Preparation for a respiratory outbreak – training and operational readiness

INTRODUCTION

Infectious disease outbreaks require large numbers of healthcare workers to be deployed to isolation facilities to manage both suspect and confirmed cases of the outbreak pathogen. The appropriate use of personal protective equipment (PPE) and powered air-purifying respirators (PAPRs) in the management of such patients is essential in order to prevent patient-to-healthcare worker spread as well as nosocomial and community transmission of the pathogen.

This article aims to provide an overview of outbreak preparedness training at the National Centre for Infectious Diseases (NCID) and Tan Tock Seng Hospital (TTSH) in Singapore. The activities undertaken and considerations in planning may be broadly applicable to institutions whose staff need to respond to outbreaks.

ORGANISATION OF RESPIRATORY OUTBREAK PREPAREDNESS TRAINING

The reality of outbreak preparedness is that most outbreak wards or intensive care units (ICUs) exist as virtual entities until they are activated to treat outbreak cases. This makes training of the staff who may be deployed to these units a challenging affair at the best of times.

Training can be from the individual level to the hospital level. Individual skills, specifically training with PPE and PAPRs, are important to reduce the risk of pathogen transmission. Scenario-based training and drills involving the multidisciplinary ward or ICU team are useful in building teamwork and for spotting discrepancies between what is espoused in the protocols and actual practice on the ground. Outbreak drills involving interdepartmental coordination within the hospital are useful as a gauge of whether existing procedures and protocols are workable. Ideally, training of these groups of professionals should be delegated to a training lead from each respective subset of professionals, who should train their own subset (e.g., medical, nursing and allied health), as there is wide variation in the individual roles and competencies of the various professional subsets.

At TTSH and NCID, PPE/PAPR training is conducted by nurse educators and the various end-users of PPE/PAPRs such as the ICUs, emergency department and operating theatre. Coupled with PPE/PAPR training, outbreak preparedness training drills involving the multidisciplinary team (i.e., nursing, medical and allied health) have been conducted. These take the form of a scenario-based drill in PPE/PAPR. Administrative and logistical support for the conduct of outbreak preparedness training is provided by the Infectious Disease Research and Training Office (IDRTO) of NCID. The administrative and logistic tasks are listed in Box 1.

PERSONAL PROTECTIVE EQUIPMENT TRAINING FOR RESPIRATORY OUTBREAKS

PPE, if worn properly, is protective against transmission of the respiratory pathogen to the healthcare worker. Data in a recent article by Chou et al. showed that PPE usage and infection control training reduced the risk of infection by coronavirus pathogens. An article by Alraddadi et al. showed that with training, the odds ratio of developing Middle East respiratory syndrome coronavirus (MERS-CoV) seropositivity among healthcare staff was 0.33. A Cochrane review found that

| Box 1. Administrative and logistical support for outbreak readiness training. |
|-----------------------------------------------|
| **Administrative tasks**                      |
| **Before course**                             |
| - Planning of course dates, instructor and trainee availability, sourcing for training venue, dissemination of course dates |
| - Coordination with respective department single point of contact |
| - Email all participants regarding date, time and venue |
| - Finalise participant list for the training |
| - Send reminders via email and TigerText to participants |
| - Disseminate training materials, pre-reading texts |
| **During course**                             |
| - Register attendance |
| - Timekeeping |
| **After course**                              |
| - Collect course feedback |
| - Update respective departments regarding course completion for their record keeping |
| - Ensure participants complete competency form before leaving the training |
| - Ensure competency forms are signed by the lead trainer |
| - Update the Infectious Disease Research and Training Office team weekly on the progress of the training |
| **Logistical support**                        |
| - Ensure training equipment is available, e.g., cardiopulmonary resuscitation mannequin, central venous pressure (CVP) mannequin, intravenous (IV) training arm |
| - Ensure consumables are available, e.g., expired CVP sets, endotracheal tubes, IV plugs, personal protective equipment, gloves, masks |
| - Borrow relevant equipment, e.g., ultrasound scanner, direct laryngoscope, videolaryngoscope, powered air-purifying respirator (PAPR) sets |
| - Assist in cleaning equipment (e.g., PAPR and mannequin) after training |
| - Ensure all training items are returned to storage |
healthcare workers’ fear of getting infecting encouraged their adherence to PPE guidelines. Mandatory training was found to improve compliance to PPE donning and doffing procedures. Unambiguous, concise guidelines made for better adherence to PPE/PAPR donning and doffing procedures.

Although PPE/PAPR training is admittedly sporadic during normal times, it was well attended in the lead-up to the pandemic. Given the tempo of the progression of the outbreak, we found that there was sufficient time to train a large group of healthcare staff using a just-in-time approach. PPE may be categorised as standard respiratory PPE, consisting of gloves, a gown and an N95 mask with eye protection, or as PPE with PAPR, which is essentially PPE consisting of a PAPR device, a hood with face shield, a gown and gloves. Standard PPE is simple to don and doff and is routinely used in day-to-day care of patients on respiratory precautions in the ICU. Hence, there is familiarity with PPE in most acute care areas. There are ample signage and posters in the ICU reminding staff of the donning and doffing procedure. This is self-explanatory and does not require much additional training. When doffing the PPE, care should always be exercised not to touch the contaminated surface of the gown and glove, and scrupulous handwashing is mandatory.

PPE with PAPR, rather than standard PPE, is worn for the specific indications listed in Box 2. Staff who perform aerosol-generating activities on patients who are on respiratory precautions will be familiar with these devices. Training for PAPR usage should be prioritised according to the staff member’s role [Box 3]. Healthcare staff performing direct care for respiratory outbreak patients who have failed all forms of N95 masks should be targeted for training as a matter of priority since they have no alternative means of protection.

Usage of PPE with PAPR requires competency training with the PAPR device. As the PAPR has been in routine use, particularly during the outbreaks of severe acute respiratory syndrome (2003), the H1N1 influenza outbreak (2009) and MERS-CoV (2013), medical and nursing staff at the ICU are familiar with their use, having gone through orientation and competency training on the devices during onboarding.

