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Contents lists available at ScienceDirect

## Air Medical Journal

journal homepage: <http://www.airmedicaljournal.com/>

## Brief Report

## Operational Policies and Procedures for Critical Care Transport During a Respiratory Pandemic



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## A B S T R A C T

The severe acute respiratory syndrome coronavirus 2 pandemic of 2020 to 2021 created unprecedented challenges for health care organizations, including those in the critical care transport sector. Critical care transport services had to rapidly adjust to changing patient demographics, distribution of diagnoses, and transport utilization stratagem. To evolve with the pandemic, organizations developed new protocols and guidelines in rapid succession. The growth bore out of a need to cater to this new patient population and their safety as well as the safety of the crewmembers from severe acute respiratory syndrome coronavirus 2. The critical changes to operations involved adaptability, efficient communication, continual reassessment, and implementation of novel approaches. Although these lessons learned were specific to coronavirus disease 2019, many processes will apply to future respiratory epidemics and pandemics.

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV2) pandemic of 2020 to 2021 created unprecedented challenges for health care organizations, including critical care transport (CCT) organizations. The changes were numerous, including a change in the patient population, with a rapid decrease in trauma and pediatrics to a preponderance of adult patients with acute hypoxemic respiratory failure. CCT teams were called on to transport these patients at potential risk to themselves, especially early in 2020, before the effectiveness of personal protective equipment (PPE) was determined. Even seemingly simple tasks, such as defining a person under investigation (PUI) for coronavirus disease 2019 (COVID-19), varied from institution to institution, putting transport organizations in the middle of conflicts.

Agility has always been an essential part of any CCT organization because clinicians and managers must adapt to an unpredictable environment. However, the frequency and speed of changes occurring during the COVID-19 pandemic were unprecedented. This report offers our best practices based on our experience and the available data. Although these procedures were developed for the COVID-19 pandemic, they will logically apply to future respiratory outbreaks and illuminate helpful changes for otherwise quotidian operations.

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## Leadership and Coordination

With the impending pandemic in the first week of March 2020, operations changed to discussions focused on crisis staffing models, facilitating successful remote work, maintaining an education infrastructure, high-level infectious patient transports, and human

resources challenges. An early lesson learned was to identify a single source to disseminate information to the organization. With each service line putting out updates on a near-daily basis, initial communications resulted in an information overload and confusion. We identified our director of safety and risk, who was supported by the chief medical officer, for all COVID-related updates and changes. Individual service line leaders provided content for these updates and vetted the final overall message. This solitary voice and source of information helped focus messages, control information, and reduce

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information clutter. We archived the updates in a SharePoint (Microsoft, Redmond, Washington, US) folder for team access. These updates initially were published daily, with progressively less frequency, until the pace of change became nominal in June 2020.

#### *Personnel Management*

Our guiding principle in planning involved protecting our operational staff from outside and internal risks. As with offices worldwide, all administrative staff switched to fully remote working very early in the pandemic. The administrative service line managers embraced remote work and partnered with our information technology team to evaluate potential data security issues. We issued company laptops with standardized operating systems and application suites with anti-virus and virtual private network (VPN) software to administrative staff. To heighten security, we implemented the Cisco (San Jose, CA, USA) 2-factor authentication system for VPN log-ons and additionally updated the firewall to support the larger number of simultaneous VPN connections during peak times.

The patient financial services team had novel needs essential to our continued operation. We issued additional monitors and docking stations to those team members' homes because the billing applications they use require dual screens to function effectively. Additionally, they are required to make and receive frequent calls for agencies. Therefore, we created time profiles on the phone server to only forward calls to their homes during their assigned shifts. Through these efforts, we actually saw a decrease in days to invoice in patient financial services.

We adopted a pre-entry health screen for anyone entering our buildings. For scheduled operational personnel, our company-wide messaging system sent a query before the shift, and the on-call administrator followed up for missed replies or reports of symptoms. For administrative and ad hoc visitors, a QR code on every external door linked to a symptom screening tool. In the bases, we adopted a 100% face-covering requirement, ultimately escalating to a medical procedure mask requirement. We also closed to all visitors, including canceling our external education programs and our ride-along program. Although important for our external education and human resources functions, we could not risk additional crew exposures.

At the same time, we scheduled a member of the operations leadership team to be on-site at each base for part of every day. This practice generated some controversy because it increased traffic at each base. We determined that the risk was outweighed by the benefits of a live listening post, in-person debriefings, and efficient information exchange.

