

## To pulse...or not to pulse...that is the question.

By John R. Goodman BS RRT

It may seem that oxygen therapy for patients with chronic lung disease has been with us “ever since we could remember.” That’s actually not quite true. As I write this article in late 2011, patients currently prescribed on long term oxygen therapy (LTOT) actually have a bewildering array of options available to them. But it wasn’t always this way.

It took almost 150 years after the discovery of oxygen in 1774 before oxygen could even be used in limited fashion and in the hospital only. This is mainly due to the fact that there was no way to safely produce and store oxygen until the oxygen cylinder was invented. Most sources agree that the first steel cylinders came out of Germany in 1886. What was the first gas stored in the new tanks...carbon dioxide. And what was the primary use...to allow draft beer to be poured on request. In fact, that is how the beer was served at the St. Louis world’s fair in 1904.

In the early 1900’s the study of respiratory physiology was making remarkable discoveries into the workings of the lungs, and the circulation that supplies the lungs. Physicians at the turn of the century weren’t totally sure the application of oxygen would be very helpful to patients with tuberculosis, asthma, or pneumonia. This was complicated by the fact that even if oxygen were given to a patient, it was always for just a few minutes at a time, several times a day. No wonder many physicians just didn’t think the oxygen was helping.

Oxygen got a big boost in the treatment of young soldiers who had been exposed to gas warfare during WWI, and by the 1920’s oxygen began to get more widespread use in the treatment of pulmonary diseases.



Gas attack in WW1



Gas mask on horse



Oxygen tent



Tank lamp

Many patients of today will remember the use of oxygen masks and tents in the past. Why wasn't there home oxygen for patients during these early years? First, there were very few physicians with the foresight to even contemplate oxygen in the home, and the entire specialty of Pulmonology was years away from being developed. Couple this with the lack of suitable equipment, and it isn't hard to see why it took a long time for oxygen to go from the hospital to the home. It wasn't until the late 1960's and early 1970's that oxygen was even considered for use in the home. Certainly there were pioneering physicians in the development of home oxygen therapy. Dr. Alvin Barach and Dr. Tom Petty to name just a few. But, you can't prescribe something that hasn't been invented yet. The aluminum oxygen cylinder was only developed in 1958.

One of the biggest and maybe most important technological development regarding LTOT was the oxygen concentrator. An oxygen concentrator uses some space age technology to separate the two main components of air which are Nitrogen and Oxygen, pump the nitrogen back into the environment, and then collect and pass along the (nearly) pure oxygen to the patient.



One of the very first home oxygen concentrators weighed over 200 pounds!

The first generation of oxygen concentrators were BIG! How about 200 pounds big! Yet, it was a huge improvement over large oxygen tanks that had to be periodically replaced.



Aluminum  
Cylinders



POC with both pulse  
and continuous flow



Variety of cylinder &  
liquid pulse devices



POC under 7  
pounds

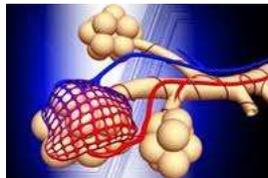
The typical LTOT patient of the 1970's and 80's had a concentrator to provide "stationary" oxygen and smaller E-tanks of oxygen for ambulation and mobility. At the same time the liquid oxygen industry was also undergoing development. So that in a relatively short span of 20-30 years LTOT patients went from almost no choices at all, to a bewildering number of choices. Concentrators have shrunk to almost the size of a pair of binoculars, weigh between 5 and 7 pounds, and have rechargeable batteries. Liquid oxygen units are similarly sized and can be carried in a number of ingenious ways. The tradeoff on small size however, in most cases has been to "pulse dose" your oxygen.

Now, why am I taking this time to describe the history of home oxygen? What's the one thing that HASN'T changed in all these years? The answer is...lung disease itself. Once you are in the 'Hypoxic club,' you have lifetime membership. So even though you now have more choices than "Carter has pills," your lung disease will dictate whether or not any individual oxygen unit can keep you well saturated under conditions of both rest and activity. In a round about way this leads back to my first question which was to pulse or not to pulse?



If your fingers are this blue, you definitely are in the Hypoxic club.

Pulse oxygen has been available since the mid 1980's. The theory behind pulse or dose therapy is based on the fact that only the oxygen found in the very first part of inhalation actually gets down to the working units of the lungs (alveoli). So if the right amount of oxygen (dose) can be delivered (pulsed) at the very leading edge of inhalation, oxygen saturations *should* be maintained. Although there have been many scientific papers published on pulse oxygen, what is found in the lab is not always what is found in live patients. What might explain these differences? Well, oxygenating the blood is actually a beautiful ballet between the delivery of oxygen



Where the beautiful ballet takes place between the alveoli and capillary network.

to the alveoli, and the delivery of an adequate capillary blood flow to those alveoli to pick up the oxygen. This is where things get a little dicey. Anything that affects either dancer in the ballet will have a profound effect on oxygen saturation. Let's simplify a bit and say the oxygen ballet players need to match up almost one for one with the blood flow ballet players. There are many other variables that are a bit beyond this article that may also contribute to "unbalancing" our delicate ballet. Suffice it to say, pulse oxygen may meet or even exceed the requirements for many patients under conditions of rest. However, all bets *may* be off with increased activity. Fortunately, we now live in an age where accurate, digital pulse oximeters are very affordable. As long as you are "titrating while you're migrating" all of these variables become much less important. As stated in last month's article, the cells of your body only know one thing. They want the normal amount of oxygen to be delivered, under all conditions, all the time.

For many patients, pulsed oxygen works beautifully under conditions of rest and activity. For others, they work while at rest, but fall a little short with activity. For others such as those patients with pulmonary fibrosis, they might not work at all due to the higher continuous flow requirements. What only matters is keeping your oxygen saturations in the normal range for where you live. Many of us clinicians have been trying for years to get patients who use pulse oxygen units to not think of the numbers as equivalent to continuous liter flows. You simply need to know the number 2 gives more oxygen than the number 1 and so on up the scale. If you get to a pulse setting of 6, and your saturation is in the 80's, you probably should go back to continuous flow and re-titrate yourself. A different

pulse device may also give more oxygen at the same setting of six. Either way, the cardinal rule is not to conserve oxygen, but to maintain oxygen saturation. Conserving oxygen *never* kept anyone alive even one more minute.

So the decision to pulse or not to pulse should truly be based on your pulse oximeter readings.



Let your pulse oximeter be your guide.

It is also important to remember that pulse oxygen is not a one size fits all therapy. You may have to “test drive” more than one device before you find one that is suitable for your individual situation. Yes, your lifestyle needs to be factored in, as well as your overall quality of life. I get that. But you can get both quality AND quantity of life if you wear your oxygen as much of the time as you can, titrate your oxygen to stay in normal range, and keep up with all of your options in oxygen, as well as new product development. I don't think we will ever see the oxygen pill, but then again, we couldn't have conceived of a standard oxygen concentrator, much less a portable version when the Beatles were playing on the Ed Sullivan show in 1964.

