RAEB Research, Analysis & Evaluation Branch
Evidence to Action

Ontario

EVIDENCE SYNTHESIS BRIEFING NOTE

TOPIC: TRANSPORTING COVID-19 PATIENTS ON NON-INVASIVE VENTILATION SUPPORT VIA EMERGENCY MEDICAL SERVICE UNITS

Information finalized as of March 4, 2021.[a] This Briefing Note was completed by the Evidence Synthesis Unit (Research, Analysis and Evaluation Branch, Ministry of Health) in collaboration with a member of the COVID-19 Evidence Synthesis Network. Please refer to the Methods section for further information.

Purpose: To summarize the evidence on whether it is safe to transport suspected or confirmed COVID-19 patients who require non-invasive ventilation (NIV) support via standardly equipped emergency medical services (EMS) units.

Key Findings: Limited information was identified on land ambulances. Information on air ambulances was included, but it is unclear if all these findings can be applied to land ambulances.

- Due to lack of information on patient infection status and limited resources and space, the risk of COVID-19 transmission in land/air ambulances is potentially higher than for other health care providers. As well, many medical interventions increase the risk of virus transmission, including aerosol-generating procedures (AGPs) such as NIV.
- According to the majority of scientific evidence and jurisdictional guidance, AGPs in ambulances should be avoided unless absolutely necessary. To protect against contact, droplet, and airborne transmission, caution should be exercised if AGPs are undertaken by using appropriate:
  - **Distancing** (e.g., initial assessments beginning from a distance of at least two metres from the patient).
  - **Personal protective equipment** (e.g., N95 masks, gowns, filters in ventilatory equipment to filter expired air).
  - **Barriers** (e.g., screens, curtains, separate compartments for drivers and patients).
  - **Patient Isolation Units** (PIUs: e.g., Swiss Air Rescue PIU, EpiShuttle® from Norway, Trexler Air Transport Isolator from the United Kingdom). For example:
    - Many European countries transport COVID-19 patients, who are spontaneously breathing or ventilated, in PIUs on both land and air ambulances, but there are mixed findings on the efficacy and safety of their use. PIUs are equipped with different ports (e.g., ventilator, wire) and a ventilation system that can generate negative or positive pressure. PIUs are beneficial because additional decontamination between transports is not required, patients can be easily transferred to/from land/airplane/helicopter ambulances, and all teams involved in transporting patients are effectively protected. However, PIUs are expensive, may require reconfiguration of existing ambulance layouts, and have limitations such as patient access and restraint.
    - Other innovative approaches include portable and reusable aerosol shields and helmets that cover patients' faces and provide protection from virus transmission. These devices contain oxygen ports, thus allowing NIV.
  - **Decontamination** of all exposed surfaces, equipment, and contact areas upon arrival at the final destination (e.g., chlorine-based cleaning products, leaving the rear doors of the ambulance open to promote air circulation).
- For example, Southern California designed six high-risk ambulances (HRAs) that were easy to decontaminate (e.g., HEPA filtration/UV light disinfection), had separate AC systems for the isolated driver and patient compartments, and achieved negative-pressure status for the treatment area. The HRAs have been used to transport passengers at high-risk of having COVID-19, and their use for confirmed COVID-19 patients is anticipated. While jurisdictions may choose not to build dedicated HRAs, the innovations implemented for this project should be considered when purchasing new ambulances for regular use.

Implementation Implications: Extreme caution is recommended if the decision is made to use NIV on suspected or confirmed COVID-19 patients in ambulances. Contact, droplet, and airborne precautions are required in an effort to minimize infection transmission. Clear standard operating procedures and routine scenario-based training of EMS providers can help reduce some of the risks.

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[a] This briefing note includes current available evidence as of the noted date. It is not intended to be an exhaustive analysis, and other relevant findings may have been reported since completion.

Context and Terminology

Emergency medical services (EMS) play a vital role in responding to requests for assistance, triaging patients, and providing emergency medical treatment and transport for ill persons, including suspected or confirmed COVID-19 patients. However, unlike patient care in the controlled environment of a health care facility, care and transports by EMS present unique challenges because of the nature of the setting, proximity to patients in an enclosed space during transport, limited airflow, limited information about their patients, frequent need for rapid medical decision-making, and a varying range of patient acuity and jurisdictional health care resources. EMS also face significant risk of virus transmission during aerosol-generating procedures (AGPs), such as airway management and non-invasive ventilation (NIV).[1,2,3,4,5,6,7,8] For example, a US study reported that EMS personnel are at a higher risk of dying from COVID-19 than other health care or emergency services professionals. The study estimated the number of EMS personnel COVID-19-related deaths is about three times higher than nurses and about five times higher than physicians.[9]

- NIV refers to the administration of mechanical ventilation without using an invasive artificial airway (e.g., endotracheal or tracheostomy tube). NIV may be delivered by means of positive-pressure and negative-pressure techniques: with the former, positive pressure is applied to the airway to inflate the lungs directly (e.g., bilevel and continuous positive airway pressure [BiPAP and CPAP], respectively), while with the latter, negative pressure is applied externally to the abdomen and thorax to draw air into the lungs through the upper airway.[10]

Supporting Evidence

Table 1 lists and describes scientific evidence and jurisdictional guidance on the safety and procedures for transporting suspected or confirmed COVID-19 patients who require NIV support via standardly equipped EMS units. In the Appendix, Table 2 and Table 3 provide detailed summaries of scientific evidence and Canadian/international guidance, respectively, on this topic. The majority of the information presented is taken directly from the identified sources.

- Limited information was identified on land ambulances. Information on air ambulances was included, but it is unclear if these findings can be applied to land ambulances.
- The majority of the information contains clinical guidance and/or recommendations; these recommendations are those of the authors of the original sources and the Research, Analysis, and Evaluation Branch does not have the expertise to evaluate such recommendations.
- The methodological quality of most of the sources identified are unclear as they have not been assessed.

Table 1: Summary of Scientific Evidence and Jurisdictional Guidance on Transporting Suspected or Confirmed COVID-19 Patients Who Require Non-Invasive Ventilation (NIV) Support Via Emergency Medical Services (EMS) Units

Scientific Evidence	**Land Ambulance** • **Aerosol Shield**: A Japanese study (Nov 19, 2020) described the design of a portable, reusable aerosol shield to cover the face of a patient during stretcher transport for ambulatory care (image). It is made of transparent vinyl chloride, and has four arm ports, one suction port to continuously maintain negative pressure inside the shield, six injection and oxygen ports, and the top of the shield is sloped ~20° to increase visibility. Intubation devices must be prepared inside the shield before the suction tube is placed through the side port.

