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Original Research

Challenges and Risks in Out-of-Hospital Transport of Patients During the Coronavirus Disease 2019 Pandemic

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A B S T R A C T

Objective: Norwegian critical care resources are regionalized making air ambulances transport of suspected or confirmed coronavirus disease 2019 (COVID-19)-positive patients a necessity. We prospectively observed pre- and interhospital transportation of patients with suspected or confirmed COVID-19 in our physician-manned emergency medical services.
Methods: This was a prospective, observational quality assurance study of primary and secondary missions conducted by 2 Norwegian air ambulances during the COVID-19 pandemic.
Results: Forty-one (24.1%) were primary missions, whereas 129 (75.9%) were interhospital transports. Most patients (158 [92.9%]) were transported with ground-based vehicles, and 12 (7.1%) were transported by rotor wing aircrafts. One hundred thirty-four of 170 patients (78.8%) were COVID-19 positive at the time of transportation. The median (interquartile range) fraction of inspired oxygen concentration was 0.60 (0.50-0.80), the positive end-expiratory pressure was 11 cm H_2O (8-13.5 cm H_2O), and the peak inspiratory pressure was 26 cm H_2O (22-30 cm H_2O). Some degree of elevated treatment challenge was reported in 157 (87.7%) transports, and in 139 (77.7%), the patient risk was considered elevated. The physician stated that some degree of elevated risk for the provider was elevated in 131 (73.2%) of the transports.
Conclusion: The capacity of the physician-manned emergency medical services to safely transfer patients remains essential to maintain resilient critical care capacity, and the perceived elevated risks should be considered in capacity planning.

In March 2020, the World Health Organization declared the coronavirus disease 2019 (COVID-19) pandemic a major global public health emergency.[1] The global number of confirmed cases and the fatality rate rapidly increased with patients in need of advanced pre- and in-hospital critical care of respiratory failure.[1,2] Norwegian critical care resources are regionalized making air ambulances transport of suspected or confirmed coronavirus disease 2019 (COVID-19)-positive patients a necessity.

Some patients were quarantined at home until a need for in-hospital care was recognized. Indication for transfer included decompensated local intensive care unit capacity or the need for a higher level of clinical care. Additionally, some coincidentally COVID-19–infected patients required transfer for other medical reasons. Interhospital transport of critically ill patients is routinely conducted by physician-manned emergency medical services (P-EMS) with specially trained consultant anesthesiologists.[3]

Initially, in the absence of rapid tests, early diagnosis of COVID-19 was challenging, forcing prehospital care providers to suspect COVID-19 in a broad range of cases.[4] The COVID-19 virus can remain

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infectious on surfaces like metal and plastic for several days and has proven to be highly contagious for person-to-person transmission.[5,6] P-EMS must routinely perform aerosol-generating interventions like airway management and ventilation, thereby increasing exposure. The technical and logistical challenges of transporting infectious patients in enclosed vehicles and aircraft created a demand for standard operational procedures regarding hygiene routines and personal protective equipment (PPE).[7-9] The perceived risk for health care providers or flight crews may influence clinical and operational decisions. Air ambulances remain a limited resource where crewmembers live and work closely together during shifts, thereby carrying a risk for crew exposure and quarantine.[10]

We aimed to prospectively observe and evaluate pre- and interhospital transportation of patients with suspected or confirmed COVID-19 in our P-EMS, with a focus on safety management for both patients and health care providers. The overall goal was to improve our practice and procedures for later stages of the current pandemic as well as for future epidemic outbreaks.

Methods

Study Setting

The Norwegian air ambulance system is governmentally funded and consists of 13 P-EMS helicopters, 7 search and rescue helicopters, and nine fixed wing aircraft.

The air ambulance departments at Oslo University Hospital (OUH) and Vestre Viken Hospital Trust (VVHT) are embedded in the national air ambulance system and use 3 helicopters (EC-135 T3 and EC-145 T2), 1 Westland Sea King search and rescue helicopter, 1 Cessna C680A Latitude, and 1 Beech B250 King Air fixed wing aircraft along with 2 ambulance vehicles designed for critical care transports and 1 high-consequence infection disease (HCID) critical care ambulance. There is 1 rapid response car (RRC) operated by OUH located in Oslo and 1 RRC operated by VVHT located in Drammen. Furthermore, air ambulance physicians occasionally assist on patient transfers with ordinary ambulances or RRCs when needed. The operational concept of care and transport of suspected or confirmed COVID-19 patients is depicted in Figure 1.

