



Expeditious formation of London Health Sciences Centre (LHSC) adult ground critical care transport team in aid of 3rd wave coronavirus disease 2019 (COVID-19) pandemic in Ontario, Canada

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Background: The third wave coronavirus disease of 2019 (COVID-19) infection resulted the highest number of intensive care unit (ICU) admissions in Toronto, Canada, which needed to decant to other hospitals in the Province of Ontario. The interfacility transport of critical and non-critical patients is the responsibility of the municipality Emergency Medical Services (EMS) and the provincially supported private company Ornge Air and Ground Ambulance Services in Ontario. The first time since the establishment of Canada Health Act that an official request from the publicly funded transport services were unable to fulfill all the requests for to offload the over-burdened ICUs to those with available capacity during the COVID-19 pandemic. In partnership with Middlesex London EMS, London Health Sciences Centre (LHSC) established a novel Critical Care Ground Transport (CCGT) team to assist Ornge with the transportation.

Case Description: A Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis to assess LHSC's potential to establish two CCGT teams staffed by critical care register nurse (CCRN), registered respiratory therapist (RRT) and ICU physicians were approved on Apr 15, 2021. April 16–May 7, 2021, Ornge requested twenty-five interfacility transports. Twenty-four were COVID-19 positive and all were mechanically ventilated. Twenty-two patients accepted for transport and three were declined. Five major patient adverse events occurred resulted increasing oxygen requirement and three equipment related incidence did not result any limitations with the transportation. All adverse events occurred early during transport and corrective actions taken following daily debriefings post transport.

Conclusions: The principles to establish an expeditionary CCGT team requires a clear mission goal with unwavering support from the institution and senior leadership. CCGT team member needs to have strong clinical, organizational, communication skills; the ability to work in small teams and the ability to thrive in extreme conditions.

Keywords: Coronavirus disease of 2019 (COVID-19); pandemic; ornge, intensive care unit (ICU); Critical Care Ground Transport (CCTG)

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Introduction

The Province of Ontario, Canada, experienced three waves of coronavirus disease of 2019 (COVID-19) infections since the declaration of the pandemic by the World Health Organization (WHO) on March 11, 2021 (1). The first wave in the spring to summer of 2020, the majority of deaths were among residents of long-term care facilities (2). A second state of emergency from January 12, 2021 till early March was influenced by the post-holiday surge of new COVID-19 infections (3). By mid-March 2021, a third wave resulted in the highest number of intensive care unit (ICU) admissions in Ontario since the start of the pandemic (4).

Ornge, formally known as Ontario Air Ambulance

Corporation, is a not-for-profit organization that provides air (rotary and fixed wings) and ground ambulance services for critical and non-critical care patients in Ontario (5). As the number of ICU COVID-19 patients rose, Toronto and surrounding hospitals quickly became overwhelmed. The Ontario Critical Care COVID-19 Command Centre urgently needed to offload patients from overburdened ICUs to those with available capacity (6). In response to the increasing demand, Ornge gradually expanded their critical care transport for air and land by 300% by April 7, 2021. However, this effort was not enough to offload the burdens of ICUs in a timely manner (7). An appeal for assistance came on April 8, 2021 from the Provincial Command Table and Ornge. London Health Sciences Centre (LHSC) in partnership with the Middlesex London Emergency Medical Services (ML-EMS) implemented a novel Critical Care Ground Transport (CCGT) team capable of transporting stabilized critically ill COVID-19 patients to the most appropriate hospital. The first transport took place on April 16, 2021.

We describe the operational process for the LHSC CCGT team and the characteristics of the twenty-two patients transferred between April 16, 2021–May 7, 2021.

Case presentation

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was not obtained from the patients transferred for publication of this case series due to the retrospective nature of this study. No accompanying images were used for publication. Copies of written consent is not available. No personal information written in the manuscript.