	◦ Ten different emergency medical technicians tested the device during a routine training course on an adult-sized mannequin for tracheal intubation with video laryngoscopy, insertion of a laryngeal tube, and manual ventilation using a bag-valve mask. The intubation success rate was 100% for all trials. Data indicate that the shield may reduce the risk of viral contamination imparted by AGPs during emergency medical transport, although some aerosol leak may still occur.[11] **<u>Air Ambulance</u>** • **Guidelines**: Limited guidance is available, but NIV is generally permitted if appropriate precautions are undertaken (e.g., PPE, training).[12,13,14,15] For example: ◦ A Canadian study (June 24, 2020) highlighted Quebec Aeromedical Evacuation Services' practical considerations for aeromedical transfers of confirmed or suspected COVID-19 patients: 1) pre-emptive endotracheal intubation is recommended for patients with the potential of respiratory decompensation during transport, regardless of COVID-19 status, to reduce NIV which is linked to increased transmission of infection; 2) prone position COVID-19 patients with acute respiratory distress syndrome; 3) transmit instructions before transports/transfers so local teams can adequately prepare the patient; 4) expect longer transfer times due to increased complexity of patient preparation, PPE, and decontamination processes; and 5) limit cross-contamination of the crew (e.g., masks, hot/cold zones).[16] ◦ The US Air Medical Physician Association's position statement (Apr 3, 2020) supports the World Health Organization's recommendation to employ standard, contact, and airborne precautions when caring for and transporting patients with suspected or confirmed COVID-19 infection who are undergoing AGPs, such as NIV. They recommend the use of a certified bacterial and viral filter in the ventilator circuit of NIV patients.[17] • **Airflow Characteristics**: An Australian study (Nov 2, 2020) found that physical barriers between the cockpit and the cabin provide a degree of protection for non-clinical aircrew. Ventilation system settings can be used to generate airflow from the cockpit into the cabin to reduce cabin air entering the cockpit. Optimal positioning of the patient is on the aft or laterally orientated stretcher, depending on the type of aircraft. The disciplined use of PPE also enhances safety measures.[18] • **Patient Isolation Units (PIUs)**: Mixed findings were identified on the efficacy and safety of using PIUs to transport patients in air ambulances. ◦ A review (May 14, 2020) described different methods used by several European organizations for transporting patients in open and closed PIU systems by helicopter and fixed-wing air ambulance during the COVID-19 pandemic.[b] Small, closed PIUs may be especially beneficial for the air transport of intubated/non-intubated COVID-19 patients because: patients can be airlifted faster; additional decontamination between transports is not required; patients can be easily transferred from an airplane to a land

[b] There are two types of PIUs. Open transport systems (e.g., Containerized Biological Containment System from the US) provide a portable isolation facility large enough for direct patient management with the medical crew wearing PPE (e.g., FFP2/3 mask, goggles or face shield, gloves, protective gown) throughout the transport. Closed air transport isolator systems (e.g., EpiShuttle® from Norway, Stretcher-Air Transport Isolators [S-ATI] and the larger Trexler Air Transport Isolator [T-ATI] from the UK, and the Swiss Air Rescue [Rega]) were originally developed for the transport of patients with other highly contagious diseases (e.g., viral hemorrhagic fever) (Albrecht et al., May 14, 2020).

ambulance or rescue helicopter, or vice versa; and all teams involved in transporting patients can be effectively protected.
    - For example, Swiss Air Rescue (Rega) developed and patented its own small PIU, which allows spontaneously breathing or mechanically ventilated patients to be transported (image).[19,c] As of May 2020, the Rega fixed-wing air ambulance successfully transferred 13 confirmed COVID-19 patients, two of which were ventilated, in the PIU. All transports were well-tolerated, although in some cases mild sedation was necessary. Six ventilated COVID-19 patients were also transported without the PIU. As of May 2020, the Rega helicopter transported 83 seriously ill COVID-19 patients: 37 patients were spontaneously breathing, and 46 were intubated and ventilated predominantly in intermittent positive pressure ventilation mode.[20]
  - A German study (Nov 24, 2020) found that the air ambulance transport of 13 patients with proven or suspected COVID-19 disease in a portable PIU, with the medical team on the outside delivering care through portholes, was a feasible option even over long distances (image). The main limitations of transports are limited access to the patient, reduced manual dexterity when delivering care through the porthole gloves, and disconnection of lines and tubes during loading/unloading procedures. An individualized risk-benefit analysis should be conducted for each patient prior to transport.[21]
  - A research article (Jul 31, 2020) concluded that there was little advantage to be gained in moving patients with COVID-19 in isolation pods during aeromedical transfers. Patients are best managed in a sitting position, with supplementary oxygen if required, or on stretchers for those who can be best managed lying down. Ventilated patients should have a high-efficiency particulate air filter in the ventilation circuit and filtering face-piece 3 (FFP3)[d] masks should be worn during AGPs (e.g., intubation, CPAP/BiPAP). In particular:
    - The Norwegian Air Ambulance Service reported mixed results from using PIUs. Some patients who may have been managed best in a sitting position were required to lay flat or semi-recumbent, and this had potentially compromised oxygen perfusion.
    - The United Kingdom Royal Air Force and Australian Defence Force experts emphasized the difficulty in managing ventilated patients in isolation pods and believed that the risks imposed outweighed any benefit.[22]
- **Helmet-Based NIV**: A US study (Nov 23, 2020) reported that helmet-based NIV in air medical transport is a viable option for the safe transport of potential or unknown COVID-19 patients who present with hypoxemia and mild-to-moderate respiratory distress without any current or anticipated airway compromise or altered mental status. Patients who require supplemental oxygen at rates greater than six L/min, high flow nasal cannula, or CPAP/BiPAP are good candidates for this device (image).[e]

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[c] Rega's PIU comprises a flexible safety hull stabilized by arched wires mounted on a hard floor plate. It is maintained under negative pressure by a high-efficiency particulate air filtered ventilation system that uses aircraft power and/or rechargeable battery power. The barrier performance has proven equal to that provided by protective clothing (Hilbert-Carius et al., Sept 22, 2020).

[d] FFP3s are the highest of three FFP filtering grades, with a minimum filtration percentage of 99% of 0.3 µm particles (Li et al, 2020).

