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Outbreak Report

Health Care Workers and Patients as Trojan Horses: a COVID19 ward outbreak

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SUMMARY

Background: Transmission in healthcare settings can result in significant infections in healthcare workers and patients. Understanding infection dynamics has important implications for methods employed in hospitals to prevent nosocomial transmission events.

Methods: In this case series report we describe a cluster of COVID-19 (Coronavirus disease 2019) in a tertiary care university hospital, in the early phases of the epidemic, after hospital visiting had been stopped and when the UK lockdown was in place.

Findings: A 48 year old patient developed COVID-19 31 days post-admission and four days after admission to a medical ward from ITU. Infection was likely acquired from an asymptomatic or minimally symptomatic healthcare worker (HCW). Subsequent investigation over a 14 day period revealed symptoms in 23 staff members and five linked cases in patients on the same ward.

Nine of the 23 affected staff members provided care for and had direct exposure with the index case. Four staff reported caring for the index case without use of personal protective equipment. One was coughed on directly by the patient 24 hours prior to the onset of symptoms.

Conclusion: SARS CoV2 infection can be introduced to a ward area by asymptomatic and minimally symptomatic healthcare workers. Staff members and patients can act as Trojan horses carrying infection into and around the hospital, setting up unexpected transmission events.

Transmission of infection from pre-symptomatic, asymptomatic and minimally symptomatic individuals means that universal use of measures to prevent transmission is required for successful reduction of transmission events in the hospital setting.

Introduction

Coronaviruses are a large family of enveloped RNA viruses including aetiological agents of the common cold, Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS). Coronavirus disease 2019 (COVID-19) is a viral

Abbreviations: COVID-19, Coronavirus disease 2019; HCW, Healthcare worker; PCR, Polymerase chain reaction; NEWS, National early warning score; SARSCoV2, Severe Acute Respiratory Syndrome coronavirus 2.

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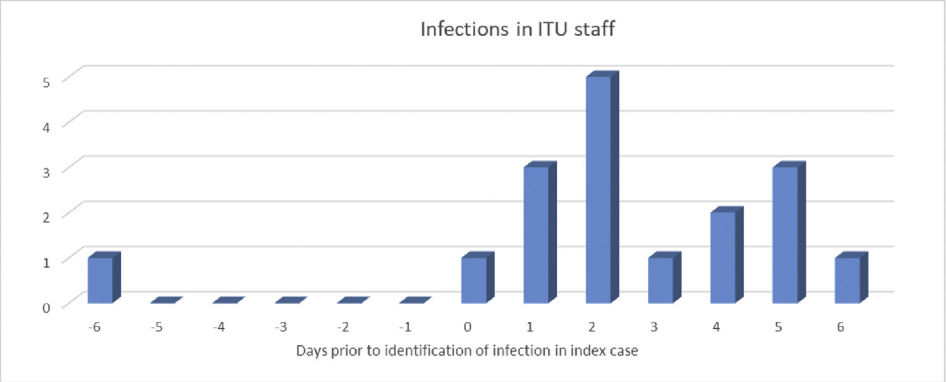

Figure 1. Timeline of symptomatic self-isolating HCW from the ITU.

infection caused by Severe Acute Respiratory Syndrome coronavirus 2 (SARS-CoV-2) - a betacoronavirus.

Transmission within healthcare settings is an important area of study as it can result in significant infections in healthcare workers (HCW), disrupt the workforce and affect vulnerable individuals. Recognition that HCW can act as points of introduction of COVID-19 into the healthcare setting has important implications for infection control methods employed in hospitals. The transmission rate amongst healthcare personnel also has implications for the hospital environment and the way that staff interact with patients and with each other.

Case report of cluster

We report on a cluster of COVID-19 (Coronavirus disease 2019) in a tertiary care university hospital, in the early phases of the epidemic in this region. The objective of this report was to describe the epidemiological investigation carried out to identify the transmission routes and source of infection. The infections began after hospital visitations had been stopped and around the time of the UK lockdown which began officially on 23rd March 2020. The cluster was associated with a patient that had acquired infection whilst in hospital, most likely from an asymptomatic or minimally symptomatic HCW. Subsequent transmission events resulted in a number of nosocomial transmissions and a high rate of infection amongst staff.