Operationalization LHSC critical care transport team

On April 9, an ICU physician lead, a clinical nurse specialist (CNS) and a senior registered respiratory therapist (RRT) at LHSC began a Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis to determine its potential to mobilize a CCGT (8). A potential strategy and developed protocol proposed and approved by senior leadership on April 13. Two teams formed consisting of one critical care registered nurse (CCRN) partner with a dedicated RRT. The North American RRT is an integral part of inter-professional healthcare team and trained to assess, monitor,

Highlight box

Key findings

- A pandemic such as coronavirus disease of 2019 (COVID-19) resulted the highest number of intensive care unit (ICU) admissions in Toronto, Canada which needed to decant to other local and regional hospitals to offload the burden in the ICUs.
- A clear mission goal and organizational accountability are required to organize an expeditious Critical Care Ground Transport (CCGT) team.
- Hospital senior leadership support is a must to expedite mandatory risk and safety assessments and mobilize required resources in the hospital and community.

What is known and what is new?

- Ornge, a government operated ground and air ambulance can be overwhelmed with critical care patient transport during a pandemic.
- Hospitals with adequate resources can establish own CCGT to assist in decanting critical care patients utilizing the Strengths, Weaknesses, Opportunities and Threats analysis (SWOT) to determine its potential to mobilized a CCGT with a clear mission goal and organizational accountability.

What is the implication and what should change now?

- Pandemic can overwhelm ICU care such as limited beds, ventilators, pharmaceutical agents and healthcare providers can result in increasing morbidity and mortality.
- Hospitals leadership needs to liaise with the provincial and municipal governments health authority; provincial or regional ground and air ambulance organization to establish multilateral cooperation and collaboration to maximize resources for patient care in preparation prior to a pandemic.
- Hospitals needs to maintain high quality CCGT members with strong clinical and communication skills; prior critical care transport experiences; ability to work well in a mobile enclosed platform and provide well maintained transport equipment.

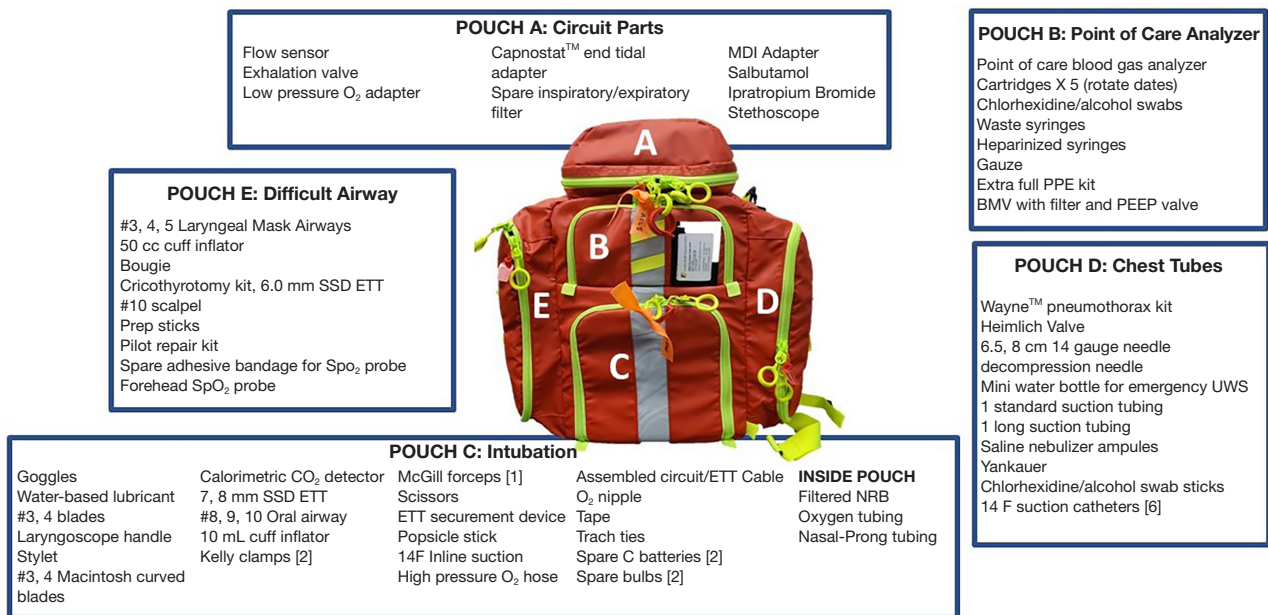


Figure 1 Airway/respiratory backpack. MDI, metered dose inhaler; BMV, bag-mask valve; PEEP, positive end-expiratory pressure; ETT, endotracheal tube; SSD, subglottic secretion drainage; NRB, non-rebreathing mask; PPE, personal protective equipment; SpO₂, oxygen saturation.

