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ORIGINAL PAPER

Electronic self-assessment of COVID-19 symptoms among healthcare workers

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Abstract

Purpose Daily monitoring of COVID-19 symptoms/history of contact in hospital staff is useful for ensuring safety in the hospital. An electronic self- assessment tool could be used to monitor staff without using excessive resources and resulting in unnecessary contact. The objective of our study was to describe the results of a self-assessment COVID-19 daily monitor log in hospital employees.

Methods A description of characteristics of staff who filled the log and follow-up of those who reported symptoms/history of contact was collected. An online self-assessment of COVID-19 symptoms/contact history was developed and used at a hospital in Bahrain. All staff completed the daily COVID-19 log. Data were collected during the month of June 2020.

Results Out of 47,388 responses, 853 (2%) of staff reported either COVID-19 symptoms/history of contact with diagnosed COVID-19 case. The most frequently reported symptom was sore throat (23%), followed by muscle pain (12.6%). The highest frequency of staff who reported symptoms and/or contact was in nurses. Of those who reported symptoms/contact, 18 were diagnosed with COVID-19. The majority (83.3%) of the infected staff obtained the virus through community transmission, and only 16.7% obtained the virus through hospital transmission.

Conclusion The electronic self-assessment log for staff during COVID-19 could be used as a safety measure in hospitals. Moreover, the study highlights the importance of targeting community transmission in an effort to increase hospital safety.

Keywords COVID-19 · Pandemic · Safety measures · Health Care Workers · Self-assessment · Technology

1 Introduction

The outbreak of coronavirus disease in Wuhan, China caused by a severe acute respiratory syndrome coronavirus 2 (SARS- CoV-2) has led to a serious pandemic resulting in a global concern [1]. As of October 21, 2020, 41,076,644 COVID-19 cases have been confirmed Worldwide and 78,533 in the Kingdom of Bahrain [2].

According to WHO guidelines for occupational health and safety for health workers, health care workers are at risk of exposure to COVID-19 since they are at the front line of the outbreak response. Health care workers that are not at the front line may also get exposed to hazards such as long working hours, psychological distress, fatigue, occupational burnout, stigma, and physical and psychological violence [3] A study in Wuhan, China, found that approximately 40% of cases were presumed hospital related-transmissions [4]. Hence, safety measures at hospitals are highly important.

COVID-19 can affect health care workers either from work through direct or indirect contact with infected patients or co-workers. It can also be acquired through community transmission. It has been evident that there was a rise in infected health care workers and also some incidences of death [5]. Although, universal precautions are usually expected to be well practiced among health care workers, however, specific Safety measures need to be implemented

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to protect health care workers and hence protecting the patients and the community. In this study, safety measures include the requirement of mask wearing, as well as a daily assessment of fitness for work.

Safety measures such as mask wearing and daily assessment of hospital workers' COVID-19 symptoms prior to entering the hospital may be beneficial at limiting the spread of COVID-19 among hospital workers [6]. Daily assessment of fitness for work has been found to be a useful preventative measure to ensure safety in hospitals [6].

Due to the risk of exposure in COVID-19 and the workforce shortages that resulted from the pandemic, an alternative to physical on site symptom screening for work may not be the most efficient/safest way. An online self-screening questionnaire to determine fitness for work may be an alternative that ensures safety while maintaining efficiency and reducing exposure risk at local screening stations. Several hospitals have developed an online screening tool to assess fitness for work for hospital workers [6, 7]. A hospital in Massachusetts made the daily online symptom tracking a mandatory task prior to entering the hospital along with the mandatory use of facemasks. Using the online tool will help limit the spread of COVID-19 in the hospital while also minimizing interaction process (by for example, having a physical face-to-face assessment) as well as addressing the pressures and shortages of the workforce (it does not require a significant number of staff members) [6]. Moreover, responses can provide valuable information for researchers and hospital interventions. They can be used to calculate the most common symptoms, as well as the most common types of transmission across departments. This information can be used to guide interventions on reducing the spread of COVID-19 in the hospital. A potential limitation is if staff members enter the hospital without using the screening tool. This limitation can be addressed by having a staff member who monitors responses.