Methods

A detailed investigation was carried out on a cluster of infections affecting staff and patients on a medical ward. Additional patient and staff cases epidemiologically linked to the outbreak were identified using a local clinical surveillance software, ICNET, and by obtaining routine staff self-isolation data. An in house real time PCR assay for COVID-19 was carried out on dry throat swabs taken from symptomatic patients and staff members working on the ward.

Demographic and clinical characteristics, details of symptoms experienced and symptom onset were prospectively collected for all patients from medical records, ICNET and interviewing ward staff. Symptoms experienced and onset date were obtained by carrying out telephone interviews of all affected HCW.

Case definition

Patient cases were defined as individuals with (A) a laboratory confirmed COVID-19 diagnosis (B) absence of COVID-19 compatible symptoms at the time of admission and infection $\geq$48 hour post hospital admission AND (C) a hospital admission that overlapped with a confirmed patient or HCW case suggesting direct or indirect contact with the index case.

HCW cases were defined as (A) a member of staff from the affected ward and (B) compatible symptoms for COVID-19 (C) onset of infection during the outbreak period. HCW's were further classified as HCW case — PCR detected, Likely HCW case - not swabbed, Likely HCW case - PCR not detected.

The analyses in this paper covered patients and HCW identified from 31/03/2020—14/04/2020.

Data management

Collected data were securely stored on a secure network drive managed by Public Health Wales. The data were cleaned using STATA version 14.2. The epidemiological curve and TICL chart outputs were generated with R studio version 3.5.1.

Results

The index case (Case 1) was a 48 year old patient admitted in early 2020 with an unrelated disseminated bacterial infection requiring ITU admission. They were discharged from ITU to a medical ward 36 days after admission. At the point of admission to the ward they were afebrile, had a tracheostomy in situ and were coughing. 40 days in to their admission and four days after their admission to the medical ward (whilst asymptomatic) they became lymphopenic. One day later they developed a maculopapular rash and became tachypnoeic, febrile and tachycardic, with a NEWS score of 12. At this point, COVID-19 was suspected and a throat swab taken that day was positive for SARS CoV2 by PCR (in house assay). It is likely that the patient acquired the infection around the time of discharge from ITU, most probably from an asymptomatic or minimally symptomatic HCW, although transmission from an unrecognised patient cannot be ruled out.

Pre-symptomatic transmission is well recognised. The period of infectivity for this patient likely began two to three days before the onset of their illness and one to two days after arrival on the medical ward. Subsequent investigation over a 14

day period revealed 23 symptomatic staff members from the same medical ward (Figure 2). Two patients in the same bay and two other patients in a neighbouring bay developed symptoms and tested positive three days after COVID-19 was detected in the index case. One other patient on the same ward developed symptoms and tested positive 11 days after it was detected in the index case. Symptoms are detailed in Table 1.

Over a 12 day period, spanning from six days before to six days after onset in the index case, there were 17 staff from the ITU self-isolating at home due to symptoms compatible with COVID-19 (Figure 1).

Of the 23 HCW cases from the affected medical ward, 16 had SARS CoV2 detected on a throat swab, three were not detected and four were not swabbed. Of the three staff in whom the virus was not detected two had symptoms of cough and chest pain (one also had myalgia and chills) and one had fever, myalgia, sore throat and reduced smell and taste (Table 1). They all had exposure to known positive cases and are likely to represent clinically false negative tests. Of the four staff that were not swabbed three were symptomatic early in the cluster. One had a fever and cough, one loss of taste and headache, one was shivery, tired with a sore throat and cough. The fourth was symptomatic later on but was unable to drive to get tested (fever, cough, diarrhoea and vomiting). Based on their symptoms and exposure history all were likely cases of COVID-19.