and treat individual patients with lung diseases or disorders. The skills involve the administration of oxygen, CPR, management of mechanical ventilation, administration of drug to the lungs, monitoring cardiopulmonary systems and measuring lung function. The CCRN and RRT members selected based on their strong clinical skills, advanced directives, prior critical care transport experiences, and ability to work well in a small team and in a mobile enclosed platform. Each team was scheduled to provide coverage from 0700–1900, 7-day a week, and on April 15, the newly formed CCGT completed their orientation. One transport per day planned to move patients west from Toronto to LHSC and surrounding hospitals or from LHSC to facilities west of London to accommodate additional inflow from Toronto. An ICU consultant or ICU fellow in training to care and manage patients with potential adverse events that may occur during a transport supported each team. Travel duration to and from LHSC were within 2–3 hours each way. This time limit was set by the constraint of a single M-tank carried in the ambulance, with the supply duration dependent on the oxygen flow rate.

In addition to the standard ground ambulance equipment (Lifepak defibrillator/pacemaker; suction), the team brought equipment familiar to the team the Hamilton T1

portable mechanical ventilator with low pressure oxygen (LPO) mode enabled; Philips IntelliVue X3 monitor with electrocardiogram (ECG), oxygen saturation (SpO₂) and 2 pressure cables; 4 Braun syringe pumps and 1 Baxter Sigma Spectrum infusion pump. Two Statpacks G3 Perfusion backpacks were used to carry disposable respiratory and cardiovascular supplies (Figures 1,2).

At 0700–0730, Ornge provided daily assignment. The on-call team contacted the sending facility to assess patient transportability (Figure 3). The inclusion criteria for transportation were ≥ 18 years old, COVID-19 positive and mechanically ventilated. The exclusion criteria for transportability mirrored Ornge operational criteria, which included fraction of inspired oxygen (FiO₂) $\geq 70\%$, positive end-expiratory pressure (PEEP) ≥ 15 cmH₂O, flow rate ≥ 15 liter/min, prone in the last 24-hour, on inhaled nitric oxide, patient greater than 84 cm wide and 272 kg, and hemodynamic instability that could not be stabilized by medications. Prior to departure, at 0800–0830, a ground ambulance from Middlesex London EMS with two primary paramedics awaits at the base hospital and review with the team members supplies and safety checklists.

Other transport documentations in addition to patient transportability created such as handover and Doctor of