[e] The helmet is a sealed and closed space that completely isolates the patient's airway and breathing, thus providing protection from exposure to pathogens transmitted through droplets or aerosols. The helmet can be used in conjunction with a high-flow

	○ The study reported on the experience of the first 10 uses of the device (nine times for an interfacility transport and once on a scene response): five patients were confirmed with COVID-19, three were suspected to have COVID-19, and two patients were considered low-risk. All patients were transported in the helmet without incident or complication, and none of the patients deteriorated during transport or required endotracheal intubation. In two instances, the neck seal was damaged during the initial application of the helmet and required a replacement. There were no cases of the neck seal failing during transport.[23] **Land vs. Air Ambulance** • A European study (Sept 22, 2020) found that the safe care and transport of 385 suspected or confirmed COVID-19 patients in PIUs, including 119 primary and 266 interfacility transport missions, was achievable across six different European ambulance services. Most patients transferred after on-scene calls were transported by ground ambulance, and these patients tended to be less sick than patients being transferred from one facility to another. Air transport (e.g., fixed-wing aircrafts) was the preferred method for patients who needed significantly more mission-related interventions and interfacility transport. NIV was used significantly more often in primary missions.[24]
International Scan	• Guidance from the US (Centers for Disease Control and Prevention, Federal Healthcare Resilience Task Force, Arizona, California, Illinois, and New Hampshire), England, Luxembourg, and Australia suggest exercising caution if AGPs are absolutely necessary by using appropriate PPE (e.g., N95 masks, viral filters between masks and oxygen delivery ports to filter expired air) and infection prevention and control procedures (e.g., decontamination, opened rear doors of ambulance to promote air circulation) in land or air ambulances.[25,26,27,28,29,30,31,32,33] For example: ○ Public Health England's guidance (updated Jan 29, 2021) for ambulance services lists NIV as a medical procedure for COVID-19 that is aerosol-generating and associated with an increased risk of respiratory transmission. Respirators, disposable gloves, coveralls, and eye/face protection should be used. Patients should wear a surgical mask, providing it does not compromise their clinical care, such as when receiving oxygen therapy. Vehicles used for AGP procedures will require enhanced decontamination of all exposed surfaces, equipment, and contact areas with a chlorine-based product (or approved equivalent) before it is returned to normal operational duties.[34] • California and Luxembourg adapted innovative approaches previously used to manage Ebola patients to transport suspected or confirmed COVID-19 patients: ○ Southern California designed six high-risk ambulances (HRAs) that were easy to decontaminate (e.g., HEPA filtration/UV light disinfection), had separate AC systems for the isolated driver and patient compartments, and achieved negative-pressure status for the treatment area (image). The HRAs have been used to transport passengers at high-risk of having COVID-19, and their use for confirmed COVID-19 patients is anticipated. While jurisdictions may choose not to build dedicated HRAs, the innovations

oxygen delivery device or a ventilator capable of NIV with leak compensation. Helmet NIV can require significant oxygen flows, and the available amount of oxygen on board the aircraft and transport distances are critical factors that must be considered when evaluating the feasibility of implementation of the device. Contraindications to the use of helmet-based NIV include altered level of consciousness, altered mental status, agitation, airway bleeding, nausea/vomiting, copious secretions or inability to safely clear secretions, respiratory failure, or immediate need for endotracheal intubation (Beckl, Nov 23, 2020).

	implemented for this project should be considered when purchasing new ambulances for regular use.[35] ○ In Luxembourg, European Air Ambulance uses an Infectious Disease Unit (IDU) or IsoPod (image). An IDU is a tent-like module originally designed for the safe transport of Ebola patients that has been adapted for COVID-19. It provides the patient space to move around, and allows for non-intensive treatment while still being completely isolated from the surroundings. An IsoPod is a smaller individual barrier-type unit, suited to patients not needing treatment, but which protects the medical team from infection. Due to restricted size inside, the IsoPod is not suitable for obese patients or patients who suffer from anxiety or claustrophobia.[36]
Canadian Scan	• The British Columbia Centre for Disease Control's Interim Guidance (Mar 19, 2020) for the British Columbia Emergency Health Services (BCEHS) Critical Care Transport program, an air medical provider, suggests avoiding AGPs (e.g., CPAP), but airborne precautions should be initiated if it is required. If high concentration oxygen and/or positive pressure ventilation are required, the appropriate oxygen delivery system should be filtered with an antimicrobial, hydrophobic filter.[37] As of May 2020, BCEHS is investigating the use of powered air-purifying respirators and PIUs.[38] • Ambulance New Brunswick's guidelines (Mar 27, 2020) for paramedics notes that an N95 respirator is required when performing AGPs on a person under investigation for COVID-19, including NIV.[39]
Ontario Scan	• Public Health Ontario's evidence brief (Mar 29, 2020) on infection prevention and control for first-responders providing direct care for suspected or confirmed COVID-19 patients summarizes that droplet, contact, and airborne precautions (e.g., N95 respirators) should be used for AGPs, including NIV. This is consistent with guidance from the Public Health Agency of Canada and World Health Organization.[40] • The Ministry of Health's training bulletin (Oct 1, 2020) provides background information on COVID-19, current infection control guidelines, and links to resources. For oxygen administration for patients with symptoms of respiratory infection, the patient should wear: 1) a surgical mask, if tolerated, with a nasal cannula if low concentration oxygen is required; and 2) low flow/high concentration oxygen mask outfitted with a hydrophobic submicron filter if high concentration oxygen is required. Following every transport of a confirmed or probable case and/or the patient's environment, paramedics must decontaminate the vehicle/aircraft, stretcher, and any reusable patient care equipment utilized during the call using a hospital-grade disinfectant in accordance with local Paramedic Service policies.[41] • A study (May 13, 2020) discussed Ornge's approach to preparing for the COVID-19 pandemic. As of April 30, 2020, Ornge organized transport for and/or transported 325 patients with either a confirmed case of or under investigation for COVID-19. A total of 52.3% of these were completed by critical care land ambulances, 28.9% were completed by fixed wing aircraft, and 16.6% were completed by rotary wing aircraft. ○ Ornge preferentially transports COVID patients using the critical care land ambulances, which are capable of 24 air changes per hour and the front driver's compartment is separate from the patient compartment. ○ Ornge has temporarily halted the use of NIV. The study noted that there is emerging evidence to support the use of NIV to prevent mechanical ventilation in COVID-19 patients. However, there is substantial fear among health care workers about the increased risk of infection transmission from using these procedures. In cases where air

	transport is required because of geography, Ornge will require these patients to be mechanically ventilated. Ornge will be participating in engineering research trials looking at the risk of droplet and aerosol dispersion using NIV in airframes based on their airflow dynamics. ○ See the study for further details about Ornge's screening, PPE, decontamination, and surge capacity approaches.[42]

Methods

The COVID-19 Evidence Synthesis Network is comprised of groups specializing in evidence synthesis and knowledge translation. The group has committed to provide their expertise to provide high-quality, relevant, and timely synthesized research evidence about COVID-19 to inform decision makers as the pandemic continues. The following member of the Network provided evidence synthesis products that were used to develop this Evidence Synthesis Briefing Note:

- Ontario Health (Cancer Care Ontario). (February 22, 2021). Safety of transporting COVID-19+ or Suspected positive patients by air (for HCPs).
- Ontario Health (Cancer Care Ontario). (February 23, 2021). Safety of transporting COVID-19+ or Suspected positive patients by ambulance (land and air) (for HCPs).

