A multicentre study on quarantined healthcare workers during the first wave of COVID-19 pandemic: Lessons learned in a resource limited setting

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Abstract

Introduction: Facing a pandemic is quite challenging for resource-poor healthcare settings. As the COVID-19 pandemic unfolded, healthcare workers (HCWs) had to work with insufficient skills, knowledge and experience regarding the novel coronavirus, which increased their risk of infection.

Methods: This study aimed to determine the personal protective equipment (PPE) usage, exposure characteristics, clinical outcomes and seroprevalence of SARS-CoV-2 antibodies among a group of quarantined HCWs in seven hospitals in the Western province of Sri Lanka, during the first wave of the pandemic. Data were collected using an interviewer-administered questionnaire and a serum sample was collected at six weeks of exposure to detect SARS-CoV-2 specific IgG antibodies. Both descriptive statistics and chi square test were performed to identify distribution patterns and associations.

Results: Of 167 quarantined HCWs, 89(53.3%) had high-risk exposures, while 78 (46.4%) reported low-risk exposures. Eighty-four HCWs have been exposed when interacting with the patient's environment and 90.5% of them were not using recommended PPE. None of the HCWs wore N95 or higher respirators when performing aerosol-generating procedures. SARS-COV-2 RT-PCR assay was performed only on 117 (70.1%) HCWs, with 49.6% of them being subjected to the test after 14days of exposure. SARS-CoV-2 specific IgG antibodies were detected in 31(18.6%) HCWs. A high seroprevalence was observed among HCWs over 40 years (n=13, 29.5%) (P=0.029).

Conclusions: This study illustrated an imperfect adherence to PPE recommendations and high transmission of COVID-19 amongst HCWs. The observed inappropriate use of RT-PCR assay and unwarranted quarantining of HCWs in a limited resource setting is concerning.

Key words: COVID-19 pandemic, quarantined healthcare workers, SARS-CoV-2 antibodies, exposure characteristics, recourse-limited setting, Sri Lanka

Introduction

The world is still in the grips of a pandemic caused by the rapidly evolving Severe Acute Respiratory Syndrome Corona Virus-2 (SARS-CoV-2). The pandemic has had a major impact on the economy and the society of Sri Lanka.[1] Moreover, it has seriously interfered with routine medical practice in the country.

As the pandemic unfolded, many healthcare workers (HCWs) had to work in unfamiliar clinical settings with insufficient skills, training, and experience due to the limited knowledge of this novel virus. Consequently, this puts frontline HCWs at high risk of

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exposure to the virus. Keeping up with emerging knowledge and changing personal protective equipment (PPE) recommendations while providing continuous care to patients added to the burden of HCWs in all settings.[2,3] A considerable variation in PPE use was observed among HCWs across the globe and poor adherence to PPE recommendations was reported in previous studies.[4] Many HCWs have contracted the disease and nosocomial outbreaks occurred in healthcare institutions.[5]

In March 2020, the World Health Organization (WHO) recommended quarantining HCWs with high-risk exposures to confirmed COVID-19 patients.[6] In some countries, this mandatory post-exposure quarantine was not practiced for various reasons. In the USA and UK, asymptomatic HCWs with exposures to COVID-19 patients were expected to remain at work under constant surveillance.[7,8] However, most resource-poor countries, including Sri Lanka with limited facilities for regular screening, have followed the 14-day mandatory quarantine recommendations of the WHO.[9] It was essential to define the exposure risk to determine whether the HCW needed to be quarantined and those exposure reviews were quite time intensive. Devoting resources to retrospective risk assessments has diverted resources from other essential services and infection prevention activities. Further, the placement of HCWs on quarantine has resulted in staff-shortage and significantly affected the functioning of health care facilities.

After detecting the first Sri Lankan national with SARS-CoV-2 infection on the 11th March 2020, many HCWs in the Western province were quarantined due to exposures to COVID-19 patients.[10] Due to limited resources, those quarantined HCWs were routinely not tested with SARS-CoV-2 RT PCR. Therefore, it was uncertain how many of them had contracted the disease.

Though there are many studies on the COVID-19 exposure risk in different healthcare settings, the data is lacking in the Sri Lankan context. Thus, this study was conducted to determine the PPE usage, exposure characteristics, clinical outcomes and seroprevalence of SARS-CoV-2 IgG antibodies among a group of quarantined HCWs at seven government and semi-government hospitals in the Western province of Sri Lanka during the first wave of the pandemic.

