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Rapid volunteer-based SARS-Cov-2 antibody screening among health care workers of a hospital in Mumbai, India

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ABSTRACT

Objectives: COVID-19 is highly contagious, and health care workers are at high risk of being infected. We carried out a rapid survey to estimate the proportion of HCWs who are serologically positive for SARS-CoV-2 in the Lokmanya Tilak Municipal General Hospital, Mumbai, India.

Material and Methods: After the consent of the hospital authorities, volunteers were asked to report at a special booth set up in the hospital between May 1, 2020, and May 16, 2020. After consent, each worker was administered a questionnaire using a handheld computer which had questions on symptoms in the past 30 days, place of posting (COVID designated area or other), work category (doctor/nurse/others), use of personal protective equipment, smoking, comorbidity, and exposure followed by a test for COVID-19 using the STANDARD Q COVID-19 IgM/IgG Duo Test of SD Biosensor. We estimated weighted seroprevalence with 95% confidence limits after adjusting for the work category. We calculated the adjusted odds ratio (aOR) using logistic regression with seropositivity as an outcome variable and others as independent variables.

Results: The final sample included 501 and 1051 subjects working in the COVID area and non-COVID area, respectively, covering 35% of the total staff of the hospital. Overall, 6.9% (95% CI of 5.7–8.2) of the hospital staff was serologically positive for SARS-Cov-2, similar in the COVID area –5.7 (3.8–8.1) and non-COVID area –7.2 (5.7–9.0). Age more than 50 years (aOR 2.65; 1.45–4.85) and being in others work category 2.84 (1.34–6.02) were identified as significant predictors of being seropositive. Only 10% of the subjects reported COVID-like illness in the past 1 month.

Conclusion: The overall modest prevalence of infection among the health care workers, especially non-doctors and nurses, and similarity of prevalence in COVID and non-COVID area staff indicate the possibility of non-hospital source of infection.

Keywords: COVID, Health care workers, Seroprevalence, Risk, Epidemiology

INTRODUCTION

COVID-19 is highly contagious, and anyone providing direct health care to an affected patient is at high risk of being infected. Health care workers (HCWs) continue to manage the frontline in the battle against COVID-19 and face an increased risk of infection when compared to those in non-health care settings.[1,2] The protection of HCWs is of paramount importance in

protecting the population.[3] Sustaining safe and quality care in the SARS-CoV-2 pandemic hinges on the health and mental wellbeing of frontline health care workers.[4] The risk of infection and other associated concerns has resulted in a high burden of depression, anxiety, and psychological distress among HCWs. Concerns related to availability and use of personal protection equipment (PPE), need for staying away from families, and fear of being quarantined have been reported by the HCWs.[5,6] These all point out to the need for rational use of HCWs for COVID management.

The actual number of health care workers infected with or died due to the COVID-19 virus across the world is unknown. The prevalence of infection among HCW exceeded 10% in Italy, compromising the capacity for hospitals to respond.[7] In the United States, as of April 9, 2020, a total of 9282 U.S. health-care providers with confirmed COVID-19 have been reported, an underestimate because the information was available for only 16% of reported cases nationwide.[8] In India, ICMR established a data portal to capture the information regarding individuals undergoing testing for SARS-CoV-2 infection. Out of this, an analysis of 21,402 records of symptomatic Indian HCW revealed 1073 (5%) confirmed SARS-CoV-2-infected HCWs.[9]

The transmission of SARS-CoV-2 in the hospital settings, whether it is from patient to patient or patient to HCW, has been shown. Concerns have also been raised that asymptomatic HCWs have the potential for transmission if they continue to work. Given the fact that studies have reported that most of those who get infected by SARS-CoV-2 remain asymptomatic,[10] knowledge about the proportion of HCWs with antibodies against SARS-CoV-2 would be important in planning our health system response to it. Serologic tests detect people who have had a prior infection and thus developed antibodies. Such tests can be used to allow people who have acquired immunity to return to work safely and to provide intelligence on the evolution of the epidemic across the population, especially in terms of attainment of herd immunity.[11,12] Concerns have been raised about the validity of the rapid antibody testing kits.[13] However, subsequent validation studies have confirmed that these can be useful tools in our fight against COVID-19.[14]

