducted by monitoring 95 HCWs. The observation for BTI was done from 45-90 days after the vaccination.

C. BTI among HCWs Registered at Indian Hospitals in the First Wave (Wuhan, Alpha, and Beta Variant)

The Indraprastha Apollo Hospital (Delhi, India) conducted [20], [21] an observational study on symptomatic-vaccinated HCWs to report the frequency of the BTI and severity of the infection. The study was done during the initial 100 days of the vaccination drive in India. It did not include the data of the Delta variant wave that was underway in this period. Only symptomatic HCWs who reported were tested for the infection and other analyses. Asymptomatic vaccinated HCWs were not included in this study. BTI rate was 2.6% (Fig. 1 and Table II). The infected individuals had minor symptoms of fever, cough, and loss of smell and taste. Hospitalisation rate was a mere 0.06%. No hospitalised patient required ICU care and no death was registered. The protection rate of the vaccine was 97.4%. The BTI in female HCWs was more (65%) as compared to males (35%) (Fig. 2). Females had more BTI than the males due to more involvement of female nursing care staff to look after the
patients than their male counterparts thus their proximity to the high viral load caused them to develop more post-vaccination (PV) SARS-CoV-2 infection. The nursing staff was the most affected (41.2%). The job-wise % distribution of BTI among HCWs was as follows: nursing staff (41.2%) > medical staff (33%) > administration (17.6%) > paramedic and supporting staff (8.2%) (Fig. 3). The data were for the period January 16-April 24, 2021 that witnessed the first three waves which hit Delhi. The data were of the initial three waves that were caused by the Original, Alpha, and Beta variants before the emergence of the Delta variant.

The study conducted [15] by PGIMER (Postgraduate Institute of Medical Education and Research, Chandigarh (India)) reported the BTI rate among HCWs during the first two waves caused by the Original Wuhan, Alpha, and Beta variants that hit the city. The study period was from January 16-April 17, 2021. Out of the total 12,248 HCWs, the study covered 7,170 individuals who received the first dose and 3,650 were fully vaccinated. The remaining 5,078 HCWs were unvaccinated at the time of study. Out of 7,170 one dose recipients, 184 (2.6%) were found infected after 44 days (median time) of vaccination. Of a total of 3,650 HCWs who were fully vaccinated, 2% (72) tested positive after 20 days (median time) of complete vaccination. For the HCWs who were fully vaccinated and completed a minimum of 14 days of follow up after the second dose, the reported BTI was at 1.6% (48 out of 3,000 HCWs) (Fig. 1). The study at PGIMER was conducted in April 2021 when vaccination in India was in the earlier stage and the Delta variant wave in Chandigarh was underway. The BTI reported at PGIMER, Chandigarh and Apollo Hospital (Delhi) during the initial outbreak (Original, Alpha, and Beta variants wave) have been compared with the BTI registered during the Delta variant’s wave at Gurugram and other Indian hospitals in Fig. 1. Table II compares the BTI results reported at PGIMER (Chandigarh) and Apollo Hospital (Delhi).

Various hospital incidenes have been shown in Fig. 4 by bars. Figure was constructed using data in Table I. Fully-vaccinated BTI infected HCWs mostly had mild symptoms and were treated at home. Vaccination prevented the risk of developing serious illness and only a very few hospitalised individuals needed ICU care or oxygen support.

| Name of Hospital | Study Period | Sample Size (HCW) | Breakthrough Infections | Hospitalisation |
|------------------|--------------|-------------------|-------------------------|-----------------|
| PGIMER Chandigarh (Chandigarh, India) | January 16-April 17, 2021 | 12,248 | 1.6% | |
| Apollo Hospital (Delhi, India) | January 16-April 24, 2021 | 3,235 | 2.6% | 0.06% |

D. BTI among the General Population of India

Indian Council of Medical Research (ICMR, India) conducted a BTI study among the general population [22], [23] and found that a very small percentage (0.03%-0.04%) contracted the infection after full vaccination (Table III). BTI rate was 0.03% for the Covishield recipients whereas it was 0.04% for those who received Covaxin. The data were collected when the Delta wave was underway. The data included only earlier outbreak and did not include the high viral load severe Delta wave that hit the country in April-May 2021. The BTI were in the range of 2-4 infections per 10,000 individuals. The bars in Fig. 5 show the BTI in the general population along with HCWs reported during the first wave.

E. Effect of the Viral Load on the Rate of BTI among HCWs

A comparison of the BTI among HCWs during the first (Original Wuhan, Alpha, and Beta) wave and the second (Delta variant) wave has been done as shown in Fig. 1. The
BTI during the Delta wave was in the range of 6%-25% whereas it was very low (1.6%-2.6%) during the first wave. The rate of the BTI was proportional to the viral load. The viral load was less in the first wave, so the BTI were also less. The viral load was more in the second wave therefore, the rate of infection was also more. This is due to the more exposure of HCWs when attending the infected patients in higher viral load healthcare facilities or networks. Fig. 6 and Table IV show the cumulative viral load in India, Delhi, Gurugram, and Chandigarh as reported on December 31, 2020, and June 30, 2021, during the first (Wuhan, Alpha and Beta) wave and the second Delta wave, respectively. The cumulative viral load in Delta variant wave (second wave) was about three times than in the first Original Wuhan variant wave (first wave). So, the % BTI were more in the second wave than reported in the first wave.

| TABLE III: BTI REGISTERED AMONG GENERAL POPULATION AFTER THE FIRST WAVE OR BEFORE ENDING THE SECOND DELTA WAVE IN OVERALL INDIA |
|--------------------------------------------------|
| Total doses | Number of recipients one-dose | Tested positive after one dose | Number of recipients two-dose | Tested positive after two-dose |
|------------|-------------------------------|-----------------------------|-------------------------------|-------------------------------|
| Covaxin: 11 million | 9,356,436 | 4,208 (0.04%) | 1,737,178 | 698 (0.04%) |
| Covishield: 116 million | 100,302,745 | 17,145 (0.02%) | 15,732,754 | 5,014 (0.03%) |

% Breakthrough Infection

Fig. 5. Comparison of BTI among HCWs and general population during the first wave.

