First impressions of the use of a new Heliox ventilator solution
The clinical use of Heliox (helium-oxygen mixtures) was originally used at the turn of the century as a breathing mixture in deep sea diving to avoid decompression sickness formed by nitrogen bubbles. Use of Heliox to improve symptoms of airway obstruction was reported as early as the 1930s. The use of Heliox has been documented in clinical studies in spontaneously breathing patients and non-invasive ventilation; however it is also being used increasingly in mechanical ventilation of intubated patients.

Heliox has been used for the past four years in the 9-bed general intensive care unit of St. Peter’s Hospital, Chertsey, Surrey in the United Kingdom. The ICU staff at St. Peter’s has been involved in the development and implementation of bedside mixing stations for Heliox delivery with different types of ventilators. The department will soon be one of the first intensive care units in the world to work with a bedside piped gas supply of Heliox. They have also recently implemented the Heliox application on their SERVO-i ventilator fl eet. Critical Care News spoke with intensive care physician Dr Ian White, about their experience with Heliox in general and early experience with the new ventilator solution.
When did you first learn about the concept of Heliox therapy, and for how long have you been utilizing the therapy?

Dr Ian White: We have been using Heliox for about 3-4 years now, starting in October 2004. We introduced it very slowly, and we were involved at an early stage building up the equipment and experience together with BOC (British Oxygen Company). The main problem of introducing any new therapy in ICU is that you’ve got to get people familiar with it, and that means getting people familiar with the basic concept and then, in this case, with using the equipment. Once you are familiar with Heliox, it is very straightforward to use. You set up the ventilator in the exact same way as for conventional ventilation, but the patients are ventilated with helium not nitrogen as the carrier gas. But it is not just the ventilation that is important; it is the logistics of Heliox that require detailed attention. The nurses, the physiotherapists and other paramedical staff have had to be educated and the portering teams have to take on the extra workload of moving the cylinders around. That takes time in the beginning. We have over 54 fulltime staff, and things moved slowly at first. Everyone needed the chance to get trained and educated using Heliox on patients. We were one of the first units to use Heliox on ventilated patients so there was no one to refer to for advice. It was a matter of trial and error. The exchange delivery station we are currently using is the second model BOC constructed, it’s a new design slightly modified from an original version.

The first ventilator we used for Heliox had some problems. It used twice as much Heliox as it should have because it had a leak, a problem that was never resolved. The ventilator was not as good as the SERVO-i ventilator, which is much more efficient. What we were gaining by using Heliox, we were losing using that ventilator, as you could set up both ventilators exactly the same but tidal volumes would drop when changing to the first ventilator compared to the SERVO-i because that brand was not as efficient. We went on to work with another ventilator brand, which was a more efficient ventilator than the first, and comparable to the SERVO-i but not as user friendly. Now we have the SERVO-i, and everyone knows how to use it since it is the main one we use on the unit, so instigating the use of Heliox with SERVO-i has not been a problem.

What FiO2 settings are you normally using when running Heliox and what is your philosophy related to this and the clinical effect of Heliox?

Dr Ian White: The only substantial clinical evidence for the use of Heliox is with severe asthmatics, the evidence for the use of Heliox in any other patient categories is mainly anecdotal. However, the more we use Heliox with other patient categories, the more experience we gain and the more we are seeing the benefits. Basically, we use Heliox on anyone with an increased work of breathing, which includes any spontaneously breathing patient going into respiratory failure, including patients with asthma, COPD, and pneumonia. For ventilated patients we want to ventilate them such as to deliver the same tidal volumes but at much lower pressures. I believe this reduces risk of lung injury. We believe that there is growing evidence that you can reduce mortality by reducing pressures, and we believe that Heliox is a way of achieving this.

What is the average length of treatment for patients treated with Heliox?