The communications specialists in any CCT organization are highly specialized employees with limited capacity for redundancy. Additionally, with shift changes and overlapping shifts, a single infected communications specialist could conceivably expose half of the team. Recognizing early that our organization could not function if multiple communications specialists fell ill and were unable to work, an early change was to close off the communications center to all outside staff. Additionally, we mandated masks in the communications center before they were required elsewhere to protect these high-priority employees.

For the transport teams, a significant operational change to reduce exposure from patients and the public was to keep the vehicle operators (helicopter pilots and emergency medical technicians [EMTs]) out of the sending and receiving hospitals. This was a significant alteration to our team dynamic and, for the ground teams accustomed to the clinical participation of the EMT, a bedside logistical change. We reintegrated the vehicle operators into the hospitals when we had demonstrated that our PPE and prevention practices had effectively prevented workplace spread, our PPE supply chain had stabilized, and in recognition of the ongoing high workload of the clinical staff.

An unanticipated consequence was that new EMTs onboarded during pandemic operations had to be reoriented to perform as part of a bedside team. We accomplished this with refresher didactic and skills education and experience in our simulation facility.

Another key change for the transport teams was the adjustment to crew duty time calculations. Conscious of provider fatigue and attentive to Federal Aviation Administration regulations for pilots, we do not plan for any helicopter or ground transport team shift to exceed 14 hours. This requires pretransport estimation of the total time for the case based on internal data analysis. We added activation/planning, at-bedside, and posttransport decontamination time buffers to those planning tools, initially as high as 90 extra minutes for some cases. We regularly adjusted those times as our teams became more efficient in the milieu and as our understanding of cases improved. Those adjustments were mostly downward, currently to 50 additional minutes for most cases, but included a bedside time addition when we implemented a complex new clinical process (ie, the transport of patients in the prone position).

#### **Transport Communications**

Operationally, the communications team played a key role in identifying COVID-positive and

PUI patients. All patients with a positive COVID polymerase chain reaction test during that hospitalization were considered positive. However, the determination of PUI is more challenging because hospital definitions varied. Initially, the communications center, focused on the CCT team's needs, would ask the sending "Are you using PPE?" and ask the receiving "Will you be treating the patient for COVID?" However, the responses to these queries varied greatly and did not always answer how the CCT team should approach the patient. The sending hospital did not always follow recommended guidelines, and the receiving hospital would often defer to assuming all patients were COVID positive regardless of symptoms. Although it is important to adhere to referring and receiving hospitals' protocols to optimize crew safety and respect clinician autonomy, the crew had ultimate discretion on determining PUI status and their PPE stance. Patients presenting to a hospital or outside agency with priority symptoms as listed by the Centers for Disease Control and Prevention, cardiac or respiratory arrest, or other unexplained illness would be treated as a PUI in the absence of a negative COVID screen and a plausible differential.

#### *Vehicle Selection*

A balance of patient acuity, distance, and time sensitivity for intervention determines vehicle assignment in our usual operational model. In the initial stages of the pandemic, operational unknowns; our relative inexperience with full barrier precautions, particularly in the context of wearing helmets and, often, personal floatation devices; and the absence of a medically trained vehicle operator led us to use ground vehicles as the primary mode of transport for the transfer of PUI or confirmed COVID patients regardless of acuity. When a patient needed rotor wing (RW) transport, as for an island or remote geographic location, we required a planning and approval conference call with the medical control physician, the administrator on call, and the transport team.

Ventilation and airflow were initial concerns in the helicopters; all of the vehicles recirculate air when using the ventilation system, and the ventilation systems had never been tested to understand the exact ways air circulated through the cabin. Initially, we would not use the cooling or heating system if we had to transport by helicopter. However, because air circulation can be necessary for the pilot to defog the cockpit in some conditions, this solution is unsustainable. The RW maintenance department developed a novel "temporary

maintenance action” to install a high-efficiency air particulate (HEPA) filter system on the aircraft recirculation vents, air conditioning inlets, and heater inlets that allowed for appropriate recirculation. Aviation operations are highly regulated so, although not required, we received a “no technical objections” letter from the airframe manufacturer and discussed the temporary maintenance action with the Federal Aviation Administration before proceeding.

