

# Post-polio and Breathing

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In an article in the spring issue of Polio Network News (2001, vol 17m no 2) Joan Headly gives a description of the breathing problems in polio survivors. With this as a starting point supplemented by personal experiences from Respiration Center East of Rigshospitalet I must in the following review background, symptoms, examinations and treatment in relation to these problems

## Acute polio

Poliovirus attacks the nerve cells in it elongated spinal cord and lower brain centers (the bulbar form) and the nerve cells in the spinal cord (the spinal form). Both forms can affect the breathing function, the bulbar form by paralyze the diaphragm and the spinal form the muscles of the chest and abdomen. The bulbous form also attacks the pharynx muscles and gives rise to misalignment and accumulation of mucus in the airways that threatens to suffocate the patient. During the polio epidemic in Copenhagen in 1952 there were many bulbs cases, of which many were rescued by tracheotomy (operatively inserted catheter in the trachea) and artificial respiration with bag and hand force. This technique was used as the first place in larger scope at Blegdamshospitalet, Copenhagen, Denmark.

## Post-polio syndrome

After the acute course, many polio victims had continued paralysis or muscle weakness in arms / legs, back and abdominal muscles, but also off the respiratory muscles with reduced lung reserve as a result. Approx. 30 of the polio survivors from Blegdam Hospital still had in

the aftermath needed support for breathing and had to use respirator a shorter or longer time of day. For many years, the condition of the polio victims was considered stable and unchanging, but time would tell that several 20 – 30 years after the acute polio case, developed the so-called post-poliosis syndrome. The symptoms of post-polio syndrome are newcomer, progressive weakness, paralysis and pain in muscles, joint pain, fatigue and rapid fatigue of the muscles. In in some cases, the post-polio syndrome is accompanied by breathing problems.

## How do weak muscles affect breathing?

The diaphragm is the most important breathing muscle. If this is weakened by polio, breathing becomes strained and reduced, especially during sleep and polio sufferers' breathing will therefore often be fast and superficial. As a result of paralysis, some of them have developed scoliosis and decreased movement of the chest. Hereby the lungs are compressed and their opportunities for development are limited. This can in cause underventilation and respiratory failure.

## How does sleep affect breathing?

The supine position reduces breathing in people with weak diaphragm, why they often prefer to sleep seated. With entered sleep weakens the reflexes that control breathing and as all muscles relax especially in the so-called REM sleep (dream sleep) it is common that it sleepers have somewhat impaired breathing. In the polio sufferer with weak muscles this can develop into a state of low oxygen content and increase in carbon dioxide in the blood, a condition that referred to as nocturnal under-ventilation, as at the earliest occurs during the REM sleep periods, later perhaps throughout the night.

Underventilation disturbs the normal sleep pattern and gives poor sleep quality.

## **How do breathing problems manifest themselves?**

The symptoms develop slowly and insidiously often over several years. They will long be perceived as a sign of natural aging and decreased activity. The polio patient might – because of the prolonged course – get used to and accept the condition. One must therefore be aware also on characters that are not normally perceived as symptoms of poor breathing and lung disease:

- Increasing shortness of breath on exertion
- Shortness of breath at rest, weak voice, short sentences interrupted by an inhalation.
- Use of shoulder and neck muscles when inhaling.
- Weak coughing power with tendency to accumulate mucus.

The symptoms of nocturnal ventilation are: Morning headache, tendency to inadvertently fall asleep during the day, poor and restless sleep perhaps with nightmares, waking up and suffocation sensation.

Most important of all are uncharacteristic symptoms as unexplained fatigue, lack ability to concentrate, poor well-being. Symptoms such as the above should lead to a further examination of the lung function, which will appear from the following.

## **Who risks getting breathing problems?**

Far from everyone who has had polio before will get breathing problems. People who under the acute polio attack needed breathing assistance (i.e. iron lung or staying "pumped") constitute a special risk group. Polio patients with permanent weakness of the abdominal muscles and

the diaphragm are another risk group. Skewness (scoliosis) and malformations of the chest are a common weakness after polio and contribute to the impaired lung function. Polio patients can – like the rest population – have disorders that affect breathing in a negative direction: asthma, bronchitis, smoker's lungs, obesity and perhaps more frequently than expected sleep apnea, i.e. pauses in breathing during sleep. With increasing age decreases lung function in all, this of course have greatest consequences in persons with already impaired lung function (small reserves).

## **How to test lung function?**

By measuring the vital capacity, you get a simple and valuable measure of lung function. The vital capacity is the maximum amount of air can be exhaled after a deep breath. It can be measured with a simple device by a general practitioner or in the hospital with a complicated equipment that provides significantly more information.

