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Brief Report

Point-of-Care Laboratory Data Collection During Critical Care Transport

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A B S T R A C T

Objective: Critical care transport involves a high level of intensive clinical care in a resource-limited environment. These patients require multiple assessments guiding specialty treatments, including blood product administration, intravenous electrolyte replacement, ventilator management, and extracorporeal membrane oxygenation. This study aims to measure the usage of point-of-care (POC) laboratory data during critical care transport.
Methods: Data were collected via electronic medical record review over 1 year of use in a hospital-based critical care rotor wing, fixed wing, and ground critical care transport team in the Southeastern United States.
Results: One hundred twenty POC tests were performed during 1,075 critical care transports over the 1-year period (8.9%). Patient transportations involved 35 extracorporeal membrane oxygenation, 21 medical, 17 cardiac, 13 neonatal, 11 respiratory failure, 8 gastrointestinal bleeding, 6 neurologic, 5 pediatrics, 3 trauma, and 1 organ donor. Seventy-eight POC laboratory tests (65%) required intervention, including ventilator changes (39.7%), electrolyte replacement (35.8%), blood products (7.6%), and other (12.8%). The remaining 42 (35%) POC laboratory tests confirmed no intervention was necessary (n = 35) and that ongoing treatments were effective (n = 7).
Conclusion: POC laboratory testing performed during critical care transport guides providers in performing essential emergent interventions in a timelier manner that may benefit critically ill patients.

Laboratory data guide the clinical treatment of critical care transport patients.[1–5] Many rural and county hospitals have a lack of resources that necessitate transport to a higher level of care. Because these patients require complex care, transport teams rely on objective data to guide their treatment plan. This includes interventions such as blood product administration, intravenous electrolyte replacement therapy, endotracheal intubation and ventilator management, and advanced cardiopulmonary devices such as extracorporeal membrane oxygenation (ECMO), percutaneous microaxial pumps, or intra-aortic balloon pumps. Point-of-care (POC) analyzers have established usefulness during critical care transports.[1] However, there is not significant research in specialty care transport, such as specialty neonatal/pediatric teams or the transport of ECMO by air and ground. This report aims to illustrate the impact POC laboratory data can provide critical care transport teams for therapeutic yield in guiding patient care. Researchers in this study have no conflicts of interest to report.

Methods

Retrospective data were obtained from a digital charting database (ZOLL emsCharts, Chelmsford, MA, USA) involving critical care transports using POC iStat (Abbott, Santa Clara, CA) analyzer data from March 2019 to March 2020. This quality improvement project was determined to meet exemption by the institutional review board. The transport program consists of 2 helicopters, 1 fixed wing, and 11 ground ambulances. Crews consisted of nurse/nurse, nurse/paramedic, or nurse/respiratory therapist teams. The POC analyzers provide data for arterial blood gases, electrolytes, hemoglobin, and hematocrit.[6] Depending on patient needs, Chem 7 and Chem 8 iStat cartridges provide the following specific values: sodium, potassium, ionized calcium, hematocrit, hemoglobin*, pH, P_{CO_2}, P_{O_2}, total carbon dioxide*, bicarbonate*, base excess*, sulfur dioxide*, chloride, anion gap*, glucose, urea nitrogen/urea, and creatinine[6] (* = calculated). Equipment was

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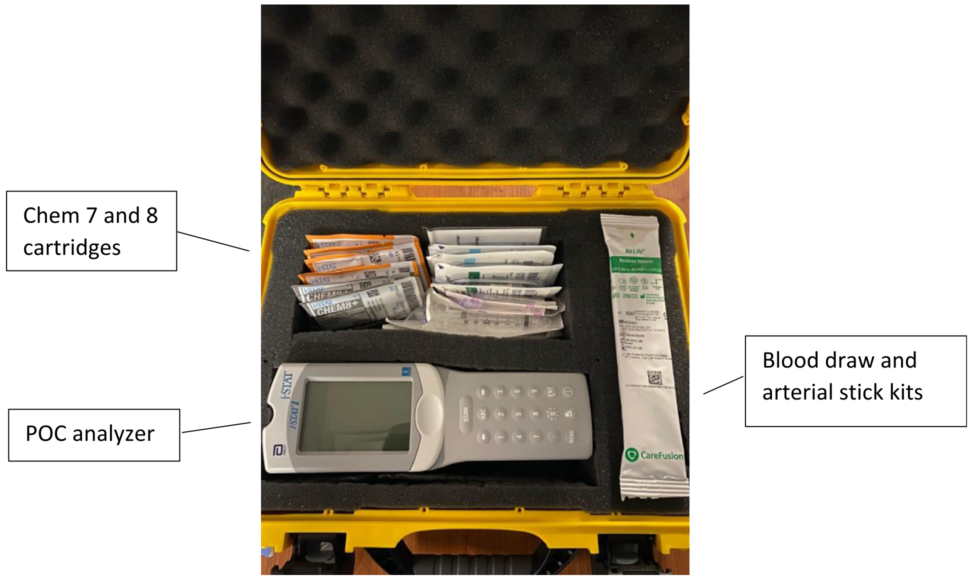

Figure 1. POC laboratory testing (Abbott iStat). All contents are lined by foam within a hard outer casing. Contents include Chem 7 and Chem 8 cartridges in the upper slot and blood draw and arterial stick kits on the right.

carried in a hard, plastic tough box for securing in vehicles during transport (Fig. 1).

