Introduction
Invasive means of ventilation via the use of a tracheostomy or electrophrenic respiration have been a widely administered method of ventilatory support in traumatic high level quadriplegic patients. However, research shows these forms of respiration to be ineffective for long term survival. Noninvasive forms of ventilation have been proposed as possible alternatives due to prior success in patients with muscular dystrophy, poliomyelitis, and generally poor vital capacity.

Purpose
The study investigated whether or not noninvasive forms of ventilation are effective in prolonging survival rates in traumatic high level quadriplegic patients.

Methods
N = 80; 64 males and 16 females
Mean age of subjects was 21.9 years
All subjects were ventilator dependent prior to partaking in the study.

Subjects underwent intensive pulmonary rehabilitation, gradually progressing to independent, noninvasive respiration over an eight step protocol:
1) Tracheostomy Intermittent Positive Pressure Ventilation (TIPPV) with full cuff inflation
2) TIPPV with deflated cuff during the day and partial inflation at night
3) TIPPV with deflated cuff at all times
4) Implementation of day-time Mouth Intermittent Positive Pressure Ventilation (MIPPV) training
5) Cuffless tracheostomy tubes
6) Full independence from tracheostomy ventilatory support with MIPPV as needed; nasal, mouth, or combo IPPV at night
7) Tracheostomy tube removed and replaced with button to allow closure at site
8) Continuation of MIPPV as needed with gradual progression of independent breathing

Results
Thirty-one of the original eighty subjects were successful with the weaning protocol. Twenty-five became independent enough to be discharged to either private residences or chronic care facilities. Only seven of the subjects were able to utilize long term 24-hour non-invasive ventilatory support following discharge (mean age: 25.4 ± 12.1 years; average length of use: 12.4 ± 6.3 years)

Discussion
Results showed non-invasive means of ventilatory support to be effective in a little less than a third of the total number of subjects. Factors such as motivation, expiratory muscle function, and converting from endotracheal intubation compared to tracheostomy all may produce greater results.

Conclusion/ Clinical Significance
Noninvasive means of respiration in traumatic high level quadriplegic patients can be a viable option for improving respiration. Success with these forms of respiration will result in a more natural form of breathing for patients, and less burden on caregivers. As physical therapists, it’s important to have a general understanding of the overall weaning procedure in order to assist in the direction of treatment and making appropriate clinical judgments.

Article #1
Two men with complete C1 quadriplegia were proven successful in noninvasive positive pressure ventilation. Both were ventilator dependent prior to the study. Health care providers adjusted ventilator settings and cuff inflation until noninvasive ventilation training was safe. Both men were discharged within several months of hospital admission to home care settings with successful outcomes.

Article #2
The effectiveness of two invasive forms of weaning from mechanical ventilators was investigated. 82 subjects were treated with either intermittent mandatory ventilation (IMV), progressive ventilator-free breathing (PFVB), or a combination of both. IMV consists of gradually decreasing the respiratory rate on the mechanical ventilator until the patient became independent with breathing whereas PFVB involves taking the patient off the mechanical ventilator completely and introducing breathing exercises via t-piece. The overall success rate was 83% with PFVB more superior in comparison to IMV.

Summary
Traumatic high-level spinal cord injuries have a significant impact on respiration. Whether through the use of invasive or non-invasive means, the overall weaning procedure is intensive. Success with weaning is not guaranteed and patients are at risk for many health issues throughout the process. However, the act of independent breathing improving the quality of life in quadriplegic patients is undeniable. Therefore, further research is indicated on the most effective means of ventilatory weaning, whether invasive or non-invasive.

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NON-INVASIVE OPTIONS FOR VENTILATORY SUPPORT OF THE TRAUMATIC HIGH LEVEL QUADRIPLEGIC PATIENT
Non-invasive overnight only

Non-invasive 24 hours/day

Non-invasive during daytime off cool overnight

TIPPV overnight, MIPPV or IPPV during daytime

%