Bahrain Defence Force-Royal Medical Services (BDF-RMS) conducted several safety measures to help to prevent the spread of COVID-19 in the hospital, in line with following Bahrain National COVID-19 Team protocols. Perhaps one of the major measures taken is to closely monitor the staff for COVID-19 symptoms [8]. Since April 12, 2020, BDF-RMS has been assessing the COVID-19 symptoms among health care workers on a daily basis. The assessment is achieved using an in-house developed electronic self-assessment log that can be accessed either by mobile devices or computers. All health care workers were asked to complete the COVID-19 log before arriving to work. If the staff is asymptomatic they get a message saying that they are fit for duty, on the other hand, a symptomatic staff will get a message with instructions to stay at home and contact the designated isolated COVID-19 staff screening clinic for further instructions. Each symptomatic staff gets an appointment to be investigated and tested on the same day of reporting unfit. Thus, the log allows identifying the symptomatic staff before arrival to work and thus limiting the risk of infectious spread if present (Figs. 1 and 2).

The COVID-LOG used in this study provided 24 h automated guidance that is individualized based on the answers. Similar tools have been used worldwide. A recent systematic review identified 63 apps that have been designated for COVID-19; for example, there were 25 in India and 18 each in UK and USA [9]. In Bahrain the government has launched Be Aware app that provides COVID-19 information and e-services such as contact tracing, test result, test appointment, PCR test certificate and announcements. Unlike our COVID-19 log, Be Aware app does not include self-assessment and monitoring of symptoms. [10] Successful use of electronic health app for COVID-19 self-assessment and symptoms monitoring has been demonstrated in Netherlands [11].

The aim of this study is to outline the characteristics of the health care workers infected with SARS- CoV-2 using data from the electronic COVID-19 Staff Daily Self-assessment Log.

2 Methods

2.1 Study design and participants

We conducted an observational cohort study using the electronic COVID-19 staff daily self-assessment log. Participants were all clinical and non-clinical health care workers working in a district hospital in Bahrain. The identity of the health care workers participating in the study was anonymous and their confidentiality was preserved. Our study was approved by both the Research & Research Ethics Committee at BDF-RMS and the COVID-19 Research National Committee in Bahrain (CRT-COVID2020-022). A total of 2000 staff members were invited to participate. The daily responses on the self-monitor log were collected for a period of one month. From the beginning of June 2020, until the end of it.

2.2 Procedures

An in-house log was developed in the district hospital, which was customized to track COVID-19 symptoms/contact history among health care workers. As per the regulations of the hospital and part of the special safety measures of the hospital, all the clinical and non-clinical staff were asked to complete the COVID-19 Log daily before coming to work. Completing the log before arriving at the hospital