The OUH and VVHT helicopter emergency medical services (EMS) covers the southeastern region of Norway with a catchment population of approximately 2 million inhabitants. The fixed wing aircrafts operate both nationally and to a lesser extent internationally. The RRC in Oslo covers 1.2 million, and the RRC in Drammen covers 260,000 inhabitants.

Study Design

We performed a prospective, observational quality assurance study of primary and secondary missions conducted by the OUH and VVHT air ambulance departments starting on the day national safety measures aiming to achieve physical distancing were introduced (March 13, 2020). The study lasted until the national reopening with most restrictions being lifted (September 25, 2021). Patients were not subject to any additional interventions to what is considered established practice in the pandemic situation. The study sought to adhere to the Strengthening the Reporting of Observational Studies in Epidemiology guidelines.[11]

Inclusion Criteria

All missions in which any of the emergency medical communication centers (EMCCs) in our catchment area received support from our physician-manned services were eligible. In cases with suspected or confirmed COVID-19, the doctor receiving the request and responding to the job completed a case report form (c.f. Supplementary file I). The air ambulance doctor consecutively registers operational, patient, and management data relevant for each mission into the electronic patient record database LabasNG RW (Normann IT, Trondheim, Norway). The EMCCs consecutively enter a communication log into the acute medical information system (Nirvaco AS, Blomsterdalen, Norway). All study data were collated into Medinsight (Biobank and Registry Support, Oslo University Hospital, Oslo,

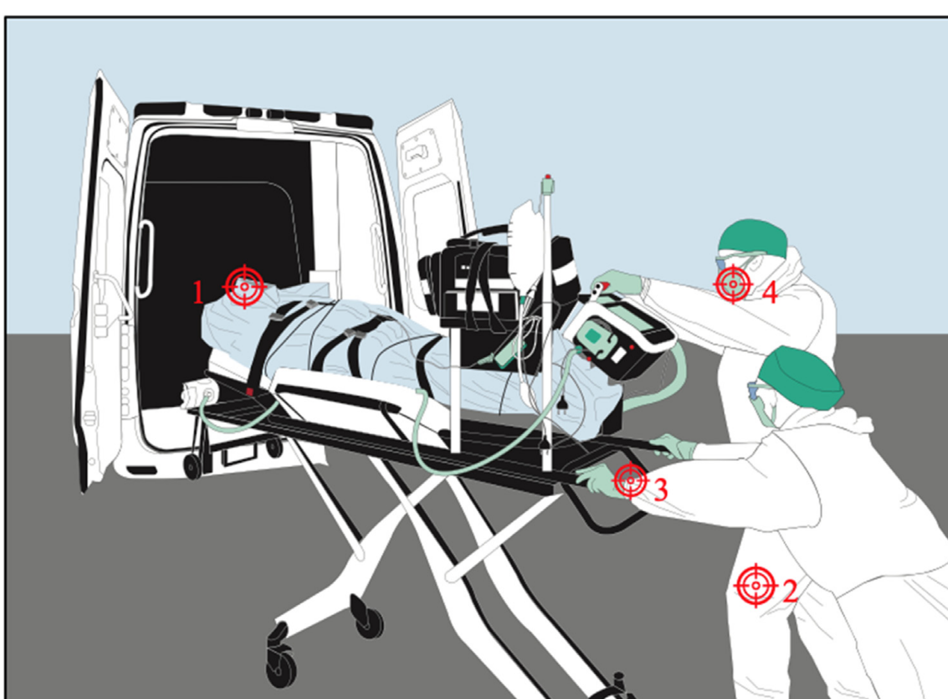

Figure 1. The operational concept of care and the transport of suspected or confirmed COVID-19 patients with indicated hotspots for accidental exposure risk. (1) Accidental disconnection of the endotracheal tube from the ventilator circuit. (2) A tear in the protective suit. (3) Defective gloves or a gap. (4) Forgotten or displaced protective mask.