In India, the Greater Mumbai area occupies only 0.015% of the landmass of India but is contributing to over 20% of the SARSCoV2 cases. Within Mumbai, the largest cluster of cases is coming from chawls in G/S ward and Asia's largest slum (Dharavi) in G/N ward.[15] The hospital that is catering to this area is the Lokmanya Tilak Municipal General Hospital (LTMGH), popularly known as Sion Hospital. To assist hospital-related policy decisions and for advocacy, we carried out a rapid survey to estimate the proportion of HCWs who are serologically positive for SARS-CoV-2 in this hospital. The survey was discussed and approved during the review meetings of the Brihanmumbai Municipal Corporation COVID task force. The Institutional Ethical Committee Clearance was taken for analysis and publication of the data.

MATERIAL AND METHODS

We conducted a cross-sectional survey among the staff of LTMGH which has 4414 staff members on its rolls. It has a total of 1462 beds, out of which 500 have been earmarked for COVID patients. We defined HCWs to include doctors, nurses, technicians, hospital attendants, sanitary workers, and the last three clubbed as "others" category. The staffs were divided into two groups – those working in COVID earmarked or designated wards and those working in the rest of the hospital.

After the consent of the hospital authorities, information was sent through departmental heads about serology testing. Volunteers were asked to report at a booth set up in the parking space of the hospital every day between May 1, 2020, and May 16, 2020, from 9.00 am to 3.30 pm. There was an enthusiastic response to the request as most of the staff wanted to know their serological status. After written consent, each worker was administered a small questionnaire which had questions on symptoms in the past 30 days, use of personal protective equipment (PPE), smoking, comorbidity, and exposure. All of them were given a finger prick and underwent a rapid serological test for COVID-19 for both IgG and IgM using the STANDARD Q COVID-19 IgM/IgG Duo Test of SD Biosensor which has been approved for use in India by the Indian Council of Medical Research (https://www.icmr.gov.in/pdf/covid/kits/Antibody_based_tests_ 14052020.pdf). The manufacturers of STANDARD Q COVID-19 IgM + IgG report 81.8% sensitivity and 96.7% specificity for their kit. All biosafety precautions were followed during the testing. The data were collected using handheld computers. Data confidentiality was fully maintained throughout the survey and its analysis.

We estimated sample size based on an alpha error of 95% and a relative precision of 30% with expected seroprevalence in COVID area to be 10% and for the non-COVID area to be 5%. The final arrived sample size was 500 for COVID area and 1000 for non-COVID area. After cleaning the dataset, we used SPSS for analysis. We estimated prevalence with 95% confidence limits of serological positivity by IgG and IgM separately and together for each of the subgroups. For estimating the prevalence for the hospital, we estimated the prevalence of each work category and estimated weighted prevalence after adjusting for their population weights. We compared the statistical significance of the difference in the profile of subjects between COVID and non-COVID area using Chi-square test. We applied logistic regression with seropositivity as an outcome variable and others as an independent variable to estimate the crude and adjusted odds ratio (aOR) to identify its determinants.

RESULTS

The final sample included 501 staff members working in COVID area and 1051 subjects working in non-COVID area. The survey covered 35.1% of the total staff of the hospital. While the hospital had 31% of its staff as doctors, 27% as nurses and 42% as other staff, this was 22%, 11% and 67% in the sample, indicating a lower response to the survey among doctors and nurses as compared to others.