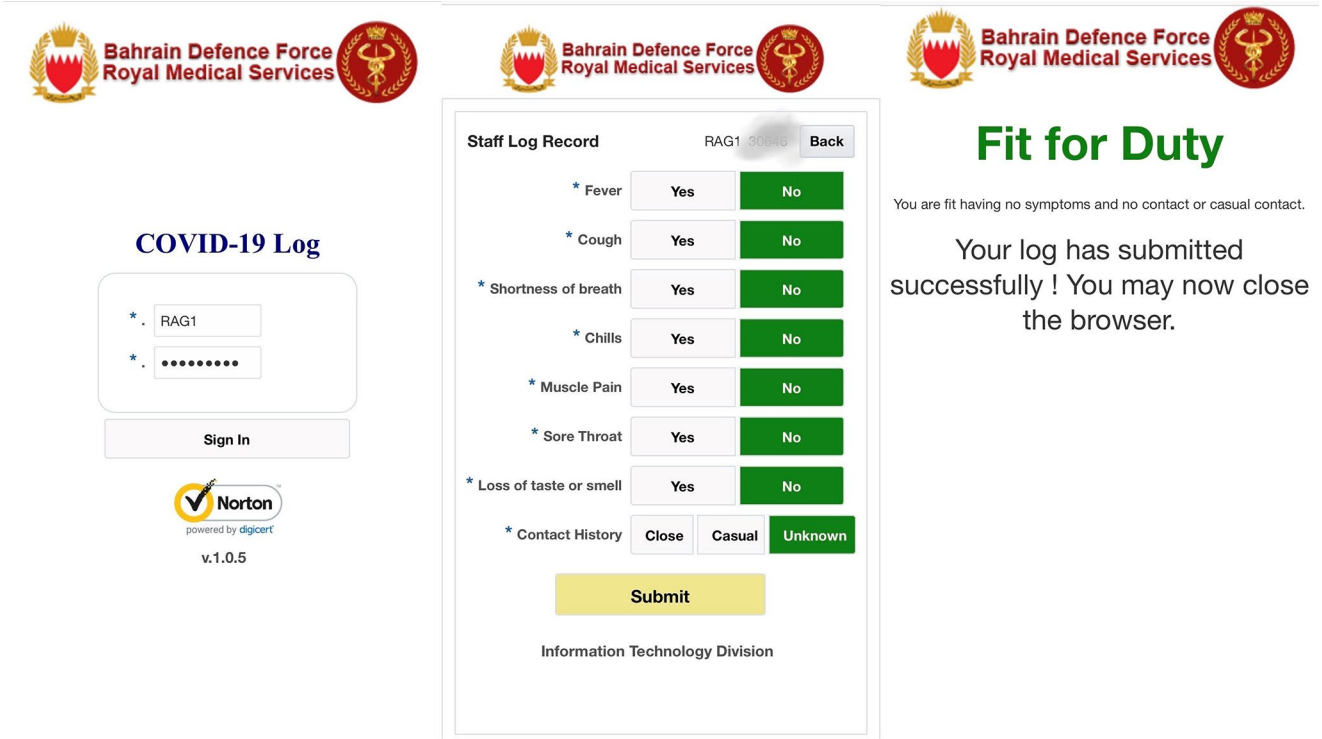


Fig. 1 COVID-19 Login page and Fit for duty

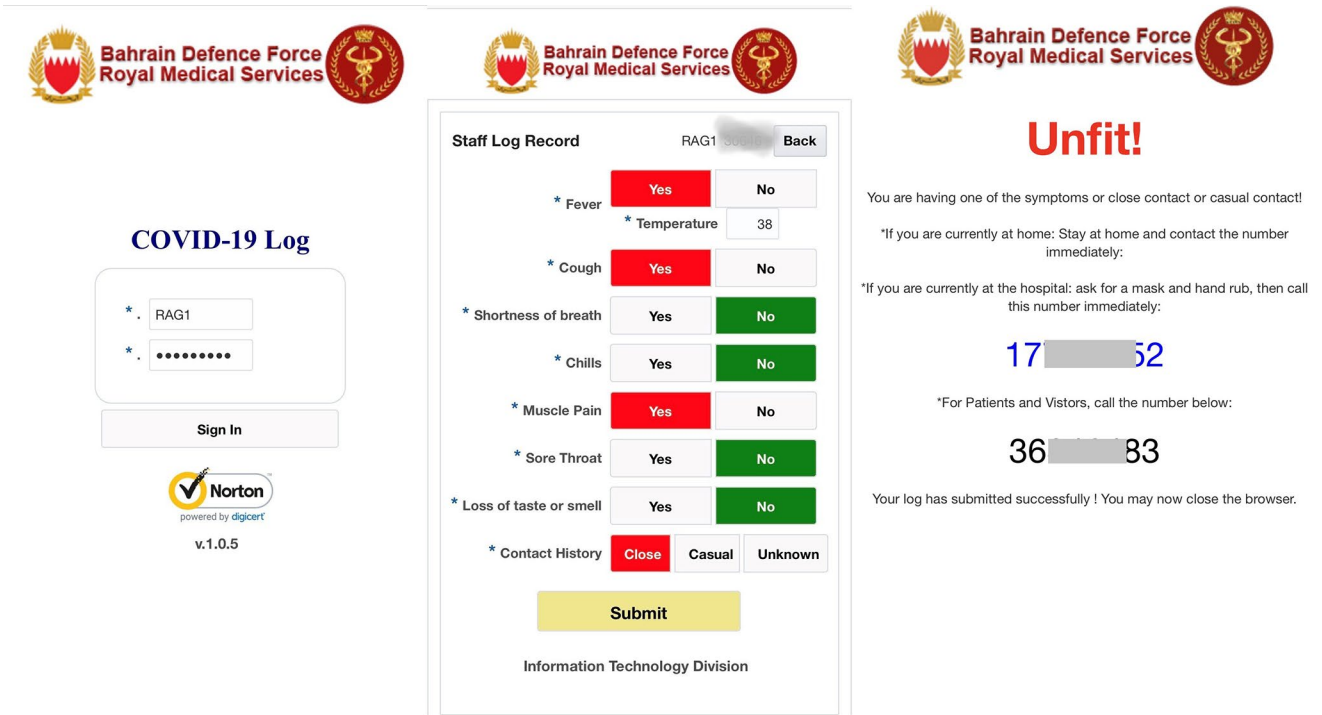


Fig. 2 Unfit status

is mandatory and is part of the safety measures taken at the hospital in order to protect all staff members. Employees were required to fill out the self-assessment daily prior to entering the hospital. Compliance with the completion of the COVID-19 Log was closely monitored by head of departments through a designated staff monitoring section in the log. Hence, each head of department had access to their own department's responses, this included names of staff members that completed the log. Upon entering the hospital, the head of department were in charge of checking to ensure that all of their staff filled out the log, and to personally call and remind those who did not fill out the log that they must do so. In addition, periodic reminders to complete the log were sent through both SMS and emails to all staff.

Staff were instructed to access the COVID-19 Log through their smartphone or computer using their hospital ID and password (Fig. 1). A quick response link was sent to staff members so that they can access the log through their smart phones. The log was a web based questionnaire which was developed using a secure hospital database. Staff members had to log in using their hospital user names and password in order to provide their responses. After accessing the log, the health care workers were asked to select from the following symptoms [8], if present: fever, cough, shortness of breath, chills, muscle pain, sore throat, loss of taste or smell. Additionally, they had to report the history of contact with COVID-19 positive case. If the staff is asymptomatic and had no contact history he/she received an automated message after submission that he/she is fit for duty (Fig. 1). If the staff is symptomatic he/she received an automated message that he/she is unfit for duty and should stay at home and contact a designated staff clinic at the hospital for COVID-19 screening (Fig. 2). The symptomatic staff got a phone consultation by a physician in the COVID-19 staff screening clinic and further instruction was given based on the history. The symptomatic staff were given an appointment to visit the COVID-19 staff screening clinic on the same day of reporting and got tested if necessary. The