



# Utilization of an Orthopedic Hood as Personal Protective Equipment for Intubation of Coronavirus Patients: a Brief Technical Report

Timothy T. Wills, MD<sup>1</sup>, Wilhelm A. Zuelzer, MD<sup>2</sup>,  
and Bryant W. Tran, MD<sup>1</sup>

## Abstract

**Background:** The novel coronavirus disease (COVID-19) has afflicted millions of people worldwide since its first case was reported in December 2019. Personal protective equipment (PPE) has been tailored accordingly, but as of April 2020, close to 10 000 health care workers in the United States have contracted COVID-19 despite wearing recommended PPE. As such, standard guidelines for PPE may be inadequate for the health care worker performing high-risk aerosolizing procedures such as endotracheal intubation. In this brief technical report, we describe the integration of an orthopedic hood cover as an item for full barrier protection against COVID-19 transmission. **Technical Description:** The Coronavirus Airway Task Force at Virginia Commonwealth University Medical Center approved this initiative and went live with the full barrier suit during the last week of March 2020. The PPE described in this report includes a Stryker T4 Hood, normally used in conjunction with the Stryker Steri-Shield T4 Helmet. Instead of the helmet, the hood is secured to the head via a baseball cap and binder clip. This head covering apparatus is to be used as an accessory to other PPE items that include an N95 mask, waterproof gown, and disposable gloves. The motor ventilation system is not used in order to prevent airborne viral entry into the hood. **Discussion:** An advantage of the full barrier suit is an additional layer of droplet protection during intubation. The most notable disadvantage is the absence of a ventilation system within the hood covering. **Conclusion:** Modification of existing PPE may provide protection for health care workers during high-risk aerosolizing procedures such as endotracheal intubation. Although the integration of this medical equipment meets the immediate needs of an escalating crisis, further innovation is on the horizon. More research is needed to confirm the safety of modified PPE.

## Keywords

adult reconstructive surgery, anesthesia, geriatric medicine, systems of care, occupational therapy

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## Background

The novel coronavirus disease (COVID-19) was first reported in Wuhan, China, in December 2019.<sup>1,2</sup> Since that time, the disease has afflicted millions of people worldwide.<sup>3</sup> With a mortality rate between 2.7% and 27.3% of the geriatric population in the United States, it has been more than 20 times more deadly than this season's influenza.<sup>4</sup> The primary route of viral transmission appears to be through respiratory droplets, although viral particles found within the path of hospital ventilation systems suggests that aerosolization of these particles makes COVID-19 even more contagious.<sup>5</sup> Only low-quality evidence exists regarding both COVID-19 transmission and the

necessary personal protective equipment (PPE) to protect health care workers from infection.<sup>6</sup> In fact, in a 2-month period between February and April 2020, close to 10 000 health

<sup>1</sup> Department of Anesthesiology, Virginia Commonwealth University Medical Center, Richmond, VA, USA

<sup>2</sup> Department of Orthopedic Surgery, Virginia Commonwealth University Medical Center, Richmond, VA, USA

### Corresponding Author:

Bryant W. Tran, Department of Anesthesiology, Virginia Commonwealth University Medical Center, P.O. Box 980695, Richmond, VA 23298, USA.

Email: bryant.tran@vcuhealth.org



care workers in the United States have contracted COVID-19 despite wearing recommended PPE.<sup>7</sup>

During endotracheal intubation, the risk of viral transmission through respiratory droplets increases by almost 7-fold.<sup>8</sup> A recent model demonstrated direct contamination of, among other surfaces, the laryngoscopist's neck and ears

by droplet and aerosolized particles following a simulated patient cough.<sup>9</sup> As such, standard guidelines for PPE may be inadequate for the health care worker performing this procedure. We describe in a brief technical report the integration of an orthopedic hood cover as an item for full barrier protection against COVID-19 transmission during endotracheal intubation.



