



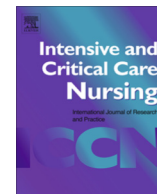
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## Intensive &amp; Critical Care Nursing

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Current insights in intensive &amp; critical care nursing

## In-hospital COVID-19 outbreak investigation: A practical approach to root cause analysis

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Transmission of SARS-CoV-2 within healthcare settings has significant implications for patients, healthcare workers (HCWs) and burdens the already stretched resources (Taylor et al., 2020). Timely identification of in-hospital transmissions and analysis of potential sources and causes are key to containing the chain of transmission. This article aims at providing a practical guidance, covering essential aspects of COVID-19 outbreak investigation within hospitals including contact tracing, screening of target population, and testing modalities. It does not touch preventive measures in detail as these are described elsewhere (Jansson et al., 2020).

Particularly during periods of high incidence of community transmission, HCW as well as patients mainly contract SARS-CoV-2 outside the hospital and can later act as a source of transmission in the hospital (Rickman et al., 2021). Further transmission to non-COVID inpatients may result from direct contact with other patients, from HCWs or visitors, while direct patient contact and cross-transmission between peers pose a risk of SARS-CoV-2 acquisition for HCW (Abbas et al., 2021a). Non-vaccination, low adherence with hand hygiene or personal protective equipment, and not respecting physical distancing in offices and commonly used hospital spaces have been related to increased risk of transmission among HCW (Gómez-Ochoa et al., 2021).

There is no consensus definition to determine when a SARS-CoV-2 infection is considered healthcare-associated. Similarly, different criteria are applied to define a healthcare-associated COVID-19 outbreak (Abbas et al., 2021a). We propose to use the median incubation period of 5 days as threshold that must have elapsed between hospital admission and onset of COVID-19 compatible symptoms to consider the case healthcare-associated. An outbreak should be considered healthcare-associated if at least 3 such cases (patients or HCW) occur within 14 days on the same ward or with any other link (e.g., physiotherapy, spending time together in the

same waiting area or back office) (Swissnoso, 2021). Hospitals should consider putting in place surveillance systems to detect healthcare-associated COVID-19 cases among patients and HCW in real-time (Abbas et al., 2021b). Upon detection of one or more potentially healthcare-associated COVID-19 cases, it is important to know the analytical steps to achieve control.

First, false-positive cases must be ruled out. Seeking advice from an infectious disease specialist or microbiologist is recommended. In selected cases, repeated PCR testing may be wise before taking further action. Upon confirmation of a healthcare-associated case, the infection control team informs affected ward (s) and initiates contact tracing in collaboration with occupational health. Unprotected COVID-19 contacts (patients and HCW) should be identified using a standardized case report form going back to 48 h before symptom onset in the index case. Unprotected contacts should be placed under quarantine according to local standards. Twice daily syndromic surveillance and repeated testing (e.g., days 0 and 5) of asymptomatic unprotected contacts is key to promptly identify positive cases. SARS-CoV-2 PCR from nasopharyngeal specimen has the highest sensitivity and is the preferred method for screening asymptomatic individuals. Nasopharyngeal rapid antigen testing can be used as an alternative if turnaround time of PCR exceeds 24 hours and hampers timely case finding (CDC, 2021).

If healthcare-associated infection is likely, but no epidemiological link can be identified, consider ward-wide screening of staff and patients. In this case, nasopharyngeal antigen-based testing for patients and PCR from pooled saliva samples of HCW are the preferred test modalities. Pooling samples of 5 individuals provides reasonable sensitivity but, depending on the number of staff and the community incidence, pooling of up to 10 samples may be acceptable (Grobe et al., 2021). If resources are limited, this approach should be considered at least in wards with patients at high risk for severe disease (e.g., geriatric wards, oncology, etc.). Equally important is auditing existing infection control measures and identifying potential breaches.

When ongoing SARS-CoV-2 transmission is suspected, systematic case-finding needs to be enhanced. Consideration should also

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be given to vaccinated patients and HCW, especially those with only partial immunity (single dose vaccination, receipt of second dose <14 days, emergence of novel SARS-CoV-2 variants) (Keehner et al., 2021). If no visitor ban is in place, this group should

