HEALTH & WELLNESS / LIFESTYLE

The Breath of Life

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Respiratory problems are the most common that are seen in American medical practice. They are also the greatest single cause of death in the U.S. Last year there were 215,000 new cases of lung cancer diagnosed in the U.S. and 162,000 people died from lung cancer. This is one-third of all cancer deaths.

The death rate for lung cancer in U.S. women has increased fivefold since the 1960s, and is now on par with the death rate for men. That old advertisement for Virginia Slims cigarettes, "You've come a long ways, baby" is literally true, but in a heartbreaking sort of way. The figures are even more striking in foreign countries. In Japan lung cancer has increased tenfold in men, and eightfold in women since 1950, as the population there has taken up the practice of smoking. The 5-year survival of lung cancer is one of the lowest of all cancers (about 10-12 percent).

Lung cancer is nine times more common in smokers than non-smokers. Happily we have moved forward since the mid-1960's, when 50% of adult Americans smoked, but unfortunately over 25% of adult Americans still smoke, and the decrease seen in the 1980's and early 1990's has now reached a plateau. More young people in high school and college smoke now than ever before. This is one of our worst health problems.

Over 16 million Americans have COPD. There are 110,000 deaths from COPD each year in the U.S. These are almost all directly caused by smoking and are thus preventable. These problems are worse in other countries. The WHO predicts that by the year 2020, COPD will be the third most common cause of death in the world, replacing strokes.

Respiratory problems are the major cause of death in elderly patients who have neurological problems, cancer, or other disabling diseases, and they are the most common source of bothersome medical problems for all the rest of us. But we cannot avoid breathing, like we can avoid a food that has been shown to be bad for us. We can go for a while without most of the things that sustain us: food, water, sunlight, companionship and love...but we cannot go more than a minute without breathing!

Genesis, first chapter: "And God breathed in the man he had created the breath of life; and man became a living being." It is the breath of life that we are talking about in this article. I want to present to you some of the medical facts about respiratory physiology so you as Oriental medical practitioners can become even better informed about the lungs and what they do. Oriental medical treatments are often effective in helping patients get over their addiction to tobacco. Of greater importance, OM treatments can do much to benefit those who suffer from Asthma, COPD, pulmonary fibrosis, and also those undergoing Western treatment for lung cancer, all of whom also need your support.

Interesting factoid: When teaching this subject a few years ago to acupuncturists in Beverly Hills, California, a student in the class asked me how easy it is to find a qualified pulmonologist. She was a smoker and had lung problems. "Let's check the local phone book", I suggested (this was just before Iphones made such directories obsolescent). We looked up pulmonologists in the Santa Monica-Beverly Hills telephone directory yellow pages, which is over 3 inches thick. There were only two of them listed in the directory, covering the population in this area. However, there were over 200 plastic surgeons, and 300 psychiatrists in the "P" part of the section for physicians!

A Brief Primer on Respiratory Physiology

"To be effective at gas exchange, the lungs cannot act in isolation; they must interact with:

- the central nervous system, which provides the rhythmic drive to breathe.
- the diaphragm and the muscles of the chest wall, which respond to signals from the central nervous system and act as a bellows for the movement of air.
- the circulatory system, which provides blood flow, and therefore the transport of gases between the tissues and the lungs"

One human lung has 300 million alveoli, giving it a total surface area for oxygen and carbon dioxide exchange which is the size of a tennis court! When in good health, the lungs are extremely efficient in this exchange, even in a smoky confined space (like one of those private restaurant rooms in China).

The bronchi and the bronchioles have a very complex histology. The epithelial cells become progressively thinner going toward the alveolus until a single layer of cuboidal cells lines the terminal bronchioles. Goblet cells lining the bronchial tract at frequent intervals secrete mucus. They decrease in number towards the alveolus and are replaced by Clara cells, which secrete a less viscous fluid that lubricates the bronchiole.

Smooth muscle in the respiratory tract increases in ratio of the muscle to the lumen size, largest in the terminal bronchioles. Cartilage is present down to the terminal bronchioles, then is absent in the respiratory bronchioles. The terminal bronchioles are about 0.5 mm in diameter, which is the diameter of the lead in an automatic pencil, and the respiratory bronchioles are even smaller. Alveoli are about 0.2 mm in diameter.

There are three neural controls of the smooth muscle: 1- Parasympathetic nervous system: provides the primary bronchoconstrictor tone for the bronchioles (cholinergic); 2- Sympathetic nervous system: causes bronchodilation of all passageways (adrenergic); and a third nervous control mechanism has been recently discovered: a non-adrenergic, non-cholinergic bronchodilation system, triggered by nitric oxide. It is also under the control of the parasympathetic nervous system. This enables the body to have the proper dilation/constriction balance when we are at rest and the sympathetic nervous system is not turned on.

The medium-sized bronchial passageways are most affected by bronchoconstriction stimulation (as in asthma) on the way to the 300 million alveoli in each lung. When they over-constrict during an asthma attack the end result is mostly expiratory wheezing with very little blockage to air inflow.