Just prior to the arrival of the first imported case of coronavirus disease 2019 (COVID-19) in Singapore, NCID and TTSH were in the process of introducing a new PAPR device, 3M Versaflo™ TR-300+ (3M, St Paul, MN, USA). In the month of January 2020, PAPR training was ongoing, organised by the various end-users of the PAPR device such as ICUs and operating theatres. This training was completed by end-January 2020 and was well attended in light of the oncoming outbreak.

With the declaration of COVID-19 as a Public Health Emergency of International Concern and the opening of our outbreak wards and ICU in late January, just-in-time PAPR training was conducted on a number of platforms within the TTSH campus by nurse educators and the IDRTO for staff who were assigned to the outbreak ICU. These included augmented nursing staff, registrars and medical officers deployed to the ICU. External staff who were deployed to NCID to provide an extracorporeal membrane oxygenation service were also trained. The Occupational Safety and Health Administration (OSHA), a United States agency, recommends that a new employee must be provided with respirator training prior to using a respirator in the workplace. The OSHA also believes that PPE/PAPR training should be conducted on an annual basis. Table 1 shows PPE and PAPR training needs during various phases of the pandemic. Our PPE and PAPR donning, doffing and decontamination procedure can be found in the Appendix 1.

**DRILLING THE INTERDISCIPLINARY WARD OR ICU TEAM**

During the interregnum between the MERS-CoV outbreak and the current COVID-19 outbreak, interdisciplinary drills involving the nursing, medical and allied health teams were conducted periodically. The training mainly consisted of practice with donning and doffing PPE with PAPR; ingress to and egress from the patient’s negative pressure room; aerosol-generating procedures such as endotracheal intubation; basic resuscitative procedures; routine nursing care; and specimen collection and dispatch [Appendix 2].

---

**Box 2. Indications for the use of personal protective equipment (PPE) with powered air-purifying respirator (PAPR).**

*Absolute indication*
- Persons who have failed all N95 mask fittings and are required to manage a patient on respiratory precautions

*Performance of aerosol-generating procedures, including:*
- Endotracheal intubation
- Tracheostomy creation
- Bronchoscopy
- Open suction
- Chest physiotherapy
- Sputum induction

*Others*
- Prolonged exposure to patient and patient environment for which prolonged use of N95 mask and standard PPE may cause discomfort.

**Box 3. Priority for personal protective equipment (PPE) with powered air-purifying respirator (PAPR) training.**

| Tier 1 | Trainers and superusers of PPE/PAPR devices |
| Tier 2 | Staff who failed N95 mask fitting and whose scope of work involves close contact with respiratory outbreak patients |
| Tier 3 | Procedurists and assistants who perform aerosol-generating procedures (usually intensive care unit, emergency department or operating theatre staff), including doctors, nursing and allied health professionals |
| Tier 4 | Other staff whose scope of work involves close contact with respiratory outbreak patients |
In the interval period between outbreaks, patients who are isolated in the negative pressure room for airborne precautions provide an opportunity to practise PPE and PAPR donning and doffing. Particular attention should be paid to specimen collection and dispatch, as these activities involve coordination between the ICU or ward team, the portering team and the laboratory receiving the specimen.

In the ramp-up phase of the pandemic, in addition to the just-in-time PPE/PAPR training, medical staff deployed to the outbreak ICU were also subjected to a simulated intubation and CPR scenario [Appendix 3]. When the outbreak was declared and outbreak wards and ICUs were opened in late January 2020, there were a series of adjustments to existing procedures during the initial period of operation. Specific to the NCID outbreak ICU, new protocols added to the existing ones included wayfinding and patient transport within the NCID building (which recently opened in 2019) to the operating theatre and radiology suite, staff safe distancing, and management of a suspect case that slipped through screening and required transport to the ICU. A drill scenario was developed for such situations, and existing and new staff were trained during a scenario-based drill [Appendix 4].

**HOSPITAL OUTBREAK PREPAREDNESS TRAINING**

Coordination between departments is key to successful outbreak response. The WHO has set out a toolkit for the organisation of hospital outbreak response drills.[3] The Ministry of Health routinely conducts exercises to assess the hospital’s response to an infectious disease suspect case arriving in the ward. The exercises are umpired by healthcare professionals from the ministry and other hospitals, and the hospital is given feedback in an after action review.[6]

**OUTBREAK TRAINING DURING AN OUTBREAK**

During an outbreak, because there is separation into ‘clean’ and ‘dirty’ teams, it is more difficult to organise training programmes. However, there is still a need to train staff who are to be deployed at the outbreak wards and ICU. It is also necessary to train existing staff who are already deployed in the outbreak wards or ICU, to close gaps in training.

Training may have to be organised in separate sites. ‘Clean’ sites such as unopened wards or training rooms should be used for training of new staff who have yet to be exposed to the pathogen. Training within the outbreak ward poses an infection risk for staff who have not been exposed to the pathogen. The aim of training new staff should be addressing PPE and PAPR training as well as leading them through fundamental basics such as ingress to and egress from the patient’s room, basic resuscitative procedures, routine nursing care, and specimen collection and despatch.

Existing staff can be trained within the outbreak ward. When the patient load is not excessive, they can be trained by simulating the process of receiving a new patient, resuscitation and inpatient management. While training should be realistic, it should be explained to the staff being trained that the exercise is not meant to be punitive but is instead meant to be a reality check to ensure that existing protocols and procedures are workable in an outbreak situation.

In conclusion, the experience of COVID-19 has led us to conclude that outbreak preparedness begins well in advance of an outbreak. It is a massive, concerted effort by the entire hospital. Most staff involved in patient care are already trained in PPE. There is also a pool of staff in various parts of the hospital who are familiar with the use of PAPR. The tempo of a respiratory outbreak lends itself well to a just-in-time training approach when there is a need to ramp up staffing. Scenario-based team training is useful to familiarise staff with the constraints of working in PPE with PAPR as well as orientate them to procedures and protocols in the outbreak ward and ICU. Hospital preparedness, interdepartmental coordination, and existing protocols and procedures should be

| Parameter | Pre-pandemic | Pre-outbreak | Initial outbreak ramp-up | Outbreak |
|-----------|--------------|--------------|--------------------------|----------|
| Date      | 2018–2019    | 1–28 January 2020 | 28 January–29 February 2020 | 5 April 2020 onwards |
| Type of training | PPE/PAPR training and scenario-based training | PPE/PAPR training | Just-in-time PPE/PAPR training scenario training | Scenario training |

| No. of staff trained* |
|----------------------|
| Doctors and respiratory therapists | 48 | 133 | 245 by 29 February 2020, 362 by 11 June 2020 | 250 |
| ICU nurses | 150 | 330 | – | 700 |

| Target audience | Staff liable for deployment to outbreak wards | ICU medical and nursing staff | Staff liable for deployment to outbreak wards and ICUs | Staff liable for deployment to outbreak ICUs |
|-----------------|---------------------------------------------|---------------------------------|-----------------------------------------------|-----------------------------------------------|
| Organiser       | Nurse educators and CDC† | Nurse educators and respective end-users of PAPR | IDRTO, NCID | Nurse educators and medical staff |