results, management and follow ups of the symptomatic staff were addressed by the infection control team involving the infectious disease physicians. In this paper we evaluated all records from 1st of June 2020 to 30th of June 2020. The percentage of positive asymptomatic staff versus symptomatic staff was calculated. Demographic data of symptomatic staff was recorded including: identification number, age, gender, occupation and department. The symptomatic staff were categorized into: working in COVID-19 facility, directly patient facing (e.g. physicians, nurses, porters, etc.), non-patient facing but potentially at high risk of nosocomial exposure (e.g. laboratory staff and domestic), non-clinical (e.g. administrative, clerical, information technology, secretarial, etc.). The symptoms and status of symptomatic staff were recorded.

Table 1 Demographic characteristics of unfit staff (n = 342)

Variable		Frequency (%)
Gender	Male	66 (19.3)
	Female	276 (80.7)
Age (years)	20–24	23 (6.7)
	25–29	72 (21.1)
	30–34	88 (25.7)
	35–39	58 (17.0)
	40–44	39 (11.4)
	45–49	33 (9.6)
	50–54	17 (5.0)
	55–59	7 (2.0)
	60–64	5 (1.5)
Profession	Doctor	76 (22.2)
	Nurse	216 (63.2)
	Professional	16 (4.7)
	Technical	17 (5.0)
	Administration	14 (4.1)
	Vocational	3 (0.9)

2.3 Statistical analysis

Statistical Package for Social Science (SPSS, version 23.0) and Minitab (version 17) were used for analyses. Descriptive analysis was measured to calculate means, frequencies and percentages were measured.

3 Results

We received a total of 47,388 entries in one month. A total of 2000 staff members were invited to participate. The median entry rate per day was 1,732. Number of entries per varied from 1028 to 1851. Out of 47,388 total entries, we had a total of 342 staffs were reported 'unfit' for duty (Reported either any symptoms or contact history with a positive COVID-19 case or both).

3.1 Follow-up of "unfit for duty" staff

After excluding duplicate entries from the 'unfit for duty' staffs, we had 342 'unfit 'staffs included in the follow-up. Demographic characteristics of unfit staff were explained in Table 1. In the unfit staff 80.7% were females and 19.3% males (n = 66). The average age of staff was 36 years (SD = 8.95). Figure 3 displays the frequency of unfit staff by profession. Highest frequency was found among nurses (63.2%) followed by doctors (22.2%).

