

Ventilator Weaning in the Pediatric Population:

Which assessments best predict readiness and success of ventilator weaning for the pediatric patient population who utilize ventilator support due to neuromuscular deficits?

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Objective

After a catastrophic injury or disease that results in a patient requiring mechanical ventilation, a primary goal for patients and families upon transition to rehabilitation hospital is determining the potential for the patient to regain the ability to breathe independently.

Nationwide (and worldwide), the pediatric population who utilize mechanical ventilator support following neurologic injury or disease has very few options for ventilator weaning once they are discharged from the ICU setting. Unlike the adult population, who have potential to pursue ventilator weaning in various long term acute care hospitals (LTACHs); there are very few such options for the pediatric population.

In the past 3-4 years, considerable expertise has been developed at SRALab to perform thorough neuromuscular assessment and treatment of diaphragm and respiratory muscle function in order to optimize the success of pediatric patients weaning from ventilator support. Pediatric physical therapists (PTs) at SRALab with advanced pulmonary training have initiated respiratory muscle assessment and manual neuromuscular facilitation techniques to provide targeted breathing re-training based on the patient's specific neurological presentation. Respiratory therapists (RTs) have increased

utilization of various pulmonary function tests/measures to assess a patient's inhalation and exhalation abilities. Furthermore, Dr. Colin Franz has supplemented the standard electrophysiologic techniques of phrenic nerve conduction studies with point of care neuromuscular ultrasound to assess hemi-diaphragm muscle bulk and contractility.

Over the past 2 years, an interdisciplinary team at SRALab has been working to formalize a "Ventilator Weaning Program" for pediatric patients with various diagnoses and adult patients with cervical SCI. Based on the heterogeneous nature of pediatric patients who use a ventilator due to neurologic impairments, there is very limited research as to best assessments for determining readiness for ventilator weaning [5, 11].


Over the past three months, our inter-disciplinary team has worked to successfully wean three pediatric patients from ventilator support. These patients had failed multiple attempts of ventilator weaning at previous settings. Given these case examples, it is becoming increasingly clear to our team that our approach and PT involvement for providing neurological assessment and neuromotor re-education has a tremendous impact on the success of ventilator weaning in this population.

With the rollout of the formal vent weaning protocol, we anticipate an increasingly steady volume of pediatric patients appropriate to initiate ventilator weaning. As we work to build this program, there is great opportunity for research into the most appropriate and feasible assessments to identify patient readiness and predict patient success with ventilator weaning.

The objective of this proposal is to collect and analyze data from specific assessments gathered by five disciplines (PT, RT, Pulmonary Medicine, Neuromuscular Medicine, Pediatric Rehabilitation Medicine). These disciplines will work together to initiate and progress ventilator weaning in the pediatric population who utilize ventilator support due to neuromuscular deficits. Upon collection of these specific assessments, data analysis would be conducted to determine correlation of values to success of ventilator weaning.

Assessments:

1. Pulmonary Measurements & Vitals (conducted by RT)
 - a. Tidal Volume
 - b. Vital Capacity (if cognitively able)

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- c. Negative Inspiratory Force
 - d. Oxygen Saturations
 - e. Heart rate
 - f. Respiratory Rate
 - g. Transcutaneous CO2
 - h. Blood Gas Values
 - i. Type and size of Airway
2. Chest Wall Excursion Measurements (conducted by PT)
 - a. Assess active expansion of chest wall to identify which respiratory muscles are activating during spontaneous breathing trials
 3. Diaphragmatic Ultrasound (supervised by Dr Franz)
 - a. Assess muscle bulk and contractility of right and left sided diaphragm muscle

Target Patient Population

Pediatric patients who present to SRALab with current ventilator dependence, but with clinical presentation and prognosis for potential liberation from ventilator support for any period of time.

Targeted pediatric diagnoses to include, but not limited to:

- SCI
 - Cervical SCI with some sparing of C3-C5
- Neuromuscular Disease
 - Guillen-Barre Syndrome
 - Transverse Myelitis
 - Acute Flaccid Myelitis
- Neurological Disease
 - Acquired (traumatic or oncology-based) brain injury
 - Febrile infection-related epilepsy syndrome (FIRES)
- Muscular Dystrophies who are recently on a vent due to functional decline based on non-pulmonary progression of disease
 - Ex: patient sustained a fracture and was placed on a short term vent
- Critical illness neuropathies/myopathies

Requested Support

Protected time for collaboration between PT, RT, and clinician-scientist to further develop the above current assessments, collect data and analyze correlations amongst the various data points and ventilator weaning success

Global Reach of Project

Literature reviews have identified a severe lack of research to guide clinical decision making regarding readiness, initiation, and progression of ventilator weaning in this targeted population [1, 7]. Additionally, very few nationwide rehabilitation hospitals specialize in, or even accept, pediatric patients with goals for ventilator weaning. The few institutions that do offer ventilator weaning for pediatric patients (Kennedy Krieger Institute, Shepherd Center, for patients over 12 years of age), do not have programs that incorporate PTs with pulmonary muscle expertise in the weaning process.

Due to these factors, SRALab is uniquely suited to become a worldwide leader in both the clinical care and research of ventilator weaning for pediatric patients with neuromuscular conditions.

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