**Figure 1.** Model for standard personal protective equipment (PPE) for airborne precautions.

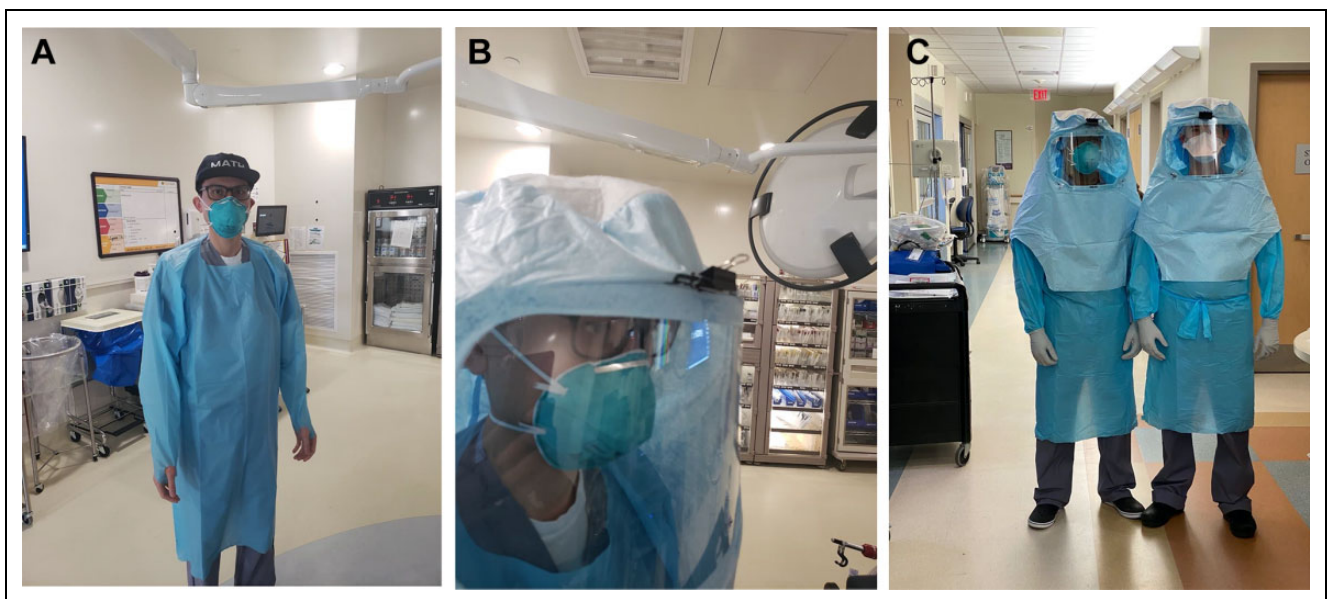
## Technical Description

This project was initiated by the Department of Anesthesiology and Department of Orthopedic Surgery at Virginia Commonwealth University Medical Center. After passing qualitative standards with a saccharin spray test, the institution's Coronavirus Airway Task Force approved its use and went live with the full barrier suit during the last week of March 2020.

Standard PPE for airborne precautions at our institution includes the following items (Figure 1):

- 3M 1860 Healthcare Particulate Respirator and Surgical Mask or Halyard Health 46827 Fluidshield PFR95 N95 Particulate Filter Respirator and Surgical Face Mask
- Generic disposable blue waterproof long sleeve nonsterile common protective equipment thumb hole isolation gown
- Halyard Health Sterling Powder-Free Nitrile exam gloves
- DeRoyal Speyes Eye Shieldz
- Optional surgical cap or bouffant cap

Upgrade to full barrier precautions requires removal of the optional surgical cap and eye shield and the addition of the following items (Figure 2A-C):



**Figure 2.** (A) Model for donning of baseball cap prior to hood covering. (B) Model for donning of hood covering. Note the use of a binder clip to secure the hood covering to the baseball cap. (C) Models for complete full barrier coverage.

- Stryker T4 Hood, normally used in conjunction with the Stryker Steri-Shield T4 Helmet
- Standard baseball cap
- Binder clip

## Discussion

In this brief technical report, we describe the redistribution of perioperative equipment to enhance the safety of health care workers during the COVID-19 crisis. Limited medical supplies have required physicians to provide innovative ideas at an unprecedented pace. An advantage of this full barrier suit is an additional layer of droplet protection during endotracheal intubation of coronavirus patients. Moreover, ease of implementation was extremely important due to the exponential increase in intubation case volume. The absence of electronic or technological equipment allowed for timely acquisition of supplies. Lastly, this outfit is intended for disposable single use only. This eliminates the need for a decontamination protocol associated with reused equipment. With the binder clip in place, the baseball hat is doffed easily and safely along with the hood.

Because of the outfit's simplicity, the most notable disadvantage of this full barrier equipment is the absence of a ventilation system within the orthopedic hood covering. As a result, body heat causes condensation in the clear hood window, and visibility can be reduced during an intubation procedure. Accumulation of carbon dioxide within the hood is possible when worn for long periods of time. In normal circumstances, the hood covering can be comfortably worn for the duration of joint replacement surgery due to the movement of air provided by the fans within the Stryker Steri-Shield T4 Helmet apparatus. The ventilation system is not recommended in a COVID-19 laden environment due to the lack of viral filtration when air is blown into the hood. Moreover, the fan component cannot be reliably sterilized for reuse. An adapter using 3-dimensional printing technology may allow for the addition of a High-Efficiency Particulate Air filter to the T4 Helmet.

Data are currently being collected regarding the use of the described full barrier PPE. To date, this remains the anesthesiologists' "first-choice" for PPE at our institution and is being used for all COVID-19 patients who require intubation from acute hypoxic respiratory failure. Although there is theoretical concern for inadequate ventilation in the absence of a helmet and fan, our team consistently performs successful intubations in the hood covering without experiencing dizziness or shortness of breath.

## Conclusion

The addition of an orthopedic hood covering to standard PPE may provide protection for health care workers during high-risk aerosolizing procedures such as endotracheal intubation. Although the integration of this medical equipment meets the immediate needs of an escalating crisis, there is certainly room for further innovation and improved versions of protective

equipment. The implications of coronavirus disease management will be relevant for years to come and more research is needed to confirm the safety of modified PPE.

## Authors' Note

T.T.W. designed, planned, and helped implement the personal protective equipment described in the report. He helped write and edit the manuscript. W.A.Z. helped write and edit the manuscript. B.W.T. designed, planned, and utilized the personal protective equipment described in the report. He helped write and edit the manuscript.



## Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: B.W.T. is a member of the editorial board for the Geriatric Orthopaedic Surgery and Rehabilitation journal.

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## ORCID iDs

Timothy T. Wills, MD  <https://orcid.org/0000-0002-2379-5171>  
Bryant W. Tran, MD  <https://orcid.org/0000-0002-1231-5611>

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