Methods

This descriptive cross-sectional study focused on HCWs, who were quarantined between 15th March to 5th April 2020, following exposure to eight SARS-CoV-2 RT- PCR confirmed patients in seven government and semi-government hospitals in the Western province, Sri Lanka. The lists of quarantined HCWs were obtained from each hospital's infection control units, and all (n=185) were invited to participate in this study. Informed written consent was obtained from healthcare workers before administering the questionnaire and collecting serology samples. Ethics approval for this study was obtained from the Ethics Review Committee, Sri Lanka Medical Association (SLMA) (Reference: ERC 20-007).

A single venous blood sample (3ml) was collected from each subject in the sixth week after their last exposure to confirmed COVID-19 patients. The serum was separated, aliquoted, and stored at -80°C in the Kotelawala Defense University research laboratory until the antibody test was performed. A validated inter-viewer-administered questionnaire developed based on the WHO Interim Guideline[6] was completed at the time of serum sampling. Data were collected on demo-graphics, occupation, comorbidities, exposure risk, use of personal protective equipment, development of symptoms during the quarantine period and post-exposure prophylaxis therapy taken by the HCWs. The information related to SARS-CoV-2 PCR assays was gathered from the participants and laboratory records.

SARS-CoV-2 specific IgG antibodies were detected using a validated commercially available Enzyme-Linked Immunosorbent Assay (ELISA) Kit (Dia Pro, Italy). This ELISA kit has been validated in Europe for clinical use and the specificity of this kit is 97.1% (95% CI 90.2-99.2), whereas overall sensitivity is around 66.3% (95% CI 57.1-75.6).[11]

Risk categorization of exposed HCWs

Exposures were categorized as high or low risk, depending on whether the appropriate PPE was used during HCW-patient interactions. Referencing guide-lines of the WHO, standard optimal PPE use was defined for each healthcare interaction.[6]

- Face to face interaction within 1m distance (droplet range) – face mask (or respirator)

- Present when patient is coughing, sneezing or vomiting – face mask (or respirator), eye protection, gloves, gown

- Present when an aerosol generating procedure (AGP) was performed on the patient – respirator, eye protection, gloves, gown

- Contact with the environment where patient was cared for – face mask (or respirator), gloves, gown

Face-to-face interactions within the droplet range for more than 15 minutes without a face mask or other interactions mentioned above without specified optimal PPE were considered high-risk exposures.

Statistical analysis

Statistical analysis was performed using SPSS version 25.0. Descriptive statistics were used to present the demographic and clinical characteristics of the HCWs. Categorical variables were presented as frequencies and percentages with a 95% confidence interval. Associations were determined using the chi-squared test and a p-value of <0.05 was considered statistically significant.

Results

During the study period, 185 HCWs were quarantined in seven government and semi-government hospitals in the Western province of Sri Lanka. Of the quarantined HCWs, 167 (90.3%) with a mean age of 35.6 years (SD ± 9.43) consented to participate in this study. The majority (64.1%) were females and nurses (44.9%) by profession. Pre-existing medical conditions were infrequent (23.4%) among HCWs in this group. The socio-demographic data and medical anamnesis of the quarantined HCWs are depicted in Table 1.

Of the surveyed HCWs 112 (67.1%) had at least one exposure, 46 (27.5%) reported more than one exposure, while nine (5.4%) had no direct contact with confirmed COVID-19 patients or their environment. Medical wards were the most common setting of exposures to COVID-19 patients, followed by the Emergency Treatment Unit (ETU). Most of the HCWs (76.6%) reported exposures during face-to-face interactions, of which only 8 (14%) were exposed without a mask. Thirteen HCWs (7.8%), who confirmed exposures when performing aerosal generating procedures (AGP) on COVID-19 patients were not wearing N95 masks or higher respirators. Another 25 (14.9%) HCWs reported exposures when the patient was coughing, sneezing, or vomiting and none of them were using optimal recommended PPE. Eighty-four HCWs (50.3%) have been exposed when interacting with the patient's environment and 90.5% of them were non-compliant with the recommended PPE. As per the WHO risk stratification guidelines, 89 (53.3%)

quarantined HCWs had high-risk exposures, while 78 (46.4%) were placed on quarantine with low-risk exposures. The PPE compliance during healthcare interactions among quarantined healthcare workers are depicted in Table 2.