There were also initial concerns about pilots’ ability to conduct effective aviation and operational radio communications while wearing N95s or surgical masks. Before the pandemic, our pilots had not been N95 fit tested. Building on our experience that medical teams could communicate on intercom and medical radios, we conducted ground and flight testing of cockpit radio operations, surveyed industry partners, and established that pilot use of masks was reasonable and common. We then rapidly fit tested the pilots, increasing their protection level and, subsequently, increasing our operational options.

Similarly, as our teams developed facility with donning, working in, and doffing full barrier precautions through a high case volume and the development of clear operational protocols, the challenge of adding helmets, night vision goggles, and personal flotation devices (PFDs) became less imposing and, ultimately, nominal.

Other precautions to protect vehicle operators translated to both ground and helicopter vehicles. We optimized cabin separation with the cloth curtain in the helicopters and type III ambulances and a solid plastic window in the type II ambulances. We directed teams to maintain airflow in all vehicles while the patient was loaded, with the patient compartment exhaust fan in ground vehicles and vehicle ventilation system in the helicopters.

At the time of this writing, we have shifted from a predominately ground vehicle selection process to one where COVID diagnosis is no longer a factor in vehicle selection for ground versus RW.

Fixed wing (FW) operations were significantly impacted because the cabin air, similar to the helicopters, is unfiltered. The airplane inherently recirculates from the front to the back of the cabin and exchanges air every 2.5 minutes. FW medical operators across the country had widely varied approaches to COVID patient transports. We opted for the most conservative approach, and, after significant investigation, we could not develop a filtration system in the same

way we did for the helicopter vehicles. When the FW is used to transport COVID patients, the aircraft must be decontaminated and out of service for 48 hours.

At the recommendation of a collaborating program, we invested in an IsoPod (AirBoss, Newmarket, Ontario, Canada) patient isolation system to transport COVID patients in the FW aircraft. The initial intent was to use the IsoPod when the helicopters could not complete the mission because of weather restrictions or there was no time-sensitive need. However, the IsoPod engendered several limitations. The device provided an encapsulated area that restricted patients to a particular position, creating height and weight limits and requiring patients to tolerate supine positioning for several hours. Following the initial uses, we found that air circulation was limited, and the IsoPod was uncomfortable for the patient for a prolonged time due to poor airflow. Aside from comfort, we identified assessment and treatment limitations. Thus, the planned use of the IsoPod required additional operational training. Accordingly, our use of the device is under 10 total cases, preferring to consider the airplane “dirty” for 48 hours after a COVID transport instead. In a dirty state, the airplane is used for additional COVID transports but not for the transport of non-COVID patients.

*Crew Personal Protective Equipment*

Our approach to team protection on transports evolved as the world’s understanding of the disease and the Centers for Disease Control and Prevention/World Health Organization guidelines evolved.<sup>1</sup> We initially wore PPE for PUI and COVID-positive cases, quickly escalating to masking all nonintubated, non-neonatal patients and having our providers wear procedure masks while inside any health care facility or transport vehicle.<sup>2,3</sup> This expanded to universal masking for the duty shift and, ultimately, to our providers wearing N95 masks while in health care facilities and transport vehicles and procedure masks the remainder of the shift. For non-neonatal PUI and confirmed COVID patients, the medical team adds gowns, eye protection, and head covering, with leg coverings optional.<sup>4</sup>

For logistics and comfort reasons, we made an early transition to an organization-issued reusable N95 (ie, Envo [Envo, Hampton, NH], a reusable mask frame with a disposable N95 filter approved by the

<u>Report Role:</u>	<u>Packaging Role:</u>
<ul style="list-style-type: none"> <li><input type="checkbox"/> <b>OBTAIN</b> report</li> <li><input type="checkbox"/> <b>COLLECT</b> chart, and signatures</li> <li><input type="checkbox"/> <b>OBTAIN</b> any additional medications for patient from facility</li> <li><input type="checkbox"/> <b>SEPARATE and ISOLATE</b> Paperwork.                             <ul style="list-style-type: none"> <li><input type="checkbox"/> BMF paperwork and Face sheet in first plastic paperwork bag. Place <b>IN</b> Packaging Bag</li> <li><input type="checkbox"/> Place patients chart in second plastic bag. Place <b>IN</b> Packaging Bag</li> </ul> </li> <li><input type="checkbox"/> Place BVM at head of stretcher</li> <li><input type="checkbox"/> <b>DISCUSS</b> with partner need for Epoprostenol (review new criteria)</li> <li><input type="checkbox"/> <b>DISCUSS with partner what additional supplies are required in the room.</b></li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> <b>PREPARE</b> <i>required and anticipated</i> equipment and supplies</li> <li><input type="checkbox"/> Request/Mix, Prime and Program infusions for transport</li> <li><input type="checkbox"/> Draw up analgosedation anticipated for duration transport (Consider using sending infusions)</li> <li><input type="checkbox"/> Draw up and administer Neuromuscular Blockade</li> <li><input type="checkbox"/> Pull out monitoring cables, attach BP cuff, SpO2 and electrodes</li> <li><input type="checkbox"/> Pull out ET/CO2, attach to PropaqMD</li> <li><input type="checkbox"/> <b>ATTACH</b> HEPA filters to ventilator (See ventilator reference)</li> <li><input type="checkbox"/> Program ventilator settings</li> </ul>
<input type="checkbox"/> <b>DON PPE</b> per PPE Reference	<input type="checkbox"/> <b>DON PPE</b> per PPE Reference

