Respirator Use in the Emergency Department During Contingency and Crisis Capacity Situations During the COVID-19 Global Pandemic

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Introduction

This proposal describes why mask respirators with disposable filters must be deployed in the Emergency Department during low resource situations, such as the current COVID-19 pandemic, with focus on the following:

1. Understanding current conventional disposable respirator types and gradings
2. The Centers for Disease Control recommendations for respirator use in resource limited settings, specifically in contingency capacity, crisis capacity and no supply situations
3. The feasibility of reuse and sterilization of disposable and face piece respirators

Air-Purifying Particulate Respirators – Understanding the types and classifications

In 1995 The National Institute for Occupational Safety and Health (NIOSH) released a standardized testing certificate for respirators and classed them based on their capability to filter air particles. Subchapter G: 42 CRF Part 84 – "Approval of Respiratory Protective Devices" classified approved respirators into three distinct series – N-Series, R-Series and P-Series[1]. Each of these have three distinct efficiency gradings – 95, 99 and 100, alluding to the percentage of particulate matter at the 0.3 micron size (3×10^{-7}m) that the filter is able to capture.

The N-Series of respirator is the most commonly used series in the healthcare setting and is capable of filtering solid and non-oil based liquid aerosol particulates but is incapable of capturing oil-based particulates. The N95 series, for example, is capable of capturing 95% of particulate including dust particles and non-oil based liquid. The N-Series respirator has a non-specific service life and can generally be reused as long as the mask is not damaged and still provides airfow[2–4].

The R-Series particulate respirators are resistant to particulate, non-oil based liquid and oil-based liquid aerosol but are generally certified for use over 8 hours and are therefore not routinely used.

Lastly, the P-Series particulate respirators are similar to the R-Series, protecting against particulate, non-oil based liquid and oil-based liquid aerosol and are rated from 40 hour to 30 days of use in undamaged filters[1].

An important distinction is that these face masks come both as disposable units (as typically seen in the health care setting, most commonly the N95 disposable) and reusable face piece units with disposable filters ("gasmask" respirators). Based on NIOSH certifications, these disposable and reusable facepiece units are equivalent in

their ability to filter particulate matter based on their series designation (N vs R vs P) and efficiency grading (95, 99 and 100).

The Centres for Disease Control recommendations for respirator use in resource limited settings

In light of the COVID-19 global pandemic, The Centers for Disease Control (CDC) have offered a series of recommendations for hospital systems' management of non-reusable supplies. As part of these recommendations, a document was published on March 17, 2020 offering a series of strategies to optimize the supply of respirators and face masks[5]. Within this, they describe how these limited resources can be extended in times of shortage. Specifically, the CDC defines three situations where the behaviour of health care providers should change with respect to face mask use that relate to the capacity of resources:

1. Conventional capacity measures – Consistent patient care without any change in daily contemporary practices. Face masks should be used according to product labelling and local/state/federal requirements. This includes one time use of disposable face masks.

2. Contingency capacity measures – Change daily standard practice but do not have a negative impact on patient care or safety of the user. May be used temporarily during periods of face mask shortages. This includes selectively cancelling elective and non-urgent procedures which require face masks, restricting face mask use to health care providers only and implementing extended use of face masks (specifically, only removing face masks if the unit is soiled, damaged or hard to breath through).

3. Crisis capacity measures – Are not within the standard of care and may be considered during periods of known face mask shortages. Strategies include using face masks beyond the manufacturer-designated shelf life, implementing re-use of face masks and prioritizing face masks for high risk activities. The consideration of N95 respirator crisis capacity use was discussed specifically and recommended extended use in a separate document[6].

4. No availability of face masks – Options include use of a face shield that covers the entire front of the face without a face mask and use of home-made masks (bandana, cloth) which are non-standardized and unvalidated.

Recently there has been great concern in Ontario regarding a shortage of both conventional surgical masks as well as air purifying particulate respirators, which is projected only to worsen if the COVID-19 pandemic unfolds. Although health care systems are familiar with disposable respirators, such as the N95, health care systems ought to consider other respirator systems, such as mask respirators that have equivalent NIOSH ratings and therefore equivalent protection for users when supplies of disposable respirators are limited. In fact, there may even be some advantage to the use of non-disposable respirators, such as a reduced risk of self inoculation during donning and doffing of equipment[7], as well as a decrease in environmental impact.

Reuse and sterilization of respirators

As related to crisis management of resources, there are few studies that have looked at the efficacy of sterilizing respirators in low resource situations although this has been a topic of discussion during the COVID-19 pandemic. Methods of sterilization include chemical disinfectants such as isopropyl alcohol or chlorine-containing solutions, heat and ultraviolet rays in the 100-280 nm range (UV-C). A summary of this evidence includes:

- A pilot study examining the feasibility of various decontamination methods including ultraviolet vs ethylene oxide, vs vaporized hydrogen peroxide vs microwave oven irradiation vs bleach found that UV, ethylene oxide and vaporized hydrogen peroxide yielded the best penetration change and flow rate changes before and after treatment[8]
- Sterilization of N95 filters with UV-C radiation modestly increases particle penetration (up to 1.25%) and does not decrease flow penetration[9]
- Microwave steam bags may also be an effective method of decontamination with almost no loss of filtration efficiency and up to 99.9% clearance of a surrogate pathogenic virus[10]

Within the automotive painter, welding and construction industries, a number of filters that are amenable to sterilization such as the 3M 5N11 and 3M 5P71, which offer NIOSH-certified N95 and P95 protection respectively. These filters can be used with adaptors such as the 3M 603 and a filter retainer such as the 3M 501, and a reusable facepiece such as the 3M 7500 series or 3M 6000 series, which can be sterilized in themselves.

Conclusion

Reusable filtered face piece respirators, such as the disposable N95 respirator commonly used in heal care settings and reusable face piece respirators with disposable filters ("gasmasks") are equivalent based on the NIOSH series classification and efficiency grading. The CDC mandate to consider extended use and reuse of disposable filters and face piece respirators in contingency and crisis capacity situations, with more extreme measures used when no face masks are available. Lastly, while there is little evidence describing the optimal methods for sterilization of these filters, some studies suggest that there is minimal loss of filtration capacity and airflow through these filters with chemical, heat and ultraviolet sterilization, provided there is no major structural loss. We are at the beginning of the COVID-19 pandemic in Southwestern Ontario and are at least in a contingency capacity situation with expected movement toward crisis capacity if the situation worsens. All health care workers must move to the extended use and user sterilization of the current supply of N95 respirators. In addition to this, concurrent use of face piece respirators with reusable filters should also be considered as an effective and efficient use of limited resources to offset the rate of decline of the current stock of reusable N95

respirators. These considerations are aimed at avoiding a no-supply/availability situation which would put health care workers, and subsequently patients, at greatest risk.

References

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