Of the 23 affected staff members, nine cared for and had direct exposure with the index case (seven based on the working roster and five based on verbal reports from the exposed staff at the time their sample was taken, three of whom were also picked up by the duty roster). Four of the five staff members with very early onset of infection were working with the index case during the likely infectious period (Figure 3). One staff member who became unwell 24 hours

Table 1
Demographic and clinical characteristics of confirmed patient cases and HCW cases from the affected medical ward.

Characteristic	Patient cases (N=6)	HCW cases (N=23)[a]
	N (%) or median [range]	
Median age, years	69 [48–93]	
Sex		
Male	3 (50.0)	-
Female	3 (50.0)	-
Died		
Yes	2 (33.3)	-
No	4 (66.7)	-
Chronic underlying conditions		
Hypertension	3 (50.0)	-
Cardiac disease	2 (33.3)	-
Renal Disease	0 (0.0)	-
Diabetes Mellitus	1 (16.7)	-
Obesity	(16.7)	-
Pulmonary Disease	2 (33.3)	-
Cancer	2 (33.3)	-
Compromised immune system	0 (0.0)	-
Liver disease	1 (16.7)	-
Symptoms		
Cough	2 (33.3)	14 (60.9)
Shortness of breath	2 (33.3)	3 (13.0)
Fever	4 (66.7)	11 (47.8)
Chest pain	1 (16.7)	6 (26.1)
Vomiting	1 (16.7)	1 (4.3)

[a] Demographic and clinical data were not available for HCW case.

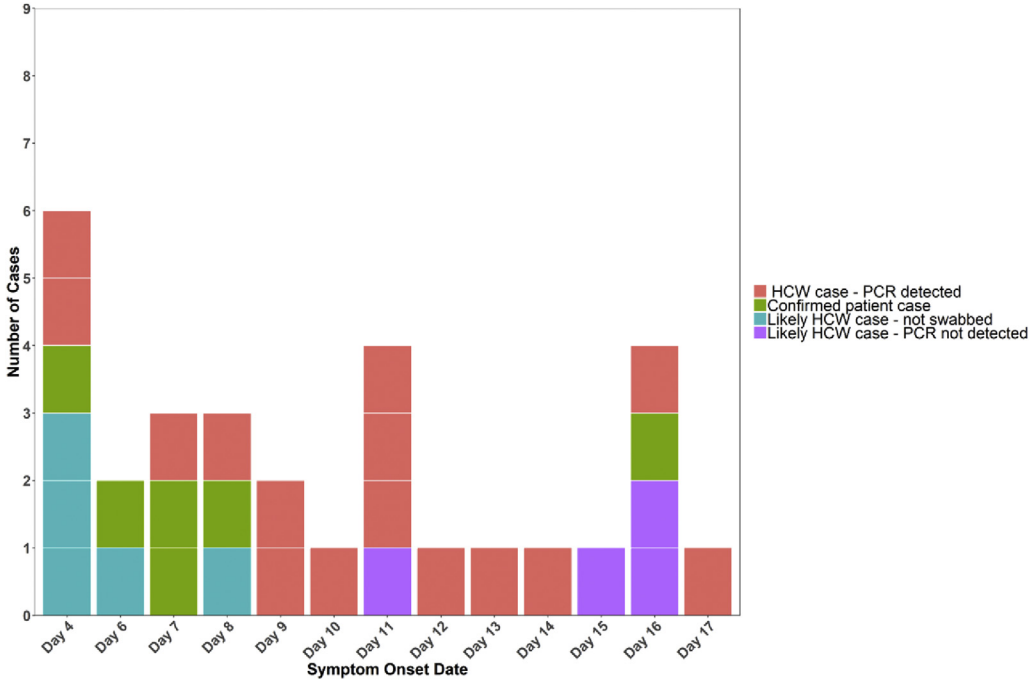

Figure 2. Epidemiological curve for all patient and HCW cases involved in the outbreak by days (Day 0 is the likely onset of infectivity in the index case).