Dr Ian White: We admit over 480 patients per year to the ICU and of these we treat on average approximately one or two patients with Heliox per week. They can remain on Heliox from any thing from a few hours to many days depending on their response. Problems arise with two patients on Heliox therapy because the staff time required in order to transport and change the cylinders at the bedside is a considerable drain on resources. This is the limiting factor on the number of patients we can treat at any time with Heliox on our unit. We will soon have piped Heliox delivered to the bedside so this will simplify the logistics and we may be able to treat more patients on a weekly basis.

Which types of patients do you normally treat with Heliox?

Dr Ian White: Ideally we want at least 60% helium, which makes it amenable to treating patients with bronchospasm who don’t have gas exchange problems. You can get oxygen in and out more easily with laminar flow, which is essentially the mechanism of action of Heliox. Patients can breathe much easier with less work of breathing and nebulized drugs get better deposition. In those patients who don’t need much oxygen you use as much helium as is possible. For patients needing a higher percent of oxygen, it can be a problem since helium and oxygen are competing for the same space. For ventilated patients, we find we are ventilating much more efficiently, we get the same tidal volumes but at lower pressures. You see a difference in tidal volumes even by adding in an extra 5% of Heliox. You have the opportunity of titrating in the Heliox so getting more efficient ventilation without compromising your oxygenation. This is anecdotal, based on our own experience and observations, at this point.
You mentioned some of the challenges of administrating and handling logistics with Heliox gas supply into the ICU. What will the opportunities be of piped delivery of Heliox to bedside?

Dr Ian White: We are in the process of finalizing our system and piped Heliox will be happening imminently. We will have a total of 5 beds where Heliox will be piped in at the bedside. We are the first ICU in Great Britain to have these pipes installed, and one of the few in Europe and worldwide for that matter.

You have recently started using the Heliox application on the SERVO-i ventilator. How many patient treatment experiences have you had so far and what are your initial impressions of running Heliox with the SERVO-i ventilator?

Dr Ian White: The systems became available in this past month, so our intensive care staff has just started using it. We have treated about 4-5 patients so far with the SERVO-i Heliox application. It seems to be working very well. We use the SERVO-i heliox changeover station to ensure seamless transition between oxygen and heliox.

Are you planning to do research on Heliox therapy, and if so, please describe in general what you are interested in investigating?

Dr Ian White: We are planning to do research and we are ready to go; we have protocols in place, approval from the ethics committee and consent forms finalized. We are ready to start recruiting patients, but we are waiting for the piped facility to be finalized, so as to afford better blinding of the study. It is difficult to blind a study while using the cylinders at bedside. In terms of what we want to investigate, we will base it on a review by Hager et al in AJRCCM from 2005, an analysis of controlled trials that studied ventilation at low tidal volumes compared to high tidal volumes. From the analysis of these studies the investigators found that the mortality was only significantly higher in the high tidal volume group if the patients were ventilated at higher mean plateau pressures.

This is the fundamental reason for using Heliox in ventilated patients, in our opinion. If you can reduce the mean plateau pressures by using Heliox, according to this analysis that has already demonstrated a reduction in mortality, the outcome is much better. My research will be for a four-hour period. We will take patients within the first 48 hours of intensive care, stabilize them generally depending on their condition, and then randomize them to receive Heliox or Nitrox mixtures, and look at the change in plateau pressures over that four hour period. The nice thing with Heliox is once you get nitrogen washout, which takes 3-4 minutes in a closed circuit, you will see if Heliox has an effect or not almost immediately, it is a mechanical thing in the short term. I genuinely believe that we will see a difference within four hours. We have had enough experience at this point to be optimistic to be able to demonstrate a reduction in pressures. We will be looking at patients with PaO2/FiO2 ratios of less than 35, but we believe that Heliox should be used much earlier to reduce the potential of damage. The Hager et al study shows us that mortality is much better if you keep plateau pressures lower, and Heliox is a way of doing that. You convert from turbulent to laminar flow hence reduce driving pressure and peak pressures. It is common sense and basic physics; by reducing pressures earlier you protect the lungs earlier, thus avoid getting stiff lungs and low compliance.