For more information, please contact the Research, Analysis and Evaluation Branch (Ministry of Health).

Appendix

Table 2: Summary of Scientific Evidence on Transporting Suspected or Confirmed COVID-19 Patients Who Require Non-Invasive Ventilation (NIV) Support Via Emergency Medical Services (EMS) Units

Study Type/Jurisdiction	Description of Findings
Land Ambulances	
Study (Japan) – Aerosol Shield	• This study (Nov 19, 2020) described the design of a portable aerosol shield for ambulatory care (image). It is made of transparent vinyl chloride and can securely cover the face of a patient during stretcher transport to minimize viral transmission. It has four arm ports (two in the front, and one on each side), one suction port to continuously maintain negative pressure inside the shield, six injection/oxygen ports, and the top of the shield is sloped ~20° to increase visibility. Intubation devices must be prepared inside the shield before the suction tube is placed through the side port. The device is reusable after disinfection with hypochlorite and ethanol. ○ Ten different EMTs tested the device during a routine training course on an adult-sized manikin for tracheal intubation with video laryngoscopy, insertion of a laryngeal tube, and manual ventilation using a bag-valve mask. The intubation success rate was 100% for all trials. Data indicate that the shield may reduce the risk of viral contamination imparted by AGPs during emergency medical transport, although some aerosol leak may still occur.[43]
Air Ambulances	
Study (Quebec) - Guidelines	• This Canadian study (June 24, 2020) highlighted Quebec Aeromedical Evacuation Services' practical considerations for aeromedical transfers of confirmed or suspected COVID-19 patients: 1) pre-emptive endotracheal intubation is recommended for patients with the potential of respiratory decompensation during transport, regardless of COVID-19 status, to reduce NIV which is linked to increased transmission of infection; 2) prone position COVID-19 patients with acute respiratory distress syndrome; 3) transmit instructions before transports/transfers so local teams can adequately prepare the patient; 4) expect longer transfer times due to increased complexity of patient preparation, PPE, and decontamination processes; and 5) limit cross-contamination of the crew (e.g., masks, hot/cold zones).[44]
Survey (US) – Guidelines	• **Objective**: Limited information exists regarding the response of helicopter emergency medical services (HEMS) programs to patients with known or suspected coronavirus disease 2019 (COVID-19). The purpose of this study was to determine changes in flight operations during the early stages of the pandemic. • **Methods**: A survey of the American College of Emergency Physicians Air Medical Section was conducted between May 13, 2020, and August 1, 2020. COVID-19 prevalence was defined as high versus low based on cases > 2,500 or ≤ 2,500. • **Results**: Of the 48 respondents, the majority (89.6%) reported that their patient guidelines had changed because of COVID-19; 89.6% of programs reported transporting COVID-19–positive patients, whereas 91.5% reported transporting persons under investigation. The majority of respondents reported additional training in COVID-19 airway management (79.2%) and PPE use (93.6%). Permitted aerosol-generating procedures included bilevel positive airway pressure (40.4%) and high-flow nasal oxygen (66.0%). No difference in guideline changes, positive COVID-19/persons under investigation transport restrictions, or permitted aerosol-generating procedures were noted between high- and low-prevalence settings. • **Conclusion**: COVID-19 has resulted in changes to HEMS guidelines regardless of local disease prevalence. The pandemic has persisted sufficiently long that data regarding the effectiveness of guideline changes should be analyzed. In the absence of definitive data, national best practices should be developed to guide COVID-19 HEMS transport.[45]
Study (India) – Guidelines	• This article (Aug 17, 2020) noted that no guidelines are available for the safe transport for aeromedical evacuation of patients with COVID-19. The spread of infection to health care workers during aeromedical evacuation is a possibility and related to duration of exposure, infectivity of the

	disease, susceptibility to the exposed person, load of infective material, the airflow system in an enclosed cabin, and aerosols generated during mechanical ventilation.[46]
Study (US) – Guidelines	• The Air Medical Physician Association's position statement (Apr 3, 2020) supports the World Health Organization recommendation to employ standard, contact, and airborne precautions when caring for and transporting patients with suspected or confirmed COVID-19 infection who are undergoing AGPs, such as nebulization, mask oxygenation, high-flow nasal cannula oxygenation, non-invasive positive pressure ventilation, endotracheal intubation, bag valve mask ventilation, cricothyrotomy, tracheostomy, and cardiopulmonary resuscitation. They also recommend the use of a certified bacterial and viral filter in the ventilator circuit of manually/mechanically/NIV ventilated patients, and recommend airborne precautions during transport to safeguard against unanticipated AGPs.[47]
Study (Australia) – Airflow Characteristics	• **Objective**: The aeromedical transport of coronavirus patients presents risks to clinicians and aircrew. Patient positioning and physical barriers may provide additional protection during flight. This paper describes airflow testing undertaken on fixed wing and rotary wing aeromedical aircraft. • **Methods**: Airflow testing was undertaken on a stationary Hawker Beechcraft B200C and Leonardo Augusta Westland 139. Airflow was simulated using a Trainer 101 (MSS Professional A/S, Odense Sø, Syddanmark, Denmark) Smoke machine. Different cabin configurations were used along with variations in heating, cooling, and ventilation systems. • **Results**: For the Hawker Beechcraft B200C, smoke generated within the forward section of the cabin was observed to fill the cabin to a fluid boundary located in-line with the forward edge of the cargo door. With the curtain closed, smoke was only observed to enter the cockpit in very small quantities. For the Leonardo AW139, smoke generated within the cabin was observed to expand to fill the cabin evenly before dissipating. With the curtain closed, smoke was observed to enter the cockpit only in small quantities. The disciplined use of PPE also enhances safety measures. • **Conclusion**: The use of physical barriers in fixed wing and rotary wing aeromedical aircraft provides some protection to aircrew. Optimal positioning of the patient is on the aft stretcher on the Beechcraft B200C and on a laterally orientated stretcher on the AW139. The results provide a baseline for further investigation into methods to protect aircrew during the coronavirus pandemic.[48]

