Portable Patient Transport Life Support System (PPTLSS) for Quickly and Efficiently Moving Warfighters through the En Route Casualty Care System (ERCCS)

White Paper
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MOVES® SLC™ Portable ICU

MOVES® SLC™
PORTABLE LIFE SUPPORT SYSTEM

THORNHILL MEDICAL
INSPIRING INNOVATION

Introduction

The battlefield environments that United States Forces face today are becoming increasingly hostile and rapidly change day-to-day, and often hour-to-hour. To succeed in this environment, our Warfighters must be highly mobile and be able to respond quickly so the enemy can be confronted at the right time and place. This battlefield environment requires a reduced medical presence that can respond quickly to provide tactical medical evacuation without compromising the standard of care.

The battlefield is the first stage of the ERCCS which is a system designed to ensure that injured warfighters receive lifesaving care from the point of injury to definitive care in the least amount of time. As injured Warfighters are moved through the system, multiple Advanced Life Support (ALS) interventions are performed by medics, doctors, nurses and surgeons to prevent Warfighters from succumbing to their injuries. As each ALS procedure is performed, the medical equipment needed to monitor and support the patient increases. This equipment is often referred to a PPTLSS. Equipment making up this system includes oxygen administration, ventilation assistance, cardiac monitoring, suctioning of airway, and vital sign monitoring. Without a PPTLSS, a patient cannot be properly supported nor can they be safely moved to a location with a higher standard of care (i.e. field hospital to hospital ship).

Movement through the ERCCS can involve something as simple as a two-person litter or as complex as C-130 transport plane and as the patient progresses, and the PPTLSS must be able to be moved with them without any interruption of care.

Current Challenges

To support a patient while proceeding through the ERCCS system, a PPTLSS must travel with the patient and include the following capabilities: an oxygen supply, ventilator system, suction system, cardiac monitoring, and vital sign monitoring. Currently, all these devices are independent of each other which results in the following challenges for care givers:

Current Equipment Required

- Patient blocked by equipment

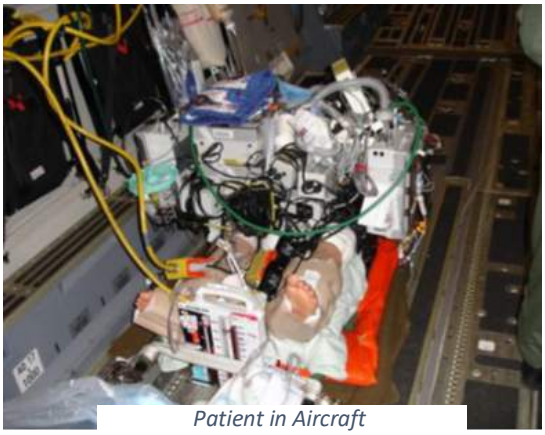
Patient Equipment Hindering Treatment

- Multiple screens to monitor
- Multiple types of batteries and chargers to keep on hand for each device while patient is moved
- Carrying enough oxygen cylinders to last through the treatment and transport in addition to the dangers of transporting compressed oxygen cylinders especially during flight operations

Oxygen Tanks Required in Transport

- Multiple personnel required to move patient and equipment, if even for short distances due to fact equipment must move along with patient
- Current equipment is designed for use in environmentally-controlled surgical suites, and may not be able to function or withstand the harsh conditions the ERCCS is faced with
- Current equipment does not travel efficiently on military vehicles and aircraft

Patient loading into Ambulance



Patient in Aircraft

As the information above conveys, the current PPTLSS equipment in use is not designed to perform in the ERCCS, nor do they make efficient use of personnel (treatment and transportation) and vehicle and aircraft space.

Solution

The MOVES® SLC™ is a commercially available portable integrated life support system that integrates the functions of a unique oxygen conserving circle circuit ventilator, an oxygen concentrator, physiological monitoring and suction (aspiration) that provides comprehensive warfighter care as they proceed through the ERCCS. This unit is small, lightweight, portable and rugged requiring only one display and one set of controls. The MOVES®SLC™ relieves the logistical burden of transporting multiple devices and compressed oxygen cylinders as the warfighter makes their way through the ERCCS.

