

Infection Control in Mass-Casualty Respiratory Care: Research Needs and Future Directions

By failing to prepare, you are preparing to fail.
—Benjamin Franklin

During the Singapore SARS (severe acute respiratory syndrome) outbreak, Khoo et al implemented a sensible approach to protecting patients and clinicians from nosocomial infection by the SARS coronavirus, and in this issue of the Journal they report on their strategy's impact on clinical outcomes.¹ Khoo et al draw attention to the many gaps in our understanding of infection-control during respiratory-care interventions.

Research on prevention of nosocomial infections has largely focused on hand hygiene, device-related infections, and clinician vaccination.²⁻⁵ Although those infection-control measures are important, a solid evidence base regarding respiratory-care-related infection control must be generated to improve our understanding of how to minimize transmission of pathogens when treating respiratory conditions.

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The efficacy of metered-dose inhalers (MDIs) for treating acute airflow obstruction has been addressed previously,⁶ and the study by Khoo et al¹ supports the effectiveness of MDIs during an epidemic. Data on the effectiveness of MDIs in protecting patients and clinicians would have been even more compelling. Nevertheless, their findings are important and useful.

Khoo et al found that 84% of nurses thought that nebulizers were more effective than MDI with spacer in relieving acute airflow obstruction—a belief not substantiated by the medical literature. Further, 96% of nurses preferred the nebulizer and thought the hospital should return to nebulizer use after the SARS outbreak. Although Khoo et al found no link between those beliefs and MDI use, the findings suggest an important clinician knowledge gap. As efforts are focused on improving infection control in respiratory care, the challenge of *implementing* best practices demands equal attention. Knowledge gaps must be closed by identifying efficacious respiratory-care infection-control interventions, and must be supplemented with rigorous examination of clinicians' knowledge, attitudes,

and behaviors, which profoundly impact the effectiveness of all interventions.

With respect to knowledge gaps, several important investigations are needed. Among the more valuable research will be the development of a widely available, rapid means to detect environmental contamination by respiratory pathogens. Important groundwork has been laid in developing that capability for SARS and influenza.^{7,8} We hope that continued advances in environmental sampling technology will soon provide practical aids in the management of respiratory outbreaks. Below we list some important avenues of investigation.

Filtration

Filtration of inspired and expired gases (eg, within the heat-and-moisture exchanger) is a subject of debate. With a ventilator that draws room air, it is recommended that there should be a filter on the inspiratory inlet, particularly in the presence of contagion, but such filtration has not been demonstrated to reduce ventilator-associated pneumonia, and its utility for filtering other respiratory pathogens is also uncertain. Filtering the expiratory limb of the ventilator circuit is intended to protect the delicate flow-monitoring and pressure-monitoring components, and some have recommended expiratory-limb filters for infection control, but it is unknown whether expired gas from intubated patients poses any risk to clinicians. The answer may depend on the setup (eg, configuration of the ventilator circuit, location of the exhalation valve), and with some humidification systems the filter may require frequent changing. It is unclear which is more dangerous: unfiltered exhaled gases or possible clinician exposure by breaking the circuit to change the filter. Further, heat-and-moisture exchangers that have filters have not been shown to reduce the ventilator-associated-pneumonia rate or to alter contamination of the environment. High-flow oxygen masks that can filter exhaled gas also warrant investigation. Although preliminary investigation suggested they may improve infection control,⁹ no study has demonstrated reduced transmission to other patients or clinicians.

Noninvasive and Manual Ventilation

Data from the SARS experience suggest that there may be a higher risk of secondary infection with noninvasive ventilation (NIV) and with manual ventilation,¹⁰⁻¹² but the true risk posed by these interventions is unclear, and systematic investigation is warranted to clarify the risk and to determine if they can be implemented safely. Investigation of NIV should focus on both whether a particular condition is likely to respond to NIV and whether the risk of secondary infection makes NIV unwise. The prospect of limited ventilation options in a scenario such as a severe influenza pandemic suggests that it is vital to clearly determine the risks of NIV and how it can be used most safely.

High-Frequency Oscillatory Ventilation

Use of high-frequency oscillatory ventilation (HFOV) may pose additional infection-control challenges in epidemic or pandemic respiratory illness.^{13,14} Standard HFOV involves constant venting of unfiltered gas from the pressure-control diaphragm into the room. The HFOV system includes one exhalation valve and 2 high-pressure dump valves, the design of which makes filtration difficult. Gas scavenging from all 3 valves might be impractical. Since the SARS experience, filtered HFOV circuits have been developed, which might be an important improvement in critical-care infection control, but to our knowledge there have been no studies of the effect of those circuits on airways resistance or their efficacy in filtering pathogens.

Knowledge Translation

It is vital that we build a knowledge base of respiratory-care infection control, but "Knowing is not enough; we must apply. Willing is not enough; we must do." (Johann Wolfgang von Goethe). There are many major gaps in the implementation of known effective interventions, some of which are not implemented simply because of a lack of clinician awareness. The finding by Khoo et al, that many nurses believe that MDI is less effective than nebulizer to treat acute airways obstruction, despite clear evidence to the contrary, demonstrates this problem.⁶ Implementation of evidence is lacking on several fronts, and clinician education is not sufficient to solve this problem, because knowledge does not necessarily translate into practice.¹⁵ Poor adherence to hand-hygiene and personal-protection-equipment protocols are primary examples. The availability of hand-hygiene methods, work load, clinician perceptions about risk and cultural norms, and other factors are more likely to predict clinician behavior than is clinicians' knowledge of efficacy. Certainly, knowledge regarding

self-protection behaviors is essential: practitioners cannot do what they do not know. However, awareness alone is not enough. It is incumbent upon the scientific community to identify and eliminate the barriers to adherence to interventions that maximize patient and clinician safety.

The findings from Khoo et al¹ support the use of MDI rather than nebulizer during a respiratory viral epidemic and highlight our infection-control knowledge gaps. Much work remains to be done to build well-informed, effective respiratory care infection control strategies.

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