FLORIDA EAST COAST POST POLIO SUPPORT GROUP

LATE EFFECTS OF POLIO -- OVERVIEW 2000
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SWALLOWING, BREATHING, ARTIFICIAL VENTILATION

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LATE EFFECTS OF POLIO-OVERVIEW 2000

SWALLOWING, BREATHING, ARTIFICIAL VENTILATION

SWALLOWING[1]

Oral Peripheral Examination: (An intact examination from the neurological point of view depends on five pairs of cranial nerves: V, VII, IX, X and XII located in the brainstem[2])

Labial (lips), lingual (tongue), palatal (soft, and uvula): range of motion (ROM), rate and strength.
Dentition: within functional limits (WFL), missing teeth, edentulous, or dentures (upper/lower).
Vocal Quality: clear, wet, or hoarse.
Cervical Auscultation: clear, wet, and/ or stridor.
Volitional Cough and Volitional Throat Clear: present, absent, or weak.
Volitional Swallow: present, or absent.
Gag: present, absent, or reduced.

Oral Stage of Swallow
For the following phases: preparation, propulsion, residual, and for the following seven consistencies: honey thick, nectar thick, thin liquid, puree, mechanical soft, soft and regular, note the number of trials, and whether the phase was WFL.
There are a minimum of 21 observations if all consistencies are tested.

Pharyngeal Stage of Swallow
Phases:

- Beginning of the pharyngeal stage: Pharyngeal swallow is initiated.
- Pharyngeal passage: The bolus passes through the pharynx.
- The epiglottis tilts down and the bolus enters the hypopharynx. Larynx elevates and closes.
- Entry of the bolus through the esophagopharyngeal sphincter. Larynx remains elevated and closed.
- Bolus enters cervical esophagus.
- Completion of pharyngeal stage.

For each of the seven consistencies note:
- ✓ Swallow Response: present, delayed, or absent.
- ✓ Laryngeal Excursion: present or absent.
- ✓ Vocal Quality: clear, wet and/or stridor.
- ✓ Cervical Auscultation: clear, wet and/or stridor.
- ✓ Cough: present or absent.
- ✓ Throat clear: present or absent.

Esophageal Stage of Swallow
Tongue, epiglottis and larynx return to normal position.
Prognosis for improvement is good, fair or poor.

Recommendations:
- ➢ Feeding procedures: positioning, presentation, compensatory strategies.
- ➢ Further diagnostic techniques: ENT referral; modified barium swallow with video-fluoroscopy.
- ➢ Dysphagia treatment program.

GERD (*gastroesophageal reflux disease*): Common with aging, hiatus hernia, and abdominal obesity. GERD causes recurrent respiratory infection, cough, asthma, hoarseness and sore throat. If the pharyngeal stage of swallowing is weakened, there will be a greater degree of aspiration during reflux and Increased symptoms. Severe GERD may require antireflux surgery.

OSA (*Obstructive sleep apnea*) and mixed sleep apnea (with an additional central component where there is a cessation of breathing for more than 10 sec) are more common when the muscles of swallowing are weak.

Since 1998 human growth hormone is being used in patients with post polio syndrome to improve muscle strength.[3] One individual described dramatic improvement in his sleep apnea. This may have occurred either from increased strength in the muscles of the mouth and pharynx and/ or the respiratory muscles. Further studies are necessary.

BREATHING

Causes of decline in breathing reserve: The vital capacity (VC or deepest breath possible) and maximum voluntary ventilation (MVV) decrease with aging. This natural aging process, which is somewhat accelerated in post polio, leads to a decrease in breathing reserve. During rest or activity the breathing reserve index for that particular state is defined as the MV/MVV. The MV is the minute ventilation or amount of air required by the person during one minute. The MVV

is the greatest amount of air the person can exchange during one minute with maximal effort.

Most post polio individuals have a decrease in breathing reserve but do not require artificial ventilation for respiratory insufficiency.

Late onset of respiratory insufficiency: after poliomyelitis first described by Dr. *Lane in England in 1974 with the following findings:*

- Respiratory insufficiency correlated with severe kyphoscoliosis and/or diaphragmatic paralysis.
- If either of these conditions were present, the size of the lungs, functional residual capacity (FRC), was under 75% of predicted normal. Otherwise, the size of the lungs was normal.
- The VC was reduced to 20-40% of predicted normal.
- There was no obstruction on spirometric studies. The amount of air expired during the first second (FEV_1) in a forced vital capacity (FVC) was over 90%. This is indicative of a restrictive pulmonary problem as opposed to an obstructive pulmonary problem when this ratio (FEV_1/FVC) is under 70%. Persons who have smoked or have asthma can have a concomitant obstructive problem.
- Response to inhaled $C0_2$ was diminished in proportion to the reduced vital capacity. This means there was no indication of central apnea or a reduced brainstem response to the blood gases.
- Arterial partial pressure of oxygen ($Pa0_2$) was normal in more than ½ of the patients.