Hundred and thirty-three quarantined HCWs (79.6%) reported the use of various medications as post-exposure prophylaxis therapy. Herbal medicines were the most frequently used prophylaxis treatment (n=125,94.0%) followed by high dose vitamin C (n=38,28.6%) and zinc supplements (n=20,15.0%). Hydroxychloroquine and azithromycin were used by two participants each. During the quarantine period, 40 (24.0%) HCWs had experienced symptoms suggestive of COVID-19. The commonest reported symptom was sore throat (n=21,52.5%) followed by cough (n=7,17.5%). The SARS-COV-2 RT-PCR was performed only on 117 (70.1%) quarantined HCWs, of which nearly half of them (n=58, 49.6%) were subjected nasopharyngeal sampling (NPS) after 14 days of the exposure and 35% (n=14) of the symptomatic HCWs were not tested with RT-PCR. None of the tested HCWs were positive for COVID-19. The majority (n=146, 87.4%) of the HCWs have reported to duty on the next day upon completion of their quarantining.

The SARS-CoV-2 specific IgG antibodies were detected among 18.6% (n=31) of HCWs at six weeks of their last exposure. Of the seropositive HCWs, 64.5% (n=20) reported high-risk exposures and 22.6% (n=07) had been symptomatic during the quarantine period. Interestingly, 14.1% (n=11/78) of the HCWs with reported low-risk exposures were seropositive compared to 22.5% (n=20/89) in the high-risk category (P =0.165). Of the HCWs who were not subjected to RT PCR assay or tested after 14 days of their last exposure, IgG antibodies were detected in 23.1% (n=25/108). In contrast, only 10.2% (n=6/59) HCWs who were RT PCR negative within the first 14 days of exposure had positive antibody response.

High seroprevalence of SARS-CoV-2 specific IgG was observed among HCWs more than 40 years (n=13,29.5%) compared to HCWs below 40 years (n=18, 14.6%) (P=0.029). There was no statistically significant association between gender, professional categories, presence of comorbidities, degree of exposure, or the presence of symptoms during the quarantine period and the IgG seroprevalence at six weeks (Table 3).

Table 1. Socio-demographic characteristics and medical anamnesis of quarantined HCWs

Variables		Frequency (n=167)	Percentage (%)
Gender	Male	60	35.9
	Female	107	64.1
Comorbidities	Chronic lung disease	15	9.0
	Dyslipidaemia	10	6.0
	Diabetes Mellitus	07	4.2
	Hypertension	06	3.6
	Thyroid disorders	03	1.8
	Immune thrombocytopenia	02	1.2
	Other*	07	4.1
Smoking	Yes	06	3.6
	No	161	96.4
Immunosuppressive therapy	Yes	03	1.8
	No	164	98.2
Type of health professional	Consultant	02	1.2
	Medical officer	29	17.4
	Nursing officer	75	44.9
	Paramedical staff	08	4.8
	Healthcare assistant	48	28.7
	Cleaning staff	03	1.8
	Other**	02	1.2
Healthcare facility unit type	Medical ward	131	78.4
	ETU	12	7.2
	ICU	09	5.4
	OPD	05	3.0
	Other wards***	04	2.4
	Other areas****	06	3.6

* other includes ischemic heart disease, stroke, anaemia, ankylosing spondylitis, osteoarthritis, immune thrombocytopenia

** other includes ambulance drivers and ward clerks

*** other includes surgical wards

**** other includes radiology department, echo room and communal hospital spaces

Table 2. PPE compliance during healthcare interactions among quarantined healthcare workers

Type of interaction		Number of exposed HCWs (n=167)	PPE usage					
			Medical mask (n, %)	N95 or higher respirator (n, %)	Eye protection (n, %)	Gloves (n, %)	Water-proof gown (n, %)	Full PPE (n, %)
Face to face interactions	>15 minutes	92	86 (93.5%)	02 (2.2%)	16 (17.4%)	45 (48.9%)	16 (17.4%)	01 (1.1%)
	<15 minutes	36	34 (94.4%)	00 (0%)	05 (13.9%)	14 (38.9%)	05 (13.9%)	00 (0%)
Present when patient coughing, sneezing or vomiting		25	23 (92.0%)	00 (0%)	02 (8.0%)	07 (28.0%)	03 (12.0%)	00 (0%)
Present when AGP is performed		13	13 (100%)	00 (0%)	00 (0%)	09 (63.2%)	01 (7.7%)	00 (0%)
Contact with the environment where patient was cared for		84	78 (92.8%)	02 (2.38%)	34 (40.5%)	54 (64.3%)	19 (22.6%)	02 (2.38%)

Table 3. Seropositivity and associated factors among quarantined healthcare workers (n=167)