Review – Patient Isolation Units (PIUs)	• This review (May 14, 2020) described different methods used by several European organizations in transporting patients by helicopter and fixed-wing air ambulance during the COVID-19 pandemic. There are two types of air rescue systems for the secondary transport of COVID-19 patients:
	  ○ Open: These transport systems provide a portable isolation facility large enough for direct patient management with the medical crew wearing PPE (e.g., FFP2/3 mask, goggles or face shield, gloves, protective gown) throughout the transport. For example, there is the Containerized Biological Containment System from the US.
	  ○ Closed: These air transport isolator systems were originally developed for the transport of patients with other highly contagious diseases (e.g., viral hemorrhagic fever), and include: 1) closed patient isolation units that separate the patient from the medical crew (e.g., EpiShuttle® from Norway); and 2) Stretcher-Air Transport Isolators (S-ATI) and the larger Trexler Air Transport Isolator (T-ATI from the UK) and the Swiss Air Rescue (Rega) patient isolation unit.
	  ○ The review summarized that the use of small, closed patient isolation units may be beneficial for the aeromedical transport of non-intubated or intubated COVID-19 patients because: patients can be airlifted faster so additional decontamination between transports is not required; patients can be easily transferred from an airplane to a land ambulance or rescue helicopter, or vice versa; and all teams involved in transporting patients can be effectively protected. For example:
	    • Rega developed and patented its own small patient isolation unit, which allows spontaneously breathing or mechanically ventilated patients to be transported in pressurized jet cabins, small helicopters, and ground-based ambulances, without the need to change between transport units. It comprises a flexible safety hull stabilized by arched wires mounted on a hard floor plate. It is maintained under negative pressure by a high-efficiency particulate air filtered ventilation system that uses aircraft power and/or rechargeable battery power (image).

	○ As of May 2020, the Rega fixed-wing air ambulance successfully transferred 13 confirmed COVID-19 patients, two of which were ventilated, in the patient isolation unit. All transports were well-tolerated, although in some cases mild sedation was necessary. Six ventilated COVID-19 patients were also transported without the patient isolation unit. ○ As of May 2020, the Rega helicopter transported 83 seriously ill COVID-19 patients: 37 patients were spontaneously breathing, and 46 were intubated and ventilated predominantly in intermittent positive pressure ventilation mode.[49] • EpiShuttle® is a reusable single-patient isolation and transport system that can be used in ambulances, helicopters, and airplanes (image). During transport, the medical crew does not need to wear full PPE. The shuttle is equipped with different ports (operator ports, wire port, ventilator port) and a ventilation system that generates more than 15 air exchanges per hour and can be used with negative or positive pressure inside, depending on who needs to be protected (the patient or the crew).[50]
Study (Germany) – PIUs	• **Introduction**: Aeromedical transport of patients with highly infectious diseases, particularly over long distances with extended transport times, is a logistical, medical and organizational challenge. Following the 2014-16 Ebola Crisis, sophisticated transport solutions have been developed, mostly utilizing large civilian and military airframes and the patient treated in a large isolation chamber. In the present COVID−19 pandemic, however, many services offer aeromedical transport of patients with highly infectious diseases in much smaller portable medical isolation units (PMIU), with the medical team on the outside, delivering care through portholes. • **Methods**: We conducted a retrospective review of all transports of patients with proven or suspected COVID−19 disease, transported by Jetcall, Idstein, Germany, between April 1 and August 1, 2020, using a PMIU (EpiShuttle, EpiGuard AS, Oslo, Norway). Demographics and medical data were analyzed using the services' standardized transport protocols. Transport−associated challenges and optimization strategies were identified by interviewing and debriefing all transport teams after each transport. • **Results**: Thirteen patients with COVID−19 have been transported in a PMIU over distances up to 7,400 kilometers (km), with flight times ranging from 02:15 hours to 11:10 hours. We identified the main limitations of PMIU transports as limited access to the patient and reduced manual dexterity when delivering care through the porthole gloves and disconnection of lines and tubes during loading and unloading procedures. Technical solutions such as Bluetooth-enabled stethoscopes, cordless ultrasound scanners and communication devices, meticulous preparation of the PMIU and the patient following standardized protocols and scenario-based training of crew members can reduce some of the risks. • **Discussion**: Transporting a patient with COVID−19 or any other highly infectious disease in a PMIU is a feasible option even over long distances, but adding a significant layer of additional risk, thus requiring a careful and individualized risk−benefit analysis for each patient prior to transport.[51]
Study – PIUs	• This research article (Jul 31, 2020) analyzed whether patient isolation pods (i.e., collapsible personnel isolation apparatus with glove box ports and a base used for avoiding unwanted contamination of harmful biological and chemical materials) are effective during aeromedical transfer of patients with COVID-19 or other highly infectious diseases. The article concluded that there was little advantage to be gained in moving patients with COVID-19 in isolation pods and patients are best managed in a sitting position, with supplementary oxygen if required, or on stretchers for those who can be best managed lying down. ○ The Norwegian Air Ambulance Service had experience in using patient isolation pods, and they reported mixed results. Some patients who may have been managed best in a sitting position, were required to lay flat or semi-recumbent, and this had potentially compromised oxygen perfusion. ○ The United Kingdom Royal Air Force and Australian Defence Force experts emphasized the difficulty in managing ventilated patients in isolation pods and believed that the risks imposed outweighed any benefit. • The article summarizes recommendations (e.g., PPE, decontamination, physical distancing), and in particular suggests ventilated patients should have a high-efficiency particulate air filter in the circuit and filtering facepiece particles class 3 (FFP3) masks be worn during AGPs (intubation or if continuous positive airway pressure/bilevel positive airway pressure is being given).[52]