A more recent study of strength in polio survivors over time showed a decrease in strength in all upper extremity muscles with the decrease ranging from large to small in both those aware of increasing weakness and those who were asymptomatic [4] Age, time since polio, gender, symptom status and weight were analyzed as possible factors. It was determined that there was a increasing rate of deterioration of strength with increasing age. The initial level of upper-extremity strength was not age-dependent. Time since polio and history of residual weakness were not significant factors. All survivors were at least 34 years post polio. The normal age-related rate of decline for muscle groups is 1.5-3%. The predicted annual percentage decrease in this group of polio survivors varied from 11.2% in those in their early 40s to 17.5 % per year for those in their late 60s and early 70s. Since the innervation of shoulder and elbow flexor groups is at a similar level in the cervical spinal cord as the innervation of the diaphragm, it would be of importance to measure the rate of decreasing diaphragm strength in this same cohort of survivors.

Breathing Exercises

A recent study has shown that patients with prior polio using daily part-time noninvasive assisted ventilation (NIPPV) are able to perform inspiratory muscle training (IMT) with no adverse effects. [5] IMT increased inspiratory muscle endurance with improvement in ADL and well-being in the patients. The patient breathed through an inspiratory threshold training device for 5 minutes with a resistance which was rated as "15" or hard on the Borg's rating of perceived exertion scale (RPE). Resistance tolerated after 10 weeks of training improved from 10.7 to 16.7cm H_20. Those patients who could only tolerate a resistance which was less than 4 cmH_20 were not able to participate in training. Patients used their own ventilator for at least 30 minutes before and after very training session. It has already been reported in the literature that subjective recovery time after exhausting muscular activity in post polio patients with declining muscle strength is longer, and may take a few days as compared to ½ to 2 days in the stable post polio patient and normal persons.[6] Therefore, it was considered necessary to rest the breathing muscles immediately after training.

For abdominal muscle strengthening, expiratory resistance breathing must be used.[7] From a study of spinal cord injury complete tetraplegics it has been learned that the shoulder girdle muscles, pectoralis major and latissium dorsi, both of which have innervation from the cervical spinal cord, can be activated as accessory expiratory muscles during coughing. [8] When there is severe abdominal muscle weakness in the post polio survivor with reasonable strength in these muscles, emphasis should be placed on further increasing their strength to assist in coughing.

ARTIFICIAL VENTILATION

Cough: The critical level for peak cough flow (PCF) is at least 2.7 L/sec.[9] Studies were carried out on ninety patients, twelve of whom had post polio syndrome. For those patients with a VC < 1500 ml, it is necessary to further inflate the lungs by glossopharyngeal breathing, or use of a manual resuscitator or ventilator to provide a maximal insufflation capacity (MIC). Lungs are inflated to 85-90% of inspiratory capacity so that high thoracoabdominal expiratory pressures can be generated on unassisted or assisted coughing. These pressures are needed to mobilize mucus. The InExsufflator cough machine by Emerson produces the necessary insufflation followed by negative pressure or suctioning of the airway.

CPAP/BIPAP (continuous or bi-level positive air pressure)

- Sleep apnea: obstructive, central, mixed

is the greatest amount of air the person can exchange during one minute with maximal effort.

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- Mechanism of obstructive sleep apnea: The oropharynx is held open by the tongue-protruding muscles and the small muscles attached to the hyoid bone in the throat. The lateral tips of this bone can be palpated below the angles of the jaw and above the larynx. These muscles dilate the pharynx a fraction of a second before inspiration occurs, and hold it open during inspiration. If they are weakened by polio, the individual may experience swallowing difficulty as well. Further neurological involvement from Parkinson's disease, strokes, or head injury, anesthesia, head flexion, obesity in the region of the head and neck, alcohol or other sedating psychotropic medications, hypothryoidism, congenital or acquired small airway size, and rapid eye movement (REM) or dream sleep are factors in producing OSA. The orophyarnx in a sleep apneic person may close with a negative pressure from inspiratory effort as small as minus 0.5 cm. H_20 whereas a normal person will maintain patency to a minus 27 cm H_20. Lying on the side helps to prevent airway collapse.
- Central sleep apnea is absence of airflow associated with failure of respiratory effort. It can be caused by pathology of the brainstem. It is also caused by the presence of upper airway closure in OSA, and when it is seen with OSA, mixed apnea is said to be present.
- CPAP is used as an "air splint" both in the nasopharynx and throat and in the lungs. BIPAP can be used for the same purpose. At a higher inspiratory pressure, BIPAP can be used as a ventilator.

Positive Pressure Ventilation:

- Use for deep breathing by air stacking in order to improve compliance or provide a deep inspiration for an adequate cough.
- Use as the most versatile form of artificial ventilation

HOME MECHANICAL VENTILATION

Patient education: A respiratory care practitioner (RCP), a respiratory R.N., a nurse practitioner or physician's assistant specializing in respiratory problems, and a chest physical therapist are all capable of providing patient education, in addition to the physician. Information is available on the Internet and from the American Lung Association, including its local chapters.