Variables		Seropositive (n, %)	Seronegative (n, %)	Significance (p value)
Age	< 40 years > 40 years	18 (14.6%) 13 (29.5%)	105 (85.4%) 31 (70.5%)	0.029
Gender	Male Female	14 (23.3%) 17 (15.9%)	46 (76.7%) 90 (84.1%)	0.235
Comorbidities	Yes No	08 (20.5%) 23 (18.0%)	31 (79.5%) 105 (82.0%)	0.721
Smoking	Yes No	02 (33.3%) 29 (18.0%)	04 (66.7%) 132 (82.0%)	0.309*

(Continued)

Variables		Seropositive (n, %)	Seronegative (n, %)	Significance (p value)
Immunosuppressive therapy	Yes	00 (0%)	03 (100%)	1.000*
	No	31 (18.9%)	133 (81.8%)	
Type of health professional	Consultant	01 (50.0%)	01 (50.0%)	0.260**
	Medical officer	07 (24.1%)	22 (75.9%)	
	Nursing officer	08 (10.7%)	67 (89.3%)	
	Paramedical staff	02 (25.0%)	06 (75.0%)	
	Healthcare assistant	12 (25.0%)	36 (75.0%)	
	Cleaning staff	01 (33.3%)	02 (66.7%)	
	Other	0 (0%)	02 (100%)	
Number of exposures	Once	19 (16.4%)	97 (83.6%)	0.248
	More than once	12 (24.0%)	38 (76.0%)	
Type of exposure	High risk	20 (22.5%)	69 (77.5%)	0.165
	Low risk	11 (14.1%)	67 (85.9%)	
Use of prophylaxis therapy	Yes	28 (21.1%)	105 (78.9%)	0.102
	No	03 (8.8%)	31 (91.2%)	
Presence of COVID like symptoms during quarantine period	Yes	07 (17.5%)	33 (82.5%)	0.843
	No	24 (18.9%)	103 (81.1%)	

*Fishers test ** Likelihood ratio

Discussion

The world has suffered three coronavirus outbreaks within two decades, where knowledge on factors contributing to the outbreak and healthcare improvements have been powerful tools in mitigating their impact. Hence, this study was conducted to determine the exposure characteristics, seroprevalence and quarantining as a strategy to contain the spread of the disease among exposed HCWs during the early phase of COVID-19 pandemic in Sri Lanka.

The results of this study indicate an imperfect adherence to PPE recommendations among HCWs. The lowest adherence to the recommended PPE use was noted among HCWs who reported exposures while patients were coughing, sneezing, or vomiting and when carrying out AGP. Thirteen (7.9%) HCWs were involved in performing AGP, like endotracheal intubation and nebulization, but none of them were wearing N95 or

higher respirators. In contrast, over-whelmingly high compliance with PPE use was observed among HCWs exposed during AGP in Ghana.[12] The use of gloves, eye-protective gears, and waterproof gowns was far from expected during all reported healthcare interactions in our study. However, high rates of compliance with medical masks were observed among HCWs in this group, consistent with the other studies.[12,13]

Although the possible reasons were not reflected in our study, the sub-optimal use of PPE could be due to the low perceived risk of COVID-19 amongst the healthcare staff. During the study period, there was no community transmission of COVID-19 in Sri Lanka, and the number of confirmed or suspected COVID-19 patients treated within healthcare institutions was minimal.[10] The eight COVID-19 patients related to the exposures in this study were treated in non-COVID

areas initially, as the diagnosis was not suspected at the time of presentation. A global online survey revealed poor adherence to PPE guidelines when treating alleged non-COVID-19 patients in most of the countries represented in the study.[4] Similarly, a German study found a lower total adherence with 76% of PPE use in the non-COVID-19 wards compared to the COVID-19 wards with a total adherence of 85%.[14] However, HCWs in the Indian subcontinent had low compliance (30.8%) with PPE use, even when the diagnosis of COVID-19 was confirmed.[4] Lack of knowledge, shortage of PPE supplies and physical discomforts caused by the PPE use, especially in warm, humid environments, may have contributed to the low PPE usage observed in this study population.

Our results showed that nearly half (46.4%) of the HCWs placed on quarantine had low-risk exposures. At the time of the study, there were no local guidelines on post-exposure quarantining of HCWs and the quarantine decisions were made as per the WHO recommendations, based on the self-reported exposure details of the HCWs. Anxiety and recall bias among healthcare workers and unfamiliarity with the WHO guidelines among exposure review committees would have resulted in the unwarranted quarantining of HCWs. Notably, a single-centre study from India showed that 24% of the HCWs were placed on quarantine despite low-risk exposures.[15] The further transmission of SARS-CoV-2 infection was not reported from any of the hospitals in this study, confirming that the contact tracing and isolation of HCWs had been effective in curbing the nosocomial spread of the disease. This high-risk quarantining strategy has been adopted in South Korea and Taiwan, where pandemic control was achieved early.[16,17] Hence, post-exposure high-risk quarantining would be the best method of managing exposed HCWs in resource-poor healthcare settings where non-isolation and constant surveillance are not feasible due to limited diagnostic facilities. However, quarantine decisions should be made with the utmost care following thorough exposure reviews and adhering to the guidelines to avoid erroneous risk categorization of the exposed HCWs.