For further understanding, departments were grouped into three groups: clinical, non-clinical and COVID-19

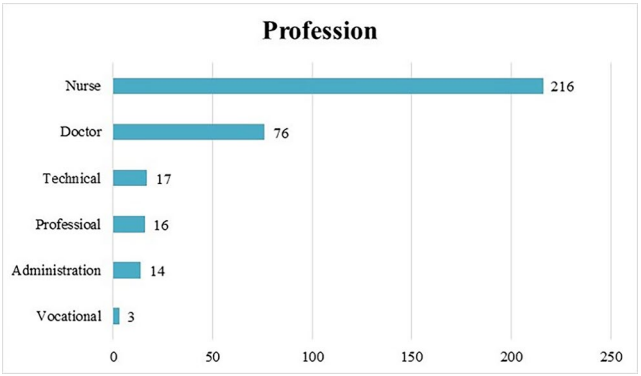


Fig. 3 Frequency distribution of unfit staffs? profession

facility. Majority (85.4%) of the unfit staff were from clinical departments (n = 292) and 7.3% (n = 25) were from non-clinical departments, whereas another 7.3% (n = 25) were from COVID-19 facilities (Fig. 4). Table 2 shows the prevalence of COVID-19 symptoms among the unfit staff. Figure 6 shows the symptomatic responses of the unfit staffs (n = 342). The most frequently reported symptoms were sore throat (23.1%) and muscle pain (12.6%) (Fig. 5).

The 'unfit' health care workers were instructed to contact the designated COVID-19 staff-screening clinic for further follow up and instructions. Table 2 shows the contact history and the results of the nasopharyngeal RT-PCR test of the unfit staff. The majority of unfit staff (90.6%) were directly working with patients and 77.8% of the staff had either casual or close contact with a positive COVID-19 case. A total of 18 (5.3%) health care workers were diagnosed as COVID-19 positive and further instructed to be in home isolation or transferred to a quarantine facility depending on their status (Table 2).

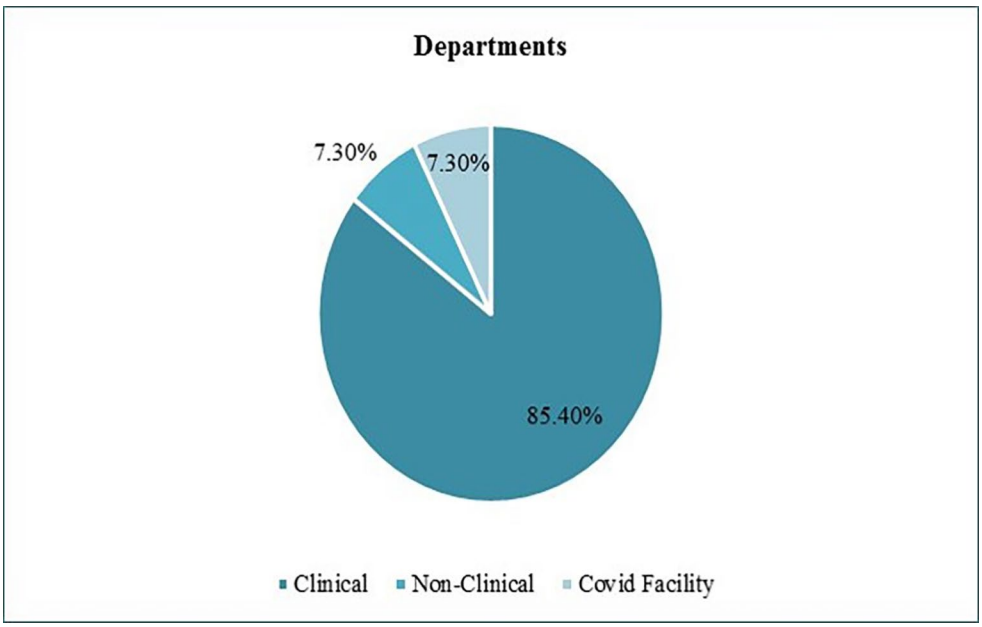
3.2 Unfit health care workers tested positive

The percentage of unfit health care workers testing positive is 5% (n = 18) with 95% CI (3.14 to 8.19). Information about those who tested positive such as demographic characteristics and 'contact history' were explained in Table 3. Most of the infected health care workers were female (72%). The median age of infected staff was 33.5 years (range from 24 to 60 years). Of the infected staff, 61% were nurses, 22% were doctors, and 17% were administrative staff. The source of infection for most of the health care workers was through community transmission (83%), whereas only 3 out of the 18 health care workers acquired it from the hospital (17%). There were no complications reported among COVID-19 positive health care staffs. Majority of the positive cases (56%) were asymptomatic, but they had history of casual or contact with a COVID-19 case (78%). A total of 17 out of the 18 positive health care workers were instructed to be in home isolation and only one staff was admitted to a COVID-19 facility. All health care workers recovered and only one remained positive during this duration of this study (Table 3).