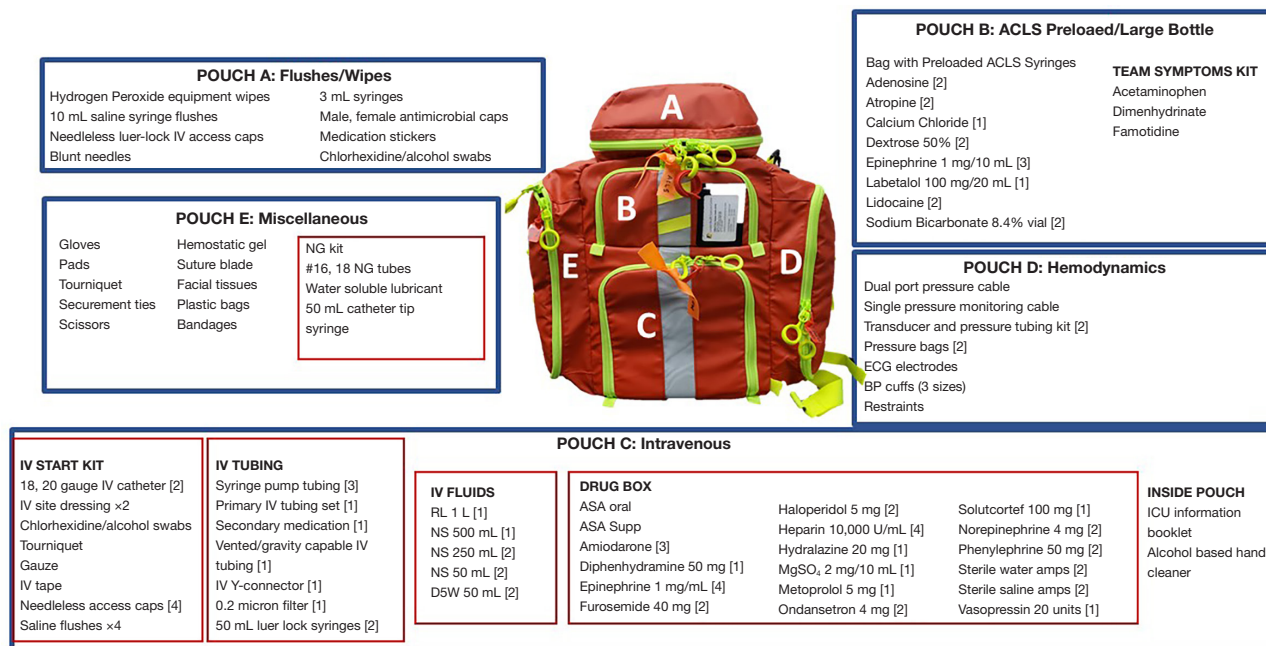


Figure 2 Cardiovascular backpack. ACLS, advanced cardiac life support; ASA, acetylsalicylic acid; D5W, 5% dextrose in water; NG, nasogastric; NS, normal saline; RL, ringer lactate; ECG, electrocardiogram; BP, blood pressure; IV, intravenous; ICU, intensive care unit.

Medicine (MD) in-transit documents (Figures 4,5). The CCRN and RRT documentation initially consisted of in-hospital documentation and graphic records. However, the CCRN switched to timed progress note entries on a separate progress sheet at every 30-minute interval for ease of recording during transport. The progress sheet handed to the receiving nurse at final destination.

After each completed transport, the CCGT and paramedic team debriefed with the project leader using a tool developed to review critical incidents, communication, team role, personal protective equipment (PPE) integrity, clinical concerns, readiness of sending and receiving facilities. Issues identified and addressed before the next transport and checklists modified as required on an ongoing basis. Upon returning to home base, the team members would sanitize all equipment and replenish transport supplies. Some of the lessons learned from the debrief were:

- (I) To minimize equipment failure during transportation, the CCTG team to perform a full equipment and battery check prior to departure from the sending hospital ICU.
- (II) Streamline documentations. CCRN and RRT to decide the most efficient and comprehensive documenting patient's hemodynamic and respiratory parameters.

- (III) Support effective communication environment between team member by encouraging feedback, ideas and suggestions.
- (IV) Contact patient's family members to ensure they know the patient to be transported outside of their home hospital and to provide them with the location and contact phone number of the receiving hospital.

Patients transported April 16–May 13, 2021:

April 16–May 7, 2021, Ornge requested twenty-five transports. Twenty-four were COVID-19 positive and all were mechanically ventilated. Twenty-two patients accepted for transport and three declined. Of these, two has escalating FiO₂ requirement and a third required dialysis, which was not available at the receiving hospital. The CCGT team transported patients from six Toronto west hospitals of which seven patients went to the Critical Care Trauma Centre (CCTC)-Victoria Campus; two patients to the Medical-Surgical Intensive Care Unit (MSICU)-University Campus and three patients each to Woodstock, Stratford and St-Thomas hospitals. During this period, LHSC continued to receive high acuity patients directly via Ornge and operated at a surge capacity of 130%. The LHSC ICUs needed to decant COVID-19 patients in their units to accept more backlog from the Toronto region. The