*Numbers trained are not exhaustive. †Nurses included in the table were designated as those who would be deployed in the ICU. Staff trained during the ramp-up phase included external staff deployed to run an on-site extracorporeal membrane oxygenation service in NCID. CDC=Communicable Disease Centre; ICU=intensive care unit; IDRTO=Infectious Disease Research and Training Office; NCID=National Centre for Infectious Diseases; PAPR=powered air-purifying respirator; PPE=personal protective equipment.
tested using periodic tabletop exercises and hospital outbreak drills.

Acknowledgements
We wish to thank our colleagues in the Nursing Education Department and Department of Infection Control for their kind permission to include the instructional guide on donning, doffing and decontamination of the PAPR device.

Supplementary Material
The Appendices are available online.

Jin Wen Lew1, MRCP, FRCPed, NV Thayalamurugan2, MSc
1Department of Respiratory and Critical Care Medicine, Tan Tock Seng Hospital, 2Department of Nursing, National Centre for Infectious Disease, Singapore

Correspondence: Mr. NV Thayalamurugan, Senior Nurse Clinician, Department of Nursing, National Centre for Infectious Disease, 16 Jalan Tan Tock Seng, 308442, Singapore. E-mail: Jeff_Thayala@ncid.sg

Received: 25 Feb 2020  Accepted: 14 Jul 2020  Published: 17 Aug 2020

REFERENCES
1. Gomersall CD, Tai DY, Loo S, Derrick JL, Goh MS, Buckley TA, et al. Expanding ICU facilities in an epidemic: Recommendations based on experience from the SARS epidemic in Hong Kong and Singapore. Intensive Care Med 2006;32:1004-13.
2. Chou R, Dana T, Buckley DJ, Selph S, Fu R, Totten AM. Epidemiology of and risk factors for coronavirus infection in health care workers. Ann Intern Med 2020;173:120-36.
3. Alraddadi BM, Al-Salmi HS, Jacobs-Slitka K, Slayton RB, Estivariz CF, Geller Al, et al. Risk factors for Middle East respiratory syndrome coronavirus infection among healthcare personnel. Emerg Infect Dis 2016;22:1915-20.
4. Houghton C, Meskell P, Delaney H, Small M, Glenton C, Booth A, et al. Barriers and facilitators to healthcare workers’ adherence with infection prevention and control (IPC) guidelines for respiratory infectious diseases: A rapid qualitative evidence synthesis. Cochrane Database Syst Rev 2020;4:CD013582.
5. World Health Organization. A practical guide for developing and conducting simulation exercises to test and validate pandemic influenza preparedness plans. Available from: https://www.who.int/influenza/ preparedness/pandemic/simex_influenza_preparedness_plans/en/. [Last accessed on 2020 Feb 21].
6. Lum LHW, Badaruddin H, Salmon S, Cutter J, Lim AY, Fisher D. Pandemic preparedness: Nationally-led simulation to test hospital systems. Ann Acad Med Singapore 2016;45:332-7.

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.
# Instructional Guide

## Donning of 3M TR 300+ Powered Air Purifying Respirator (PAPR) and Versaflo Hood with Tier 2 PPE for Patient on Full Precautions

### KNOWLEDGE

| 1 | Discuss the purpose(s) of proper donning of 3M TR300+ PAPR with Versaflo hood. |
|---|---|
| 1.1 | To prevent infection / transmission of patient with respiratory pathogen such as MERS CoV, SARS, Avian Influenza to healthcare providers. |

| 2 | Discuss the indication(s). |
|---|---|
| 2.1 | N95 respirator is the recommended respiratory protection when managing patient with suspected / confirmed respiratory pathogen. PAPR may be used when performing aerosolizing or invasive procedures. |

| 3 | Discuss the principles of infection control in managing patient on Full Precautions. |
|---|---|
| 3.1 | Do not bring any personal items including mobile phone into an isolation room. |
| 3.2 | Do not bring other items (e.g case notes) into isolation room. |
| 3.3 | Follow strict Airborne, Contact and Standard Precautions. |
| 3.4 | Always perform hand hygiene before touching your face, mouth, eye or mucous membrane. |

### SKILLS

| 1 | Prepare requisites as required. |
|---|---|
| 1.1 | 3M Versaflo TR300+ PAPR |
|   | • Battery |
|   | • Motor/blower unit |
|   | • Filter |
|   | • Airflow indicator tube |
|   | • Breathing tube |
|   | • S-855E hood suspension (headgear) & S-805E replacement hood |
|   | • Air-flow adjustment cover (blue cover) |
| 1.2 | Disposable sleeve cover |
| 1.3 | Twist tie x 2 |
| 1.4 | Shower cap x 1 |
| 1.5 | Gown x 1 |
| 1.6 | Gloves x 1 pair |

| 2 | Perform hand rub. |
|---|---|
| 2.1 | Rub hands together till dry. |

| 3 | Perform airflow check and low flow alarm check on PAPR. |
|---|---|
| 3.1 | Slot a fully charged battery into the blower unit (Battery LED 5 bars = 100%). |
| 3.2 | Ensure filter is properly installed into the blower unit. |
| 3.3 | Press the power button for 2 seconds then release to turn on the blower unit. |
|   | **Note:** Ensure air flow is maintained at 185 LPM. |
| 3.4 | Attach airflow indicator tube to the blower airflow outlet in an upright position. |
|   | **Note:** Ensure that the float ball is rested at/above the marking "E". |
| 3.5 | Remove the airflow indicator tube. |
| 3.6 | Perform occlusion test by covering the blower airflow outlet with own palm, making a tight seal. |
|   | **Note:** In 30 seconds or less, an audible alarm will be heard, followed by flashing red LED on low flow indicator. |
| 3.7 | Remove palm from blower outlet, turn off the blower unit. |
# Instructional Guide

