

COVID-19

Investigation of a COVID-19 outbreak in a University Cardio-Thoracic Hospital in Cairo: exploration of the risk to healthcare workers and patients

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Keywords

COVID-19 • Outbreak • Healthcare workers • Hospital

Summary

Background. Corona virus Disease 2019 (COVID-19) pandemic has posed a challenge to health sectors all over the world. The pandemic arrived in Egypt a few weeks after Europe and Asia, with rapidly rising numbers. Health care workers (HCWs) are front liners sustaining a major risk of acquiring the infection.

Aim. In this work, we analyse an outbreak of COVID-19 in a University hospital in Cairo involving HCWs of different categories, patients and patients' accompanying relatives.

Methods. Following the reporting of the first COVID-19 confirmed case; a 55-year-old nurse at the hospital, a total of 645 healthcare workers, patients and patients' accompanying relatives were tested for SARS-CoV-2 by real-time reverse transcription polymerase chain reaction (rRT-PCR) assay.

Results. Twenty-four out of 589 HCWs, 3 out of 42 patient and 4 out of 14 patients' accompanying relatives tested positive for COVID-19. No physicians, pharmacists or technicians were infected. Nursing staff and housekeeping staff were the most at risk of contracting the infection with a risk ratio of 4.99 (95% CI: 1.4-17.6) and 5.08 (95% CI: 1.4-18.4) respectively. Clustering of infected HCWs was observed in paediatrics' ICU and in the 6th floor of the hospital.

Conclusions. Nursing and housekeeping staff sustain a significantly higher risk of COVID-19 infection compared to other staff categories. The nature of their duties and the frequent unprotected contact between members of these categories may play a role in increasing their risk.

Introduction

Several cases of pneumonia of unknown origin were reported on the 31st of December 2019 from Wuhan City in China and a new virus was identified on the 7th of January as the cause. The new virus (Known as SARS COV2) belongs to the same family of severe acute respiratory syndrome (SARS) and Middle East Respiratory Syndrome Coronavirus (MERS-CoV) [1]. By February 11, 2020, the World Health Organization (WHO) officially named the disease resulting from infection with SARS-CoV-2 as coronavirus disease 2019 (COVID-19). COVID-19 represents a spectrum of clinical manifestations that typically include fever, dry cough, and fatigue, often with pulmonary involvement, which progresses in some cases into severe illness and death [1, 2].

COVID-19 was declared a pandemic by the 12th of March 2020 [1]. Several studies have calculated the basic reproduction number R_0 ; that is used to estimate the average number of secondary cases generated by an infectious case in a fully susceptible population during the early phase of the outbreak. R_0 for COVID-19 was estimated to range between 2 and 3, suggesting the

potential of sustained human-to-human transmission [3]. By the first days of April 2020, the total number of reported confirmed cases surpassed one million worldwide with over 47,000 associated deaths [4].

In Africa, the pandemic was delayed for a few weeks behind Europe and Asia, however the number of cases has been rapidly increasing. The small numbers reported initially in Africa may be attributed to a relatively low air travel density in addition to lower coverage with SARS-CoV-2 testing [5-7]. Egypt has reported its first COVID-19 case on February 14th, 2020 and the numbers have been rising ever since. By the first days of April, Egypt has reported more than 1,000 confirmed cases. On the 12th of May, the reported cases reached around 10,000 with more than 500 deaths [8].

Health care providers have been at the frontlines in the battle against COVID-19 and they sustain a major risk of acquiring the infection. There has been wide variation in the rates of infection reported among healthcare workers (HCWs) ranging between 2.1 and 29% [1, 9]. In Italy, as of April 3rd 2020, around 10,000 healthcare workers have been infected [5]. Healthcare workers are particularly vulnerable to infection from 'super-spreading events' of hospital transmission and exposure

to a higher concentration of the virus from sustained contact in closed settings [3, 9, 10]. Infected healthcare workers also risk spreading the virus to their families and friends, especially those who are elderly or have chronic medical conditions [11].

If HCWs get sick and get out of work, hospital care could collapse, as seen in countries such as Italy and Spain [12]. Here, we describe an outbreak of COVID-19 in a University hospital in Cairo during the first wave of COVID-19 pandemic; which largely involved HCWs in the period from the 10th to the 24th of April 2020. We believe that documenting our experience from the earlier waves can inform healthcare facilities preparedness for the recurrent waves, given the constantly emerging SARS COV2 variants and the relatively slow progress in vaccination coverage in developing countries including Egypt [13-15]. Egypt is currently going through the fourth wave with over 300,000 recorded confirmed cases and over 17,000 recorded deaths [14].