Transport Number:					
Report Taken From:		Date/Time:		SDM and Telephone:	
				Family informed of transfer? Y N	
Patient Name:		DOB:		Allergies: Blood Transfusion Refusal?	
Admission Date:		Sending Facility:		Sending Facility Address:	
		Sending MD:		Unit/Bed#: Phone#:	
Arrival Date:		Receiving Facility:		Receiving Facility Address:	
		Receiving MD:		Unit/Bed#: Phone#:	
Height and Weight		Resuscitation Status		Date COVID-19 Pos Neg	
				Isolation Precautions: Contact: Droplet: Airborne: None:	
Past Medical History:					
Temp:		BP:	HR:	RR:	SpO ₂ :
					FiO ₂ :
Relevant Medical Info/Reason for admission:					
Ventilator Settings:			IV Access: Foley: NG/Feeding Tube: TPN: Dialysis:		
CT & X-Ray/Echo/Cardiac Cath/other Procedures: LAST PRONED:			Cultures/Antimicrobials:		
Medication List: Dexamethasone started on?: Tocilizumab given?			Infusions:		
Laboratory:					
Hematology		Chemistry	Enzymes	Blood Gas	Misc.
Hgb		Glu	CK	FiO ₂	
Hct		BUN	Trop-I		
WBC		Creat	Repeat	pH	
Shift (L/R)		Na	1 st	PO ₂	
RBC		K	2 nd	PCO ₂	
PLT		Cl	3 rd	HCO ₃	
		CO ₂	LDH	BE	
INR		Ca		O ₂ sat	
PTT		Mg			

Figure 3 Pre-departure telephone medical assessment. SDM, substitution decision maker; DOB, date of birth; MD, Doctor of Medicine; COVID-19, coronavirus disease of 2019; Temp, temperature; BP, blood pressure; HR, heart rate; RR, respiratory rate; SpO₂, oxygen saturation; FiO₂, fraction of inspired oxygen; IV, intravenous; NG, nasal-gastric; CT, computed tomography; TPN, total parenteral nutrition; Hgb, hemoglobin; Hct, hematocrit; WBC, white blood cell; RBC, red blood cell count; PLT, platelet; INR, international normalized ratio; PTT, partial thromboplastin time; Glu, glucose; BUN, blood urea nitrogen; Creat, creatinine; Na, sodium; K, potassium; Cl, chloride; CO₂, carbon dioxide; Ca, calcium; Mg, magnesium; CK, creatine kinase; Trop-I, troponin-I; LDH, lactate-dehydrogenase; PH, potential hydrogen; PO₂, partial pressure of oxygen; PCO₂, partial pressure of carbon dioxide; BE, base excess; O₂ sat, oxygen saturation.

<input type="checkbox"/> Resuscitation Status	
<input type="checkbox"/> Precautions	
<input type="checkbox"/> Reason for Admission, COVID-19 timing	
<input type="checkbox"/> PMH	
<input type="checkbox"/> Neurological status	
<input type="checkbox"/> Airway difficulty <input type="checkbox"/> ETT Tip, size, markings at teeth <input type="checkbox"/> Ventilator parameters <input type="checkbox"/> Last gases <input type="checkbox"/> Suctioning <input type="checkbox"/> Trach day	
<input type="checkbox"/> Hemodynamic Stability <input type="checkbox"/> Vasoactive drugs? <input type="checkbox"/> Other BP interventions (fluid, diuretics, antihypertensives)	
<input type="checkbox"/> Heart rate and rhythm <input type="checkbox"/> Interventions? (antiarrhythmics, pacing)	
Renal <input type="checkbox"/> Urine output/Fluid balance <input type="checkbox"/> Urea/Creatinine	
GI <input type="checkbox"/> Feeding (enteral, TPN) <input type="checkbox"/> FT placement, marking on nose <input type="checkbox"/> Tolerance <input type="checkbox"/> Last bowel movement <input type="checkbox"/> Glycemic control, insulin	
<input type="checkbox"/> Lab abnormalities <input type="checkbox"/> Consent for blood products	
<input type="checkbox"/> Sepsis, cultures and antimicrobials	
<input type="checkbox"/> Skin	CVC: IHD: PICC: Arterial line: NG: FT/GJ (tip location) Foley : Rectal Tube : Chest Tube : Drains :
<input type="checkbox"/> Other issues <input type="checkbox"/> Copy of sending chart	Family SDM Telephone

Figure 4 Handover tool documentation. COVID-19, coronavirus disease of 2019; PMH, past medical history; ETT, endotracheal tube; BP, blood pressure; GI, gastro-intestinal; TPN, total parenteral nutrition; FT, feeding tube; CVC, central venous catheter; IHD, intermittent hemodialysis; PICC, peripherally inserted central catheter; NG, naso-gastric; GJ, gastrojejunostomy; SDM, substitute decision maker.