As compared to the non-COVID area, the respondents working in the COVID designated area were significantly more likely to be younger, female, doctors, or nurses, and not have comorbidity [Table 1]. The two groups did not differ in terms of smoking status or presence of COVID-like symptoms. About 10% of staff reported COVID-like symptoms (fever, cough, and breathlessness) in the past 1 month. In keeping with the place of posting, significantly higher exposure to COVID case was reported in the COVID group who were also more like to use Full PPE. In the COVID-designated area, direct care to a COVID patient was being provided by 89.2% and full PPE was being used by 81% of the respondents. The exposure to COVID case was almost exclusively in the workplace and neighborhood in the respondents working in the non-COVID area.

Overall, the weighted prevalence of serologically positivity among the hospital staff for SARS-Cov2 was 6.9% (95% CI; 5.7–8.2) [Table 2]. Doctors (2.7%; 1.2–5.0) had much lower seroprevalence than nurses (7.1%; 3.7–12.0) and other hospital staff (9.8%; 8.0–11.7). The respondents from the COVID designated area had significantly lower seropositivity (5.0, 3.3, and 7.3) than from the non-COVID area (9.3; 7.6 11.2). Among those positive either by IgG or IgM, 69.6% were positive by IgM, indicating a recent infection. Only 8 (17%) among the 47 who had IgM antibody reported a COVID-like symptom in the past 1 month, indicating a high degree of asymptomatic nature of the infection.

Seropositivity by the area of work of different sub-groups is shown in Table 3. In none of the sub-groups, the seropositivity was significantly different between the areas for work. Once weighted for the proportion of different categories of workers, there was no significant difference in seroprevalence between COVID designated area and non-COVID area (5.7; 3.8–8.1 vs. 7.2; 5.7–9.0). The seroprevalence was not significantly different among those who reported COVID-like symptoms in the last month as compared to those who did not.

In the multivariate analysis, the area of work was no longer a significant determinant of seropositivity (aOR 0.37; 0.09–1.57) [Table 4]. Only age more than 50 years (aOR 2.65; 1.45–4.85) and being a non-doctor or nurse HCW (2.84 (1.34–6.02) were identified as significant predictors of being seropositive.

Table 1: Profile of the study subjects by the area of posting.

Factors	Options	Area of work				*P*-value
		COVID Designated area (*n*=501)		Non-COVID area (*n*=1051)		
Age group	17–30	229	45.7	240	22.8	<0.0001
	31–50	213	42.5	499	47.5	
	51+	059	11.8	312	29.7	
Sex	Male	216	43.1	674	64.1	
	Female	285	56.9	377	35.9	
Work category	Doctors	231	46.1	108	10.3	<0.0001
	Nurses	089	17.8	081	7.7	
	Others*	181	36.1	862	82.0	
Any reported comorbidity#	Any	061	12.2	220	20.9	<0.0001
	None	440	87.8	831	79.1	
Smoking history	Yes	22	4.4	48	4.6	0.876
	No	479	95.6	1003	95.4	
COVID like symptoms@	Any symptom	53	10.6	95	9.0	0.334
	None of them	448	89.4	956	91.0	
Level of exposure	Caring for COVID patient	447	89.2	5	0.5	<0.001
	COVID case in the family	10	2.0	2	0.2	
	COVID case in the building/workplace	42	8.4	789	75.1	
	No exposure to COVID case at home/workplace	2	0.4	255	24.2	
Use of personal protective equipment	PPE including N95 mask or 3 Ply surgical mask	405	80.8	383	36.4	<0.0001
	N95 or 3 ply mask only	83	16.6	410	39.0	
	Only cloth mask	013	2.6	258	24.6	

*Others – hospital sanitation attendants and other hospital staff. #Hypertension, coronary artery disease, diabetes mellitus, chronic respiratory disease, chronic kidney disease, cancer, hepatitis, stroke, or CVA. @Fever, cough/sore throat, difficulty in breathing reported in the past 30 days.