**Donning of 3M TR 300+ Powered Air Purifying Respirator (PAPR) and Versaflo Hood with Tier 2 PPE for Patient on Full Precautions**

| Step | Action |
|------|--------|
| 4    | Assemble PAPR.  
| 4.1  | Adjust size of the S-855E head suspension (headgear).  
| 4.2  | Insert the S-855E head suspension (headgear) into the S-805 replacement hood. Ensure the sides of the hood are locked with the hood assembly.  
| 4.3  | Insert the breathing tube into the disposable sleeve cover. Secure both ends with twist ties.  
| 4.4  | Attach the air-flow adjustment cover (blue cover) onto the head suspension (headgear).  
| 4.5  | Twist the air-flow adjustment cover (blue cover) to ensure that the air vent on the head suspension (headgear) is activated.  
| 4.6  | Connect one end of the breathing tube to the head suspension (headgear).  
| 4.7  | Connect the other end of the breathing tube to the blower unit.  
| 4.8  | Place the assembled unit on a trolley or table top.  
| 5    | Perform hand rub.  
| 5.1  | Rub hands together till dry.  
| 6    | Put on shower cap.  
| 6.1  | Ensure that hair is tucked in.  
| 7    | Power ON the PAPR.  
| 7.1  | Press the power button for 2 seconds and release.  
| 7.2  | Adjust airflow to 205 LPM and air vent (if preferred).  
| 8    | Put on PAPR.  
| 8.1  | Buckle the waist belt with the blower unit around the waist.  
| 8.2  | Adjust belt accordingly.  
| 9    | Put on the hood assembly.  
| 9.1  | Put the hood over your face.  
| 9.2  | Use the mirror and fasten the hood ties on the both sides.  
| 10   | Put on gown.  
| 10.1 | Fasten the neck tie.  
| 10.2 | Ensure back of clothing is covered.  
| 10.3 | Pull the waist tie and tie at the back of gown. (*Do NOT tie dead knot*)  
| 11   | Put on gloves.  
| 11.1 | Use the correct size of gloves.  
| 11.2 | Pull the gloves OVER the cuff of the sleeves.  
| 12   | Check with Spotter or Mirror.  
| 12.1 | Check the hood is covering over the face.  
| 12.2 | Check gloves are OVER the cuff of the sleeves.  
| 12.3 | Check gown covers the back and PAPR.  
| 12.4 | *Note: Before entering the isolation room check that the pressure gauge is within the acceptable range (Minimal at -2.5 pa).*  

## ATTITUDE

| Step | Attitude |
|------|----------|
| 1    | Professionalism  
| 1.1  | Demonstrate responsible behaviour.  
| 2    | Safety  
| 2.1  | Adhere to infection control practices / safety precautions at all times.
# Instructional Guide

## Removal of 3M TR 300+ Powered Air Purifying Respirator (PAPR) and Versaflo Hood with Tier 2 PPE for Patient on Full Precautions

### KNOWLEDGE

| 1 | Discuss the purpose(s) of proper removal of 3M TR 300+ PAPR with Versaflo hood. | 1.1 | To prevent infection / transmission of patient with respiratory pathogen such as MERS CoV, SARS, Avian Influenza to healthcare providers. |
|---|---|---|---|
| 2 | Discuss the indication(s). | 2.1 | After contact with suspected / confirmed patient with respiratory pathogen such as MERS CoV, SARS, Avian Influenza. |
| 3 | Discuss the principles of infection control in managing patient on Full Precautions. | 3.1 | Follow strict Airborne, Contact and Standard Precautions. |
|   |   | 3.2 | Always perform hand hygiene before touching your face, mouth, eyes or mucous membrane. |

### SKILLS

#### Pre-doffing

1. Inform *Doffing partner* and circulating nurse.

2. **Doffing partner** to put on PPE and standby in the ante room.

   **Note:** If you are wearing spectacle, secure sides with adhesive tapes.

   | 2.1 | Put on correct N95 mask model and size. |
   | 2.2 | Put on visor mask. |
   |   | (a) Hook loop over ears (for ear loop visor) or fasten the upper tie followed by the lower tie (for visor with strap). |
   |   | (b) Ensure that the visor mask covers the N95 mask. |
   | 2.3 | Put on gown. |
   |   | (a) Fasten the neck tie. |
   |   | (b) Ensure back of clothing is covered. |
   |   | (c) Pull the waist tie and tie at the back of gown. *(Do NOT tie dead knot)* |
   | 2.4 | Put on gloves. |
   |   | (a) Use the correct size of gloves. |
   |   | (b) Pull the gloves OVER the cuff of the sleeve. |

3. Circulating nurse to prepare a container outside the ante room.

   | 3.1 | Remove the cover of container. |
   | 3.2 | Lay an impervious/blue sheet at the base of a container. |
   | 3.3 | Place the container on the trolley and park it outside the ante room. |

#### Inside the Patient’s Room

4. Remove gloves.

   | 4.1 | Grasp the glove with your opposite hand at wrist. |
   | 4.2 | Peel the glove downward by turning inside out. |
   | 4.3 | Hold the glove in the gloved hand. |
   | 4.4 | Slide the fingers of the ungloved hand under the remaining glove. |
   | 4.5 | Peel the glove downward by turning inside out. |
   | 4.6 | Throw into biohazard bin. |

5. Remove gown.

   | 5.1 | Unfasten the waist tie then the neck tie. |
   | 5.2 | Pull away from the neck and shoulder. |
   | 5.3 | Using the opposite hand, slide your hand through the sleeve touching **inside** of gown only, turning it inside out. |
### Instructional Guide

Removal of 3M TR 300+ Powered Air Purifying Respirator (PAPR) and Versaflo Hood with Tier 2 PPE for Patient on Full Precautions

| Step | Action |
|------|--------|
| 5    | Remove gown. 5.1 Repeat on the other hand. 5.5 Fold and roll the contaminated surface inward and downward. 5.6 Do not flip or shake the gown. 5.7 Throw into biohazard bin. |
| 6    | Perform hand hygiene. 6.1 Perform 7 steps of handwashing or handrub. |
| 7    | Proceed to the ante room. 7.1 Walk over to the ante room. |