Norway) and double-checked for accuracy. Deidentified data were extracted and analyzed in R statistical software (R Foundation for Statistical Computing, Vienna, Austria).

Exclusion Criteria

Aborted or rejected missions without any patient contact were excluded from the study.

Variables

We collected operational and patient descriptors (eg, the acute medical information system number, the time and location data, cooperating emergency services, platform descriptor [type of transport], age, and sex). Diagnoses were classified according to the *International Classification of Diseases, Tenth Revision*.[12] The severity of injury or illness was depicted using the National Advisory Committee for Aeronautics score.[13] Medical comorbidities were depicted using the American Society of Anesthesiologists Physical Status Classification System.[14] Management descriptors included the type of PPE, patient isolation initiatives, and vehicle protective measures. Patient interventions (ie, endotracheal intubation and ventilation), drugs (type and dose), mode of ventilatory support, fraction of inspired oxygen, positive end-expiratory pressure/continuous positive airway pressure, peak pressure/flow, and need for vasopressors were also collected. Feasibility was evaluated using data on operator-reported adverse events. User-reported procedural functionality and user-reported procedural confidence were described using a Likert scale ranging from 1 (does not work/no confidence) to 7 (works excellently/excellent confidence).

Statistical Analysis

Descriptive statistics were applied to present the data using the mean with the 95% confidence interval or the median with the interquartile range (IQR) as appropriate. No comparative statistical analyses were performed.

Ethics

Because this was a quality assurance project, the study protocol was considered outside the mandate of the Regional Committees for Medical and Health Research Ethics (REC reference 122901). The local data protection officers approved the study (OUS 20/07171 and VVHT 20/03358). The study is in line with the current European General Data Protection Regulation. Patient consent was not required.

Results

In total, 179 missions were eligible for this study. In 9 missions, patients were left on scene or transported by means other than our EMS. Of the remaining missions, 41 (24.1%) were primary missions, whereas 129 (75.9%) were secondary missions (ie, interhospital transports). Most patients (158 [92.9%]) were transported with ground-based vehicles, and 12 (7.1%) were transported by rotor wing aircrafts. One hundred thirty-four of 170 patients (78.8%) were COVID-19 positive at the time of transportation. In 24 (13.4%) missions, the reason for dispatch was not COVID-19 related, but they were handled as HCIDs mission because of known or suspected positive COVID-19 status. The modes of transportation and patient characteristics in primary and secondary transports are summarized in Table 1.

The frequency of missions eligible for the study varied throughout the 23-month period. The number of missions per month (Figure 2) shows a close correlation to the prevalence of COVID-19 in the general population.

In the group of patients undergoing secondary transports, 105 (81.4%) were either intubated or ventilated through a tracheostomy. The median fraction of inspired oxygen concentration was 0.60 (IQR, 0.50-0.80), the positive end-expiratory pressure was 11 cm H_2O (IQR, 8-13.5 cm H_2O), and the peak inspiratory pressure was 26 cm H_2O (IQR, 22-30 cm H_2O). Seventy-four patients (57.4%) received continuous infusion with vasopressors, mainly norepinephrine.

In addition, of the total population, 3 patients received inhaled nitric oxide during transport, and 5 patients were transported in the prone position. One of the prone patients was transported in a rotor wing aircraft, and 4 were transported in ground-based vehicles.

Physician ratings of an increased challenge in patient treatment, patient risk, and provider risk because of HCID protective measures are depicted in Figure 3.

Some degree of elevated treatment challenge was reported in 157 (87.7%) transports, and in 139 (77.7%), the patient risk was considered elevated. The physician stated that some degree of elevated risk for the provider was elevated in 131 (73.2%) of the transports. The reported complications during treatment and transportation of patients with COVID-19 or with suspicion of COVID-19 are depicted in Table 2.

