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BRIEF RESEARCH REPORT

Emergency Medical Services

Safety of air medical transport of patients with COVID-19 by personnel using routine personal protective equipment

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Abstract

Objective: Air medical transport of patients with known or suspected coronavirus disease 2019 (COVID-19) likely represents a high-risk exposure to crew members as aircraft cabins are quite small resulting in close personal contact. The actual risk to medical crew members is not known.

Methods: We conducted an institutional review board-exempt, retrospective study of air medical transport of patients with known or suspected COVID-19 by 8 programs in the Four Corners Region to determine the number of symptomatic COVID-19 among air medical crew members compared to total exposure time. All programs used similar routine personal protective equipment (PPE), including N-95 masks and eye protection. Total exposure time was considered from time of first patient contact until hand-off at a receiving hospital.

Results: There were 616 air transports: 62% by fixed-wing and 38% by rotor-wing aircraft between March 15 and September 6, 2020. Among transported patients, 407 (66%) were confirmed COVID+ and 209 (34%) were under investigation. Patient contact time ranged from 38 to 432 minutes with an average of 140 minutes. The total exposure time for medical crew was 2924 hours; exposure time to confirmed COVID+ patients was 2008 hours. Only 30% of patients were intubated, and the remainder had no oxygen (8%), low-flow nasal cannula (42%), mask (11%), high-flow nasal cannula (4.5%), and continuous positive airway pressure or bilevel positive airway pressure (3.5%). Two flight crew members out of 108 developed COVID that was presumed related to work.

Conclusions: Air medical transport of patients with known or suspected COVID-19 using routine PPE is considered effective for protecting medical crew members, even when patients are not intubated. This has implications for health care personnel in any setting that involves care of patients with COVID-19 in similarly confined spaces.

KEYWORDS
air medical, COVID-19, HEMS, occupational health, PPE, safety

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1 | INTRODUCTION

1.1 | Background

The Centers for Disease Control and Prevention (CDC) reported 120,467 cases of coronavirus disease 2019 (COVID-19) among US health care personnel with almost 600 deaths.[1] Air medical transport is a unique and challenging infection control environment because of the close physical proximity of air medical personnel to the patients in confined spaces with variable ventilation. The isolated Four Corners region of the southwestern United States was hit particularly hard with COVID-19 and the tertiary care resources are located at a substantial geographic distance. This distance resulted in many requests for air medical transport using both rotor-wing helicopters (RW) and fixed-wing (FW) aircraft.

1.2 | Importance

Air medical personnel were often in contact with these patients for many hours. If transport creates an unreasonable risk for these personnel, then additional measures to mitigate exposure will be necessary or transport will need to be curtailed.

1.3 | Goals of this investigation

We sought to look rigorously at our experience and better quantify the actual risk to transport personnel. It was our hypothesis that air medical transport of patients with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) using strict attention to relatively basic infection control procedures and routine personal protective equipment (PPE) does not result in a substantial risk to the transport personnel even when patients are not intubated.

The Bottom Line

In a sample of air-medical transports of patients with possible or diagnosed COVID-19, there was a low rate of transmission to transport personnel using routine personal protective equipment.

2 | METHODS

2.1 | Study design and setting

We conducted a survey of air medical transport programs that participate in the New Mexico Air Medical Transport Committee and transported any confirmed or suspected COVID-19+ patients from March through September of 2020. This was reviewed by the University of New Mexico Health Sciences Center institutional review board and determined to be exempt.

2.2 | Selection of participants/exposures

All air medical programs that participate in the New Mexico Air Medical Transport Committee were invited to voluntarily participate by email. Routine PPE was considered to include hair covering, eye protection, gowns, and N-95 masks. Exclusion criteria included patients transported without PPE or use of any kind of isolation pod or hood, powered air-purifying respirators, or N-100 masks. Pilots were excluded owing to the large variety of aircraft configurations and agency policies that made for a very heterogenous air medical personnel. All involved programs were routinely using high-efficiency particulate air (HEPA) filters for patients who were receiving positive pressure ventilation and ventilators were generally placed on stand-by and endotracheal tubes clamped by air medical personnel before moving a patient from hospital to transport ventilator.

2.3 | Measurements

Participating programs entered de-identified transport data into a RedCap tool and then waited 2 weeks to provide de-identified information about any known or suspected COVID-19 cases among transport personnel that were considered to be definitely or likely work-related as determined by the program director or agency human resources department. Measurements were tabulated through RedCap results and Excel spreadsheet. The data were collected and entered by the designee of each individual agency and collated into the central spreadsheet. There is no adequate way to identify any missing transports as this was voluntary data collection.