The parameters for collecting POC laboratory data were protocol based. These included 1) known or suspected electrolyte abnormalities, 2) an acute change in patient condition, 3) a critically ill patient without laboratory tests in > 4 hours or blood gas analysis in > 2 hours, 4) a significant change to ventilator settings or concern for inadequate ventilation/oxygenation, 5) cardiac dysrhythmias, or 6) provider discretion based on clinical judgment or assessment findings.[7]

The transport team completed state board of nursing competency-based skills to acquire radial artery stick access, arterial line draw, or venous blood samples. Blood was obtained either at the bedside of the referring facility, in the requesting ambulance during a scene flight, or during air/ground transport. Interventions were selected by transport providers working within protocol-based guidelines approved by local medical control. Examples of intervention thresholds included administering blood for low hemoglobin, giving calcium for hypocalcemia, or pharmacology for hyperkalemia.

Results

There were 1,075 critical care transports with 120 iStat laboratory data assessments performed (8.9%). Of the 120 transports, 78 interventions for therapeutic yield were initiated (65.0%). Interventions were divided into 4 categories: ventilator changes (39.7%), electrolyte replacement (35.8%), blood products (7.6%), and other (12.8%) (Fig. 2). Of note, 29.1% of iStat uses were for ECMO patients, all of which resulted in an intervention, typically an ECMO rate change or blood transfusion.

Seven laboratory tests were performed to assess ongoing interventions from the referring hospital, such as checking hemoglobin for blood transfusion. Thirty-five laboratory tests indicated that no interventions were required. Patient ages ranged from weeks to 90 years old with an average age of 43.9 years. The demographics were 13 neonates < 40 weeks' gestation, 3 infants <1 year old, 4 children 1 to 18 years old, and 100 adults >18 years old. Transportation criteria were assigned to 10 categories: 35 ECMO, 31 medical, 17 cardiac, 13 neonatal, 11 respiratory failure, 8 gastrointestinal bleeding, 6 neurologic, 5 pediatrics, 3 trauma, and 1 organ donor.

Discussion

Our results illustrate that access to POC laboratory values in the setting of critical care transport provides data essential to performing emergent intervention for a therapeutic yield aimed to improve patient outcomes. Rapid results from the POC machine are able to give the transport team the relevant data to initiate or continue treatments.[1,8] These findings are similar to those reported by Gruszecki et al,[1] who found that using both physical examination and advanced POC monitoring could improve patient safety with quantifiable laboratory data.

Observations showed that patients requiring ECMO transports required complex medical management. These patients required

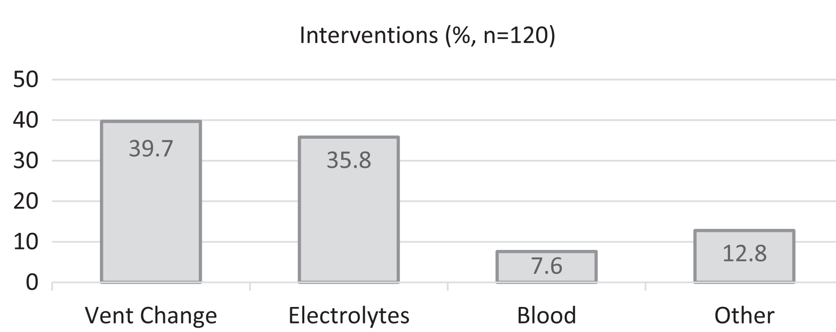

Figure 2. The percentage of interventions resulting from POC test results (N = 120).

frequent laboratory assessments to prompt interventions and resuscitation.[9] After cannulation, the teams were able to verify that ECMO was working to lower P_{CO_2} and increase p_{O_2}. With this resource, a ventilator protocol was created to align evidence-based practice in postcannulation ventilator strategy earlier before departing the bedside for transport.[7] The critical care transport community has yet to publish data on this particular subset of information, and efforts should be taken to explore this patient population. Data collected in this study were used to implement new protocols. By adding the iStat POC laboratory data to the critical care transport team arsenal, the team was able to increase their ability to deliver treatments. The 2020 protocol changes included adding the ability to administer packed red blood cells to medical patients with hemoglobin less than 8 g/dL with signs of shock or any hemoglobin less than 7 g/dL[7]; previously packed red blood cells were only given to trauma patients with signs of hypotensive shock. An entire protocol was created to include correction or replacement therapy of electrolytes. This included replacing 20 mEq potassium for serum potassium < 3.4 mmol/L or giving 1 g calcium gluconate and 50 mEq sodium bicarbonate for potassium > 5.5 mmol/L,[7] the administration of 2 g calcium gluconate for calcium < 7.5 mg/dL or ionized calcium < 1.0 mmol/L,[7] and administering 2 g magnesium sulfate for magnesium < 1.7 mg/dL.[7]

As reported, there were 35 laboratory draws that did not require an intervention. This validated that the patients had received the early interventions they needed, such as outside hospital blood products, electrolyte therapy, or adequate ventilator settings. Among the 35 laboratory draws, there were 7 laboratory draws that were tests that validated current therapy (ie, infusion of packed red cells with a new hemoglobin > 8 g/dL or a repeat arterial blood gas after ventilator changes at the sending hospital).

Conclusion

Using portable POC laboratory analyzers for critical care transport guides providers in performing essential emergent interventions in a timelier manner that may benefit critically ill patients. Specifically, the transport of ECMO patients benefits from POC laboratory testing due to the amount of interventions needed and the complexity of their transport. Long-term patient outcomes were not explored. Exploration of 30-, 60-, and 90-day mortality rates and survival to discharge rates is warranted. The financial impact was not explored and would be valuable in future studies.

Further investigation of program operational complications will be crucial for improved patient outcomes in future transports. Exploration of other benefits from POC laboratory testing should be explored such as a measuring lactate in sepsis patients, titrating activated partial thromboplastin time in cardiac assist devices, or arterial blood gases in the setting of nitric oxide and epoprostenol inhalation.

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