**Inside the Ante Room**

| Step | Action |
|------|--------|
| 8    | Put on a pair of new gloves. 8.1 Use the correct size of gloves. |
| 9    | Wipe the face shield of the replacement hood. 9.1 Take one disinfectant wipe. 9.2 Wipe the face shield of the replacement hood in one single direction (S-flow). 9.3 Throw the disinfectant wipe into biohazard bin. |
| 10   | **Doffing partner** to assist in disconnecting PAPR. 10.1 Take the disinfectant wiper(s). 10.2 Unfasten hood ties at the sides. 10.3 Switch off the blower unit. 10.4 Open the disinfectant wipe. 10.5 Wipe the blower unit followed by the breathing tube sleeve and blue cover. 10.6 Throw the wipe into biohazard bin. 10.7 Release the twist ties from the breathing tube sleeve. 10.8 Hold on to the blue cover and disconnect the breathing tube from the hood assembly. 10.9 With one hand holding onto the breathing tube, pull the tube sleeve away from the breathing tube. 10.10 Throw the sleeve & twist ties into biohazard bin. |
| 11   | Remove PAPR. 11.2 **Doffing partner** supports the blower unit & breathing tube while staff unfasten the waist belt. 11.2 **Doffing partner** places the blower unit with breathing tube and blue cover into the container parked outside the ante room. |
| 12   | Remove hood assembly. 12.1 Tilt head forward. 12.2 Removes hood assembly by pulling from the top, in an upward direction away from the face. 12.3 **Doffing partner** receives the hood and detach the hood from the head suspension. 12.4 **Doffing partner** places the head suspension and hood in the container parked outside ante room. |
| 13   | Remove shower cap. 13.1 Pull from the top of the shower cap away from head. 13.2 Throw into biohazard bin. |
| 14   | Remove gloves. 14.1 Grasp the glove with your opposite hand at wrist. 14.2 Peel glove downward by turning inside out. 14.3 Hold the glove in the gloved hand. 14.4 Slide the fingers of the ungloved hand under the remaining glove. 14.5 Peel glove downward by turning inside out. 14.6 Throw into biohazard bin. |
### Instructional Guide

**Removal of 3M TR 300+ Powered Air Purifying Respirator (PAPR) and Versaflo Hood with Tier 2 PPE for Patient on Full Precautions**

| Step | Description |
|------|-------------|
| 15   | Perform handwash. (Perform 7 steps of handwashing). |
| 16   | Exit the ante room. (Exit from the ante room). |
| 17   | Remove adhesive tapes. (Remove adhesive tapes from the spectacle (if applicable).) |
| 18   | Bringing PAPR for decontamination. (Cover the container.) |
|      | Bring it to the designated room for decontamination. |
| 19   | **Doffing partner** to change gloves and assist the remaining member(s) to remove PAPR before proceeding to remove own PPE. |
| 20   | **Removal of PPE for Doffing partner.** |
| 20.1 | Remove gloves. |
|      | (a) Grasp the glove with your opposite hand at wrist. |
|      | (b) Peel the glove downward by turning inside out. |
|      | (c) Hold the glove in the gloved hand. |
|      | (d) Slide the fingers of the ungloved hand under the remaining glove. |
|      | (e) Peel the glove downward by turning inside out. |
|      | (f) Throw into the biohazard bin. |
| 20.2 | Remove visor mask followed by N95 mask. |
|      | **Visor Mask** |
|      | (a) Loosen the lower strap first followed by the upper strap. |
|      | (b) Remove mask by holding onto the upper strap away from face. |
|      | (c) Discard into biohazard bin. |
|      | **N95 Mask** |
|      | (a) Remove N95 mask in accordance to manufacturer's recommendation / hospital protocol. |
|      | (b) Discard into biohazard bin. |
| 20.3 | Remove gown. |
|      | (a) Untfasten the waist tie then the neck tie. |
|      | (b) Pull the gown away from the neck and shoulder. |
|      | (c) Using the opposite hand, slide your hand through the sleeve touching *inside* of gown only, turning it inside out. |
|      | (d) Repeat on the other hand. |
|      | (e) Fold and roll the contaminated surface inward and downward. |
|      | (f) Do not flip or shake the gown. |
|      | (g) Throw into biohazard bin. |
| 20.4 | Perform handwash. |
|      | (a) Perform 7 steps of handwashing. |
|      | (b) Use clean towel to switch off the water tape (for hand operated tap). |
|      | (c) Dry hands with clean towel. |
|      | (d) Discard all used towels into biohazard bin. |
| 20.5 | Exit from the ante room. |
| 20.6 | Remove adhesive tapes from the spectacle (if applicable). |
# Instructional Guide

## Removal of 3M TR 300+ Powered Air Purifying Respirator (PAPR) and Versaflo Hood with Tier 2 PPE for Patient on Full Precautions

### Attitude

|   |   |   |
|---|---|---|
| 1 | Professionalism | 1.1 | Demonstrate responsible behaviour. |
| 2 | Safety | 2.1 | Adhere to infection control practices / safety precautions at all times. |

### Instructional Guide

## Decontamination of 3M TR 300+ Powered Air Purifying Respirator (PAPR) with or without Versaflo Hood

### Knowledge

|   |   |   |
|---|---|---|
| 1 | Discuss the purpose(s) of proper decontamination of 3M TR 300+ PAPR. | 1.1 | To ensure the used PAPR is clean and safe for the next use. |
| 2 | Discuss the indication(s). | 2.1 | After every used. |
| 3 | Discuss the principles of infection control in managing PAPR decontamination. | 3.1 | It is the user’s responsibilities to decontaminate the PAPR after use. |
|   |   | 3.2 | Disinfection should ONLY be carried out in a designated decontamination room. |
|   |   | 3.3 | User to put on appropriate PPE such as gown, gloves and eye protection (visor mask, face shield or google). |
|   |   | 3.4 | Use disinfectant wipes for decontamination. |
|   |   | 3.5 | PAPR must be stored in a clean container at a designated storage area after disinfection. |