2.4 | Outcomes

The primary outcome measure was known or suspected COVID-19 cases among transport personnel that were considered to be definitely or likely work related as a factor of total exposure time.

2.5 | Analysis

No statistical analysis was applied to the data received.

3 | RESULTS

3.1 | Characteristics of study subjects

There were 616 qualifying patient transports among 8 agencies using FW aircraft in 384 (62%) and RW aircraft in 232 (38%).

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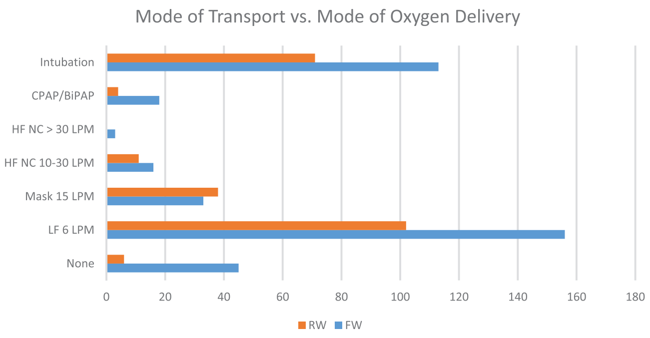

FIGURE 1 Oxygen delivery method by mode of transport. BiPAP, bilevel positive airway pressure; CPAP, continuous positive airway pressure; FW, fixed wing (airplane); HF NC, high-flow nasal cannula; RW, rotor wing (helicopter)

TABLE 1 Oxygen delivery mode by time of exposure

Mode of oxygen delivery	Mean time of exposure
No supplemental oxygen	130 minutes (SD 35)
Low-flow nasal cannula 6 L per minute	121 minutes (SD 35)
Non-rebreather mask 15 L per minute	120 minutes (SD 42)
High-flow nasal cannula 10–30 L per minute	129 minutes (SD 38)
High-flow nasal cannula > 30 L per minute	166 minutes (SD 26)
CPAP/BiPAP	149 minutes (SD 44)
Intubated	179 minutes (SD 61)

BiPAP, bilevel positive airway pressure; CPAP, continuous positive airway pressure.

3.2 | Main results

Of the patients transported, 407 (66%) were confirmed COVID+ and 209 (34%) were still under investigation. Patient contact time for personnel ranged from 38 to 432 minutes with an average of 140 minutes. The total exposure time for all personnel combined was 175,457 minutes or 2924 hours. The total exposure time with confirmed COVID+ patients was 120,489 minutes or 2008 hours. Only 184 patients (30%) were intubated but personnel performed the intubation procedure in only 10 cases. The remainder had no oxygen in 51 cases (8%), low-flow nasal cannula in 258 (42%), oxygen mask up to 15 L in 71 (11%), high-flow nasal cannula up to 30 L in 27 (4%), high-flow nasal cannula >30 L in 3 (0.5%) and non-invasive positive pressure via continuous positive airway pressure or bilevel positive airway pressure in 22 (3.5%). Figure 1 shows the breakdown of oxygen delivery modes by platform (RW vs FW). Table 1 and Table 2 show the breakdown of average and total exposure time by mode of oxygen delivery. Two personnel out of 108 (1.85%) developed symptomatic COVID-19 that was definitely or likely related to work.

TABLE 2 Oxygen delivery mode by frequency of occurance

Mode of oxygen delivery	Number of events
No supplemental oxygen	51
Low-flow nasal cannula 6 L per minute	258
Non-rebreather mask 15 L per minute	71
High-flow asal cannula 10–30 L per minute	27
High-flow nasal cannula > 30 L per minute	3
CPAP/BiPAP	22
Intubated	184

BiPAP, bilevel positive airway pressure; CPAP, continuous positive airway pressure.

3.3 | Limitations

We are able to report only on symptomatic infections. Some reports suggest up to 6.4% of infected health care personnel are asymptomatic.[2] We are unable to ascertain with certainty if the affected personnel became sick from an exposure while transporting an infected patient. The prevalence of COVID-19 in some communities where personnel live was very high during all or parts of the study period and some had secondary employment in hospitals or doing ground-based emergency medical services (EMS). If these infections were acquired outside of the air medical transport environment then the overall risk is less. We are unable to determine the actual exposure time for each individual. It is possible that the 2 affected individuals had more exposure to infected patients than other personnel, which would make the overall risk less. We are also unable to report the risk to pilots or stratify by aircraft type or mode of oxygenation. The relative risk of transporting non-intubated patients may be higher than that of transporting intubated patients.