CCGT team decanted from CCTC and MSICU, seven and three patients to hospitals west of London Middlesex region.

Patient characteristics in *Table 1* describes older males were transported than females, while females transported had a higher body mass index (BMI). The transporting time from the sending hospital to the receiving hospital was less than 2-hour.

Prior to departure from the sending facilities, the CCGT team requested pre-transport stabilization intervention on six patients. Two patients required stabilization for hypotension, systolic blood pressure (SBP) <90 mmHg and/or mean arterial pressure (MAP) <65 mmHg for more

than 5-minute, while others required conversion of inhaled isoflurane to propofol infusion; insertion of a central line; clarification the goals of care and one cycle of peritoneal dialysis.

All twenty-one patients had the same mode of ventilation except one patient transitioned from pressure support ventilation (PSV) to adaptive support ventilation (ASV). *In-vitro* whole blood analyzer (ISTAT) utilized prior to arrival at destination found sixteen patients under-ventilated and five patients were over-ventilated. Although prone positioning within the preceding 24 hours considered a contraindication to transport, one patient who had been supinated within 2 hours of departure was successfully

Patient Name: DOB:	LHSC PIN: Gender: M F Transporting Team: RN_RT RN_RT_MD	Departure Time: Arrival Time: Accepting ICU: CCTC MSICU
Admission Dx:	Comorbidities: 1. 2. 3.	4. 5. 6. 7.
BMI:		
IV Lines: L/R IJ	L/R femoral	L/R PICC Peripheral IV L/R Dialysis Line
Mechanical Ventilation:		
Departure Parameter: 1. Mode/FiO ₂ : 2. Insp Pressure/Volume/RR: 3. TV: 4. Peak Airway Pressure: 5. PEEP 6. Blood gas		Arrival Parameter: 1. Mode/FiO ₂ : 2. Insp Pressure/Volume/RR: 3. TV: 4. Peak Airway Pressure: 5. PEEP 6. Blood gas
IV Infusions:		
Departure dose: 1. Fentanyl/Hydromorphone: 2. Propofol: 3. Versed: 4. Rocuronium: 5. Insulin: 6. Epinephrine: 7. Norepinephrine: 8. Phenylephrine: 9. Vasopressin:		Arrival Dose: 1. Fentanyl/Hydromorphone: 2. Propofol: 3. Versed: 4. Rocuronium: 5. Insulin: 6. Epinephrine: 7. Norepinephrine: 8. Phenylephrine: 9. Vasopressin:
IV Direct Medications and Total Fluid Given Enroute:		
Nutrition: NG Tube	Nasal Feeding Tube	G/J Tube Enteral TPN
Critical Incident:		
Event:	Action:	Result:

Figure 5 Physician enroute documentation. DOB, date of birth; LHSC PIN, London Health Sciences Centre patient identification number; RN_RT_MD, registered nurse _ respiratory technologist _ doctor of medicine; ICU, intensive care unit; CCTC, Critical Care Trauma Centre; MSICU, Medical Surgical Intensive Care Unit; BMI, body mass index; IV, intravenous; L/R IJ, left/right internal jugular; L/R PICC, left/right peripherally inserted central catheter; FiO₂, fraction of inspired oxygen; Insp, inspiratory; RR, respiratory rate; TV, tidal volume; PEEP, positive end-expiratory pressure; NG, naso-gastric; G/J, gastrojejunostomy; TPN, total parenteral nutrition.

transported. Lower oxygen tank consumption than anticipated was also observed with the Hamilton transport ventilator; had continued transports been required, higher FiO₂ threshold could have been supported.

