

Healthcare worker infections with the SARS-CoV-2 virus following the inception of an adult COVID-19 intensive care unit

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In Australia, there have been outbreaks of coronavirus disease 2019 (COVID-19) caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) virus in healthcare workers (HCWs), with an estimated 70% of infections acquired at work, in the pre-vaccination era.^{1,2}

In July 2021, a ‘third wave’ of SARS-CoV-2 infections began in New South Wales (NSW), Australia, with 91 SARS-CoV-2 infections recorded in HCWs by 22 September.³ To manage the outbreak, our hospital opened an additional intensive care unit (ICU), dedicated to managing adult patients with COVID-19. Due to limited robust data on strategies to prevent infections in HCWs, this cohort study was conducted to determine whether the new COVID-19 ICU could be operationalised using infection-prevention strategies that would result in zero ICU staff infections from SARS-CoV-2.^{4–6}

During a 6-week period from 9 August to 19 September 2021, we examined data from all patients admitted to the new COVID-19 ICU and ICU staff who tested positive for SARS-CoV-2. The hospital Human Research Ethics Committee had no ethical concerns.

The hospital had 590 beds and a single 13-bed general ICU. The new 11-bed COVID-19 ICU was repurposed from an existing ward adjacent to the existing ICU.

The SARS-CoV-2 infection-prevention strategies used for the new ICU are detailed in Box 1.

During the study period, the community prevalence of SARS-CoV-2 ranged between 61.2 and 227.0 per 100 000 population.^{7,8}

There were 75 patients who were admitted to the COVID-19 ICU. The mean age was 54 years and 76% were male. The mean acute physiology and chronic health evaluation (APACHE) II score was 11 (s.d. 6). The proportion of patients receiving invasive ventilation, non-invasive ventilation and high-flow nasal oxygenation were 31%, 26% and 75% respectively.

Approximately 214 nursing, medical and allied health staff spent an estimated 13 900 h in the COVID-19 ICU. There were zero SARS-CoV-2 infections (95% confidence interval 0–1.7%) recorded in staff working in the COVID-19 ICU during the study period.

Our study demonstrated that no ICU staff contracted SARS-CoV-2 infections during the first 6 weeks of operation of a new COVID-19 ICU. We postulate that the elements that

Box 1. SARS-CoV-2 transmission prevention strategies in the new COVID-19 ICU.

Environment

- Single patient rooms with negative flow ventilation (no anterooms)
- Doors to patient rooms alarm if left open
- ICU entrance with change rooms, showers and separate area to put on and remove personal protective equipment (PPE)
- Separate staff office and toilet area
- Three separate staff dining areas with one person per 4 m² limit

Patient factors

- Observation of patient by staff from outside of patient room where possible
- Surgical face mask worn by patients over high flow nasal cannula if staff present in patient room
- Non-vented circuit used for non-invasive ventilation where possible
- Visitation ban

Patient waste disposal

- Disposable urine containers and disposable bed pans
- Absorbent polymer powder used to solidify liquids to aid disposal

Staff vaccination

- Mandatory ICU staff vaccination (two doses of BNT162b2 (BioNTech/Pfizer) vaccine)

Staff numbers

- Nurse-to-patient ratio one-to-one, or one-to-two if both patients are stable on low levels of support
- Nurse manager during daytime
- Nursing team leader for each shift
- Ward secretary for restocking and administrative services during daytime
- Cleaners (two) during daytime

Staff personal protective equipment

- On entering ICU – wear surgical scrubs, disposable N95 mask, cleanable eyewear, and wipeable footwear
- Before entering patient room – wear additional disposable fluid repellent gown, disposable long cuff nitrile gloves, disposable balaclava head and neck covering, and disposable face shield
- Before exiting patient room – remove disposable gown, gloves, head and neck covering and face shield
- After exiting patient room – clean eyewear, discard and replace disposable N95 mask

- Endotracheal intubation – same as PPE for entering patient room
- Sterile procedures – same as PPE for entering patient room except sterile gown and gloves

Staff quantitative mask fit testing

- Mandatory staff mask fit testing (TSI PortaCount Pro + Respirator Fit Tester 8038 and FitPro + 3.2.0 (TSI, USA))

Staff education and administration

- Training and monitoring of staff by nurse educators, clinical nurse consultant, and special projects team during daytime
- Mandatory competency assessment for putting on and removing PPE
- Review and incident management of observed PPE breaches
- Signs instructing how to put on and remove PPE and when to perform hand hygiene placed inside and outside all patient rooms and at all PPE stations
- Social distancing, minimisation of crowding
- Restrictions on non-essential face-to-face meetings
- Furloughing staff at risk from community or occupational exposure

Staff surveillance testing

- Mandatory surveillance testing twice a week if staff reside in a community with a high prevalence of SARS-CoV-2 infection (multi-panel polymerase chain reaction (PCR) test using SARS-CoV-2, influenza and RSV panel (AusDiagnostics Pty Ltd))

- Mandatory testing if staff have COVID-19 symptoms
- Voluntary surveillance testing, otherwise up to twice a week

were likely to have made this possible were preventing environmental contamination to the common areas of the ICU, enhanced PPE when in direct patient contact, and meticulous education of infection prevention procedures.

There are currently no other publications specifically demonstrating the design and operational specifications for a COVID-19 ICU that completely negate workplace SARS-CoV-2 infection transmission.⁹

Limitations to our study include being conducted in a single centre and a short observation period. Surveillance testing for SARS-CoV-2 infection in HCWs was not mandatory, except in HCWs from community areas with high prevalence, so it is possible that some HCWs may have had undiagnosed asymptomatic infection.

Some of the infection-prevention procedures could be regarded as overcautious and may have resource implications where PPE supply is limited. It is unknown whether using less PPE could also negate workplace SARS-CoV-2 transmission in ICU HCWs.

In conclusion, our study demonstrates that it is possible to operationalise a COVID-19 ICU in a way that prevents workplace SARS-CoV-2 transmission to staff.

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Data availability. The data that support this study cannot be publicly shared due to ethical or privacy reasons and may be shared upon reasonable request to the corresponding author.

Conflicts of interest. Winston Cheung declares that he has convened educational events that have received financial assistance from 3M, AB Applied Biosystems, AB Sciex, Abbott Medical Optics, Actelion, Advanz Pharma, Alcon, Amgen, Aquatic Solutions, Aspen, Avant Mutual, Bayer Healthcare, BD, Bioline, Boehringer-Ingelheim, B Braun, Celgene, Charcot-Marie-Tooth Association of Australia, CSL Biotherapies, Fresenius Kabi, Glaxo Smith Kline, Genzyme, Immune System Therapeutics, Infusion 360, Invitrogen, Ipsen, Janssen-Cilag, Johnson and Johnson, Leica Microsystems, Life Technologies, Lilly, Macrogen, Medtronic, MACS Miltenyi Biotec, Merck Sharpe and Dohme, National Home Doctor Service, Novartis, Pfizer, PPS Mutual, Roche, Sanofi-Aventis, Schering Plough, Servier, and Wyeth. None of the other authors have any relevant conflicts of interest to declare.

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