4 Discussion

Out of 47,388 responses, 853 (2%) of staff reported either COVID-19 symptoms or history of contact with diagnosed COVID-19 case. The most frequently reported symptom was sore throat (23%), followed by muscle pain (12.6%). The highest frequency of staff who reported symptoms/and or contact was in nurses. Of those who reported symptoms/contact, 18 were diagnosed with COVID-19. The majority

Fig. 4 Percentages of unfit staffs' department



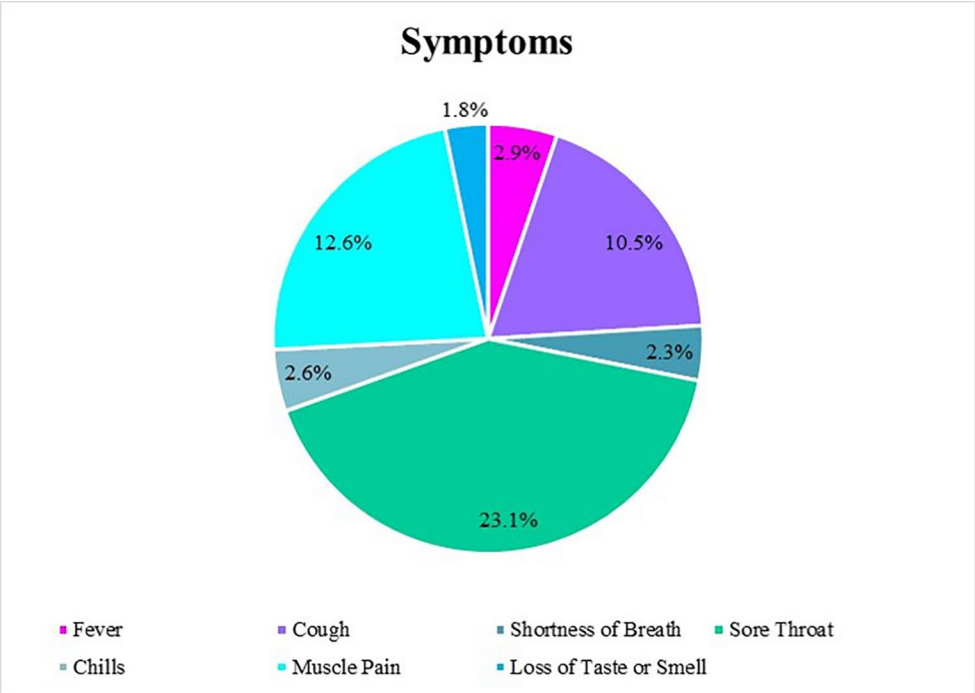


Fig. 5 Percentages of symptoms reported by 'unfit' staffs

Table 2 Contact History and COVID-19 Test Follow-up Information for Unfit Staff (n = 342)

		Frequency (%)
Suspected cases tested negative		324 (94.7%)
Suspected cases tested positive		18 (5.3%)
Working In COVID Facility	Yes	25 (7.3)
	No	317 (92.7)
Staff Is Working:	Directly Facing Patients	310 (90.6)
	Non-Patient Facing	6 (1.8)
	Non-Clinical	26 (7.6)
Close Or Casual Contact With A COVID Patient	Yes	266 (77.8)
	No	76 (22.2)
Status	Discharged Due To Non-COVID Disease	9 (2.6)
	Home Isolation	67 (19.6)
	Admitted	1 (0.3)
	None Of The Above	265 (77.5)
Outcome	Tested Negative	313 (91.5)
	Recovered (was positive and now negative)	17 (5.0)
	Still positive	1 (0.3)
	No test done	11 (3.2)

(83.3%) of the infected staff in this study obtained the virus through community transmission, and only 16.7% obtained the virus through hospital transmission.