**Table 1**  
Definition and investigation into one or several incidental nosocomial COVID-19 case (s).

Definitions	
Nosocomial COVID-19 case	<ul style="list-style-type: none"> <li>• New onset of symptoms AND/OR a positive test result AND/OR a CT scan suggestive of COVID-19 five or more days after admission AND a strong suspicion of healthcare transmission</li> </ul>
Nosocomial COVID-19 outbreak	<ul style="list-style-type: none"> <li>• Detection of <math>\geq 3</math> nosocomial COVID-19 cases (patients, HCW) with a possible temporal (within 72 h of each other) or local link</li> </ul>
Unprotected contact	<ul style="list-style-type: none"> <li>• Contact within 48 h before symptom onset in the index case (within 48 h before the positive test if no symptoms) and</li> <li>• within 1,5 m and for cumulatively more than 15 min<sup>1</sup> without protection (e.g. neither the HCW nor the patient wear a mask and have no physical barrier, e.g. plastic screen) or</li> <li>• care or medical examination or professional activity involving aerosol generating procedures without adequate personal protective equipment irrespective of the duration of exposure or</li> <li>• direct contact with respiratory secretions or body fluids without adequate personal protective equipment</li> </ul>
Proposed investigational steps	
Suspected nosocomial COVID-19 case	<ul style="list-style-type: none"> <li>• Rule out false-positive cases</li> <li>• Consult an infectious diseases specialist or microbiologist to discuss the case</li> </ul>
Confirmed incidental nosocomial COVID-19 case	<ul style="list-style-type: none"> <li>• Inform affected ward(s)</li> <li>• Audit infection control measures</li> <li>• Perform contact tracing and list all potential close contacts (patients and HCW)</li> <li>• Perform active surveillance of unprotected contacts (screening by means of PCR or antigen test on day 0 and 5)</li> <li>• If no epidemiological link can be identified, consider ward wide screening of staff (and patients)</li> </ul>
No epidemiological link identifiable	<ul style="list-style-type: none"> <li>• Consider ward-wide screening of patients (nasopharyngeal antigen-test or PCR) and HCW (pooled PCR)</li> <li>• Audit existing infection control measures and identify potential breaches</li> </ul>
Ongoing transmission	<ul style="list-style-type: none"> <li>• Enhance systematic case finding in patients and HCW: <ul style="list-style-type: none"> <li>■ include other non-affected wards in the point-prevalence screening</li> <li>■ include individuals with assumed partial immunity (e.g. single dose vaccine only, second vaccine dose within the last 14 days)</li> </ul> </li> <li>• Consider repeated point-prevalence screening ward wide (day 0, 5, 10)</li> <li>• Consider expanding the screening to visitors</li> <li>• Notify local public health authorities</li> </ul>
Whole viral genome sequencing	<ul style="list-style-type: none"> <li>• If requested by public health authorities</li> <li>• In case of concern of immune escaping variant (e.g. infection in a previously vaccinated HCW or patient)</li> <li>• For scientific purposes</li> </ul>

<sup>1</sup> With emergence of more transmissible variants, the duration of close contact may become irrelevant.

also be considered as a target for expanded screening, but on a voluntary basis. In wards with high-risk patients, regular visits should be allowed only with a valid COVID-19 certificate (tested, vaccinated, recovered). Screening of HCW and patients, on the contrary, should be mandatory unless there are compelling reasons that make testing prohibitive (Table 1).

We recommend notifying health authorities if wards must be closed or procedures postponed and if local regulations require it. If numbers of contacts are becoming high, contact tracing and follow-up can be prioritized to the highest-risk exposure contacts (e.g., patients with longer exposure) or those with higher impact in case of transmission (e.g., those HCW involved in direct patient care or working with most vulnerable patients). Additionally, introducing periodic testing of hospitalized patients in affected wards and of HCW working in high-risk areas (ICU, oncology, geriatrics) is strongly recommended, unless they are vaccinated.

Although data suggest that whole genome sequencing (WGS) can contribute to a better understanding of transmission dynamics (Lucey et al., 2021), immediate utility of this method, e.g., in terms of faster termination of an outbreak and prevention of further nosocomial cases, remains inconclusive because of the lack of timeliness of results. Capacity to analyze large sample volumes and the need for specialized personnel further limits broad application of this tool. Importantly, WGS does not replace thorough epidemiological investigation by means of routine contact tracing (Løvestad et al., 2021). WGS remains essential to retrospectively identify unrecognized transmission sources in order to implement effective preventive measures (Kim et al., 2021). WGS also plays a pivotal role in identifying new variants of potential concern. Discussing the need for WGS with public health authorities is recommended.

In summary, awareness of the multiple sources of SARS-CoV-2 transmission within hospitals is essential. Depending on the number of nosocomial cases, we recommend a stepwise approach to root-cause analysis, with routine contact tracing, sound testing strategies and related preventive measures as cornerstones for rapidly identifying potential sources of infection.

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