Study (US) – Helmet-Based NIV	• This study (Nov 23, 2020) reported that helmet-based NIV in air medical transport is a viable option for the safe transport of potential or known COVID-19 patients who present with hypoxemia and mild to moderate respiratory distress without any current or anticipated airway compromise or altered mental status. Patients who require supplemental oxygen at rates greater than 6 L/min, high flow nasal cannula, or CPAP/BiPAP are good candidates for this device. Contraindications to the use of helmet-based NIV include altered level of consciousness, altered mental status, agitation, airway bleeding, nausea/vomiting, copious secretions or inability to safely clear secretions, respiratory failure, or immediate need for endotracheal intubation. o The helmet is a sealed and closed space that completely isolates the patient's airway and breathing, thus providing protection from exposure to pathogens transmitted through droplets or aerosols. The helmet can be used in conjunction with a high-flow oxygen delivery device or a ventilator capable of NIV with leak compensation. Helmet NIV can require significant oxygen flows, and the available amount of oxygen on board the aircraft and transport distances are critical factors that must be considered when evaluating the feasibility of implementation of the device. o Given the most likely modes of transmission through droplets, aerosols, and fomite contact, airway procedures such as endotracheal intubation place air medical crews and other health care providers at high risk for exposure. This, together with data that suggest that a large cohort of coronavirus disease 2019 patients have better outcomes if we can avoid intubating them, creates a need for a safe method of NIV or high-flow oxygen delivery during transport. Commonly used and successful in-hospital regimens for these patients are high-flow nasal cannula and continuous positive airway pressure or bilevel positive airway pressure. In some studies, helmet NIV has been shown to be a viable, if not superior, alternative to these therapies for patients with acute hypoxemic respiratory failure. Furthermore, because it is a sealed and closed space that completely isolates the patient's airway and breathing, it provides a very high degree of protection from exposure to pathogens transmitted through droplets or aerosols. o The study reported on the experience of the first 10 uses of the device at Life Link III (nine times for an interfacility transport and once on a scene response). Five patients were confirmed with COVID-19, three were suspected to have COVID-19, and two patients were considered low-risk. All patients were transported in the helmet without incident or complication, and none of the patients deteriorated during transport or required endotracheal intubation. In two instances, the neck seal was damaged during the initial application of the helmet and required a replacement. There were no cases of the neck seal failing during transport.[53]
Land vs. Air Ambulances	
Study (Europe)	• **Objectives**: This study (Sept 22, 2020) aimed to describe the issues faced by air ambulance services in Europe as they transport potential COVID-19 patients. • **Methods**: Nine different HEMS providers in seven different countries across Europe were invited to share their experiences and to report their data regarding the care, transport, and safety measures in suspected or confirmed COVID-19 missions. Six air ambulance providers in six countries agreed and reported their data regarding development of special procedures and safety instructions in preparation for the COVID-19 pandemic. Four providers agreed to provide mission related data. Three hundred eighty-five COVID-19-related missions were analysed, including 119 primary transport missions and 266 interfacility transport missions. • **Results**: All providers had developed special procedures and safety instructions in preparation for COVID-19. Ground transport was the preferred mode of transport in primary missions, whereas air transport was preferred for interfacility transport. In some countries the transport of COVID-19 patients by regular air ambulance services was avoided. Patients in interfacility transport missions had a significantly higher median (range) NACA Score 4 (2-5) compared with 3 (1-7), needed significantly more medical interventions, were significantly younger (59.6 ± 16 vs 65 ± 21 years), and were significantly more often male (73% vs 60.5%). NIV was used significantly more often in primary missions • **Conclusions**: All participating air ambulance providers were prepared for COVID-19. Safe care and transport of suspected or confirmed COVID-19 patients is achievable. Most patients on primary missions were transported by ground. These patients were less sick than interfacility transport patients, for whom air transport was the preferred method.[54]

Table 3: Summary of Canadian and International Guidance on Transporting Suspected or Confirmed COVID-19 Patients Who Require Non-Invasive Ventilation (NIV) Support Via Emergency Medical Services (EMS) Units

Jurisdiction	Best Practices and Recommendations
Canada	

Ontario	A study (May 13, 2020) discussed Ornge's approach to preparing for the COVID-19 pandemic. As of April 30, 2020, Ornge has organized transport for and/or transported 325 patients with either a confirmed case of or under investigation for COVID-19. A total of 52.3% of these were completed by critical care land ambulances, 28.9% were completed by fixed wing aircraft, and 16.6% were completed by rotary wing aircraft. Of these, 71% required oxygen therapy, approximately 1% received oxygen by high flow nasal cannula, 59% were intubated and being mechanically ventilated, approximately 1% were transported prone, and approximately 1% were transported on extracorporeal membrane oxygenation. The average duration of these transports was 115 minutes. During this time, no staff members tested positive for COVID-19.
	• **Medical Procedures**: Ornge preferentially transports COVID patients using the critical care land ambulances, which are capable of 24 air changes per hour and the front driver's compartment is separate from the patient compartment. Ornge has restricted the use of oxygen by high flow nasal cannula to only critical care land ambulances and temporarily halted the use of NIV.
	  ○ The study noted that there is emerging evidence to support the use of high flow nasal cannula and NIV to prevent mechanical ventilation in COVID-19 patients. However, there is substantial fear among health care workers about the increased risk of infection transmission from using these procedures. In cases where air transport is required because of geography, Ornge will require these patients to be mechanically ventilated.
	  ○ Ornge will be participating in engineering research trials looking at the risk of droplet and aerosol dispersion using high flow nasal cannula and NIV in airframes based on their current airflow dynamics.
	• **Screening**: Ornge implemented screening using the Provincial Transfer Authorization Centre, which offers an online tool to screen for COVID-19. All transport providers are warned of potential COVID-19 transfers before transport. Ornge decided early during the pandemic to use airborne precautions for all potential COVID-19 cases (since Ornge paramedics are unable to change from droplet to airborne precautions while in an aircraft or vehicle, before performing an AGP).
	• **PPE**: Ornge procured reusable N95 facemasks with disposable filters and washable water-resistant gowns.
	• **Decontamination**: A vaporized hydrogen peroxide disinfection system (Nocospray, Montreal) is used.
	• **Surge Capacity**: Critical care transport is performed by one critical care paramedic and one primary care paramedic, thereby doubling capacity. As well, Ornge has solicited 46 paramedic volunteers to form a COVID-19 Ornge Surge Response Team (OSRT). They can be dropped off at any facility to help with airway management and mechanical ventilation pending transport. The team's deployment kit has the equipment and medications to be able to function independently, and includes a fully equipped airway management bag, a portable mechanical ventilator, monitors, medications, and infusion pumps. Their equipment is also compatible with the transport equipment of all municipal land ambulances.
	  ○ In the Northern community, Ornge has augmented three remote health care facilities with additional ventilators from their own stockpile. Two ventilated patients can be transported in select private air carrier aircraft with OSRT paramedics.
	  ○ In Southern Ontario, Ornge has partnered with Toronto Paramedic Services (TPS) to develop a plan for transporting multiple critically ill COVID-19 patients in the TPS ambulance bus. This ambulance bus would be driven by a TPS paramedic, and critical care could be provided by OSRT paramedics. The bus can transport four ventilated patients or up to eight stretcher-bound patients.[55]