Methods

The first confirmed COVID-19 case detected in Cardio-thoracic academy hospital was a 55-year-old senior female nurse on the 10th of April 2020. Cardio-thoracic academy hospital is a tertiary university hospital 151 beds, two distinct operating theatres, three Intensive care units (ICUs) and one Coronary care unit (CCU).

An outbreak investigation was initiated to trace the source of infection between the 10th and 24th of April 2020. Nasopharyngeal swabs were taken from all 589 health care workers at the hospital, and all 42 inpatients at that time along with 14 patients’ accompanying relatives who stayed at the hospital. Nasopharyngeal swabs were tested at Ain Shams University hospitals’ laboratory by real-time reverse transcription polymerase chain reaction (rRT-PCR) assay for the qualitative detection of nucleic acid from SARS-CoV-2. The current study protocol aimed to describe the outbreak of SARS-CoV-2 in the hospital without any changes in the policies of the hospital or interventions for the patients. Accordingly, it was exempted from the ethical reviewing. However confidentiality of patient’s data was assured together with reporting of the disease to the Ministry of health.

STATISTICAL ANALYSIS

Statistical analysis was done using SPSS version 24. Data were presented in frequency and related percentage. Chi square test and Fisher’s exact test were used to compare categorical variables. The risk ratio was calculated for the exposed groups with 95% confidence interval. The risk ratio was adjusted for gender using the Mantel Haenzel technique. Significance level was considered at $p < 0.05$.

Results

Between the 10th and the 24th of April 2020, COVID-19 testing was done for 645 subjects distributed as follows:

Tab. I. Cardio-thoracic hospital floors and number of cases in each floor.

Floor	Departments/wards	Number of cases*
8 th floor	Adult ICU Chest ICU (nurse) Pediatric ICU (2 patients and 4 nurses)	- • ●●●●●●
7 th floor	Private inpatient rooms (single rooms) Housekeepers	•
6 th floor	Double or triple inpatient rooms (index case) One room for accompanying family members Nursing staff office Housekeepers	• ●●●●● ●●●●● ●●●●●
4 th floor	Under renovation	-
5 th floor	Under renovation	-
3 rd floor	Central Sterile Supply Department (CSSD)	-
2 nd floor	Coronary Care Unit (CCU) Cardiac Catheterization Lab Cardiac Operating Room OR1 Chest Operating Room OR2 (two nurses) Housekeepers	- - - ●● •
1 st floor	Lecture halls (the lectures were suspended)	
Ground floor	Administrative offices Outpatient Emergency Room	●●● - -
Under ground	Kitchen Laundry	• -