Discussion

Helicopter EMS were involved in the transport of confirmed or suspected COVID-19 patients throughout the entire pandemic. Norwegian hospitals were found to operate within capacity during the pandemic and reported low mortality rates.[15] However, interhospital patient transfer capability was considered crucial to avoid decompensated intensive care unit capacity, and transfer activity was associated with the community prevalence of COVID-19. Because of crew safety, most transports were interhospital transfers using ground

Table 1
Modes of Transportation and Patient Characteristics in Primary and Secondary Transports

	Primary Transports		Secondary Transports	
	n	% or IQR	n	% or IQR
Number of patients transported	41	24.1[a]	129	75.9[a]
Ground ambulance	36	87.8	14	10.9
Intensive care ambulance	0	0	14	10.9
HCID ambulance	0	0	94	72.9
Air ambulance helicopter	5	12.2	7	5.4
Age	60	51-71	58	45-66
Male sex	28	56	84	67.2
COVID-19 verified pretransport	15	30.6	119	95.2
ASA-PS score	3	2-3	3	2-3
NACA score	6	4-6	5	5-5

Percentages are given as fractions within the specified group unless otherwise indicated.
[a] Percentage is given as a fraction of the total population.ASA-PS = American Society of Anaesthesiologists Physical Status Classification System; COVID-19 = coronavirus disease 2019; HCID = high-consequence infection disease; IQR = interquartile range; NACA = National Advisory Committee for Aeronautics.

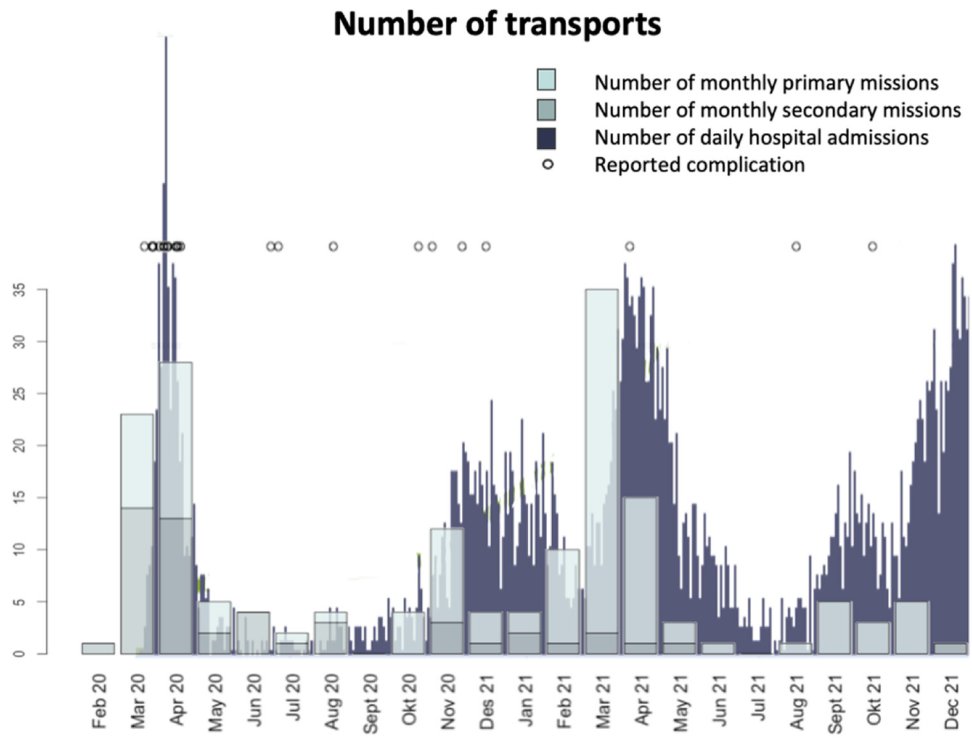

Figure 2. The number of primary and secondary missions per month superimposed over the daily number of national hospital admissions. The reported complications related to transport are indicated by small circles.

ambulances even with transport distances ordinarily covered by air. Most of these patients were intubated because of respiratory failure. Physicians rated a minor change in patient treatment and elevated patient and provider risk because of HCID protective measures in most transports. Our findings indicate that the safe care and transport of suspected or confirmed COVID-19 patients are achievable.[8,16]

