

Justifying quarantine in preventing the spread of COVID-19 in healthcare

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Background	The first COVID-19-positive patient was identified in Ireland on 29 February 2020 (Department of Health, Government of Ireland; https://www.gov.ie/en/pressrelease/2f75fd-statement-from-the-national-public-healthemergency-team-sat-29-feb/). Healthcare worker (HCW) quarantining became a core intervention for those identified as 'close contacts' to reduce onward transmission within the workplace to patients and colleagues. Whether a quarantining strategy could be justified at a time when there was an increased demand for the services of HCWs remained unknown.
Aims	To establish whether quarantining staff away from a healthcare setting during a pandemic is justified.
Methods	This retrospective study examined close contacts of COVID-19-positive index cases (both residents and HCWs) in a community hospital over a 4-week period from 1 to 28 April 2020. Close contacts were identified in accordance with national guidelines. Zones of the hospital were examined to determine the number of COVID-positive index cases and their close contacts. A cumulative result for the hospital was recorded.
Results	While outcomes varied over time, per zone and per HCW category, the overall conversion rate from close contact to an index case was 30%.
Conclusions	This study vindicates the policy of quarantining close contact HCWs from their workplaces as they pose a significant threat to both their patients and fellow workers.
Key words	Community hospital; COVID-19; healthcare workers; quarantine; workplace health and safety.

Introduction

Quarantine of close contacts of confirmed cases is a universal strategy to prevent onward transmission of SARS-CoV-2 [1,2]. Quarantining close contacts for a period at least equal to the average incubation period minimizes further spread within the community and workplace and may prevent population-wide restrictions. In the healthcare setting, protection of patients and healthcare workers (HCWs) is required to minimize hospital outbreaks that further disrupt routine and preventative care for non-COVID conditions. However, such measures come at a price as the quarantined worker is no longer available to provide patient care, adding further pressure to an already stretched workplace. Quarantining away from their patients and work environment is often a source of frustration and guilt for HCWs, especially during a pandemic of the magnitude of COVID-19,

when they are most needed [3,4]. Healthcare management has struggled with the concept of sending home apparently healthy HCWs at a time of increased demand for healthcare delivery. The transmission of SARS-CoV-2 is thought to be overdispersed with substantial variability in the number of onward transmissions for any given case (superspreading). We sought to estimate the onward transmission in HCWs during the peak of wave one in a community hospital.

Methods

This is a retrospective study of COVID-19 Occupational Health Contact-Tracing Records of HCWs in a small community hospital (108 beds), in the Republic of Ireland. The hospital had four zones for resident occupancy. The number of residents per zone varied (21, 14, 31 and 42 beds in zones 1, 2, 3 and 4, respectively). Each

Key learning points

What is already known about this subject:

- We identified no published works specifically measuring the outcome of preventative quarantining of healthcare workers during COVID-19, but there were several publications relating to quarantine as a public health measure for the control of COVID-19 outbreaks and to the psychological and psychosocial effects of quarantining [3,4].

What this study adds:

- This study contributes to the overall literature for workplace health and safety of healthcare workers specifically relating to quarantining during the COVID-19 pandemic.
- This study justifies the exclusion from the workplace of healthcare workers identified as close contacts as part of a suite of measures designed to restrict viral spread.

What impact this may have on practice or policy:

- Quarantining healthcare workers from the workplace when identified as a close contact of an index case is appropriate.
- Quarantined healthcare workers can be reassured that their removal from the provision of 'on-site' service delivery can be justified based on resultant restricted spread of the virus.

zone differed in patient dependency, ranging from severe dementia and high dependency (Zone 2), milder dementia and intermediate dependency (Zone 1), physical frailty and decreased mobility (Zone 3) and fully mobile and orientated patients (Zone 4).

HCWs include doctors, nurses, healthcare assistants (HCAs) and multitask attendants (MTAs), all of whom were largely restricted to working within a particular zone. However, especially before the extent of the outbreak was fully appreciated, due to exigencies of the service there may have been instances of staff from one zone being required to work in another.

Two cohorts of close contacts of COVID-19-positive index cases (residents and HCWs) were included in the study. An index case for each cohort was either a resident or a HCW. Close contacts were defined according to the Health Protection Surveillance Centre (HPSC) [5]. The criteria used to differentiate 'close' from 'non-close' (casual) contact include distance, time and personal protective equipment (PPE) used. Cumulative shift period contact duration of 15 min or longer were deemed 'close' if they occurred within 1 m of the index case in the absence of appropriate PPE. The interaction between HCW and index case determined the appropriate PPE. Any unprotected exposure of the eyes or mouth or mucus membranes, to the bodily fluids of the index case constituted 'close contact'. Contact with fomites in the absence of appropriate and timely hygiene also resulted in a 'close contact' determination. All other contacts not fulfilling any of the criteria outlined are deemed casual [5].