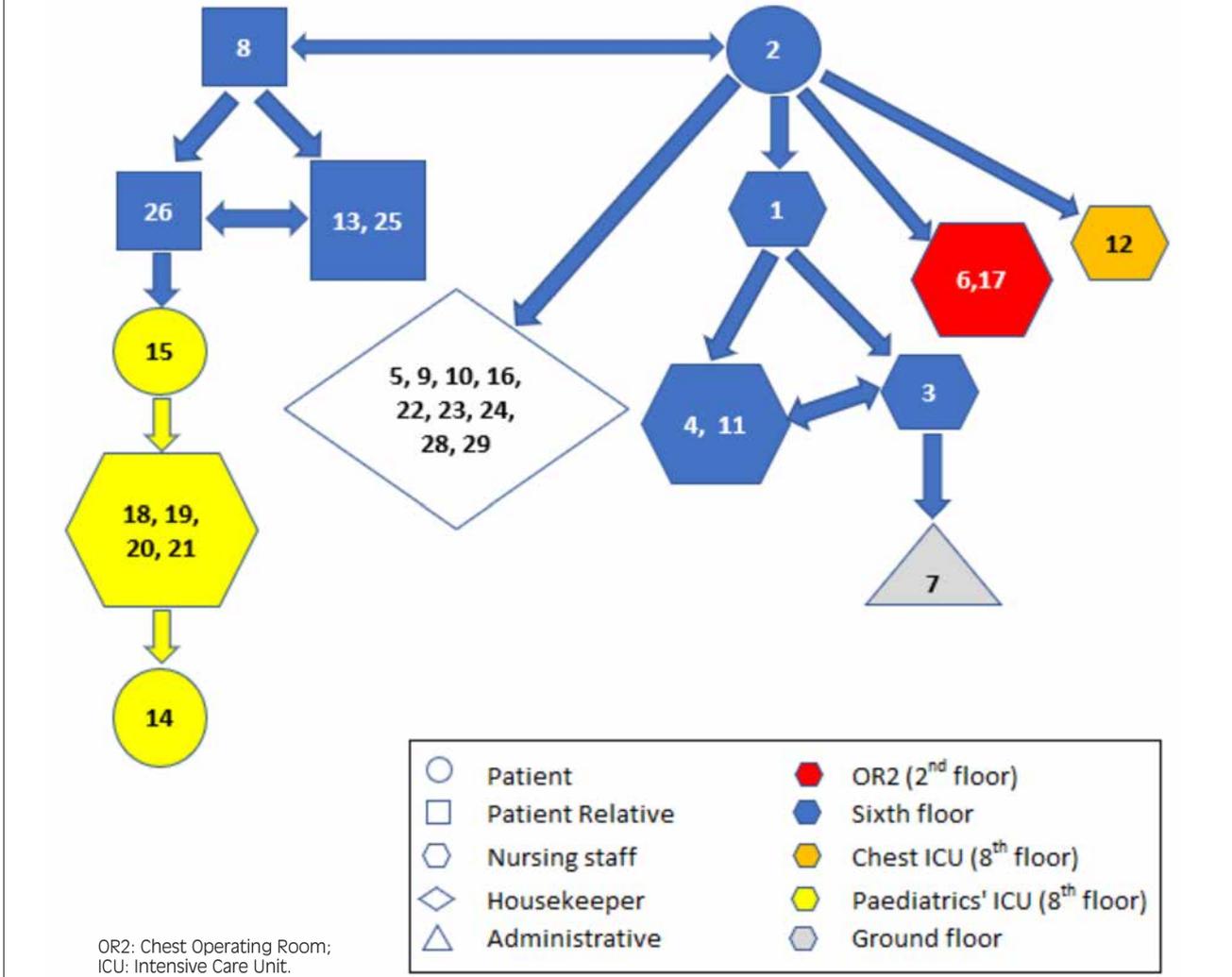
* Three infected housekeepers who work on night shift moved across the Cardio-Thoracic hospital floors,

42 patients and 14 of their relatives who accompanied them at the hospital, 147 of the nursing staff, 61 physicians, 6 pharmacists, 14 technicians, 118 housekeepers, 197 administrative officials and 43 security officers. A total of 31 COVID-19 cases were confirmed: 3 Patients and 4 of the patients’ accompanying relatives in addition to 24 HCWs. Table I shows the distribution of confirmed COVID-19 cases across the hospital.

DESCRIPTION OF THE OUTBREAK

On the 10th of April 2020, a senior nurse, 55 years old (denoted by number 1 in Fig. 1), started to complain of fever, severe malaise and minor cough. She tested positive for SARS-COV-2 by rRT-PCR. She had no contact with known cases of COVID-19. At that time, contact tracing was the strategy applied by Egyptian Ministry of Health. The Hospital administration started to test all patients and health care workers working in the hospital. One female patient (the suspected index case; denoted by number 2 in Fig. 1) was found positive. This patient had chylous pericardial effusion. She was admitted on February 17th, 2020 and was discharged on April 13th, 2020. She had received care in several areas in the hospital (Operation theatre, Chest ICU and inpatient ward). Figure 1 shows the proposed transmission map of COVID-19 outbreak in the hospital.

Fig. 1. Transmission Map of infected subjects during the COVID-19 outbreak in Cardio-Thoracic hospital. Numbers indicate the order of receiving laboratory confirmatory test results. Numbers are not necessarily associated with the date of infection or the appearance of symptoms.



SIXTH FLOOR FOR INPATIENT ROOMS

As seen in Table I, the sixth floor includes inpatient rooms with multiple beds. The suspected index case was admitted in one of these rooms. One or more nurses were infected during contact with the index patient. It is quite noticeable that four nurses acquired the infection and none of the patients in the same floor were infected although they were cared for by some of the infected nurses.

There is one small poorly ventilated office for nursing staff where they usually assemble. Nurses usually wear masks or other protective equipment when providing patient care, but they are not keen on following this practice when in contact with each other.

The mother of the assumed index case (denoted by number 8 in Figure 1) who accompanied her at the hospital also tested positive. She stayed together with nine other patients' relatives in one room in the sixth floor assigned for family members of child patients in the ICU who accompany the patients during their hospital stay. They used to gather in it where they shared meals and food utensils. Four out of ten of patient relatives in that room tested positive.

CHEST OPERATION ROOM AND CHEST ICU

Two nurses from the chest operation suite and one nurse from the chest ICU were infected. They were probably infected during contact with the suspected index case that received care in these areas.