### Skills

|   |   |   |
|---|---|---|
| 1 | Prepare requisites as required. | 1.1 | Disinfectant wipes |
|   |   | 1.2 | Disposable cloth |
|   |   | 1.3 | Gloves |
|   |   | 1.4 | Gown |
|   |   | 1.5 | Visor Mask |
|   |   | 1.6 | Alcohol based hand rub |
|   |   | 1.7 | Clean container |
|   |   | 1.8 | Impervious/blue sheets |
| 2 | Push the trolley (with a container which contains used PAPR components) into a designated decontamination room. |   |
| 3 | Perform hand rub. | 3.1 | Rub hands together till dry. |
| 4 | Put on visor mask. | 4.1 | For visor mask with strap |
|   |   | Fasten the upper tie followed by the lower tie. *(Do NOT tie dead knot)* |
|   |   | 4.2 | For visor mask with ear loop |
|   |   | Hook loop over ears. |
| 5 | Put on gown. | 5.1 | Fasten the neck tie. |
|   |   | 5.2 | Ensure back of clothing is covered. |
|   |   | 5.3 | Pull the waist tie and tie at the back of gown. *(Do NOT tie dead knot)* |
| 6 | Put on gloves. | 6.1 | Use the correct size of gloves. |
|   |   | 6.2 | Pull the gloves OVER the cuff of the sleeve. |
### Instructional Guide

**Decontamination of 3M TR 300+ Powered Air Purifying Respirator (PAPR) with or without Versaflo Hood**

| Step | Task Description |
|------|------------------|
| 7    | Place impervious/blue sheet.  
**Purpose:** To place the PAPR components after wipe down with the disinfectant wipe. |
| 8    | Remove cover from container.  
| 8.1  | Remove cover from container and place on the lower shelf of trolley. |
| 9    | Clean the S-805E replacement hood. *(If any)*  
| 9.1  | Take out S-805E replacement hood from container and place it on the table top.  
| 9.2  | Open disinfectant wipe.  
| 9.3  | Wipe the replacement hood in one single direction.  
| 9.4  | Place the hood on the impervious/blue sheet and allow 10 minutes contact time.  
| 9.5  | Discard the disinfectant wipe into biohazard bin. |
| 10   | Clean S-855E head suspension (headgear).  
| 10.1 | Take out S-855E head suspension (headgear) from container and place it on the table top.  
| 10.2 | Open disinfectant wipe.  
| 10.3 | Wipe the hood assembly in one single direction.  
| 10.4 | Place the head suspension (headgear) on the impervious/blue sheet and allow 10 minutes contact time.  
| 10.5 | Discard the disinfectant wipe into biohazard bin. |
| 11   | Clean breathing tube and blue cover.  
| 11.1 | Disconnect the breathing tube and the blue cover from the blower unit.  
| 11.2 | Place them on the table top.  
| 11.3 | Open disinfectant wipe.  
| 11.4 | Wipe the exterior of the breathing tube in one single direction, fold the tube along the way.  
| 11.5 | Flip the wipe. Wipe the blue cover.  
| 11.6 | Place breathing tube and blue cover on the impervious/blue sheet and allow 10 minutes contact time.  
| 11.7 | Discard the used wipe into biohazard bin. |
| 12   | Clean battery pack, blower unit and waist belt.  
| 12.1 | Remove the battery pack.  
| 12.2 | Place the battery pack, blower unit and waist belt on the table top.  
| 12.3 | Open disinfectant wipe.  
| 12.4 | Wipe the battery pack in one single direction.  
| 12.5 | Place the battery pack on the impervious/blue sheet and allow 10 minutes contact time.  
| 12.6 | Wipe blower unit and waist belt in one single direction.  
**Note:** Do NOT allow disinfectant solution to enter into the unit.  
| 12.7 | Place the blower unit and waist belt on the impervious/blue sheet and allow 10 minutes contact time.  
| 12.8 | Discard the used wipe into biohazard bin. |
| 13   | Discard the used impervious/blue sheet from the container into biohazard bin. |
# Instructional Guide

Decontamination of 3M TR 300+ Powered Air Purifying Respirator (PAPR) with or without Versaflo Hood

| Step | Description |
|------|-------------|
| 14   | Remove gloves. |
| 14.1 | Grasp the inner glove with your opposite hand at wrist. |
| 14.2 | Peel the glove downward by turning inside out. |
| 14.3 | Hold the glove in the inner gloved hand. |
| 14.4 | Slide the fingers of the ungloved hand under the remaining inner glove. |
| 14.5 | Peel the glove downward by turning inside out. |
| 14.6 | Discard into biohazard bin. |
| 15   | Perform hand rub. |
| 15.1 | Rub hands together till dry. |
| 16   | Put on gloves. |
| 16.1 | Use the correct size of gloves. |
| 16.2 | Pull the gloves OVER the cuff of the sleeves. |
| 17   | Clean container and cover. |
| 17.1 | Open disinfectant wipe. |
| 17.2 | Wipe the inner and outer part of the container in S flow direction. |
| 17.3 | Place the cover on table top and wipe both surfaces in S flow direction. |
| 17.4 | Place the cover on top of the container. |
| 17.5 | Allow 10 minutes contact time for the container and cover. |
| 17.6 | Clean the used surface area of table top in S flow direction using the disinfectant wipe. |
| 17.7 | Discard the used wipe into biohazard bin. |
| 18   | Remove gloves. |
| 18.1 | Grasp the inner glove with your opposite hand at wrist. |
| 18.2 | Peel the glove downward by turning inside out. |
| 18.3 | Hold the glove in the inner gloved hand. |
| 18.4 | Slide the fingers of the ungloved hand under the remaining inner glove. |
| 18.5 | Peel the glove downward by turning inside out. |
| 18.6 | Discard into biohazard bin. |
| 19   | Remove visor mask. |
| 19.1 | For visor mask with strap |
| 19.1(i) | Loosen the lower strap first followed by the upper strap. |
| 19.1(ii) | Remove mask by holding onto the upper strap away from face. |
| 19.2 | For visor mask with ear loop |
| 19.2(i) | Grab the ear loops, remove from ears. |
| 19.2(ii) | Discard into biohazard bin. |
| 20   | Remove gown. |
| 20.1 | Unfasten the waist tie then the neck tie. |
| 20.2 | Pull away from the neck and shoulder. |
| 20.3 | Using the opposite hand, slide your hand through the sleeve touching inside of gown only, turning it inside out. |
| 20.4 | Repeat on the other hand. |
| 20.5 | Fold and roll the contaminated surface inward and downward. |
| 20.6 | Do not flip or shake the gown. |
| 20.7 | Discard into biohazard bin. |
# Instructional Guide