One non-COVID-19 patient was in a neurological coma and the second patient was in the recovery phase did not require continuous infusions of narcotics and/or sedatives. Neuromuscular blockers were required in eight patients and vasopressors in ten patients. Patients transported from Toronto had higher acuity than those transported from LHSC.

Adverse events during critical care transport remains common and can be harmful to the patient. The incidence and severity of the events varies between published studies. This discrepancy resulted from the differences in the definition used for adverse events (9,10). We utilized the adverse event definition from Parmentier-Decrucq *et al.*, Table 2 (11). Major related patient adverse event included five patients required an increase of FiO₂ by 5–25% from baseline and one patient required FiO₂ 60% to 90%. However, two patients decreased FiO₂ from

Table 1 Patient characteristics

Patient characteristics	Value (N=22)
Age (years), median (IQR)	59.5 [36–82]
BMI (kg/m ²), median (IQR)	29.82 (19.27–36.31)
Sex, N (%)	
Male	14 (63.64)
Female	8 (36.64)
Comorbidities, N (%)	
Diabetes	9 (40.91)
Hypertension	10 (45.45)
Dyslipidemia	7 (31.82)
Asthma	1 (4.55)
CHF	1 (4.55)
Renal failure	4 (18.18)
Obesity, BMI >30	10 (43.48)
Minutes of transport (minutes), median (IQR)	113.50 (80–180)
PaO ₂ :FiO ₂ prior to transport, median (IQR)	192.5 (86.67–425)
PaO ₂ :FiO ₂ on arrival, median (IQR)	180.18 (100.83–454.29)
PaCO ₂ prior to transport, median (IQR)	50.50 (23–87)
PaCO ₂ on arrival, median (IQR)	52.05 (27–113)
Modes of ventilation, N (%)	
Departure	
AC-PC	13 (59.09)
AC-VC	5 (22.73)
PSV	4 (18.18)
Arrival	
AC-PC	13 (59.09)
AC-VC	5 (22.73)
PSV	3 (13.67)
ASV	1 (4.55)
Infusion medications, N (%)	
Departure	
Cisatracurium or rocuronium	7 (31.82)
Fentanyl or hydromorphone	19 (86.36)
Propofol or midazolam	17 (77.27)
Norepinephrine	12 (54.54)

Table 1 (continued)**Table 1** (continued)

Patient characteristics	Value (N=22)
Arrival	
Cisatracurium or rocuronium	5 (22.73)
Fentanyl or hydromorphone	18 (81.82)
Propofol or midazolam	17 (77.27)
Norepinephrine	12 (54.54)

IQR, interquartile range; BMI, body mass index; CHF, congestive heart failure; PaO₂, partial pressure of oxygen; FiO₂, fraction of inspired oxygen; PaCO₂, partial pressure of carbon dioxide; AC-PC, assist control-pressure control; AC-VC, assist control-volume control; PSV, pressure support ventilation; ASV, adaptive support ventilation.

Table 2 Adverse events definition during critical care transport

Major patient-related adverse events during transport:

- (I) Oxygen desaturation
- (II) Extubation
- (III) Accidental central venous catheter removal
- (IV) Hemodynamic instability
- (V) Increase vasopressor dose

Minor-patient related adverse events:

- (I) Agitation
- (II) Accidental nasogastric tube pulled out
- (III) Vomiting
- (IV) Peripheral venous catheter incident
- (V) Central venous catheter incident
- (VI) Arterial line incident
- (VII) Accidental dislodging of urinary catheter
- (VIII) Disconnection of endotracheal tube and airway equipment

Equipment-related incidents during transport:

- (I) Incident with airway equipment (alarm, adjustment)
- (II) Incident with monitor (battery, alarm)
- (III) Incident with infusion pumps (battery, alarm)

60% to 50%. There was no minor patient related adverse events. However, three equipment related incidents during interfacility transport, near misses related to electrical power. Battery charging failure occurred twice (syringe pump charging station and portable monitor). In each case, alternating current (AC) power was available which prevented an adverse event. A third incident occurred when there was an unrecognized loss of AC power in the ambulance. All device function was maintained because of adequate battery power. Each incidence occurred early on and corrective action was taken following daily debriefings. Additional checks including confirmation of ambulance and battery charge prior to departure was added to safety checklists.