A randomized trial concluded that dexterity and attention were not inferior when wearing PPE and that PPE should be used on a low-threshold basis.[17] The use of patient isolation units separating the patient from the medical crew has been described but requires training and availability of incubators.[18] It remains challenging for both EMCCs and EMS personnel to acquire adequate information of a patient's infectious status in primary missions.[19] Patients with COVID-19 and severe hypoxemia posed a considerable clinical challenge for the EMS.[4] International guidelines exist, but these should be continuously reassessed to secure best practice as experience and evidence emerge.[10,20]

Limitations

We recognize that the inclusion criteria were subjective but pragmatic, leaving a potential for inclusion bias. The questionnaire was developed under time pressure, and no recognized and validated format was applied. Also, prospective observational studies remain a risk for respondent fatigue.

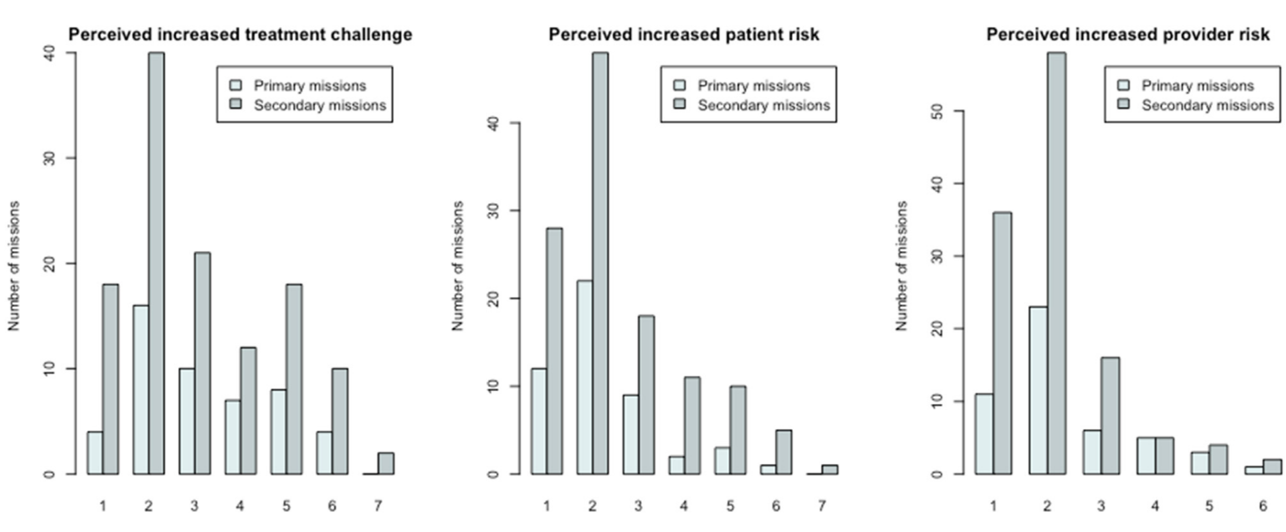

Figure 3. Physician ratings of an increased challenge in patient treatment, patient risk, and provider risk because of HCID protective measures. Data are presented on a 1 to 7 Likert scale where 1 is "no change" and 7 is "very large change" from normal.

Table 2
Reported Complications During Treatment and Transportation in Patients With Coronavirus Disease 2019 or With Suspicion of Coronavirus Disease 2019

Complication Category	Description	Number
PPE		
Protective suit	Tear in suit during dressing or treatment	5
Gloves	Tear or gap between glove and suit	2
Other	Forgotten PPE items, dislocation of mask, dew on glasses	4
Ventilator related		
Accidental disconnection from ventilator		9
ETT cuff leakage		1
Oxygen	Empty or shortage during mission	2
Other	Forgotten HEPA filter during RSI	1
Other	Delayed initiation of treatment because of PPE	1

ETT = endotracheal tube; HEPA = high-efficiency particle arresting; PPE = personal protective equipment; RSI = rapid sequence induction.

Conclusion

In future pandemics, EMS capacity to safely transfer patients remains essential to maintain resilient critical care capacity, and the perceived elevated risks should be considered in capacity planning.

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