Figure 1. The prepatient contact procedure.

**At the receiving unit:****Packaging/Report Role:**

- Work together to transition patient onto receiving bed.

**\*If unable to procure cleaning supplies/PPE from receiving unit, BMF staff should continue to wear BMF PPE (N95, gloves) and use BMF purple wipes on stretcher to decontaminate stretcher and medical equipment.\***

**Report Role:**

- Once the patient is off the stretcher
- Move the stretcher outside for decontamination
- PASS equipment to decontaminate out to the packaging role person
- SANITIZE gloved hands
- REMOVE PPE sanitize hands
- RETRIEVE AND COMPLETE temporary medical record
- RETRIEVE AND HANDOFF patient's chart
- OBTAIN Cleaning Supplies/PPE from receiving for decontamination

**Packaging Role**

- Once the patient is off the stretcher
- KEEP MASK ON
- SANITIZE gloved hands
- REMOVE Gown and glove
- DON new gloves
- WIPE DOWN stretcher from top down with purple to wipes
- WIPE DOWN bags
  - Exterior (including back panel)
  - Straps
  - Bottom
  - Compartment and contents of any pouch opened
- WIPE DOWN patient record bag with purple top wipe.
- WIPE DOWN equipment with purple top wipe
- WIPE DOWN unopened COVID kit (If opened, dispose of entire kit)
- WIPE DOWN O2 tank
- PLACE on clean stretcher
- REMOVE PPE sanitize hands
- OBTAIN Cleaning Supplies/PPE gown from receiving for decontamination

**Figure 2.** The equipment decontamination procedure.

National Institute for Occupational Safety and Health). The Envo mask initially did not filter exhaled air. With user feedback, they developed a plug to render the exhalation valve inoperable, and all exhaled air is filtered. Additionally, we provided nondisposable eyewear to all crews.

Because community prevalence has demonstrated a significantly sustained decline and increasingly available data demonstrating the efficacy of 3-layer procedure masks (with masks on the patient and the provider) in preventing spread from asymptomatic patients, our confidence in this level of protection allowed the consideration of

increasing health care worker comfort associated with procedure masks over the N95-level protection. Concomitantly, our staff vaccination rate reached nearly 100%. Importantly, all staff retain the option to continue wearing N95-level protection at their discretion.

Initially, although clinical staff had undergone fit testing and initial training for full barrier precautions, clinicians were not facile with the new processes. Knowing that 1 of the key lessons learned from the domestic Ebola experience was the risk for infection from poor PPE doffing, we retrained all staff with electronic learning and live return demonstration training for safe donning and doffing. We

wrote the processes into specific disposable checklists to be used on every transport. The processes included integrating full barrier PPE with helmets and night vision goggles for helicopter operations. As the pandemic continued, especially with an impending second wave, we worried about PPE fatigue. To ensure adherence with PPE procedures and reduce complacency, crewmembers have undergone recurrent PPE training.

Over a quarter of our helicopter transports involve extended over-water legs, which require teams to wear PFDs. Crewmembers evaluated and tested the wearing of PPE over the PFD in a Modular Egress Training Simulator (Survival Systems Limited, Dartmouth, Nova Scotia, Canada) at a commercial water survival training facility. The study's purpose was to examine the effect of wearing isolation PPE on aircrew members' ability to safely egress a helicopter, swim, and deploy the life vest in the advent of an over-water ditching event. An unexpected lesson learned was that it was impossible to breathe through a wet N95. We incorporated these learnings into a staff communication, shift briefings, and a poster on the way out to the flight line. The findings resulted in specific procedures of the proper use of PPE/PFDs with new training curriculum.