## Decontamination of 3M TR 300+ Powered Air Purifying Respirator (PAPR) with or without Versaflo Hood

|   |   |   |
|---|---|---|
| 21 | Perform handwash. | 21.1 Perform 7 steps of handwashing.  
21.2 Use towel to switch off the water tap (for hand operated tap).  
21.3 Dry hands with towel.  
21.4 Discard all towels in biohazard bin. |
| 22 | Put on gloves. | 22.1 Use the correct size of gloves. |
| 23 | Place impervious/blue sheet. | 23.1 Place an impervious/blue sheet on the other side (clean side) of the table top. |
| 24 | Re-wipe all cleaned components. | 24.1 Dampen a disposable cloth with water.  
24.2 Re-wipe all the components and place on the new impervious/blue sheet.  
**Purpose:** Re-wiping is to remove residue chlorine.  
24.3 Flip the cloth. Wipe the inner and outer part of the container and the cover.  
24.4 Place the container and cover on the trolley and allow to air dry.  
24.5 Wrap the disposable cloth with the used impervious/blue sheet.  
24.6 Discard into biohazard bin. |
| 25 | Remove gloves. | 25.1 Grasp the inner glove with your opposite hand at wrist.  
25.2 Peel the glove downward by turning inside out.  
25.3 Hold the glove in the inner gloved hand.  
25.4 Slide the fingers of the ungloved hand under the remaining inner glove.  
25.5 Peel the glove downward by turning inside out.  
25.6 Discard into biohazard bin. |
| 26 | Perform hand rub. | 26.1 Rub hands together till dry. |
| 27 | Dry all components. | 27.1 Allow to air dry before use or place them in a clean container for storage. |
| 28 | Pack equipment. | 28.1 Place all components in a clean container.  
28.2 Discard the used impervious/blue sheet into biohazard bin. |
| 29 | Return to storage. | 29.1 Return the container with the clean PAPR items to the designated storage area. |
| 30 | Clean trolley. | 30.1 Open alcohol wipe.  
30.2 Wipe the trolley in S flow direction for flat surfaces and single direction for other surfaces.  
30.3 Discard the alcohol wipe into biohazard bin. |
| 31 | Perform hand rub. | 31.1 Rub hands together till dry. |

## Attitude

|   |   |   |
|---|---|---|
| 1 | Professionalism. | 1.1 Demonstrate responsible behaviour. |
| 2 | Safety. | 2.1 Adhere to infection control practices / safety precautions at all times. |
APPENDIX 2
Pre-Pandemic (Pre-COVID-19) Respiratory Pathogen Training Scenario

Scenario

Biodata
Mr Chen, 75/Chinese/male, Singaporean
Past medical history
Diabetes mellitus
Hypertension
Heavy smoker
Ischaemic heart disease (ejection fraction 45% with SWMA)

History of present illness
Returns home to Singapore after a visit to his ancestral village in China
Left for China 14 days ago
Was symptomatic 7 days ago – had cough and sore throat
Flew home to Singapore last night
Unsure about exposure to birds and wild game
Complains of cough, shortness of breath and fever

In emergency department:
BP 180/70 mmHg
HR 100 bpm
SpO₂ 92% on FiO₂ 50% by Ventimask
H S1S2
L bilateral creps basally, occasional wheeze
JVP elevated
CXR: Bilateral basal infiltrates, cardiomegaly, upper lobe diversion
Troponin: 3,300 ng/L
BNP: 2,500 ng/L

Impression
1. Severe community-acquired pneumonia
2. Heart failure
3. Myocardial infarction

ED decides to admit the patient to High Dependency, under respiratory precautions in view of the respiratory deterioration.

Kindly carry on with treatment and management.
## Props needed

**Training venue:**
- Simulation centre
- Outbreak ICU

**Patient:**
- Patient mannequin (Laerdal)
- CVP mannequin
- Arterial line mannequin

**Bed:**
- ICU bed

**Hardware required:**
- Ultrasound machine
- Disposable laryngoscopes
- Videolaryngoscopes

**Consumables:**
- Ultrasound gel
- KY Jelly
- Drapes for CVC insertion
- Expired ETT
- Gum elastic bougie
- Expired CVC sets
- Expired IA line needles
- Handrubs, paper towels, antiseptic soap

**PPE:**
- PPE gowns
- N95 masks
- Gloves
- PAPR sets

## Scenario | Potential pitfalls
--- | ---
**Respiratory precautions** | Wear appropriate PPE, don and doff correctly
Wear PPE and PAPR for aerosol-generating procedures
Use double door anteroom – enter and exit appropriately as doors may not be interlocking

**Decision on NIV vs. mechanical ventilation** | Recognise that NIV may be a potential risk for aerosolisation of pathogen
Select MDI over nebuliser
Recognise need for mechanical ventilation

**Intubation** | Coordination before intubation
Nursing/medical/RT to wear PAPR for procedure

**Vascular lines: IA line, CVC insertion** | Cleaning and draping for CVC procedure
Usage of ultrasonography with appropriate draping and disinfection post procedure

**Specimen collection and dispatch** | Specimen collection
Specimen dispatch out of the patient room, in appropriate receptacle
Call lab before dispatch to lab

**Patient resuscitation** | Clamp ETT before changing ventilation over to Ambu bag
Avoid close contact with patient secretions

**Equipment decontamination** | Decontamination of PAPR after use
Decontamination of ultrasound machine after use
APPENDIX 3
Just-in-Time Training Scenario

Scenario

Biodata
Mr Chen, 75/Chinese/male, Singaporean
Past medical history
Diabetes mellitus
Hypertension
Heavy smoker
Ischaemic heart disease (ejection fraction 45% with SWMA)

History of present illness
Returns home to Singapore after a visit to his ancestral village in China
Left for China 14 days ago
Was symptomatic 7 days ago – had cough and sore throat
Flew home to Singapore last night
Unsure about exposure to birds and wild game
Complains of cough, shortness of breath and fever

In emergency department:
BP 180/70 mmHg
HR 100 bpm
SpO$_2$ 92% on Fi O$_2$ 50% by Ventimask
H S1 S2
L bilateral creps basally, occasional wheeze
JVP elevated
CXR: Bilateral basal infiltrates, cardiomegaly, upper lobe diversion
Troponin: 3,300 ng/L
BNP: 2,500 ng/L

Impression
1. Severe community-acquired pneumonia
2. Heart failure
3. Myocardial infarction

Instruction to trainee
This patient is now in your ICU.
Please proceed with intubation in view of patient’s impending deterioration.