PAEDIATRIC ICU

The paediatrics ICU is intended for care of post-operative paediatric cardiac patients. Two patients in paediatrics ICU tested positive. The mothers of three children, who stayed in the sixth floor were infected. One infected child (denoted by number 15 in Fig. 1) had a COVID-19 positive mother (denoted by number 26 in Fig. 1). The second child (number 14 in Fig. 1) probably contracted the infection from infected nurses.

Four nurses in the paediatrics ICU were infected. They may have transmitted the infection to each other or have been infected while caring for the first infected child (denoted by number 15 in Fig. 1). Nursing care for children in paediatric ICU is different from care in the regular inpatient ward, as it involves closer contact with

Tab. II. Incidence of infection during the hospital COVID-19 outbreak.

	No. screened	Infected	Risk ratio	
		No. (%)	RR (95% CI)	
Total subjects	645	31 (4.8)		
Age				
< 20	15	2 (13.3)	4.6 (0.9-25.3)	
20-< 30	150	9 (5.6)	1.9 (0.7-5.5)	
30-< 40	187	6 (3.2)	1	
≥ 40	283	14 (4.9)	1.6 (0.6-4.2)	
Gender				
Male	363	10 (2.8)	1	
Female	282	21 (7.4)	2.7 (1.3-5.6)	
Screened hospital groups				
Patients	41 ^a	2 (4.9)	4.4 (0.7-27.3)	
Family members*	14	4 (28.3)		
Healthcare workers				
<i>Nursing staff</i>	147	11 (7.5)	6.98 (1.9-25.5)	4.99 (1.4-17.6) ^c
<i>Housekeepers</i>	118	9 (7.6)	7.1 (1.89-26.8)	5.08 (1.4-18.4) ^c
<i>Physicians</i>	61	0	-	
<i>Other workers^b</i>	262	3 (1.15)	1	

^a The index case removed from the calculation; ^b One case (the husband of an infected nurse) was removed from the calculation; ^c adjusted RR for gender; * This group has peculiar situation of close contact and thus was not compared with other groups.

patients and frequent performance of Aerosol generating procedures (AGPs) such as suction and ventilation.

HOUSEKEEPERS

The incidence of infection in the housekeeping workers was 7.6%. During investigating this outbreak, we found that housekeepers gather frequently for example, during mealtimes. During these gatherings, housekeepers didn't wear masks or practice social distancing.

OTHER INFECTED HCWS

There were no infections among physicians or pharmacists. Four infections were detected among other non-clinical health care workers. One administrative worker (denoted by number 7 in Fig. 1) contracted the infection from his wife, a nurse working in the sixth floor (denoted by number 3 in Fig. 1). The acquired infection in the other three non-clinical workers; namely one security personnel, one kitchen worker and a medical equipment engineer could not be tracked to a hospital source of infection.

None of the infected subjects died except the 2 paediatric cases in the ICU; probably as a result of their primary conditions.

Table II shows that young age was associated with higher risk of infection. This finding is probably specific to our hospital where vulnerable paediatric patients with underlying cardio-thoracic conditions are admitted. Our investigation also shows that women are twice as likely to get infected compared to men. This may be attributed to the type of exposure female nurses and female relatives are subjected to during caring for patients or coming in contact with each other.

The risk ratio of acquiring the infection among the nursing staff and housekeepers was almost seven times

that of non-clinical hospital workers. The risk was still statistically significant after adjusting for gender (Tab II).

Discussion

The described outbreak occurred at the time when the number of confirmed COVID-19 cases announced by the Egyptian Ministry of Health (MOH) was substantially low making community transmission less likely [16].

Infection of HCWs during care of COVID-19 patients has been documented in previous studies. In a study in the USA, 35.5% of HCWs who have been exposed to a single infected patient, in one hospital, developed symptoms [9]. Foci of SARS-COV-2 infections in the hospital, especially in undetected or asymptomatic cases, pose a potential risk for healthcare workers and other hospitalized patients as well.

Our investigation has shown that nursing staff and housekeepers sustained the highest risk of infection. It is well established that the risk of HCWs infection can be reduced by adherence to infection control precautions within health facilities. Essentially, the use of personal protective equipment (PPE) including gowns, gloves, facemasks, and a face shields or goggles especially when performing AGPs [17]. If they are made available, the proper use of PPE requires training and supervision, especially at the wake of an epidemic when healthcare workers may not have be familiar with intensive use of PPE [18].

