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 R0; 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. R0 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]. In Egypt, the first COVID-19 case was reported 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, Egypt has reported more than 10,000 confirmed cases.
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:

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

| Tab. II. Incidence of infection during the hospital COVID-19 outbreak. |
|---------------------|---------------|--------------|
| No. screened | Infected | Risk ratio |
|---------------------|---------------|--------------|
| Total subjects | 645 31 (4.8) | RR (95% CI) |
| 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 | 41a | 2 (4.9) | 4.4 (0.7-27.3) |
| Family members* | 14 | 4 (28.3) | |
| Healthcare workers | | | |
| Nursing staff | 147 | 11 (7.5) | 6.98 (1.9-25.5) |
| Housekeepers | 118 | 9 (7.6) | 7.1 (1.89-26.8) |
| Physicians | 61 | 0 | 5.08 (1.4-18.4) |
| Other workersb | 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.
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**

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