Table 2: Seroprevalence (percentage; 95% CI) among health care workers of Lokmanya Tilak Municipal General Hospital (LTMGH).

Antibodies category	Sample	IgM	IgG	Either (IgG or IgM)	Both (IgG and IgM)
Sample population	1552	5.5 (4.4–6.7)	4.9 (3.9–6.1)	7.9 (6.6–9.4)	2.4 (1.7–3.3)
Doctors	339	1.8 (0.7–3.8)	0.9 (0.2–2.6)	2.7 (1.2–5.0)	No observation
Nurses	170	5.3 (2.4–9.8)	4.1 (1.7–8.3)	7.1 (3.7–12.0)	2.4 (0.6–5.9)
Others	1043	6.7 (5.3–8.4)	6.3 (4.9–8.0)	9.8 (8.0–11.7)	3.3 (2.3–4.5)
COVID designated Area	501	3.8 (2.3–5.9)	2.4 (1.2–4.1)	5.0 (3.3–7.3)	1.2 (0.4–2.6)
Non-COVID area	1051	6.3 (4.9–7.9)	6.1 (4.7–7.7)	9.3 (7.6–11.2)	3.0 (2.1–4.3)
Hospital population*	4414	4.8 (3.8–6.0)	4.1 (3.1–5.2)	6.9 (5.7–8.2)	2.0 (1.4 2.8)

*Weighted by population proportion of work categories (0.31 for doctors, 0.27 for nurses and 0.42 for other staff

Table 3: Seropositivity (percentage; 95% CI) among sub-groups in COVID and non-COVID areas.

Factors	Options	COVID area	Non-COVID area
		n=501	*n*=1051
Age group	17–30	2.6 (1.0–5.6)	5.8 (3.2–9.6)
	31–50	6.6 (3.6–10.8)	8.8 (6.5–11.7)
	51+	8.5 (2.8–18.7)	12.8 (9.3–17.1)
Sex	Male	6.0 (3.2–10.1)	9.2 (7.1–11.6)
	Female	4.2 (2.2–7.2)	9.5 (6.8–13.0)
Work category	Doctors	2.6 (1.0–5.6)	2.8 (0.6–7.9)
	Nurses	6.7 (2.5–14.1)	7.4 (2.8–15.4)
	Others	7.2 (3.9–12.0)	10.3 (8.4–12.6)
Any reported comorbidity#	None*	4.5 (2.8–6.9)	9.5 (7.6–11.7)
	Yes	8.2 (2.7–18.1)	8.6 (5.3–13.2)
Smoking history	Yes	4.5 (0.1- 22.8)	10.4 (3.5–22.7)
	No	5.0 (3.2–7.4)	9.3 (7.5–11.2)
COVID like symptoms@	Any symptom	7.5 (2.1–18.2)	12.6 (6.7–21.0)
	None of them	4.7 (2.9–7.1)	9.0 (7.3–11.00)
Use of personal protective equipment	PPE including N95 or 3 ply surgical mask	4.7 (2.8–7.2)	8.6 (6.0–11.9)
	N95 or 3 ply mask	6.0 (2.0–13.5)	8.0 (5.6–11.1)
	Only cloth mask	7.7 (0.2–36.0)	12.4 (8.6–17.1)
Level of exposure to a COVID case	Caring for COVID patient	5.4 (3.5–7.9)	-
	COVID case in the family	9.5(0.3–44.5)	-
	COVID case in the building/ workplace	-	9.3 (7.3–11.5)
	No exposure to COVID case at home/workplace	-	9.8 (6.5–14.1)

*Others – hospital/sanitation attendants and other hospital staff. #hypertension, coronary artery disease, diabetes mellitus, chronic respiratory disease, chronic kidney disease, cancer, hepatitis, stroke, or CVA. @Fever, cough, sore throat, difficulty in breathing reported in the past 30 days