It is important to measure vital capacity in both sitting and lying position, large drop in lying position indicates weakness of the diaphragm. The vital capacity of lung ash is between 3 – 5 liters depending on size, age and sex.

If the vital capacity falls to half of that for normal value of the person, one must be vigilant, as the coughing force is now taken off and colds and pneumonia can have a serious course.

Underventilation must be expected when vital capacity has dropped to a third of normal. Vital capacity is used as an ongoing measure of the development of the respiratory disorder. Vital capacity provides a measure of lung volume. By measuring mouth pressure, you can get a measure of the strength of the respiratory muscles. It is measured lowest pressure exerted during inhalation, this provides a measure of the strength of the muscles for

inhalation and can be compared to vital capacity, and the highest pressure that can be performed during exhalation, giving a valuable measure of coughing power.

The same can be achieved by the so-called Cough Peak Flow. To that measurement, use the same flowmeter as used to control people with asthma. The lung function tests may be extended with pressure measurements in esophagus and stomach for the purpose of obtaining accurate measurements of the pressure conditions in the thoracic cavity and thus of the strength in the breathing muscles.

An unpleasant but necessary study is arterial punctures. Arterial blood = plus vein blood gives namely information on lung function, especially on the oxygenation which cannot be obtained by taking one regular blood test (venous blood). The puncture usually performed in the carotid artery, artery radialis and the blood is analyzed for oxygen content, oxygen and carbon dioxide pressure, acidity and derivatives values. Blood oxygen content, but none of those other values, can be measured with a pulse oximeter and a squeeze on a finger. Pulse oximetry is thus a poor replacement for the artery puncture, and then there are many sources of error in this study, the values must be assessed critically.

The same applies to the values for carbon dioxide, which it is waste material to be excreted through the lungs. An increased value is an expression of reduced air exchange in the pulmonary alveoli.

Elevated values are accepted common in patients with chronic bronchitis (smoker's lungs) and many doctors and pulmonary specialists, are prone to transfer this acceptance in patients with neuromuscular disorders, including post-polio patients. With these persons is quite a small increase in the carbon dioxide value, i.e. values above 6 kPa, expression for underventilation, which requires the largest

vigilance, further investigations and possibly treat

## When to refer to the respiration centers?

A polio and other neuromuscular patient should, if it has not already done so, be referred to the respiration center when

- There are symptoms of nocturnal ventilation
- The vital capacity drops to values of 1 – 1.5 liters / 15–20 ml / kg
- Carbon dioxide values are rising, also within normal range and / or
- The cough is insufficient, possibly with frequent respiratory infections, In order for the studies to be supplemented with e.g. nocturnal sleep and breathing examination, so-called polysomnography.

As the name suggests a large number of measurements are made, all with sensors located outside the body (i.e. none plug!), giving you an ongoing registration and analysis of the sleep stages and of the breathing during sleep. This is the only way nightly underventilation can be found on. Polysomnography is also used to check if an initiated treatment is effective and satisfactory. If one is once referred to the respiratory center, will continue control and treatment of the respiratory disorder takes place there, outpatient or during hospitalization, with studies as already mentioned. The controls carried out as required every six months or every year and more frequently if the development is critical. The purpose of the connection to the respiratory center and the frequent checks are that one thereby gets opportunity to intervene with treatment in a calm phase of the breathing problem, before any pneumonia or other life-threatening condition for example. heart failure makes an emergency intervention compelling required. The patient is kept in the respiratory center continuously

informed about the development of the disease and treatment options, and may in consultation with the doctors themselves decide treatment wishes and possibly restrictions in the treatment.

### **Preventive treatment with CPAP**

There is a lot of doubt as to whether it is using breathing exercises, physiotherapy or on other way is possible even to improve lung function, but by daily exercise and sensible lifestyle (avoid smoke and obesity) can keep the lungs going and avoid further strain on the breath. Most polio patients have "dry" lungs, i.e. only a little mucus in the airways, and the reduced coughing force will in daily life cause only few problems. Persons with abundant mucus formation and tendency to respiratory tract infections are sometimes recommended preventive treatment with CPAP sometimes daily.

CPAP is an abbreviation of Continuous Positive Airway Pressure. By this treatment transferred a pressure of 10 – 15 cm H<sub>2</sub>O from a compressor over a face mask for the lungs. Hereby the air is pressed down into the outer lung section "behind" the mucus, which then easier can be brought up. CPAP is also widely used as treatment for mucus accumulation in respiratory tract and in case of impending respiratory failure. Some polio patients have nocturnal breathing breaks, so-called sleep apnea. This condition is noted on same way as nocturnal ventilation using polysomnography. The treatment of this condition, CPAP is given over a nasal mask, which the person lies with all night.