Props needed
Training venue:
Simulation centre
Patient:
Patient mannequin (Laerdal)
Bed:
ICU bed
Hardware required:
Disposable laryngoscopes (C-MAC, Glidescope or MacGrath)
Videolaryngoscopes
Consumables:
KY Jelly
Expired ETT
ETT stylets
Gum elastic bougie
Handrubs, paper towels, antiseptic soap
PPE:
PPE gowns
N95 masks
Gloves
PAPR sets
| Scenario                  | Potential pitfalls                                                                                                                                 |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| Respiratory precautions  | Wear appropriate PPE, don and doff correctly  
Wear PPE and PAPR for aerosol-generating procedures  
Use double door anteroom – enter and exit appropriately as doors may not be interlocking |
| Intubation               | Coordination before intubation  
Nursing/medical/RT to wear PAPR for procedure  
Communication during procedure  
Test out ability to use unfamiliar laryngoscopy devices |
| Equipment decontamination| Decontamination of PAPR after use |
| Cardiopulmonary resuscitation | Avoid contact with contaminated surfaces  
Stand on step stool to apply chest compressions |

**APPENDIX 4**

**Scenario Training During Outbreak**

**Scenario**

**Biodata**
- Mr Chen, 75/Chinese/male, Singaporean
- Past medical history
  - Diabetes mellitus
  - Hypertension
  - Heavy smoker
  - Ischaemic heart disease (ejection fraction 45% with SWMA)
- History of present illness
  - Returns home to Singapore after a visit to his ancestral village in China
  - Left for China 14 days ago
  - Was symptomatic 7 days ago – had cough and sore throat
  - Flew home to Singapore last night
  - Unsure about exposure to birds and wild game
  - Complains of cough, shortness of breath and fever
- In emergency department:
  - BP 180/70 mmHg
  - HR 100 bpm
  - SpO₂ 92% on FiO₂ 50% by Ventimask
  - H S1S2
  - L bilateral creps basally, occasional wheeze
  - JVP elevated
  - CXR: bilateral basal infiltrates, cardiomegaly, upper lobe diversion
  - Troponin: 3,300 ng/L
  - BNP: 2,500 ng/L
- Impression
  1. Severe community-acquired pneumonia
  2. Heart failure
  3. Myocardial infarction
- ED decides to admit the patient to High Dependency, under respiratory precautions in view of the respiratory deterioration.
- Kindly carry on with treatment and management.
**Props needed**

**Training venue:**
- Simulation centre
- Outbreak ICU

**Patient:**
- Patient mannequin (Laerdal)
- CVP mannequin
- Arterial line mannequin

**Bed:**
- ICU bed

**Hardware required:**
- Ultrasound machine
- Disposable laryngoscopes
- Videolaryngoscopes

**Consumables:**
- Ultrasound gel
- KY Jelly
- Drapes for CVC insertion
- Expired ETT
- Gum elastic bougie
- Expired CVC sets
- Expired IA line needles
- Handrubs, paper towels, antiseptic soap

**PPE:**
- PPE gowns
- N95 masks
- Gloves
- PAPR sets
| Scenario                          | Potential pitfalls                                                                                   |
|----------------------------------|------------------------------------------------------------------------------------------------------|
| Respiratory precautions          | Wear appropriate PPE, don and doff correctly                                                         |
|                                  | Wear PPE and PAPR for aerosol-generating procedures                                                  |
|                                  | Use double door anteroom – enter and exit appropriately as doors may not be interlocking            |
| Decision on NIV vs. mechanical   | Recognise that NIV may be a potential risk for aerosolisation of pathogen                            |
| ventilation                      | Select MDI via spacer over nebuliser                                                                  |
|                                  | Recognise need for mechanical ventilation                                                            |
| Intubation                       | Coordination before intubation                                                                      |
|                                  | Nursing/medical/RT to wear PAPR for procedure                                                        |
|                                  | Maintain good seal with bag mask resuscitator                                                       |
|                                  | Use of heat moisture exchanger (HME) filter on Ambu bag and PEEP valve during preoxygenation         |
| Suctioning                       | Utilise in-line suction device for suctioning once patient has been intubated                       |
| Vascular lines: IA line, CVC     | Consider doffing of contaminated gown and gloves before proceeding to anteroom to don sterile gown over PAPR |
| insertion                        | Cleaning and draping for CVC procedure                                                               |
|                                  | Usage of ultrasonography with appropriate draping and disinfection post procedure                    |
| PAPR failure/distress            | PAPR failure may occur periodically                                                                  |
|                                  | Staff to use hand signal to indicate PAPR failure                                                    |
|                                  | Colleagues outside room to anticipate distress and prepare to expedite doffing PAPR                 |
| Specimen collection and dispatch | Specimen collection                                                                                  |
|                                  | Specimen dispatch out of the patient room, in appropriate receptacle                                  |
|                                  | Call lab before dispatch to the lab                                                                  |
| Patient resuscitation            | Clamp ETT before changing ventilation over to Ambu bag                                                |
|                                  | Avoid close contact with patient secretions                                                          |
| Equipment decontamination        | Decontamination of PAPR after use                                                                    |
|                                  | Decontamination of ultrasound machine after use                                                      |
| Avoidance of secretion aerosolisation | Prior to opening the circuit, e.g., when changing the ventilator, the endotracheal tube should be clamped and the ventilator placed on standby to avoid aerosolisation |
| Patient transport                | Activate security to facilitate transfer and clear transport route                                     |
|                                  | Ensure destination is ready to receive patient                                                        |