The blood vessels in the lungs are extremely vasoactive: they can constrict down to complete closure, and can also dilate tremendously as well. They can handle the tremendous increase in pulmonary circulation with exercise, without raising the pressure of the blood flowing in. All the cardiac output flows into the lungs, and at rest this is about 5 liters a minute. This can increase to as much as 25 liters a minute during exercise, requiring the pulmonary vessels to accommodate five times the normal volume of blood in the lungs. They do so by dilating tremendously, keeping the blood pressure low so gas exchange can take place efficiently. The normal systolic blood pressure of an adult is 120/80mmHg, but in the pulmonary circulation the blood pressure is about 20/10.

The lungs and chest wall both have elastic properties. They tend to resist each other: as the lungs expand, they stretch the chest wall, which resists this expansion. Each lung has a resting size. It can be expanded or contracted in two ways: 1- by positive pressure from within the bronchial tree, causing it to expand when hooked up to a pressure respirator, for example (like blowing up a balloon); 2- by negative pressure when the diaphragm descends, sucking air into the lungs (like pulling back on the barrel of a syringe). This is what happens with breathing.

Again, the elastic properties of the chest wall causes it to resist expansion as air is sucked in. There is positive pressure in the respiratory tract as the air rushes in, and a counterbalancing negative pressure in the pleural space. Remember: the chest wall resists as the lung expands: they act opposite to each other! How much negative pressure is required to expand the lungs depends on the compliance (elasticity and flexibility) of the lung tissue. The compliance is decreased in many diseases, with less expansion and less gas exchange. The actual lung capacity is decreased in many diseases and is increased in others.

Definitions (these are pulmonary function studies):

Inflation Parameters:

- Total lung capacity (TLC): the volume of gas in the lungs at the completion of a maximum inspiration. It is as much as 6 liters (6000 cc's).
- Tidal Volume (TV): the normal amount of gas exchanged in a typical breath, in and out: diminished in many illnesses, increased in others. Typically, at rest, it is about 500 cc's.
- Inspiratory capacity (IC): going from a resting state and taking as big a breath as possible.
- Vital capacity: breathing all air out, then taking in as big a breath as possible.

Deflation Parameters:

- Functional residual capacity (FRC): the gas volume in the lung when it is at rest: when the inward elastic recoil of the lung to deflate is equal to the pressure of air within it, also balanced by elastic recoil of the chest wall to deflate the lungs. This is the way the lungs are between breaths.
- Expiratory reserve volume (ERV): the extra air that can be expelled after a normal breath is completed.
- Residual volume (RV): the amount of gas left in the lungs after maximum exhalation (some gas is still present in the airways and alveoli of the lungs and cannot be expelled).

Flow Rate Parameters:

- *Maximum expiratory flow rate* (MEFR): measured in milliliters of air per second: notably decreased with the bronchospasm of asthma (more detail later on this, in the next article). This is measured with a simple flow-meter device. Many practitioners have these.
- This is often refined to an even better test: MMEFR: *maximum mid-expiratory flow rate*. This requires a computerized measuring device, available in respiratory labs.

Ventilation:

A typical breath is 500 ml (cc's) of air, and the normal frequency is 12-14 x minute. This is about 6,000 cc's per minute. This can be increased even more than the blood flow during exercise. The air intake can go as high as 80,000 cc's per minute (in and out).

The anatomic dead space is about 150 cc's. This is the amount of gas 'wasted' that does not reach the alveoli; that which is in the trachea and the larger passages and just sloshes back and forth. Thus: a tidal volume breath = alveolar volume plus dead space. The dead space is higher in bronchiestasis, COPD, and pulmonary embolism.

Pulse Oximetry

A device can be placed on the fingertip to measure oxygen saturation as well as heart rate. Healthy individuals at sea level usually exhibit oxygen saturation values (SaO2) between 96% and 99%. An SaO2 value below 90% causes hypoxemia and cyanosis and is considered very dangerous. The affinity of hemoglobin to oxygen may impair or enhance oxygen release at the tissue level based on pH, temperature, and CO2 levels. Fortunately for life, the hemoglobin holds on to oxygen in the lungs, and then releases it in the tissues where the environment is more acidic (lower pH), where it is slightly warmer, and where the CO2 concentration is higher.

Thus, in shock, with the patient's tissues severely acidotic, perhaps with a fever, more oxygen will be released into the tissues than you might expect from the O2 saturation levels and possible cyanosis. This will at least help the odds that the patient will survive!

Normal blood gas values are as follows:

- partial pressure of oxygen (PaO2): 75-100 mm Hg
- oxygen saturation (SpO2,SaO2;): 94-100%
- oxygen content (CaO2): (18-20 ml O2/dL)
- pH: 7.35-7.45
- partial pressure of carbon dioxide (PaCO2): 35-45 mm Hg
- bicarbonate (HCO3): 22-26 mEq/liter
- Base excess: 0 (+/- 2 mEq/L) negative in metabolic acidosis; positive in metabolic alkalosis
- Anion gap: 12 mEq/L (+/- 4): useful in identifying the type of metabolic acidosis

One of the best online articles I've seen on the interpretation of arterial blood oxygen levels, including the differences between Pa02, Sa02, and O2 content is from Mt. Sinai Hospital in New York. This article is easy to understand and I highly recommend it.

In my next article I will review the major pulmonary problems you will encounter in your Oriental medical practice: asthma, bronchiectasis, COPD, pulmonary fibrosis, and cystic fibrosis. We needed to cover the basic physiology first. I hope this will help you as you treat your patients with respiratory problems.

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