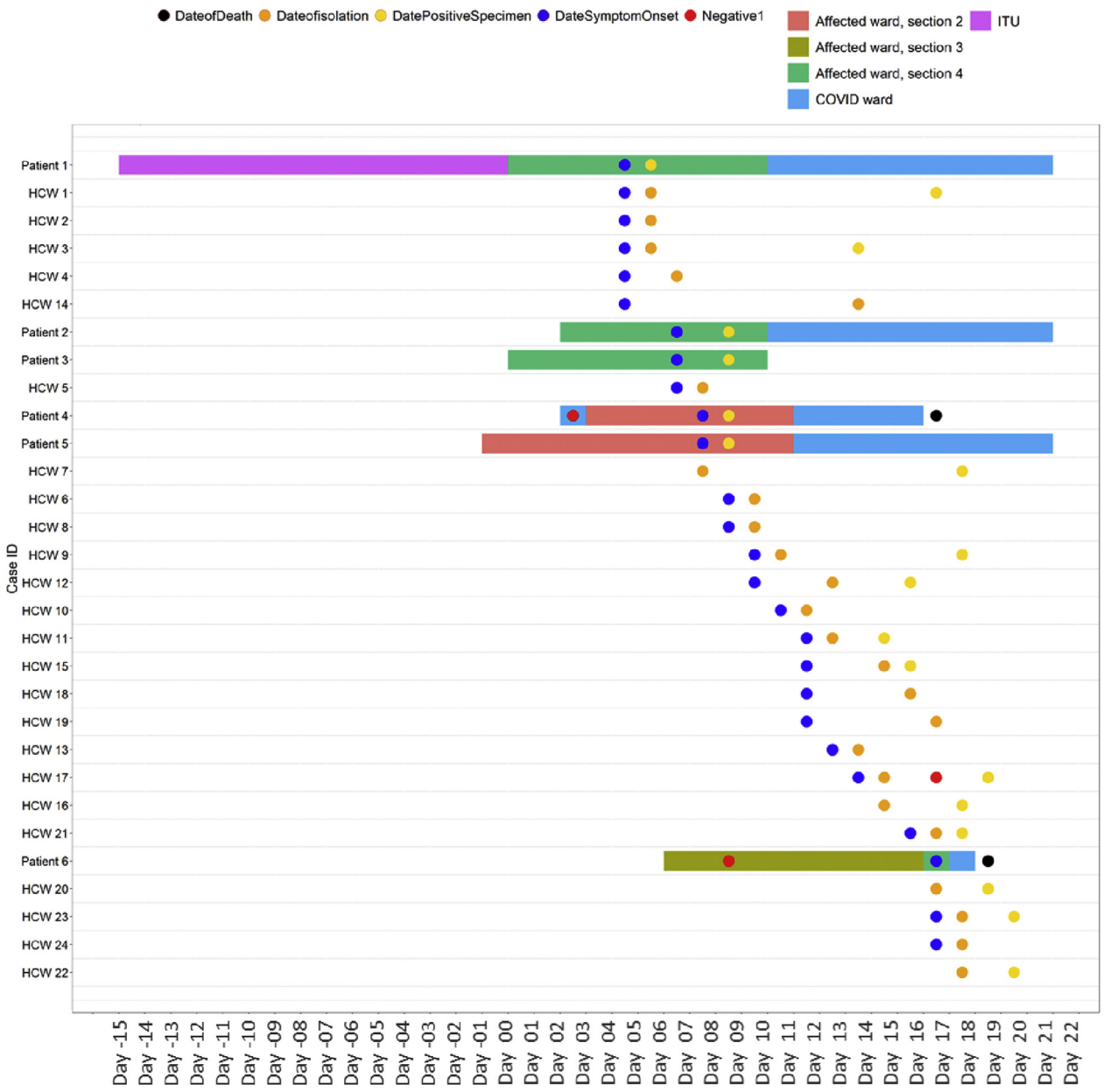

Figure 3. Epidemiological links and timeline of patient and HCW cases. Day 0 is the likely onset of infectivity in the index case.