DISCUSSION

This is the first study on seroprevalence of SARS-CoV-2 among HCWs from India, where the COVID pandemic is yet to peak. It has shown that 6.9% of the health care staff had antibody against SARS-CoV-2, with IgM antibody among 4.8% and IgG among 4.1%. Age more than 50 years and being a hospital/sanitation attendant were the risk factors for being seropositive. This was a rapid survey and has limitations typical for such surveys such as lack of representativeness due to the voluntary selection bias and lower validity, especially sensitivity of rapid testing antibody kits used. The HCWs were being provided with hydroxychloroquine by the hospital, though we did not collect information on its actual use. As we do not have the data from the community, it is not possible to say whether the reported seroprevalence is higher than that of the community. The results also have to be understood in terms of the usefulness of antibody tests. IgM antibodies generally rise to become detectable in approximately 5–7 days after the initial onset of symptoms and remain so for 14–21 days. About day 14, after symptom onset, IgG will rise above detection levels, peaking around or after clinical recovery and will remain detectable for months or even years after the resolution of infection.[16] Validation of a rapid kit against PCR-positivity in the absence of a serological gold standard has revealed a sensitivity of 69% and 93.1% and specificity of 100% and 99.2% for IgM and IgG, respectively.[14]

Table 4: Determinants of seropositivity in LTMGH.

	Crude odds ratio (95% CI)	Adjusted odds ratio (95% CI)
Area of work		
COVID	0.51 (0.33–0.80)	0.37 (0.09 1.57)
Non–COVD	Reference	Reference
Age group		
17–30	Reference	Reference
31–50	1.99 (1.18–3.36)	1.65 (0.96–2.83)
51+	3.10 (1.80–5.35)	2.65 (1.45–4.85)
Sex		
Male	1.18 (0.81–1.72)	0.90 (0.59–1.38)
Female	Reference	Reference
Type of work		
Doctors	Reference	Reference
Nurses	2.79 (1.15–6.75)	2.08 (0.83–5.20)
Others*	3.97 (1.99–7.95)	2.84 (1.34–6.02)
Any reported comorbidity*		
Present	1.11 (0.69–1.76)	0.73 (0.44–1.21)
Absent	Reference	Reference
Smoking history		
Yes	1.09 (0.46–2.58)	1.23 (0.50–3.00)
No	Reference	Reference
Symptoms		
Any symptom	1.47 (0.84–2.56)	1.59 (0.90–2.82)
None of them	Reference	Reference
Use of personal protective equipment		
PPE including N95 or 3 Ply surgical mask	Reference	Reference
N95 or 3 Ply Mask	1.18 (0.77–1.83)	0.92 (0.58–1.46)
Only Cloth mask	1.96 (1.24–3.11)	1.35 (0.80–2.25)
Level of exposure to a COVID case		
Taking care of COVID patient in hospital	0.52 (0.29–0.93)	2.43 (0.53–11.21)
COVID case in the family	0.84 (0.11–6.81)	1.87 (0.18–19.41)
COVID case in the building/workplace	0.89 (0.55–1.44)	0.99 (0.61–1.63)
No exposure to COVID case at home/workplace	Reference	Reference

*Others – hospital/sanitation attendants and other hospital staff. #Hypertension, coronary artery disease, diabetes mellitus, chronic respiratory disease, chronic kidney disease, cancer, hepatitis, stroke or CVA. @Fever, cough/ sore throat, difficulty in breathing reported in the past 30 days

Most earlier studies on COVID-19 among HCWs have focused on antigen testing among symptomatic individuals or contacts. In a study, among 316 health care workers of the University Hospital Essen, Germany, who were tested for SARS-CoV-2-IgG antibodies, only 1.6% were detected to be IgG positive.[17] A study among HCWs in Spain reported 31.6% of workers to be IgG positive, whereas, in a multi-hospital study in Lombardy, Italy, 3 to 43% of the health care and administrative staff were positive for IgG.[18,19]