The SARS-CoV-2 RT PCR assays were performed only on 70.1% (n=117) of quarantined HCWs and all were negative. On the contrary, 31 HCWs were seropositive six weeks after their last exposure. Notably, most of the seropositive HCWs were either not tested or had undergone the nasopharyngeal swab sampling (NSP) after 14 days of their last exposure (n=25, 80.6%). This might explain the discrepancy in the results between the two diagnostic assays. Conversely, six (10.2%) HCWs who had undergone NPS within the first 14 days with negative results were

also seropositive. These findings corroborate the data from an Italian study, which revealed a 7.4% (175/2375) frequency of positive IgG among HCWs with negative SARS-CoV-2 RT- PCR.[18] Another study from the USA found that 25% of the seropositive HCWs had a negative SARS-CoV-2 PCR test at a median time of 35 days prior to the serological test.[19] Of note, the analytical sensitivity and detection limits of the PCR assays and imperfect specificity of the serological test may have influenced our results. The subsequent unknown exposures to COVID-19 patients at work and in the community is another possibility for seropositivity. Delays in the supplies and limited knowledge during the early phase of the pandemic would have contributed to the inappropriate timing of the RT-PCR assay. The findings highlight the importance of rational use of available diagnostic facilities, especially in the limited resource setting.

The results of our study indicate a high likelihood of being seropositive among health care workers more than 40 years of age. The effect of age on sero-prevalence was inconsistent in previous studies. The age group 50-59 years was associated with a higher seroprevalence rate in a study on health professionals in the USA.[19] A recent systematic review and a meta-analysis of seroprevalence of SARS-CoV-2 antibodies in HCWs exhibit a high prevalence of IgG antibodies among HCWs above 40 years in Europe and East Asia. Conversely, another study revealed a high sero-prevalence among younger HCWs (<40 years of age) in the USA.[20]

Concerning the occupation, a high seroprevalence was detected amongst health care assistants (38.7%), followed by the nurses (25.8%) and medical officers (25.8%). This may reflect their involvement in direct patient care rather than the ancillary staff. Comparable to our finding, a single-centre study from Italy detected the highest seroprevalence amongst healthcare assistants attending to the primary needs of patients.[18] Noteworthy is that a large proportion of the seropositive HCWs were asymptomatic during the quarantine period, in line with many other studies.[18,19] Those asymptomatic HCWs could have been potential disease carriers and caused nosocomial outbreaks unless placed on quarantine. Finally, the frequent use of herbal prophylaxis by exposed HCWs is interesting. No significant difference in the seropositivity was noted between herbal prophylaxis users and the non-users.

Recall bias is a limitation of this study, which may have influenced the observed adherence rates to the PPE use and risk categorization. Further questions about hand hygiene, donning and doffing of PPE were not obtained in this study, which could have influenced

the seropositivity of HCWs. There is also a probability of subsequent exposures to the COVID-19 patients, which cannot be ruled out.

Conclusions

This study clearly illustrates poor compliance with PPE use and high transmission of COVID-19 among HCWs during the first wave of the pandemic. Complete adherence to PPE recommendations should be encouraged among HCWs irrespective of the perceived risk of COVID-19 in any healthcare setting. Contact tracing and isolation of exposed HCWs had effectively mitigated nosocomial transmission of the disease. However, undue quarantining of healthcare workers with low-risk exposures had resulted in the wastage of human resources. Emphasis on accurate exposure reporting, early implementation of local quarantining guidelines and strict adherence to them could have minimized this unwarranted isolation of the HCWs.

COVID-19 pandemic is still progressing in many countries including Sri Lanka. Emergence of new variants of the virus and infection among fully vaccinated individuals are paramount concerns. Prompt response through provision of knowledge, skills and equipment to HCWs, early implementation of the local guidelines with complete adherence and logical use of available resources are crucial for managing a COVID-19 resurgence and any future pandemics of similar nature in limited-resource settings.

Statements and declarations

Availability of data and material

The supporting data and material of this study are available from the corresponding author upon reasonable request. Patient's de-identification will be maintained in sharing the data.

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Conflict of interest

The authors declare that they have no competing interests.

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