In our analysis of 47,388 responses over a period of one month, 2% (n = 853) of the staff reported unfit to attend work (by either having COVID-19 symptoms or contact with COVID-19 positive individual). This is in contrast to another cohort study that found 20% of frontline health care workers reported at least one symptom associated with COVID-19. [12] Out of 47,388, only 5.26% of those who were unfit tested positive for COVID-19 which is less than the 10–20% that was reported in previous cross-sectional studies. [13, 14] Most of the infected health care workers were female (72.2%) which is similar to a previous study conducted in a hospital in Italy (73%). [13]

In this study, 88.9% of infected staff were working directly with patients. Most of the infected health care workers were nurses (61.1%), followed by clinicians (22.2%) and administrative staff (16.7%). This can be explained by the high distribution of the nurses in the hospital, in general, and in the COVID-19 teams. This is similar to other countries, which their teams composed of approximately

Table 3 Information of unfit staff tested positive (n = 18)

Variable		Frequency (%)
Gender	Male	5 (28)
	Female	13 (72)
Age group	20–24	2 (11)
	25–29	4 (22)
	30–34	5 (28)
	40–44	1 (6)
	45–49	4 (22)
	50–54	1 (6)
	60–64	1 (6)
Profession	Doctor	4 (22)
	Nurse	11 (61)
	Administration	3 (17)
Department type	Clinical	14 (78)
	Non-Clinical	2 (11)
	Covid-19 Facility	2 (11)
Staff is Working	Directly Facing Patients	16 (89)
	Non-Clinical	2 (11)
Close or casual contact with a COVID case	Yes	14 (78)
	No	4 (22)
Source of infection	Hospital acquired	3 (17)
	Community transmission	15 (83)
Status	Home isolation	17 (94)
	Admitted	1 (6)
Outcome	Recovered (was + ve now –ve)	17 (94)
	Still Positive	1 (6)
Symptoms	**No Symptoms (but contact history)**	10 (56)
	Fever	1 (6)
	Muscle Pain	1 (6)
	Shortness of Breath	1 (6)
	Loss of Taste and Smell	1 (6)
	Fever, Cough	1 (6)
	Sore Throat, Loss of Taste/Smell	1 (6)
	Muscle Pain, Loss of Taste/Smell	1 (6)
	Fever, cough, sore throat, muscle pain	1 (6)

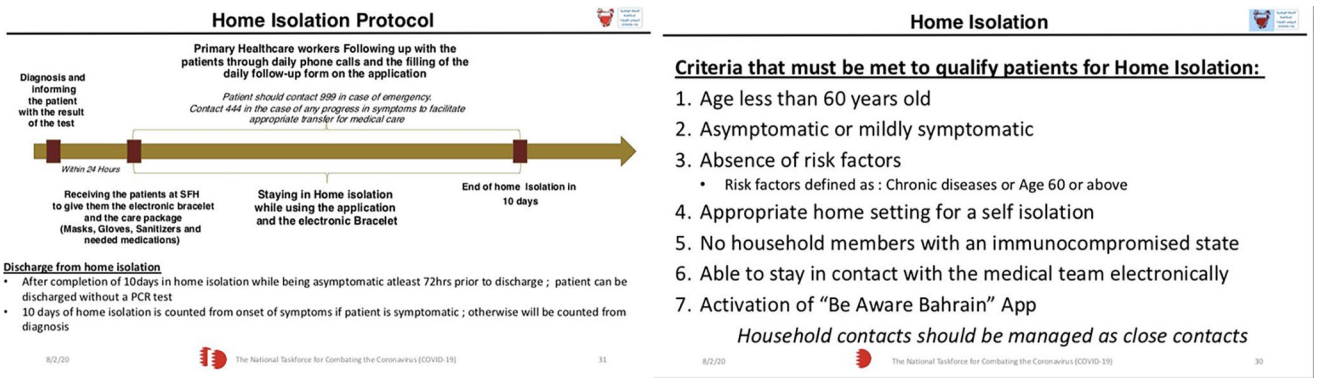


Fig. 6 Bahrain protocol for home isolation (2020)