	The Ministry of Health's training bulletin (Oct 1, 2020) provides background information on COVID-19, current infection control guidelines, and links to resources. • For oxygen administration for patients with symptoms of respiratory infection, the patient should wear: 1) a surgical mask, if tolerated, with a nasal cannula if low concentration oxygen is required; and 2) low flow/high concentration oxygen mask outfitted with a hydrophobic submicron filter if high concentration oxygen is required. • Following every transport of a confirmed or probable case and/or the patient's environment, paramedics must decontaminate the vehicle/aircraft, stretcher and any reusable patient care equipment utilized during the call using a hospital-grade disinfectant in accordance with local Paramedic Service policies.[56]
	The Public Services Health and Safety Association's guidance provides resources and best practices to help prevent the spread of COVID-19 (e.g., PPE, decontamination).[57]
	Public Health Ontario's evidence brief (Mar 29, 2020) on infection prevention and control for first-responders providing direct care for suspected or confirmed COVID-19 patients summarizes that: • COVID-19 is primarily transmitted via droplets and fomites during close contact. Droplet and Contact Precautions including eye protection, surgical/procedure masks (hereafter referred to as masks), gloves, gowns, and meticulous and frequent hand hygiene are recommended for first responders to prevent COVID-19 transmission. • Airborne spread has not been reported for COVID-19. Airborne Precautions, including N95 respirators, are recommended in addition to Droplet and Contact Precautions for AGPs which include: tracheal intubation, NIV, tracheotomy, cardiopulmonary resuscitation during airway management, manual ventilation, bronchoscopy, non-invasive positive pressure ventilation for acute respiratory failure (CPAP, BiPAP), and high flow oxygen therapy. • The use of Droplet and Contact Precautions, with Airborne Precautions only used for aerosol-generating medical procedures (AGMPs), is consistent with current evidence on COVID-19, as well as guidance from the Public Health Agency of Canada and World Health Organization. • Advice for health care workers' to use Routine Practices and point of care risk assessments to determine appropriate PPE for care of confirmed or suspected COVID-19 patients is applicable to first responders and individuals providing first aid. • First responders should select PPE based on a patient interaction risk assessment. Droplet and Contact Precautions are recommended for the routine care of confirmed or suspected COVID-19 patients. An N95 respirator should be used to perform AGP.[58]

British Columbia	The British Columbia Emergency Health Services (BCEHS) Critical Care Transport program is an air medical provider.
	• **Airway Management**: BCEHS paramedic practice leaders identified some high-risk AGMPs, such as intubation, high-flow nasal cannula oxygenation, non-invasive positive-pressure ventilation, nebulization, and the risk of mechanical ventilator circuit breach. Clinical practice updates were disseminated to staff by various means, including the BCEHS handbook phone application, e-mail memos, leadership updates, practice update videos, and face-to-face learning sessions.[59] For example, the BC Centre for Disease Control's Interim Guidance (Mar 19, 2020) for BCEHS suggests:
	  ○ Patients should be transported with full ventilation as available in style of ambulance. Full ventilation may include but not be limited to all windows closed, and interior ventilation system and exhaust fan on.
	  ○ Isolating the driver from the patient compartment and keep pass-through door tightly closed.
	  ○ Avoiding AGMPs, including nebulized Ventolin, intubation, Bag Valve Mask (BVM ventilation), SGA insertion, CPAP, OptiFlow, and high-flow nasal cannulas. If AGMP is required, initiate airborne precautions. If an AGMP is performed by the attendant and the transport vehicle does not have an isolated drivers' compartment, the driver should clean hands and don a new N95 respirator.
	  ○ Creating a negative pressure environment in the patient compartment of ambulance and set the rear exhaust fans in the patient compartment to HIGH in order to maximize air extraction.
	  ○ If high concentration oxygen and/or positive pressure ventilation are required, appropriate oxygen delivery system should be filtered with an antimicrobial, hydrophobic filter.[60]

	• **PPE**: BCEHS adapted their PPE to include hospital scrubs, one-piece Tyvek suits with hoods, and half facepiece reusable silicone respirators with extended life particulate filters for enhanced durability and increased comfort. The confined space, limited airflow, and inability to stop and exit the aircraft mean that crews use PPE differently than ground-based EMS personnel. • **Decontamination**: BCEHS paramedics wipe all surfaces within two-metres of the patient with an accelerated hydrogen peroxide solution. • **Innovations:** As of May 2020, BCEHS is investigating the use of powered air-purifying respirators and patient isolation pods.[61]
New Brunswick	Ambulance New Brunswick's guidelines (Mar 27, 2020) for paramedics outlines limits on workplace practices, infection prevention and control procedures, hand hygiene, and the use of PPE. • **AGMPs**: An N95 respirator is required when performing AGMPs on a person under investigation for COVID-19. AGMP include tracheal intubation, non-invasive ventilation, cardiopulmonary resuscitation, and manual ventilation.[62]
United States (US)	

Centers for Disease Control and Prevention (CDC)	Guidance (July 15, 2020) for first responders, including EMS, on AGPs suggests:
	• Consult with medical control before performing AGPs for specific guidance. EMS personnel should exercise caution if an AGP is necessary.
	  ○ An N95 or equivalent or higher-level respirator such as disposable filtering facepiece respirators, powered air-purifying respirators, or elastomeric respirator instead of a facemask, should be used in addition to the other PPE described, by EMS personnel present for or performing AGPs.
	  ○ Bag valve masks and other ventilatory equipment, should be equipped with HEPA filtration to filter expired air.
	  ○ EMS systems should consult their ventilator equipment manufacturer to confirm appropriate filtration capability and the effect of filtration on positive-pressure ventilation.
	  ○ If possible, the rear doors of the transport vehicle should be opened and the HVAC system should be activated during AGPs. This should be done away from pedestrian traffic.
	  ○ If possible, discontinue AGPs prior to entering the destination facility or communicate with receiving personnel that AGPs are being implemented.[63]

Federal Healthcare Resilience Task Force	Guidance (April 24, 2020) for EMS transport of patients states: • Surgical masks are an acceptable alternative to N95 respirators until the supply chain is restored. Respirators should be prioritized for procedures that are likely to generate respiratory aerosols (e.g., bag valve mask, non-rebreather mask, CPAP, intubation) which would pose the highest exposure risk to health care providers. • Cover any respiratory device that is being used for treatment of the patient (i.e., nebulizer), or any administration of oxygen device (i.e., nasal cannula with a simple face mask). If patient condition allows, discontinue use of the respiratory treatment device before entering the hospital. • If there are shortages of gowns, they should be prioritized for AGPs, care activities where splashes and sprays are anticipated, and high-contact patient care activities that provide opportunities for transfer of pathogens to the hands and clothing of health care professionals.[64]
Arizona	The Arizona Department of Health Services' training guide (Dec 14, 2020) suggests avoiding non-invasive positive pressure ventilation (e.g., CPAP, BiPAP) unless absolutely necessary and discontinuing prior to entry into a public space. If a viral filter is available, it should be placed between the mask and oxygen delivery port. Advanced airway management (e.g., endotracheal intubation, high flow oxygen) is not recommended.[65]
California	In 2014, Southern California intensified planning and response to manage Ebola patients. The counties of Los Angeles, Orange, and Ventura counties created a regional solution for treating and transporting highly infectious patients by creating high-risk ambulances (HRAs). While agencies may choose not to build dedicated HRAs, the innovations implemented for this project – isolating the patient compartment from the driver's area and installing separate air conditioning systems for each; HEPA filtration/UV light disinfection; the creation of a negative-pressure environment; and including decontamination methods during design/construction – should be considered when purchasing new ambulances for day-to-day use. These innovations could address the infection-control and cross-contamination problems EMS has struggled with for years. • **Training**: Personnel has to be trained and equipped with specialized PPE: powered air-purifying respirators, suits, boots, and heavy gloves.