Close contact HCWs quarantined between 1 April and 28 April 2020 were included in the study. Each of the four zones was examined to determine the number of SARS-CoV-2-positive index cases, their close contacts and subsequent conversion rate. We recorded a cumulative result for the hospital.

The epidemiological, demographic, clinical and outcome data were first captured during telephone interviews with HCWs identified as contacts of SARS-CoV-2-positive residents or HCWs in one or more of the four zones in the community hospital. Data were extracted from contact-tracing forms, using a standardized data collection form based on WHO's Epi Core Variables for outbreak investigations [6]. All data were anonymized prior to being analysed and reviewed by the participating researchers and any difference in interpretation between researchers was resolved through discussion.

When a new index case (resident or HCW) was identified in the hospital, a list of contacts was compiled following discussion with hospital management. These contacts completed telephone interviews with the contact-tracing team. Based on this interview, the occupational health contact-tracing team determined the category of contact to be either close or casual. While high community levels of infection could influence the number of index cases among those exposed to the community, it would not have had any direct influence on the number of close contacts exposed to a specific index case. The number of close contacts of an index case related solely to the number and nature of interaction between both parties rather than to the status of the close contact.

In index cases, the period of interest for contact-tracing commenced 48 h before symptoms developed and continued until the individual went into isolation. For residents, this involved isolation in a single room, with all further interactions being undertaken using appropriate PPE, while staff self-isolated at their domicile. Towards the end of the study period, routine screening of all staff and residents at the hospital was undertaken by the Department of Public Health to identify pre- and asymptomatic disease to prevent the further spread of

the virus [7]. Where an asymptomatic SARS-CoV-2 swab positive individual was detected, either resident or staff, the contact-tracing period commenced 24 h prior to the taking of the swab and continued until the individual entered isolation.

On identification of their status, close contacts immediately left the workplace and quarantined for a period of 14 days, while self-monitoring for symptoms of COVID-19. They were instructed to report symptoms immediately so that an urgent SARS-CoV-2 swab could be arranged. Quarantined staff also received a daily text message, enquiring if they had COVID-19 symptoms and if so, were advised to urgently contact the Occupational Health Department. Individuals symptomatic at the time of contact-tracing were automatically referred for SARS-CoV-2 swab and advised to self-isolate until informed of result.

As visitors to the residential facility were severely restricted and only permitted, clad in the appropriate PPE, in the event of an emergency, staff alone had potential exposure to external contacts. While public health guidance encouraged maintenance of social distancing during essential activities, such as shopping etc., adherence to this policy could not be guaranteed throughout. This obviously was something outside the control of hospital's management.

The first patient to be diagnosed with SARS-CoV-2 was in Zone 1, and the first HCWs identified as close contacts of an index case were also from Zone 1. Undoubtedly, the infection was introduced into the facility from the community, whether by a visitor prior to the embargo on visitors (acknowledging an incubation period of up to 14 days), by a member of staff who continued to commute from the community or by the admission of an asymptomatic carrier to the zone. Irrespective of the origin of the transmission, once the index case was identified, all staff who had been in contact during the period of infectivity were contact-traced and defined as either a close or casual contact. It is accepted that where a close contact converted to an index case, transmission from the original index case is implied rather than proven.

The study was granted ethical approval by the Clinical Research Ethics Committee (CREC), University College Cork.

Results

Results are presented per zone and the overall conversion rate from close contact to index case during the quarantine period is also calculated for the community hospital as a whole (Table 1).

Zone 1 was at full capacity at the time of the outbreak. All 21 residents tested positive with SARS-CoV-2, from 4 April 2020 to 17 April 2020. The outbreak in Zone 1

lasted for 3 weeks with 29% SARS-CoV-2-positive residents on week 1, 38% week 2 and 33% week 3. During that time, seven nurses and 10 MTAs/HCAs were deemed close contacts of some or all the residents, and consequently were quarantined away from the workplace for 2 weeks from the last day of exposure. During quarantine, four nurses and four MTAs/HCAs developed symptoms and tested SARS-CoV-2 positive. An additional one quarantined nurse and two quarantined MTAs/HCAs tested SARS-CoV-2 positive on routine screening while asymptomatic. Therefore, a total of five nurses (71%) and six MTAs/HCAs (60%) who were close contacts of resident index cases became secondary cases (overall conversion 65%). A further nine nurses and 12 MTAs/HCAs who worked in Zone 1 but were not deemed close contacts tested positive. Among these index cases, seven nurses and seven MTAs/HCAs became symptomatic while two nurses and five MTAs/HCAs were found to be positive on routine screening.