4 | DISCUSSION

In this retrospective survey, the risk to air medical personnel wearing routine PPE from transport of patients with known or suspected COVID-19 infection was quite low. Overall, <2% of personnel developed symptomatic COVID-19 infection through a suspected work exposure despite almost 3000 collective hours of exposure. Although we should strive to avoid any infection that has the potential to cause morbidity and mortality and could be transmitted to other patients, colleagues, or family members, the incidence in this study is less than most of us working in this profession anticipated. This is reflected by the fact that some air medical programs in our region completely refused to transport any patients with suspected COVID-19 infection and others limited transport to patients who were intubated; thus, creating a closed ventilation circuit.

The literature examining risk of infectious disease transmission to air medical personnel from patients is essentially non-existent. The risk of disease transmission from commercial air travel is generally low.[3] However, transmission of airborne microorganisms on commercial aircraft between unprotected passengers has been documented with measles,[4] tuberculosis,[5] and influenza.[6] The ability to extrapolate these findings in older commercial aircraft to air medical transport of patients in small FW and RW aircraft is very limited. The risk to EMS providers is not well known either. A recent study in King County, Washington, showed that only 0.4% of 700 providers involved in 274 encounters with patients with confirmed COVID-19 infection tested positive.[7] However, it is difficult to make a comparison as each provider likely had a single brief exposure rather than multiple very extended contacts.

In our study, only a minority of patients were intubated. Intubated patients are generally considered to represent the lowest infection risk especially when in-line HEPA filters and good technique are used during changeover from a hospital ventilator to the transport ventilator; these were both standard practices in all involved agencies during this time period. Initially, a strategy for early intubation of patients with COVID-19 infection was suggested to limit aerosol generation.[8] However, it became clear that this approach was not tenable because of the limited availability of ventilators and also that it was not clinically necessary.[9] As less invasive therapies have become more common, the question of provider safety as it pertains to oxygenation therapies and aerosol generation is increasingly important.

The Air Medical Physician Association Position Statement on COVID-19 considers mask oxygenation, high-flow nasal cannula oxygenation, and non-invasive positive pressure ventilation (NIPPV) to be aerosol-generating procedures, which should all be avoided in confined spaces.[10] The CDC considers NIPPV to be an aerosol-generating procedure but are "uncertain" about high-flow oxygen therapy. Studies of actual particle and aerosol dispersion with different oxygenation therapies are limited and none involved actual patients in confined spaces.[2,11] Such studies are needed but our research suggests that use of routine PPE is remarkably effective at limiting the transmission of the SARS-CoV-2 virus even when aerosol-generating techniques are employed for oxygenation in confined spaces without negative pressure air flow.

Strategies to mitigate risk beyond proper PPE include placement of a procedure mask over a non-breather mask or nasal cannula as was commonly done by agencies in our study. This is likely helpful based on limited data.[2] Using a ventilator and tight-fitting unvented mask to deliver NIPPV, such that most or all expired air is directed through a HEPA filter, also makes good clinical sense and was the norm for agencies in our study as well. Of course, all patients not being ventilated were wearing procedure masks. It is not clear whether intubating patients before transport or avoiding certain types of oxygen therapy that may potentially generate more aerosols would offer additional protection.

In this retrospective case series, air medical transport of patients with known or suspected COVID-19 using routine PPE including an N-95 mask resulted in a low rate of symptomatic infection among air medical personnel, despite many patients not being intubated and being managed with potential aerosol generating techniques. Until further prospective research can be completed this has implications for any health care settings that involve care of COVID-19 patients, especially in similarly confined spaces.

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AUTHOR CONTRIBUTIONS

DB and ML conceived this brief research paper. DB, MO, ML, and DD designed the redcap survey/data collection tool. DB and MO supervised the conduct of the trial and data collection. DB, MO, and DD undertook recruitment of participating agencies. Each respective agency managed the data, including quality control and entered it into the RedCap tool. DB, MO, and DD drafted the manuscript, and all authors contributed substantially to its revision. DB takes responsibility for the paper as a whole.

CONFLICTS OF INTEREST

All authors have affirmed they have no conflicts of interest to declare.

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