	• **Design**: A multidisciplinary team designed the six HRAs, including ambulance, EMS, hospital, public health, epidemiology, risk management, and fleet personnel. The goal was to create vehicles that were easy to decontaminate, had separate AC systems for the driver and patient compartments, and achieved negative-pressure status for the treatment area. The team considered van and modular-type ambulances but opted against them due to cost and because they units would not be used for standard patient transports. • **Use**: The HRAs have been used successfully in multiple exercises, including the federal multistate air-transport exercises. They have been used to transport passengers at high-risk of having COVID-19, due to their ease of cleaning/decontamination and the fact that the crew can ride up front without PPE due to the separate air conditioning system. The passenger communicates with the crew via intercom. Use of the ambulances for confirmed COVID-19 patients is anticipated.[66]
Illinois	The Illinois Department of Public Health's guidance EMS clinicians should exercise caution if an AGP (e.g., bag valve mask ventilation, oropharyngeal suctioning, endotracheal intubation, nebulizer treatment, CPAP, BiPAP, or resuscitation involving emergency intubation or cardiopulmonary resuscitation) is necessary. If possible, the rear doors of the transport vehicle should be opened and the HVAC system should be activated during AGPs. This should be done away from pedestrian traffic.[67]
New Hampshire	The state Department of Safety's emergency protocol notes that EMS providers should exercise caution if an AGP (e.g., bag valve mask ventilation, oropharyngeal suctioning, endotracheal intubation, nebulizer treatment, CPAP, BiPAP, or resuscitation) involving emergency intubation or cardiopulmonary resuscitation is necessary. Ventilatory equipment, should be equipped with HEPA or other viral filter (if available) to filter expired air. • If available, place a clear drape (medical drape, shower curtain, or drop cloth) over the patient's face and head to reduce exposure to aerosolized secretions. • If possible, the rear doors of the transport vehicle should be opened and the HVAC system should be activated during APGs. This should be done away from pedestrian traffic. • If possible, consult with medical control before performing AGPs for specific guidance.[68]
Europe	
Luxembourg	Air medical transport provider European Air Ambulance (Oct 19, 2020) introduced new streamlined procedures to deal with the transportation of COVID-19 patients. The control centre activates different protocols depending on whether the patient has a confirmed positive or negative diagnosis and depending on their general condition, with additional procedures for those whose COVID-19 status is unknown. • In some cases, the use of an IsoPod or Infectious Disease Unit (IDU) may be required (image). EAA's IDU is a tent-like module originally designed for the safe transport of Ebola patients, which has been adapted for COVID-19. It gives the patient space to move around, and allows for non-intensive treatment while still being completely isolated from the surroundings. An IsoPod is a smaller individual barrier-type unit, suited to patients not needing treatment, but which protects the medical team from infection. Due to restricted size inside, the IsoPod is not suitable for obese patients or patients who suffer from anxiety or claustrophobia.[69]
United Kingdom	

England	According to Public Health England's guidance (updated Jan 29, 2021) for ambulance services:
	• **AGPs**: NIV (BiPAP and CPAP) are listed as a medical procedure for COVID-19 that have been reported to be aerosol generating and are associated with an increased risk of respiratory transmission.
	  ○ Respirators should be used to prevent inhalation of small airborne particles arising from AGPs. Disposable gloves, coveralls, and eye/face protection should also be used.
	  ○ Patients are required to wear a surgical mask, providing it does not compromise their clinical care, such as when receiving oxygen therapy.
	  ○ For any vehicle when AGP procedures have been performed, the vehicle will require an enhanced decontamination of all exposed surfaces, equipment, and contact areas before it is returned to normal operational duties, with a chlorine-based product (or approved equivalent).

	• **Air Ambulance Transport**: On occasions, AGPs will be necessary during the airborne transfer of suspected and confirmed COVID-19 patients (e.g., emergency airway suction). Despite measures being taken to avoid AGPs being routinely delivered on the aircraft, planning must be made for this eventuality, including consideration of donning the appropriate level of PPE prior to take-off.
	  ○ Barriers: Organizations should consider whether the cockpit can be isolated from the medical cabin sufficiently to prevent contact, droplet, and airborne transmission, for example using an 'air-tight' bulkhead seal and separating cabin and cockpit ventilation systems. Where this can be achieved, the aircraft may be considered in a similar way to a land ambulance with a closed bulkhead between attending medical personnel and ambulance driver. If the cockpit and medical cabin cannot be separated, organizations must consider whether other measures to avoid transmission are feasible. This includes contact and droplet avoidance, maintaining a distance from pilot(s) to the patient of >2 metres or appropriate PPE against these modes of transmission (which may or may not be practicable). Additionally, for the avoidance of airborne transmission, fit-tested FFP3 respiratory protection would need to be donned before any AGP.
	  ○ Isolation Pods: Some organizations may consider the use of isolation pods with appropriate air filtration where cabin separation is not possible.
	  ○ Decontamination: Following the carriage of a suspected or confirmed COVID-19 patient, it is recommended that both aircraft cabin and equipment are decontaminated.[70]

Australia	

Federal Government	Guidance (Feb 10, 2020) notes that paramedics and ambulance first responders are advised to follow specific PPE requirements (outlined below) while assessing and treating patients in self-quarantine or isolation, regardless of whether or not respiratory symptoms are present.
	• **AGPs**: AGPs include tracheal intubation, NIV, tracheotomy, CPR, manual ventilation before intubation, and bronchoscopy. Contact and airborne precautions are recommended when performing AGPs, including intubation and cardiopulmonary resuscitation. These precautions include:
	  ○ Performing hand hygiene before donning a gown, eye protection, a P2/N95 respirator (which should be fit checked) and gloves;
	  ○ Having the driver don a P2/N95 respirator and protective eyewear;
	  ○ After the AGP, removing gloves (perform hand hygiene), eye protection, gown (perform hand hygiene), and P2/N95 respirator (perform hand hygiene);
	  ○ Not touching the front of any item of PPE during removal;
	  ○ Disposing of used PPE in a clinical waste bag; and
	  ○ Cleaning ambulance equipment and surfaces with disinfectant wipes by a person wearing clean PPE (i.e. gloves, gown, protective eyewear, and surgical mask).[71]

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