Bronchial hygiene regimens: Nebulization, use of metered dose inhalers (MDIs), postural drainage, assisted coughing can be taught by the RCP, a respiratory R.N. or a chest physical therapist. The medications for nebulization are prescribed by the physician.

Relaxation techniques: These are always of value to relieve stress when an individual is breathing on his own with little reserve. However, the individual must recognize when it is necessary to use the ventilator.

Diaphragmatic retraining: A client with absent diaphragmatic function can not retrain the diaphragm as can be done in chronic obstructive pulmonary disease of moderate degree. See above for retraining if the diaphragm and other inspiratory muscles are weak, but not paralyzed.

Support and coaching: This is necessary when a client is learning noninvasive ventilation by nasal mask or by mouth. It is also important when a client learns to synchronize his breathing with a rocking bed or other body ventilator. If the client has a tracheostomy with no cuff, a deflated cuff, or a fenestration, he must be trained to use the air flow from the ventilator for breathing or for speaking.

Arterial blood gases, invasive and noninvasive: Arterial blood must be placed on ice and tested for 0_2 and $C0_2$ within a matter of minutes for accuracy,. Generally noninvasive oximetry to measure oxygen saturation of the capillary blood and capnography to measure the end-tidal carbon dioxide are done in the home. The client may have his own portable oximeter.

Pulmonary function tests: Generally the only study done in the home is a vital capacity or a peak flow. For more comprehensive studies the client is expected to go to a PFT laboratory at a local hospital.

Sputum cultures and sensitivities: In the presence of chronic bronchitis, which is more common with a tracheostomy, it may be necessary to determine the organisms responsible for a flare-up (acute bronchitis), and the antibiotics to which they are sensitive. A recent retrospective study of 684 ventilator users, including 371 post-polio survivors, was carried out on the effect of home mechanical ventilator use versus oxygen therapy on pneumonia and hospitalization rates. [10] Pneumonia and hospitalization rates were significantly higher for ventilator users with gastrostomy tubes. For persons with neuromuscular ventilatory insufficiency without gastrostomy tubes, more than 90% of the pneumonias and hospitalizations were triggered by otherwise benign intercurrent upper respiratory tract infections. Oxygen therapy, when assisted ventilation for ventilatory insufficiency was needed, was associated with a significantly higher rate of pneumonias and hospitalizations.

Mobile electrocardiograms: These can be ordered by the pulmonologist/internist/general practitioner caring for the client if there is any suspicion that chest pain or shortness of breath is related to the heart.

Ventilator management: A registered respiratory care practitioner (RCP) visits on a regular basis and when an emergency related to the equipment occurs. He is instrumental in teaching those in the home care setting how to use the ventilator.

Tracheostomy care: The tracheostomy tube is usually replaced once every 6 wks. by an ENT specialist. At times the client's family doctor may replace it or the person may go to a local ER or diagnostic and treatment center for it to be done. The client may replace it himself with the assistance of a family member, if needed. Tracheostomy care on a daily basis is performed by the client or caregivers. Suctioning in some states can be performed by caregivers who have been trained by a licensed professional. A client with the use of his hands is taught to suction himself.

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REFERENCES:

1. Bedside Dysphagia Evaluation Form, Coler Goldwater Specialty Hospital and Nursing Facility, 10/99.

2. Bulbar and Spinal Polio. Holland, H.Florida East Coast Post-Polio Support Group-Vol. 8, #1, July/August 2000.

3. New Hope in Post-Polio Syndrome. Perlmutter, D. Florida East Coast Post-Polio Support Group-Vol. 8, #1, July/August 2000.

4. Changes in Strength Over Time Among Polio Survivors. Klein, MG et al. Arch Phys Med Rehabil 81: 1059-1064, August, 2000.

5. Inspiratory Muscle Training in Patients With Prior Polio Who Use Part-Time Assisted Ventilation. Klefbeck, B et al. Arch Phys Med Rehabil 81: 1065-1071. August, 2000.

6. Subjective Recovery Time After Exhausting Muscular Activity in Postpolio and Control Subjects. Agre, JC et al. Am J Phys Med Rehabil 77 (2) 140-144, March/April, 1998.

7. Abdominal Muscle Activity During Inspiratory and Expiratory Resistance Breathing. Ugalde, V et al. Arch Phys Med Rehabil 8l, p 1262, Sept, 2000.

8. Expiratory Function in Complete Tetraplegics: Study of Spirometry, Maximal Expiratory Pressure, and Muscle Activity of Pectoralis Major and Latissimus Dorsi Muscles. Fujiwara, T et al. Am J Phys Med Rehabil 78 (5): 464-469, Sept/Oct, 1999.

9. Maximum Insufflation Capacity: Vital Capacity and Cough Flows in Neuromuscular Disease. Kang, SW, Bach, JR. Am J Phys Med Rehabil 79 (3):222-227, May/June, 2000.

10. Neuromuscular Ventilatory Insufficiency: Effect of Home Mechanical Ventilator Use v Oxygen Therapy on Pneumonia and Hospitalization Rates. Bach, JR, et al. Am J Phys Med Rehabil77 (1) 8-19, Jan/Feb, 1998.