### **Treatment of underventilation Bi-PAP**

Next step in the treatment of failing breathing function is Bi-PAP ventilation, that – unlike CPAP – increases air exchange in the lungs. By increasing the air exchange, the body can get rid of more

carbon dioxide and the values in the blood will decrease. Bi-PAP ventilation is thus the first step in the treatment of underventilation. The name Bi-PAP refers to the device works with two (= bi-) presses, one higher below inhalation and a lower during exhalation, the difference with the two presses determines how much air being moved. The Bi-PAP devices are simple to operate, easy to transport and reliable in operation with long operating time. They make just a little noise and have in contrast for other respirator types no alarm functions. The Bi-PAP device is connected via an air hose to a nasal mask held in place by means of a kiss similar or net-shaped "headgear". Bi-PAP ventilation is used mainly for persons who only need nocturnal breathing support.

### **When is Bi-PAP treatment necessary?**

No definitive answer can be given this question. The timing will depend on a long number of factors such as the course of the disease, the lung function, the wishes and expectations of the polio patient complemented by clinical experience of the doctors. Symptoms of nocturnal underventilation, recurrent respiratory infections, weak cough, fatigue, poor well-being and objective signs such as carbon dioxide values above 6 kPa, rising carbon dioxide values at night, lung function with vital capacity below 1 liter and low airway pressure will suggest that the time has come or is imminent. Once the decision is made, instruction and training in Bi-PAP treatment take place during admission to the Respiration Center. The polio patients with hand and arm function can themselves put the nasal mask on and off and even turn on and turn off the appliance. The vast majority of polio patients do not need extra help to carry out Bi-PAP treatment in their own home. The treatment takes place at night and for a

maximum of a couple of hours in the daytime, so the extroverted activities can therefore continue unchanged. The purpose of Bi-PAP treatment is as stated to increase air exchange in the lungs. Thereby one is obtained better aeration of carbon dioxide, greater unfolding of the lungs and better regulation of breathing. As the machine takes over the work of breathing, the breathing muscles get one much needed rest.

The polio patient will experience that the signs of nocturnal under-ventilation will disappear, there will be more energy for the daily chores there will come fewer or no respiratory infections, all in all a better well-being and quality of life.

On its negative side gets some pressure nuisance from the mask, other dryness of the respiratory tract, nuisances that in most cases can be remedied. Bi-PAP ventilation is one respiratory supportive treatment, not a complete takeover of breathing. Thus, the Bi-PAP user can, if the accident is out, manage a single night without the machine.

### **When is Bi-PAP ventilation no longer sufficient?**

Most polio patients with Bi-PAP cope lifelong with this treatment. Some experience over time a stronger weakening of breathing, which requires treatment several hours of the day, some get related illnesses, which places greater demands on air exchange than a Bi-PAP machine can perform, others have mucus and secretions in the airways that block the passage of air and which cannot be coughed up. The Respiration Centers recommends in these cases to go to the next step in treatment, tracheotomy and respirator.

### **Tracheotomy and respirator**

A tracheotomy is an operative opening in the trachea of the neck. In the opening is

placed one lethal cannula or a tracheotomy cannula / tube, which can be connected to a ventilator's hose system or plugged in if breathing assistance is not needed. It's a big and far-reaching decision for the polio patient to accept a tracheotomy. In the vast majority of cases there is plenty of time for conversations and information from the staff at the Respiration Center, as well as a meeting with an already tracheotomized person will be helpful before making the decision. With a tracheotomy, the air exchange can from the ventilator fully cover the need, also in periods of pneumonia. By lowering a suction catheter through the tracheotomy cannula can mucus be brought up, whereby the airway is kept open. Treatment with tracheotomy and ventilator can, if necessary, be carried out around the clock, as the user can talk and eat while the ventilator is running.

You cannot do that when using a nasal mask and Bi-PAP.

There are also negative aspects to this treatment.

With a tracheotomy, the polio patient has received a visible sign of his respiratory disability, the tube that sits in the throat. Tracheotomy cannulas must be kept clean by regular suction and shift. It can in the most severely disabled mean that assistance from specially trained respiratory assistants is needed. A tracheotomy is an unnatural thing for the body, who sometimes reacts with bleeding episodes and scar tissue formation. There is thus a price for to have tracheotomy, that is however – after the respiration centers opinion – outweighed by the benefits for this here group of polio victims. Tracheotomy and ventilator treatment are a safe bet and uncomplicated procedure, if given instructions are complied with and good care is given. This is confirmed of the fact that in this country there are several polio victims who in the whole period since the

great polio epidemic in 1952 has been  
tracheotomized and respirator treated.