60% of nurses. [15] A follow up of unfit staff revealed that the most common reported symptoms were sore throat and muscle pain. However, the majority of the unfit staff were asymptomatic but had a history of contact with a COVID-19 infected person. Hospital staff are at risk for infections due to working directly with patients. [16, 17] Interestingly, the majority (83.3%) of the infected staff in this study obtained the virus through community transmission, and only 16.7% obtained the virus through hospital transmission. This is in line with past studies on mildly symptomatic health care workers infected with SARS-CoV-2 who assumed that most of the transmission most likely happened during community transmission. [18, 19] Another study found that only 3% of healthcare workers who were diagnosed with COVID-19 were in contact with an inpatient infected with COVID-19. [20] This finding suggests the possibility of an increased risk of community transmission for obtaining the virus over hospital risk. It is possible that the preventative methods and procedures taken at hospitals (e.g. such as requirement of wear of personal protective equipment (PPE)) are effective in managing the risk associated with exposure. The findings suggest that while working at a hospital poses a risk to contracting a virus and safety measures should be taken, a huge emphasis should be placed on finding strategies to reduce the likelihood of community transmission among health care staff. An implication of this finding is that it demonstrates the importance of increasing the focus on interventions that reduce community transmission to hospital staff. This can include educational interventions such as lectures.

A total of 55.5% of the unfit staff that tested positive were asymptomatic. They were instructed to follow the national home isolation protocol (94.4%) [21] where they had been followed by a designated physician's team on a daily basis. This was similar to a study conducted in USA and showed 90% of the infected health care workers were not hospitalized [12]. This could be attributed to the younger age of the infected health care workers compared to the hospitalized COVID-19 patients, as well as the periodic testing of health care workers especially the ones working in COVID-19 facility, which might identify mild cases in early stages [12]. This finding could be used to encourage future researches to study the effects of periodic testing and other factors that may contribute to lower levels of transmission as well as lower severity. This could provide a long term benefit of guiding hospital protocols during infectious outbreaks.

The presence of a self-monitoring tool for hospital staff such as the one used in this study, could potentially eliminate any unnecessary encounters and hospital visits which could prevent exposure. Moreover, the requirement to fill the log before coming to work can also help ensure safety in hospitals by minimizing the entry of those who have symptoms or who have been in contact. The active assessment of symptoms and contact in the checkpoint desks on each entrance of the hospital provides an additional confirmation of the status of fitness of the staff. Additionally, the 24 h availability of automated guidance saves time and avoids excessive use of hospital resources as it prevents unnecessary phone calls and visits. Direct access to a COVID-19 screening clinic that was designated to staff only has a direct advantage of prioritization of testing of health care workers and perhaps an indirect advantage of lowering the psychological impact of the pandemic. Moreover, the information obtained from the responses could provide suggestions for enhancing interventions focused on reducing the spread of COVID-19 as well as provide directions for future researchers. The finding that community transmission is the most common mode of transmission in this study suggests the potential effectiveness of hospital measures (Ex. mask wearing, PPE equipment) at reducing the spread of COVID-19 within the hospital. Future researchers can continue to identify the effectiveness of these hospital measures at reducing the spread of COVID-19. Moreover, this finding can be used to encourage an increased focus on interventions that reduce the likelihood of community transmission.

A limitation includes the possibility of staff forgetting to provide their daily responses, as well as those who provide double responses. This could affect the results, however can be managed in the future by advancing the electronic system to include alerts/reminders and not allowing more than one response a day.

5 Conclusion

The introduced digital self-assessment tool for hospital staff during the COVID-19 pandemic could be used as a safety measure while also potentially saving time and eliminating the use of unnecessary hospital resources. Future studies should examine the effectiveness of this tool by performing a sensitivity analysis. Moreover, while there is much attention regarding the risk of hospital staff being infected at their job, their risk of being infected via community transmission deserves equal attention. The long term benefits of this tool is that it can inform future interventions at reducing the risk of spread during any infectious disease outbreak.

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Author Contribution Conceptualization of the research: RA, AA and

AS; data curation: RA; formal analysis: AA. Writing of manuscript: AS; review and editing of manuscript: RA, AA and AS.

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Data Availability The corresponding author may be contacted for all material used and data obtained from this study.

Code Availability Not applicable.

Declarations

Conflict of Interest The authors have no conflicts of interest to declare.

Ethical Approval The identity of the health care workers participating in the study will be anonymous and their confidentiality will be preserved. The study will be submitted for ethical approval by the Research & Research Ethics Committee at BDF-RMS and the COVID-19 Research National Committee (CRT-COVID2020-022).

Consent to participate Not Applicable.

Consent for publication Not Applicable.

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