after exposure was coughed on directly by the index case whilst not wearing any personal protective equipment. Whilst there is no record of any contact for the fifth staff member from the roster, the staff member verbally reported contact with positive staff and symptomatic patients on the ward. Three staff reported caring for the index case without use of personal protective equipment (the ward was considered a negative ward and personal protective equipment (fluid repellent surgical face masks, eye protection, aprons and gloves) was not in routine use in accordance with Public Health England guidelines at the time).

The index case was swabbed four days after admission to the medical ward. A total of four other patient cases were identified on the affected ward with a patient attack rate of 9.8% (6/61). Of the five linked positive patient cases, four became symptomatic and tested positive three days after the infection was identified in the index case. Two were from the same bay and two from a neighbouring bay (Figure 3). A further patient who developed symptoms and tested positive eleven days after the infection was identified in the index case had been admitted 13 days earlier with lethargy, difficulty swallowing, dehydration and general decline. They likely acquired infection during their admission in the affected ward. They had been swabbed as a "possible exposed" patient and tested negative for SARSCoV2 five days into admission.

The cluster of infections spread over 14 days. Not all staff or patients had direct contact with the index case. It is likely that the infection was propagated through the ward by further transmission events from pre-symptomatic, minimally symptomatic and asymptomatic staff. The hospital environment is crowded and it is difficult for staff to practice social distancing effectively in the hospital. The ward is made up of four cubicles

(no en-suite facilities), two five bedded bays, two six-bedded bays, one four-bedded bay and five shared toilets. There is an atrium area that contains a single shared desk which is often busy and crowded. The ward contains one small room (4m x 4m) where staff would sometimes congregate for short breaks (the ward is a significant distance from the canteen). Close contact between staff is common when working at the main ward desk, during breaks in crowded and small break rooms and during routine patient care. The significant number of staff cases is likely related to these factors along with the lack of universal use of personal protective equipment for patient care at this time.

Hand hygiene compliance on the ward at this time (carried out monthly) were 100%. Credit for cleaning scores were 96%.

Four out of six asymptomatic staff identified from the affected medical ward were swabbed at the end of the outbreak and all tested negative. In total 23 out of 29 staff on the ward developed COVID-19 infection over a 14 day period. This rate of infection far exceeded the number of infections on other wards and in the community at the time and is extremely unlikely to have occurred by chance.

Discussion

Coronavirus was first identified following an outbreak of pneumonia in Wuhan City, Hubei Province, China, in December 2019 [1]. It is transmitted from person to person highly effectively. Human transmission is thought to occur predominately via close contact with respiratory droplets produced when a person exhales, sneezes, or coughs, or via contact with fomites. Airborne transmission is possible in specific circumstances such as when aerosol generating procedures are performed; e.g. endotracheal intubation. Some data suggests that airborne transmission during routine patient care may also be possible. However, based on the available evidence, WHO currently recommends droplet and contact precautions for those people caring for COVID-19 patients. Airborne precautions are recommended only in circumstances and settings when aerosol generating procedures are performed. Nosocomial transmission is well recognised [2].

Transmission from individuals is variable and is likely related to specific factors of the host and their contacts. Some individuals appear to transmit the infection relatively unreadily. Others seem to be highly effective transmitters. Multiple super-spreading events have been reported. These events are associated with explosive growth early in an outbreak and sustained transmission in later stages [3]. Super-spreaders can pass the infection on to large numbers of contacts, including HCW. Super-spreaders are a well-recognised phenomenon. The 20:80 rule suggests that 80% of infections are caused by 20% of infected individuals that spread infection most readily [4].