How important is evidence-based medicine when choosing a ventilation therapy, in your opinion?

Dr Ian White: It is very, very important, and unfortunately for this reason a lot of physicians aren’t using Heliox, since the evidence base behind it is not significant enough yet. But the problem with this is that there will not be any evidence for anything if one is not willing to try something new. Someone must have a vision and once basic experience is in place and seems to support the vision, you formalize by means of studies and then offer a new therapy to the public domain. If your studies are significant, they will support the new therapy. The documentation behind Heliox use is increasing steadily, there is quite a lot that has been published recently but more Level 1 evidence is needed.
as our standard ventilator anyway, so I think it will give us more opportunities to use Heliox as time goes by.

Since we are doing recruitment with the Open Lung Tool on SERVO-i, this will also give us opportunities to do lung recruitment using Heliox. I have modified the recommended recruitment protocol slightly; I do an inspiratory hold at the end of the cycle, which does not increase pressures, but gives the pressures time to spread diffusely. I think we can recruit the lungs better with Heliox; it gives us a new dimension, not only pressures, flow and time, but also density thus lowering the driving force.

How easy or difficult was it to implement the new SERVO-i Heliox technology among your staff members?

Dr Ian White: It has been very easy, absolutely, the staff are all familiar with Heliox therapy, and we have all been working so long with the SERVO-i ventilator that they are all comfortable with it. With new staff members, you have to be overly cautious in terms of explaining about the significance of changing the amount of oxygen and how that can affect the amount of Heliox and tidal volumes. But that is mainly for new staff members. The rest of our people here are now very experienced.

What is your experience of delivering Heliox with non-invasive ventilation therapy?

Dr Ian White: We have delivered a lot of Heliox to spontaneously breathing patients both via a face mask and using NIV. We want to avoid putting patients on ventilators as much as possible; mechanical ventilation poses the risk of lung damage through ventilator induced lung injury, ventilator associated pneumonias to name just a couple of problems. With Heliox you can buy the patient time, they have reduced work of breathing hence reduced oxygen demands, thus giving the patient time to heal. In spontaneously breathing patients you often see an immediate improvement. Pre-clinical studies and a few individual patient studies have indicated that if you ventilate patients with Heliox, you may reduce the amount of inflammatory changes. So Heliox not only has mechanical lung protective effects, it may have anti-inflammatory effects as well. We don’t know enough about this emerging data yet, but it is very exciting.

You mentioned your experience of Heliox therapy while nebulizing. Do you perceive better distribution or more optimal drug use?

Dr Ian White: There is laminar flow in the lower airways anyway, but it is the matter of getting the nebulized drug through the upper airways that may be a challenge. The harder the patient is working, the more turbulent the flow there is in the upper airways. If you can convert turbulent flow here to laminar flow and lower the patients’ work of breathing, there is better delivery and deposition of bronchodilatory drugs to the lower airway and we are using Heliox to achieve this.

References


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Biography

Dr Ian White received his initial medical training at Kings College Medical School in London from 1985-1991, and qualified as MB BS in June 1991, and Fellow of the Royal College of Anaesthesia in 1998, and CCST in 2002. His previous appointments include Senior House Officer, Accident and Emergency at Wexham Park Hospital, Slough, Senior House Officer Anaesthetics at St. Peters Hospital in Chertsey, as well as Queens Medical Center City Hospital in Nottingham. Dr White served as Registrar in Anaesthetics at Royal Marsden Hospital in London in 1996, and Registrar in Anaesthetics at Ealing Hospital in London from 1996-1997. He was Special Registrar at the Imperial College School of Medicine at Hammersmith Hospital in London from 1997-1998, and Lecturer in Anaesthesia and Intensive Care at the Imperial College London and Chelsea & Westminster Hospital from 1998-2003. Dr Ian White is currently Consultant Anaesthetist/Intensivist at St Peter’s Hospital in Chertsey, Surrey in the United Kingdom, a position he has held since 2003.