#### *Vehicle and Equipment Decontamination*

Before COVID-19, all staff, including nurses, paramedics, and EMTs, were trained to use standard decontamination wipes and solutions for thorough cleaning of all transport vehicles and equipment at the start of every shift and completion of each call. We monitor performance with a novel ultraviolet light-sensitive marking system.

The pandemic created 2 needs: higher-intensity decontamination after each transport and an increased frequency of "deep disinfection." It is in these areas in which some of our most intense and fastest cycle changes occurred. A multidisciplinary team developed specific processes to limit equipment exposure on transports, including pre-deploying high-use disposable items out of the transport gear and vehicles, preparing high-use medications in advance, and a conscious planning pause before entering the patient room so that the transport packs containing most of our equipment could remain unopened and outside the patient rooms, reducing their risk for contamination. At the end of the patient care interval, role-specific checklists separated clean and dirty equipment for decontamination by PPE-covered providers, continuing through a full vehicle decontamination process. [Figures 1 and 2](#) show samples of these processes, which went through nearly 10 iterations. The checklists, including the team PPE checklists described earlier, were printed on paper so that the teams had a disposable copy available for real-time use on every transport.

For the vehicles, we identified particular products (Hyperfect 256 and Hyperfect RTU, Genesan, Gorham, ME, USA) suitable for ground and air vehicles. There are differences between the ground and air vehicles due to directives from the Federal Aviation Administration and aircraft manufacturer. PPE-protected team members disinfected the vehicles at the receiving facilities in a prescribed manner (including exterior door handles, seat belt buckles, and radio controls and adhering to required "dwell time" guidelines) before returning to the base. For deep disinfection, we acquired a SteraMist (TOMI

Environmental Solutions, Frederick, MD) system, which decontaminates the interior of the ground vehicles every 30 days. This system is not suitable for use in the helicopters and airplane.

We are fortunate to be able to report that after 1 year and nearly 1,400 COVID transports, we have not lost any staff work time due to a work-acquired COVID-19 infection.

#### *Supply Chain*

We experienced the same critical supply challenges as other health systems, and our most significant challenge was in mechanical ventilation supplies. Before the pandemic, we had used a heat moisture exchange filter on our vent circuits but had never entertained the use of a HEPA filter. When we developed an acute shortage, we developed a process change to incorporate the HEPA filter from the sending facility vent circuit into our vent circuit, hoping to reduce our burn rate.

Simultaneously, we called on existing relationships with other transport services in the country and hospitals, both in and out of the Boston MedFlight consortium. We were fortunate that we were always able to secure adequate supplies.

This experience highlighted organizational deficiencies in our supply chain. We modeled supply use for ordinary and COVID patients, used internal and external models to project volume, and created a critical medical supply dashboard indicating resource capacity that we used to guide strategic purchasing and warehousing. In retrospect, this is appropriate for nonpandemic operations as well. We also used the events to reimagine our warehousing and remote base supply systems.

#### **Conclusion**

The SARS-CoV2 pandemic of 2020 to 2021 created unprecedented challenges for the CCT sector. CCT services had to rapidly adjust, developing new operational approaches, protocols, and guidelines in rapid succession. The growth bore out of a need to cater to this new patient population and their safety as well as the safety of the crewmembers from SARS-CoV2. The critical changes to operations involved adaptability, efficient communication, continual reassessment, and implementation of novel approaches. This report offers our lessons learned and best practices based on our experience and the best available data. Although these procedures were developed for the COVID-19 pandemic, they logically will apply to future respiratory outbreaks and may illuminate helpful changes for otherwise quotidian operations.

#### **References**

1. CDC. Strategies for optimizing the supply of N95 respirators: COVID-19. Available at: <https://www.cdc.gov/coronavirus/2019-ncov/hcp/respirators-strategy/index.html>. Accessed March 29, 2021.
2. Mahmood SU, Crimbley F, Khan S, et al. Strategies for rational use of personal protective equipment (PPE) among healthcare providers during the COVID-19 crisis. *Cureus*. 2020;12:e8248.
3. Jain U. Risk of COVID-19 due to shortage of personal protective equipment. *Cureus*. 2020;12:e8837.
4. Verbeek JH, Rajamaki B, Ijaz S, et al. Personal protective equipment for preventing highly infectious diseases due to exposure to contaminated body fluids in health-care staff. *Cochrane Database Syst Rev*. 2020;15:CD011621.