Transmission from asymptomatic and pre-symptomatic individuals is also well recognised. Estimates of asymptomatic infection range from 18% (modelling study from the Diamond Princess Cruise ship) [5] to 31% (Japanese study of citizens evacuated from Wuhan City) [6] to 50—75% (data from an isolated village of 3000 people in Italy) [7]. Pre-symptomatic transmission has been reported in 12.6% of cases [8] and has been predicted to account for 44% of infections [9]. Transmission during the incubation period has also been described [10].

The incubation period ranges from 1 to 14 days [11]. The median incubation period has been estimated to be approximately 5 days [12,13].

The case fatality rate of COVID-19 is known to increase with age [13] and with the presence of comorbidities [14]. Activity in the hospital had been significantly reduced in the period leading up to these outbreaks. Patients remaining in hospital at this time were therefore vulnerable to severe infection with COVID-19 and at higher risk of a poor outcome because of the presence of co-morbidities.

The strengths of this report are the in depth description of a well-defined cluster of infections in a hospital setting during the early phases of the SARS-CoV2 epidemic that capture many of the features that make coronavirus difficult to contain. The report provides valuable lessons that are crucial to containing this infection as well as other viral infections in the healthcare setting (the consequences of which likely often go unnoticed) and in terms of preparing for future pandemic threats. The limitations include the inability to exactly track the modes of transmission from one individual to another during this outbreak and consequently to identify which prevention measure have the greatest impact in terms of preventing similar events in the future.

Conclusion

The outbreak reported in this paper demonstrate several features. Firstly, SARS-CoV2 infection can be introduced to a ward area by asymptomatic and minimally symptomatic HCW. HCW and patients can act as Trojan horses carrying infection into and around the hospital, setting up unexpected transmission events. In this case infection was most likely introduced by an asymptomatic or minimally symptomatic HCW and then transferred via a longstanding patient from ITU to a previously negative medical ward.

Secondly, recognition is less likely when patients acquire COVID-19 in hospital and particularly during the early phases of the epidemic. A high level of suspicion for COVID-19 is required to reduce the risks posed by this type of event, even when rates of infection in the area and hospital are low. HCW need to have a low threshold for testing and be vigilant for clues such as CXR changes, low lymphocyte count, fever, cough and viral illness.

Thirdly, at this time of limited herd resistance, infection is transmitted highly effectively from staff-to-patient, patient-to-patient and staff-to-staff. Consequently, infection can be rapidly amplified in the hospital setting. This is compounded by cramped conditions in the hospital, including small rest rooms and staff communal areas that impair attempts to contain infection and facilitate staff-to-staff spread. Staff shortages and lack of redundancy in the system also encourage staff members to work when unwell. This stoicism, that is an important part of maintaining function of the NHS, causes significant problems in terms of in-hospital transmission of infection to vulnerable patients and other staff members. This phenomenon is more easily recognised and more damaging during this pandemic because of the lack of herd immunity, high attack rate and high case fatality rate of the novel pathogen SARSCoV2.

As such, early recognition of COVID-19 (with a robust test and trace system) combined with high levels of compliance with the use of preventative measures (a combination of social

distancing, compliance with infection, prevention and control precautions — e.g. hand hygiene and cough hygiene and appropriate routine use of personal protective equipment) is required to reduce the threat posed by COVID-19 in the hospital environment and is crucial to prevent un-curtailed transmission events in the hospital setting. The presence of transmission of infection from pre-symptomatic, asymptomatic and minimally symptomatic individuals means that routine use of all of the above precautions is required for successful reduction/prevention of transmission events in the hospital setting. Where possible liberal use of masks to reduce transmission from asymptomatic, pre-symptomatic and minimally symptomatic infected individuals (staff and patients) to others (staff and patients) should be encouraged.

Conflicts of interest, funding and ethics

All authors declare no conflict of interest. The authors received no financial support to carry out this work. This report contains information collected as part of routine management of an outbreak and as such ethical approval was not required. The report has been reviewed by the Health Board Ethical department and approved for submission. The manuscript has been reviewed by the Health Board Information Governance department, who confirmed the report is compliant with information governance standards.

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