AFRL
AIR FORCE RESEARCH LABORATORY

ADVANCING MECHANICAL VENTILATION (MV) through

KEY BENEFITS

- **Train clinicians w/ limited exposure**
- **Long-term material solution to support patient /casualty care w/ mechanical ventilation**
- **Achieve a higher level of competency through better training & preparation of clinicians.**
- **Optimizes care for patients requiring mechanical ventilation.**
- **Improves patient management during patient movement.**

WHAT IS IT?

Caring for combat casualties often requires MV to provide accurate oxygen delivery and support safe, efficacious patient care during movement across expeditionary and en route care (ERC).
MV requires settings unique to each patient and managed by clinicians to ensure proper oxygenation levels.

The technology allows clinicians to practice MV patient management w/ validated simulated scenarios. Learners can adjust the ventilator and monitor real-time patient responses driven by a physiological model.

The advanced trainer currently has seven validated scenarios: 1) Mild Acute Respiratory Distress Syndrome (ARDS) w/progressive fall in Oxygenation, 2) Moderate Chronic Obstructive Pulmonary Disease (COPD) w/subsequent Bronchospasm, 3) Mild Traumatic Brain Injury (TBI) w/worsening ARDS, 4) Mild ARDS w/tension Pneumothorax, 5) Moderate ARDS w/Right Mainstem Intubation, 6) Hypoxemic Respiratory Failure-Pneumonia, 7) Hypoxemic Respiratory Failure Plugged ETT.

The technology allows clinicians to gain/maintain competency through better training and preparation to manage combat casualties requiring MV. The goal is to prepare clinicians and maintain skills and abilities.

HOW DOES IT WORK? Over the last two years, AFRL, Human Effectiveness Directorate, Air and Space Biosceinces Division, Product Development Branch, En Route Care Section collaborated with the University of Cincinnati, InGMar Medical LLC, and Kitware Inc. to advance an initial prototype of an all-in-one advanced simulator for training in mechanical ventilation.

The system is designed to allow clinicians to practice providing care consistent with current and emerging best practices and in compliance with ARDSNET and Joint Trauma Clinical Practice Guidelines. Each scenario provides relevant clinical data for the clinician to manage the patient. The system is designed to operate without a human trainer.

Each scenario allows the clinician to make changes and responds with appropriate physiological responses based on ARDSNET/CPG. It provides real-time feedback and debriefs after each scenario.

MV is used throughout the continuum of care. This advanced simulator can prepare our clinicians to provide critical care.

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WHY IS IT IMPORTANT?

Clinicians currently utilize mechanical ventilation, both public and military, to care for patients who require breathing support due to various conditions. These include ARDS, chronic lung disease conditions, acute lung injuries, and trauma. Mechanical ventilation has been framed as a very common lifesaving intervention. Some data suggest that over half of patients who are admitted to an intensive care unit in the United States will require at least 24-72 hours on a ventilator for support. Managing these patients requires extensive training due to the various complications and methods to treat the conditions. In the military environment, the use of mechanical ventilation can be found from the point of injury to role 5, and the care for patients can become very complicated due to several factors such as the need for prolonged care, austere environment, transport, either via rotary wing or critical care air transport teams (CCATT) and task saturation can confound this complex modality.

Another factor for the military to consider is the potential for skill decay. Many military medical treatment facilities are limited to the type of patients/high acuity levels that require mechanical ventilation. However, clinicians stationed at lower care facilities can often be deployed with the expectation of providing intensive care. When this occurs, the military clinician will require just-in-time or refresher training to ensure skills are refreshed.

The advanced mechanical simulator is designed to train clinicians responsible for treating patients using mechanical ventilation at all skill levels and experiences. *Short-Term Impact: The development of this mechanical ventilation simulator provides realistic and advanced* scenarios based on current clinical practice guidelines as a training tool to augment training needs. The simulator includes clinically relevant scenarios that can be utilized by any learner. The simulator also provides feedback and, if needed, recycling of the scenario to ensure full comprehension. *Long-Term Impact:* Delivers a solution to a gap in the Joint community. This need has been highlighted as recently as the COVID-19 pandemic and supported by the Air Force Education and Training Command: "I can envision not only CCATT training but training for all providers who lack regular ventilator exposure to ensure that providers are prepared for pandemics or other mass utilization scenarios." The advanced simulator can provide a long-term material solution to support any patient/casualty that requires mechanical ventilation and will help create a more robust training tool for public and military clinicians.

Hardware-in-the-Loop Simulation Pipeline

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