Because of the positive SARS-CoV-2 swab results in these HCWs, a further 34 HCWs were quarantined from the workplace (18 nurses, and 16 MTAs/HCAs). Of this figure of 34, eight became SARS-CoV-2 positive while in quarantine (two nurses and six MTAs/HCAs). This represents an overall conversion rate of 24% from quarantine to positive swab, among close contacts of HCWs, 11% for nurses and 38% for MTAs/HCAs in Zone 1.

The total conversion rate of HCWs in Zone 1 identified as close contacts of either residents or other HCW index cases during their period of quarantine ($n = 51$) was 28% (7/25) for nurses, 46% (12/26) for MTAs/HCAs and 37% (19/51) overall.

Zone 2 of the community hospital is a specialized Dementia Unit and was also at full capacity (14) at the time of the outbreak. Initially six of the residents developed symptoms and tested positive for SARS-CoV-2. A further two residents tested positive on routine swabbing but were asymptomatic. These index cases occurred throughout the 4 weeks with 12% presenting in week 1, 50% in week 2, 26% in week 3 and 12% in week 4. During that time, 15 HCWs, six nurses and nine MTAs/HCAs, were deemed close contacts and were quarantined from the workplace for a 2-week period. During this quarantine, only one HCW, an MTA/HCA, swabbed positive for SARS-CoV-2 following the onset of symptoms, which represents a conversion rate from quarantine to index case among close contacts of Zone 2 residents of 0% for nurses, 11% for MTAs/HCAs and 7% overall.

Separately, among staff who worked in Zone 2 who were not identified as close contacts, one nurse and three MTAs/HCAs tested positive for SARS-CoV-2 following the development of symptoms. Arising from this group, eight close contacts were identified (two nurses and six MTAs/HCAs) and quarantined. None developed COVID-19 symptoms during their period of quarantine.

Table 1. Summary of the results per zone as well as for the community hospital as a whole

Hospital zone	Quarantined HCWs	SARS-CoV-2 positive	Conversion rate
1	51	19	37%
2	21	1	5%
3	9	4	44%
4	0	0	0%
TOTAL	81	24	30%

Table illustrating the conversion of those HCWs identified as close contacts of index case per hospital zone, and number who subsequently tested positive for SARS-CoV-2 (index cases) as well as the rate of conversion.

In total, in Zone 2 the conversion of those HCWs defined as close contacts ($n = 21$) of SARS-CoV-2-positive residents or HCWs was 0% (0/6) for nurses, 7% (1/15) for MTAs/HCAs and 5% (1/21) overall during their period of quarantine.

Zone 3 has the capacity for 31 residents. Nine of the residents developed symptoms and tested positive for SARS-CoV-2, five in week 2 (56%) and four in week 3 (44%). As a result, five nurses and three MTAs/HCAs were considered close contacts and were quarantined for 2 weeks. During their period of quarantine, none of the nurses became symptomatic but three MTAs/HCAs became symptomatic and swabbed positive for SARS-CoV-2, a total HCW conversion rate of 38%.

In addition, one nurse and one MTA/HCA were found to be SARS-CoV-2 positive on routine screening in week 3. This resulted in just one close contact, who then tested SARS-CoV-2 positive on routine screening during the period of quarantine.

The overall conversion of resident or HCW close contacts in Zone 3 was 17% (1/6) for nurses, and 100% (3/3) for MTAs/HCAs giving a combined conversion rate among HCWs of 44% for the zone.

Zone 4 is the largest zone in the Community Hospital with capacity for 42 beds. Despite this, it was the zone with the fewest COVID-positive residents or HCWs. None of the residents or staff developed symptoms. Two residents were found to be SARS-CoV-2 positive on routine swabbing in week 3. No close contacts were identified and no HCWs became SARS-CoV-2 in Zone 4 during the study period. Hospital management had designated Zone 4 as a COVID-free zone, and this may be why it had the fewest index cases.