F. Effect of the Viral Load on the Rate of BTI among HCWs and General Population

Bars in Fig. 5 compare the BTI among HCWs and the general population registered in the first wave (Original Wuhan, Alpha, and Beta variants). The BTI rate was more (1.6-2.6%) among the HCWs as compared to the general population (0.03-0.04%). This was due to the over exposure of HCWs to a high viral load as compared to the general population.

G. Vaccination Status in India

The detail of the vaccine doses used in India has been given in Table IV and Fig. 7 and 8. Till April 19, 2021; 127 million doses of vaccines were administered in India [24]. Out of 127 million doses, the share of Covaxin (Bharat Biotech, India) and Covishield (Serum Institute of India, India) was 11 million and 116 million, respectively (Fig. 9). The first dose of Covaxin was administered to 9,356,436 recipients and 1,737,178 individuals received the second dose. The Covishield vaccine was inoculated to 100,302,745 individuals as the first dose and 15,732,754 doses were given as the second dose. Out of the recipients who had Covaxin, 4,208 (0.04%) were infected after the first dose, and 695 (0.04%) tested positive for the virus after full vaccination. In the case of Covishield, at least 17,145 (0.02%) tested positive for the infection after receiving the first dose, and 5,014 (0.03%) had COVID-19 infection after receiving the second dose. Public health experts have advised that even after receiving two doses, recipients should adopt COVID-19 appropriate behaviour to avoid getting BIT.

| TABLE IV: THE CUMULATIVE VIRAL LOAD IN INDIA, DELHI, GURUGRAM, AND CHANDIGARH RECORDED IN THE FIRST (ORIGINAL ALPHA AND BETA VARIANTS) AND THE SECOND WAVE (DELTA VARIANT) |
|--------------------------------------------------|
| Name of the city and India | As on December 31, 2020 (after the Alpha and Beta wave) | As on June 30, 2021 (after the Delta wave) |
|---------------------------|-------------------------------------------------|----------------------------------|
| India | 10,286,312 | 30,411,634 |
| Delhi | 624,795 | 1,434,188 |
| Gurugram | 56,805 | 180,695 |
| Chandigarh | 19,748 | 61,670 |
IV. CONCLUSIONS

The data analysis of BTI among HCWs in various hospital networks in India revealed important results. The rate of the BTI was proportional to the viral load HCWs exposed. Since the viral load was less in the first wave, the BTI remained low. As the viral load surged in the second wave, the infections among the HCWs increased. This is due to the more vulnerability of HCWs while attending the infected patients in higher viral load conditions. The BTI rate was more (1.6-2.6%) among the HCWs as compared to the general population (0.03-0.04%) as reported in the first wave. This was attributed again to the exposure of HCWs to a high viral load as compared to the general population. Most of the hospitals registered a BTI rate in the range of 6-7% (Medanta, Park, Narayana, Civil Hospital, Fortis Healthcare, and Max). The Maulana Azad and Fortis Centre had 11% and 13%, respectively whereas one hospital, the Max Healthcare-IGIB recorded a higher BTI of 25%. Most of the BTI were mild. The recovery rate was almost 100% except for one elderly clinician staff succumbed to the infection while under the treatment in ICU care. Apollo Hospital conducted the study during the initial 100 days of the vaccination drive in India when the Delta variant wave was on its way. BTI of 2.6% were reported. The protection rate of the vaccine was 97.4%. Females had more BTI (65%) than the males (35%) due to more involvement of female nursing care staff to look after the patients than male counterparts thus their proximity to the high viral load triggered them to develop more post-vaccination (PV) SARS-CoV-2 infection. A BTI rate of 1.6% was registered during the study conducted between January 16-April 17, 2021 by PGIMER among the HCWs who were fully vaccinated and completed 14 days of follow up after the second dose of vaccine. A small percentage of BTI and negligible mortality rate suggested that the vaccination does offer a protective shield against the infection. A single dose of the COVID-19 vaccine reduces the risk of spreading novel coronavirus infection. However, the public health experts have advised that even after receiving two doses, recipients should adopt COVID-19 appropriate behaviour because they may get BTI. Although vaccinating an individual has shown to decrease COVID-19 symptoms and severity of the disease. However, their role in preventing completely coronavirus transmission is still unclear. More investigations are needed.

V. STATEMENTS

The data and results in this article are reproducible. The copyright of the article belongs to the corresponding author (ZS). Author Zameer Shervani, Ph.D. is the Director of the Food & Energy Security Research & Product Center, Sendai, Japan. Co-authors contributed online. Authors have qualifications: Kehkeshan Fatma Ph.D.; Sadia Hasan, Ph.D.; Arif Siddiquie Ph.D.; Venkata Phani Sai Reddy Vuyyuru MBBS; Nudrat Jamal M.Sc.; Aiman Ibbrahim MBBS, MD, Samar Siddiqui MBBS, DGO; Adil Ahmed Khan MBBS; Parangimalai Diwakar Madan Kumar BDS, MDS; Atif Ibrahim MBBS.

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