Discussion

COVID-19 pandemic continues to challenge hospital systems and ICU capacity around the globe. To overcome demand, the movement of critically ill patients from overburdened regions to facilities with available capacity may be required (12). We describe here our experience and lessons learned in the successful creation of an expeditionary CCGT team, safely completed twenty-two regional land transports. From our experience, the main principles in establishing an expeditionary transport team are the following:

- (I) Conduct a SWOT analysis to identify potential resources, organizational impact and program feasibility (8).
- (II) Establish a clear mission goal and organizational accountability.
- (III) Obtain urgent senior leadership support in order to expedite mandatory risk and safety assessments and mobilize required resources.
- (IV) Establish clear communication channels between the transport team, emergency medical services and central dispatch (Ornge).
- (V) Select experienced team members with strong clinical, organization and communication skills. Members have demonstrated ability to thrive in uncertain situations and establish solutions in extreme conditions. The ability to maintain composure while working without usual support systems is critical.
- (VI) Develop protocols and safety checklists to be implemented quickly and modified daily as new experiences arise.

- (VII) Utilize a rapid cycle improvement strategy such as Plan, Study, Do, Act (PSDA) cycle to provide ongoing quality and safety.
- (VIII) Debrief daily and act on improvement opportunities immediately.
- (IX) Critical care transport is known to be difficult even during usual operations (13). It is imperative to establish clear communication with sending/receiving facility; choosing mode of transfer; pre-transfer stabilization and preparation; personnel accompanying the patient; equipment and monitoring required during the transfer; documentation and handover of the patient at the receiving facility (14,15). Evidence on clear transport principles and robust studies are lacking (16). A recent qualitative study published the importance of using checklists, special education programs, employing personnel interested in transport medicine which highlighted the need to standardize patient transports (15). Studies have also suggested that specific key qualities are required with the transport team members, such as collaborative teamwork, good problem-solving skills, mental agility, adequate physical fitness, compassion and excellent communication skills (14,17-19). It is accepted critically ill patients should be transferred by this specialized retrieval teams (20,21), but the composition, training and assessment of these teams is still an ongoing discussion (16). Certain skills and competencies have been noted to improve technical and non-technical performance during critical care transport; namely, previous ICU or deployment experience (22), flexibility, independence, critical thinking, problem solving, communication skills that enhance teamwork and crisis resource management (16,22). These research findings played a role in the development of our recommended principles.

In COVID-19 pandemic, many countries have shared their experience with transport of COVID-19 patients. Kuwait (23) and Singapore (24) demonstrated detailed planning that resulted in safe transport of mechanically ventilated patients, included broad categories such as transport equipment required, preparations before transport, the transport process, after arrival, and the post transfer decontamination. A set of transport guidelines developed in India to help mitigate the tremendous

overburdening of the health care system (25). In France, a recent study involving 133 inter-hospital transfers of mechanically ventilated COVID-19 patients did not find an increase in ICU mortality but did report an increase in the median length of mechanical ventilation in the transferred group compared to the non-transferred group, 18 days [11–24] and 14 days [8–20], respectively ($P=0.007$) (26). This supports creation of expeditionary CCGT teams to help mitigate the management and spread of COVID-19 surge and future pandemics.

Conclusions

Third wave COVID-19 hit Toronto, Ontario, Canada by mid-March 2021 had a significant impact on its health system capacity such as ICU beds and mechanical ventilators. A novel Critical Care Ground Transport team was formed utilizing the SWOT analysis to determine its potential to mobilized a CCGT with clear mission goal and organizational accountability. Transport team members must have strong clinical and communication skills; prior critical care transport experiences; ability to work well in a mobile enclosed platform with a small team. Utilize a rapid cycle improvement strategy such as PSDA cycle to provide ongoing quality and safety with each completed patient transport.

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Footnote

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at <https://jhmhp.amegroups.com/article/view/10.21037/jhmhp-22-137/coif>). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are

appropriately investigated and resolved. All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was not obtained from the patients transferred for publication of this case series due to the retrospective nature of this study. Copies of written consent is not available. No personal information written in the manuscript.

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