CLINICAL TECHNIQUE

Portable Biosafety Barrier Innovations to Limit Transmissibility of Infectious Diseases during Patient Care in Resource-limited Settings during the COVID-19 Pandemic

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Abstract

Background: The coronavirus disease-2019 (COVID-19) pandemic has brought about a change in healthcare practices that are likely to persist into the foreseeable future. In particular, is the exposure risk to the healthcare practitioners in the emergency department (ED) and the intensive care units. Mitigating this issue in a low-resource setting remains challenging, and in particular, in developing nations such as India, where ED patient flows can overwhelm a system and its human resources, breaking down processes and infecting healthcare workers (HCWs).

Technique: To tackle this and the possible lack of appropriate personal protective equipment (PPE), we designed and built biosafety barrier devices using local resources for use in patient stabilization, transport, and continued care in the ED or the intensive care units.

Results: Four biosafety devices bio-safe levels 1 and 2, ultra-ductile portable interface of interventions in infections, and tented transport trolley for transmissibility (4T) were tested for the feasibility of usage for patient care during the pandemic with simulation.

Conclusion: We anticipate that with time it may be common practice for *in situ* isolation of patients in the emergency departments with a suspicion of an infectious disease. With the proof of concept, simulation, hospital infection control committee (HICC) approval, and trial run, we look to close the gaps that exist in these initial innovations.

Keywords: Barrier enclosure, Coronavirus disease-2019, Emergency department, Healthcare workers, India, Resource-limited settings, Transmission of infection.

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The COVID-19 pandemic heralded a global health crisis necessitating rapid adaptations in healthcare infrastructure to mitigate this havoc. Overburdened healthcare systems operating beyond their maximum capacity saw HCWs with limited knowledge and experience being recruited into the front line pool, thereby increasing the number of HCW infected. Innovations across the world have been attempted from the use of simple plastic sheets to complex negative pressure isolation rooms,[1,2] and various biocontainment devices have been improvised during this pandemic[3] that have helped reduce transmissibility and address concerns regarding adequacy or even lack of PPE. Keeping this in mind, we proceeded to innovate during the lockdown with available local resources.

Biosafety Barrier Devices

Bio-safe Level 1 – Resuscitation and Continued Critical Care Isolation Unit

The Level 1 B-SAFE is a stand-alone unit made of square bar steel with hinges, support bars, and heavy duty wheels. It is foldable to fit into a lift and is sized to fit an ICU bed. It is covered with clear plastic (0.125 mm) and has six hand ports with sleeves. There are two sleeves each at the head end, the right, and left side of the patient. The units can be used in an emergency stabilization area where suspect patients awaiting test reports are held. The unit also has oxygen, suction, ventilator, and monitor ports allowing continued care in an ICU setting Figure 1.

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Bio-safe Level 2 – Intubation and Resuscitation Isolation Unit

The Level-2 B-SAFE is designed for use in an emergency bay that caters to undifferentiated patients requiring noninvasive ventilation or intubation. Although it is mobile and compact, it does not cover the entire patient bed.

Fig. 1: Pictorial depiction of biosafety barrier devices

UDUPI – Ultra-ductile Portable Interface for Interventions in Infections

A preassembled device made of the same clear 0.125 mm plastic sheet, a light-weight welded frame with heavy-duty wheels, and two hand ports with sleeves. This biosafety barrier device was designed to cater to a larger patient population in an open area where individualized contact is impossible. Its use is variable, allowing simple history taking, examination to intubation, and nasopharyngeal swab collection.

4T-tented Transport Trolley in Transmissibility

This biosafety barrier device is a lightweight frame made of UPVC pipes or 10 mm square bar and clear 0.125 mm plastic sheets with two hand ports with sleeves at the head end for intubation and airway management. It is sized to cover the transport trolleys and can be modified to fit any bed. In comparison to the Level-2 B-SAFE, this device covers the entire trolley and provides better protection from aerosolization.

For disinfection of the barrier devices, an earmarked area is identified outside the patient care area. The sleeves of all devices can be removed and sterilized as per the HICC protocols and replaced by maintaining an air seal. 1% Sodium hypochlorite spray or fogging is used for the interiors and wipe down of exterior surface is performed for disinfection; which is in line with the recommendations by Centers for Disease Control (CDC) for disinfection of body fluid spillage.[4] The integrity of the barrier is inspected for before every reuse.

The rapid escalation of this pandemic has caught unprepared healthcare systems off-guard and procurement of PPE has been a challenge. Previously, Ebola and Nipah virus outbreaks alerted the need for isolation units and barrier devices in management of patients.[5] It has been well-documented that barrier devices prevent and reduce exposure to body fluids as well as aerosolized droplets.[1,3]

The implementation of said devices could have constraints such as need for training for ease of use by treating physician. Serial simulations were conducted with a high-fidelity mannequin in a small cohort of Emergency physicians at various phases of design and manufacturing. Ergonomic changes derived were then implemented in the design. Though usage of such devices including ours has rolled out in clinical practice during this disaster,[6,7] we realize the importance of rigourous testing with structured protocols to prove reduction in transmissibility to HCW without compromising patient safety.

In resource-limited setting, where appropriate PPE is scarce, we hope that the barrier devices add to the existing armamentarium of infection control devices and practices for delivering quality healthcare.

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