Discussion

We examined the records of HCWs working in a small community hospital in Ireland, during a 4-week period in April 2020 at the height of the first wave of COVID-19 to determine the extent of conversion to index cases of quarantined HCWs close contacts. A COVID-19 outbreak commenced in Zone 1 of this community hospital in early April 2020 and gradually affected all zones of the hospital. The overall conversion to SARS-CoV-2 swab positive among close contacts during the period of

quarantine was 21% for nurses, 36% for MTAs/HCAs and 30% overall. The conversion rate variability was also seen in the zonal analysis and might reflect higher patient dependency rates in some zones.

We acknowledge that there are many factors influencing the conversion rate in healthcare settings such as: the degree of patient dependency on HCWs; the physical infrastructure of the healthcare setting including the number of single versus shared rooms; size and ventilation of commonly shared dining rooms and lounge areas; staff facilities such as changing rooms, ablution units, canteen and rest areas for staff; staff work patterns and interaction with the community, including travel to work arrangements; and finally the prevalence of community transmission.

Additional factors that could have contributed to the lower conversion rate from close contact to index case over time among HCWs include identification of COVID-19-positive residents in the facility; increased awareness among staff of the mechanisms by which SARS-CoV-2 could be spread within their workplace and the measures necessary to minimize the spread; and increased availability of PPE.

However, these factors are based on conjecture and further research is required to provide definitive evidence of their contribution. While the definition of a close contact remains constant, minor behavioural changes can greatly influence the rate of conversion.

A disadvantage of our study is the assumption that the secondary cases identified were infected by hospital index cases. Although there was community contact-tracing during the study period, it was incomplete and hampered by delayed test results. Therefore, it is conceivable that an asymptomatic and/or unidentified index case, either within the healthcare setting or outside of it, could also be responsible for the conversion of the close contact. However, during the study period, Ireland was in lockdown and contacts for HCWs were limited to home-bound family and work; therefore, it is plausible that transmission occurred in the hospital environment. Nevertheless, even if some transmission occurred outside the hospital, an additional benefit of quarantine was to prevent these secondary cases further transmitting virus to residents and colleagues.

Our study does provide some justification for the quarantining of HCWs away from the workplace to safeguard against the spread of SARS-CoV-2. As such, it can provide comfort to staff who felt ‘guilty’ being sent home from work at a time of great need. The knowledge that their enforced absence from the workplace potentially prevented more widespread transmission of SARS-CoV-2 among the most vulnerable of individuals can be a source of consolation to them.

However, the findings of a 30% conversion rate from close contact to index case also imply that many HCWs quarantined did not pose any danger to residents but did deprive the healthcare system of their services at a crucial time.

We ask if this conundrum of maximizing service delivery while minimizing potential for disease spread could be tackled in other ways. One possible consideration might be to always provide highly efficient PPE for all HCWs. However, full PPE can be quite restrictive, uncomfortable and neither user- nor patient-friendly. Another possibility would be to provide all close contact HCWs with highly efficient PPE. The aim here would be to protect fellow HCWs from contracting COVID-19 from index cases as well as protecting patients/residents from the potential exposure to an asymptomatic HCW during the presymptomatic phase. If such transmission is preventable, the HCWs could remain in the workplace and carry out their normal duties. Of course, they would also have to self-monitor for symptoms, and immediately depart from the workplace if they developed symptoms and arrange for immediate swabbing to detect SARS-CoV-2. The introduction of rapid antigen testing might be useful in this context. Additionally, donning and doffing of PPE would have to be carried out in strict isolation acknowledging that the only fail-safe method of preventing nosocomial spread is to always regard every patient and every member of staff as potentially infectious, and to wear full PPE throughout the work shift. This solution would create its own significant problems, not least, related to the acquisition of adequate PPE, both in terms of quality and quantity. PPE can be a trade-off between availability, safety, comfort and cost. During the early days of COVID-19, we saw a shortage of PPE availability and therefore, we argue that quarantining of HCW who have been identified as close contacts of index cases must continue and can be justified based on a 30% conversion rate.

The recent reduction in the period of quarantine from 14 to 10 days subject to negative swabs on day 0 and day 10 has resulted in an earlier return of some quarantined HCWs. More recently again, the vaccination of HCWs against COVID-19 has had a major positive impact on transmission within healthcare settings.

Overall, this retrospective study of COVID-19 workplace contact-tracing indicates that quarantining close contact HCWs is warranted to prevent onward transmission of the virus. There is a need for future research in other institutions such as more acute hospital settings to determine whether the conversion rates are any different from those seen in this community hospital setting and whether the same is true of quarantining HCWs in the acute healthcare settings.

Competing interests

None declared.

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