Our study reported a higher prevalence of infection among people aged more than 50 years. This could be either due to greater exposure or better serological response. The study in Spain did not report any age-specific differences in those who were seropositive and those who were not.[18] Sandri *et al*. from Italy have reported significantly higher seropositivity among females, which we did not find. They also reported that middle-aged men (not women) were more likely to induce an antibody response.[19] We did not find a gender differential in age relationship in our study. A study from China reported that HCWs with more than 5 years of service were likely to have better practice and attitude toward risk protection.[20]

This study has reported higher rates of infection in the hospital and sanitation attendants as compared to doctors and nurses. Unlike our study, the study in Spain reported a higher infection rate among doctors, nurses, and nurse assistants as compared to technicians. It reported higher but similar seropositivity among both COVID designated areas and non-COVID areas, as compared to management areas.[18] In our study, we did not find any difference in seropositivity between staff of COVID and non-COVID area of the hospital. This could be since this posting was on a rotating basis and not permanent, and also, the COVID cases were not the main contributors to the infection among the HCWs.

Another study by Steensels *et al*. in Belgium also provided an estimate of 6.4% of the hospital staff having IgG antibodies which were not associated with contact with COVID patients in the hospitals but associated with household contact of COVID patient.[21]

The source of infection for HCWs can be from taking part in the management of COVID patients, non-patient sources in the hospital or at home/neighborhood/travel, which could vary by category of worker. For hospital and sanitation attendants, possible higher exposure at the workplace could be due to lower availability, understanding, and compliance to PPE use. Lack of availability and training in the use of PPE and overall low levels of preparedness has been reported by doctors in a survey across states in India.[5] A large hospital-based study in Syria showed high compliance with protective measures by hospital staff which was due to the training provided and was more among doctors and nurses and lower among pharmacists.[22] Another factor could be related to inappropriate disposal of PPE by staff members, increasing the exposure of hospital and sanitary attendants who are tasked for their final disposal. However, the possibility of higher exposure to hospital and sanitary attendants at the community level is also a definite possibility. It is likely that they come from surrounding areas, including that of Dharavi, which are reporting more cases, whereas doctors and nurses are more likely to stay in hostels or gated communities. In the study in Lombardy, hospital administrative staff had a similar percentage of positivity as health-care professionals. Among the seven participating hospitals, the frequency of IgG positivity and SARS-CoV-2 infection was dependent on the geographical exposure to the virus and to extra-hospital exposure.[19] These point to the possibility of the community being the primary source of infection in these subjects.

CONCLUSION

In conclusion, the seropositivity for SARS-CoV-2 was low among the HCWs and probably more related to community-level transmission than hospital transmission. However, this does not mean that we lower our guards within the hospital. The presence of antibodies in the absence of H/O symptoms means that we need to be even more cautious in hospitals with masks and social distancing, hand washing, sanitization, etc., as these asymptomatic persons could be source of infection for other staff as well as patients. Most infection control procedures, which health workers follow, are driven primarily by concerns about patient safety.[23] It is time that we made them protect HCWS also.

Our response to protect HCW against COVID must stand on two pillars – monitoring and surveillance and protection.[24,25] The crisis has highlighted the lack of a good surveillance system for occupational hazards, including COVID among HCWs. Repeated serosurveys to map the progress of this infection among the HCWs are needed. As we learn to deal with the pandemic in a routine way, we will need to develop appropriate tools for the rapid assessment of health-care facilities for their preparedness protecting health care workers.[26] The COVID-19 outbreak has alerted us to the need for a planned stockpile of PPE and other essentials for effective infectious disease preparedness to protect HCWs. This study also emphasizes the need for training on proper use PPEs, and continuing education especially focusing on hospital and sanitary attendants and those aged 50 or more.

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Declaration of patient consent

Institutional Review Board permission obtained for the study.

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Conflicts of interest

There are no conflicts of interest.

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