The MOVES®SLC™ device was designed in partnership with the United States Marine Corps to meet several key requirements:

- Providing standard of care oxygen therapy for critically injured patients ***without oxygen tanks***
- Complete integration of monitoring, ventilation, suction and oxygen concentration in a truly integrated system
- Fit in all transport platforms from a basic litter to an intensive care gurney with complete access to the patient throughout the movement in the ERCCS

The MOVES® SLC™ builds upon the functionality of the current PPTLSS deployed by the USMC through the development of an improved user interface and display, the addition of a broader range of ventilator modes, the addition of more physiological monitors that are more advanced, as well as full functionality with a separate optional remote screen interface module (tablet). Furthermore, the oxygen concentrator can be run cyclically to provide an FiO_2 up to 85% for ventilated patients (similar to the current PPTLSS) but can also be run in a new continuous mode to provide an even higher FiO_2 to ventilated patients while also having functionality to operate as a standalone low flow oxygen concentrator capable of providing breathing gas with a high concentration of oxygen to a mask or nasal canula. The MOVES® SLC™ is also smaller and lighter than the current PPTLSS presently in use. Functionality includes:

- Physiological Monitoring: FiO2 / ETCO2 (+Capnography) / ABP / CVP / ICP / NIBP / Masimo® SpO2 (+Optional Masimo® Rainbow® SET Parameters) / 12 Lead ECG / Patient Temperature (x2); Patient data trends up to 24 hours
- Oxygen Concentrator: FiO2 up to 85% (independent of minute ventilation) for ventilated patients in cyclic mode; FiO2 greater than 85% (independent of minute ventilation) for ventilated patients in continuous mode; up to 93% O2 in concentrated breathing gas at 2.5 LPM for non-ventilated patients
- Ventilator: IMV / SIMV / SIMV+PS / AC / PSV / APRV (Pressure or Volume Control)
- Suction: 100 - 325 mmHg

In addition, the MOVES® SLC™ has been designed to operate in the harsh environments associated with the battlefield and the transportation challenges faced in the ERCCS. System specifications:

- Weight: 17 kg (37 lbs.) excl. batteries/clamps
- Battery Weight: 1.5 kg (3.3 lbs.) each
  Dimensions: 84 cm (33″) L x 14 cm (5.5″) W x 25 cm (10″) H
- Body Material: Aluminum
- Temp-Operating: -26 °C to 54 °C (-15 °F to 129 °F)
- Temp-Storage: -26 °C to 60 °C (-15 °F to 140 °F)
- Water Ingress: IPX4
- Humidity: 15% - 95% RH non-condensing
- Altitude: 0 - 5.5 km (18,000 ft.)
  Vibration: Tested to MIL-STD-810G and US Army Joint Enroute Care Equipment Test Standard (JECETS) for rotary-wing, fixed wing and jet aircraft as well as ground transportation vehicles.
- Power: 100-240V AC 50/60Hz or battery power
- Battery: Lithium polymer
  - Typical: up to 6 hrs. / set of 2
  - Minimum: 2.5 hrs / set of 2
  - Charge time: 2.5 hrs / set of 2

The MOVES® SLC™ has been tested to confirm it meets all specifications listed above, as well as the relevant FDA and international standards for electronic medical devices with respect to the functionality is possesses. The MOVES® SLC™ is FDA approved under reference K161420, and is also approved for sale by Health Canada, the European Economic Area (CE Mark), and several other jurisdictions worldwide. The MOVES® SLC™ has undergone real and simulated life-cycle testing to confirm reliability in various extreme environmental and use environments. It has also been evaluated for airworthiness by the United Stated Army Aeromedical Research Laboratory (USAARL) against the Joint Enroute Care Equipment Test Standard (JECETS). Test data generated or

commissioned by TRI can be supplied if requested, and test data generated by USAARL can be found in "USAARL Report No. 2016-14", which can be obtained by contacting the USAARL Enroute Care and Airworthiness Division directly for further instructions.

Summary:

The MOVES® SLC™ design makes it safe and easy to operate by enlisted personnel with minimal paramedic training. What sets it apart from any other PPTLSS is that at present the MOVES® SLC™ is the only existing full circle portable/transport ventilator in the world. We have designed it with the thought of remote and hostile environment operations by minimally qualified personnel. It is meant to remain operational in the rain or sea spray short of immersion, as well as in dust storm or air polluted with exhaust gasses.

The MOVES® SLC™ has been designed to incorporate multiple medical devices and monitors that currently make up a PPTLSS into one single portable unit that can stand up to the harsh conditions of all the phases of a ERCCS. With the ability of MOVES® SLC™ to function in both field surgical suites and hospitals, as well as during ground or air transport, the device can stay connected to the patient throughout the continuum of care without the need for transfer from one set of equipment to another. This system is currently deployed by the Belgian and Malaysian Armed Forces.