Introduction

Persons with spinal cord injury often have neuromuscular consequences that directly affect their respiratory function. Individuals with tetraplegia may have decreased diaphragm motor function that impairs ventilation. Injuries at the thoracic level (paraplegia) can result in the loss of intercostal (located between the ribs) muscles as well as abdominal muscles. This places them at risk for developing pneumonia (lung tissue inflammation of infectious etiology) and other respiratory complications such as atelectasis (a state of airlessness within the lung) and ventilatory failure.

The National Spinal Cord Injury Statistical Center (NSCISC) has been following individuals with SCI for 25 years after injury. During that time, the causes of death that appears to have the greatest impact on reduced life expectancy for this population includes pneumonia, pulmonary emboli and septicemia.

Pulmonary Care during Hospitalization

To minimize respiratory problems after a spinal cord injury, one needs to practice proper techniques and treatments during acute care and in rehabilitation. These include proper positioning and postural changes, proper breathing techniques, coughing, and suctioning. It is important to give vaccinations for influenza and pneumococcal infections during this time.

An increasing number of individuals who survive the initial spinal cord injury require tracheostomy placement and ventilatory support in acute care. Often times, support is needed for weeks following. When a ventilator is no longer required, ventilatory assistance using BiPAP (biphasic positive airway pressure system) may be required.

A common practice in pulmonary rehabilitation with individuals with SCI is to perform the QUAD cough or manually assist the patient as he/she coughs voluntarily. Another technology available uses a device that assists the individual in clearing bronchopulmonary secretions. This non-invasive procedure gradually applies positive pressure to the airway, then rapidly shifts to a negative pressure. This produces a high expiratory flow rate from the lungs that simulates a cough. The use of this equipment must be medically prescribed.

The advantage to this procedure is that the need for suctioning to clear the patient’s airways is greatly reduced. In a recent study using this technology, the preliminary results showed patients coughed less, maintained a clear airway longer, had fewer respiratory complications and missed fewer days of therapy. One “cough machine”, the In-Exsufflator®, is currently available from J.H. Emerson Co.

Research continues in the use of functional electrical stimulation (FES) with individuals with SCI to assist in producing coughs. Preliminary studies had indicated this method approximately as effective as manually assisted coughs.

A new device, the QuikCoff™, uses this FES technology and is available from B and B Medical. They have completed clinical trials and are currently awaiting FDA approval for sale in the United States. There is also ongoing research into the use of surgically implanted electrodes that aid in coughing.
A recent study on the use of the pneumococcal vaccine in individuals with SCI found that most persons with SCI responded to the vaccine. The antibody concentrations against these infections were maintained in most persons for at least 1 year after vaccination. A follow-up study is in progress to examine the length of time an individual maintains immunity and the need to revaccination in persons with SCI.

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**New Drug Studies**

Theophylline is a drug used to improve the function of nerves to muscles that control breathing. Although theophylline is used clinically in cases of respiratory dysfunction such as asthma, the drug has never been used to activate respiratory pathways and improve respiratory muscle function following SCI in humans.

With funding from the National Institutes of Health, Harry Goshgarian, PhD, recently initiated clinical studies to test the therapeutic effects of theophylline in spinal cord injured patients. The study is trying to understand the mechanisms that unmask the inactive motor pathways that restore function to muscles paralyzed by a spinal cord injury. His research project, “Drug-Induced Motor Recovery after Spinal Cord Injury”, proposes pharmacological management of the respiratory system to enhance the body’s respiratory centers and restore function to respiratory muscles.9,10

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Oxandrin® is an anabolic steroid used in a previous study indicating a positive tendency for improving the pulmonary function in individuals with SCI.11 Currently researchers are looking at combining its use with resistive inspiratory muscle training.11,12

**Respiratory Care and Patient Education**

It is important to review respiratory complications and ways to prevent them with patients during their education classes while in rehabilitation. The topics to review with the patients should include proper breathing exercises, strengthening exercises, and health tips to prevent respiratory problems.

Patient education can be a part of physical therapy. “ShouldAir” classes emphasize the need for patients to learn the importance of balanced shoulders and efficient breathing techniques.13 Because of the complications brought on by smoking, there is a need for instructions in ways to preserve lung function over the long term. This should include smoking cessation efforts for SCI patients.14 In a study on self-reported respiratory problems with individuals with chronic SCI, those current smokers with paraplegia reported more frequent episodes of phlegm and wheezing.15

**Related Respiratory Research**

Sleep Apnea is a type of breathing disorder where individuals have episodes of absent breathing while asleep. This can result in fatigue, daytime sleepiness, cognitive deficits such as memory and concentration difficulties,16 and personality changes such as depression. Sleep apnea can be life threatening.

A current research project at the UAB-RRTC on Secondary Conditions of SCI is being conducted by Dr. Amie Jackson that looks at the diagnosis and treatment of sleep apnea in individuals with chronic high thoracic and cervical SCI. Additional information on this project is located on the web at http://main.uab.edu/show.asp?durki=10003.
Long-Term Respiratory Care, Follow-up and Research

There is a need for constant respiratory care of individuals with SCI following their rehabilitation. This is especially true for those with higher levels of injury and the older individuals. A recent analysis of the data collected by NSCISC shows that pneumonia and atelectasis were one of the most common long-term secondary medical complications found in individuals at their annual follow-up visits. This study reviewed data on annual medical evaluations performed at one, two, five, 10, 15, and 20 years on patients injured between 1973 – 1998. Risk factors included neurological classification and current age.

Individuals with tetraplegia complete had significantly increased incidence of atelectasis / pneumonia when compared to tetraplegia-incomplete and paraplegia (both complete and incomplete). See Table 1. The incidence of pneumonia with SCI in individuals over 60 years old was significantly greater than younger age groups.17

A change in the mortality trends after the first post-injury year was also seen. The mortality rate for persons injured in the 1993-1997 time period is 25.1% higher than for persons injured in the 1988-1992 period. When restricted to ventilator-dependent persons, this mortality rate is 75.5% higher for persons injured in 1993-97 vs. 1988-92, thereby reversing significant trends toward improving survival reported previously for this population. Additional research is needed to identify reasons for these increased mortality rates.18

Resources

Smoking and Lungs, Skin & Bladder
A pamphlet related to aging with a spinal cord injury. Available on the web at www.craighospital.org/c2s_smoking.html To order contact Craig Rehabilitation Center, 3425 S. Clarkson St. Englewood, CO 80110. Call 303-789-8202, or e-mail irene@craig-hospital.org

Wellness and Risk Assessment Profile (WRAP)

Can be ordered from Craig Hospital (see above address) as a self-contained computer software program that can be loaded onto a personal computer. WRAP can be used at home, in a rehabilitation hospital, physician’s office, or independent living center. After completing the questionnaire on the computer, the user receives his or her wellness assessment and risk profile on-screen or can have it printed immediately.

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Table 1 - Incidence of Pneumonia and/or Atelectasis at Level and Completeness of Injury During Post-Injury Years17
References