Nurses and housekeepers are assumed to be aware of the importance of PPE and trained to wear them. We could question whether they were adequately protected. Also, It is well known that PPE resources are scarce in the first place, and given the current pandemic both high-income

and low-income countries are witnessing shortages [19]. HCWs don't only communicate with infected patients and contaminated patients' surroundings, but they also communicate with each other. We have observed in our investigation that nurses in the 6th floor (where four of them have been infected), stayed in a small poorly ventilated office. Nurses spent a long time in that room together without wearing PPE. They also shared meals and utensils and did not practice proper social distancing. One study showed that clinical healthcare workers dealing directly with patients, like doctors and nurses, perceive that the main mode of acquiring COVID-19 infection is through inadequate protection when working at a close distance with infected case [20]. This may draw the belief that healthcare workers in our hospital considered infected patient as the main source of infection but were less cautious, if at all, when dealing with each other. Prolonged unprotected exposure between HCWs who stay in such proximity, carries a risk of rapid and widespread transmission among hospital staff. In addition to wearing PPE at all times, HCWs should also adhere to cough etiquette and hand washing and should maintain at least two meters distance from others [5]. At the time of this investigation, the recommendations were that HCWs who have an unprotected exposure to an infected person were advised to remain in quarantine for 14 days since last exposure [17]. If several HCWs were exposed at once and had to be quarantined, this could have resulted in hospital care collapse.

In this investigation we found that the incidence of acquired SARS-CoV-2 among hospital cleaning staff was comparable to that observed among the nursing staff. This would highlight the significant risk of COVID-19 transmission in this, often neglected, category of hospital workers. Most infection control guidelines published during this COVID-19 pandemic realized this risk and recommended the necessary PPE use [21, 22]. It is possible that transmission of infection among housekeepers has been associated with hospital environmental exposures – as cleaning and handling waste without proper PPE use – or through incautious behaviour when housekeeping staff came together. So, this category of healthcare workers needs continuing supply of PPE as well as focused repeated infection control training and supervision.

Two child patients contracted the infection postoperatively in the paediatrics ICU during this hospital outbreak. Unfortunately, these two patients had high probability of dying as a result of their underlying cardiac conditions; which eventually occurred. Critical illness and childhood age were found to be risk factors for acquiring COVID-19 infection in our hospital [23]. On the other hand, it appears that ICU patients are an important source of infection to HCWs especially nursing staff. This is expected given the fact that nurses perform more frequent AGPs to ICU patients [17, 18].

Another category that took on special importance in the context of this COVID-19 hospital outbreak is the patients' family companions. Four out of fourteen family companions have been infected. Family companions

posed risk to each other since they stayed in the same room, without any form of PPE or any concept of social distancing. Also, these family companions could have posed a risk to the patients they tended to, to the HCWs and to their own families when they return home. The policy of allowing a family companion inside the hospital may need to be restricted throughout the COVID-19 pandemic. If allowed to stay, the numbers of companions in the one room available at the hospital may need to be reduced. Family companions allowed to stay need to receive clear instructions on how to prevent COVID-19 transmission inside the hospital.

The non-medical administrative staff seems to be at risk of infection, although we couldn't trace a hospital source of infection except for one of them: the husband of an infected nurse. This raises concerns about HCWs carrying the infection to their family members at home. In conclusion, nursing and housekeeping staff in our hospital sustained a significantly higher risk of COVID-19 infection compared to other staff categories. The nature of their duties and the frequent interaction between members of these categories may play a role in increasing their risk. Reducing unprotected contact between hospital staff members and emphasising the use of PPE and adherence to infection control practices at all times is essential to prevent future hospital COVID-19 outbreaks. Since family companions also appear to be especially at risk, permission for their stay in the hospital should be restricted.

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Conflict of interest statement

The authors declare no conflict of interest.

Authors' contributions

Samia A Girgis: Conception and design of the study, Head of outbreak investigation team, Acquisition of data
Moshira Halim: Conception and design of the study, member of outbreak investigation team, Acquisition of data.

Ihab S Habil: Conception and design of the study, Data management, Data analysis and interpretation, Drafting the article.

Wafaa M. Hussein: Data management, Drafting the article
Isis M. Mossad: Data management, Drafting the article.
Ahmed Abdel-Aziz: Overseeing administrative approvals for the study, Field preparation for the outbreak investigation, Critical revision of the article.

Ayman M Saleh: Overseeing administrative approvals for the study, Overseeing the outbreak investigation, Critical revision of the article
Ashraf Omar: Overseeing

administrative approvals for the study, Critical revision of the article and final approval.

Mahmoud El-Meteini: Overseeing administrative approvals for the study, Critical revision of the article and final approval of the submitted version.

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