EVOLUTION OF RESPIRATORY VENTILATORS

The earliest interest in the principle of artificial breathing is generally first attributed to the Roman physician, Galen. He reported the artificial inflation of the lungs of a dead animal through the use of bellows. Between the 14th and 19th centuries, many scientists and physicians (including Vesalius, Hooke, Tossach, Priestley, Brodie, and Dalziel) continued to experiment with the principle of artificially-assisted breathing in both animals and humans, preparing the way for the eventual development of practical mechanical ventilation.

1908
George Poe was the first to demonstrate effective mechanical respiration by asphyxiating dogs, rats and rabbits and then apparently restoring them to life by forcing oxygen from a cylinder into their lungs through a piece of tubing.

1920s
The late 1920s saw the beginning of the age of practical mechanical ventilation, when the iron lung was first developed by Drinker and Shaw in 1929. This device, also known as the Drinker and Shaw tank, was a large, airtight metal cylinder that enclosed the entire patient, with the exception of the head and neck which were sealed from the device with a rubber gasket and exposed to the room air. Negative pressure, generated within the cylinder using an electric pump, caused the patient's chest to rise. This device was particularly effective as a non-invasive form of mechanical ventilation for patients with normal airways, such as those with polio. However, it was not very useful for patients with significant respiratory disorders.

1940s - 1950s
The iron lung was refined over the next few years and used extensively during the polio epidemic of the 1940s and 1950s. However, only incremental changes were made to the device over this time, and the basic principle of the procedure was not changed. Units developed during the 1950s included the Pulmowrap, invented by the JH Emerson Company in Cambridge, Massachusetts, and Breasy Medical Equipment’s Hayek Oscillator, marketed from London. These models incorporated either an airtight jacket or a flexible chest cuirass system to maintain adequate negative pressure ventilation. It is interesting to note that both models are still in service around the world to maintain ventilator support in patients with neuromuscular disorders, chest wall deformities, and central hypoventilation syndrome.
1960s - 1970s

The 1960s and early 1970s saw the development of the volume-cycled 3-PV ventilator and two pressure-cycled devices, including the Bennett and Bird ventilators. These machines marked a departure from the earlier iron lung concept, providing for the first time ventilation through the use of a positive-pressure. In the early 1970s, two revolutionary ventilators – the Ohio 560, from Ohio Medical Products, and the Bennett MA-I, from Puritan-Bennett Corp – were developed. Both ventilators were electronically controlled, constant-volume ventilators offering many user-friendly features such as variable ventilator mode selection and easy-to-read display panels. They also offered accurate adjustment of the fraction of inspired oxygen (FiO2), a physiologic “sigh breath” to limit atelectasis, inspiratory humidification, positive end-expiratory pressure (PEEP), and numerous alarm systems. The MA-I ventilator is still in use today around the world.

Today

Mechanical ventilators have evolved into high-tech devices that allow a patient’s ventilatory demands to be synchronized with augmentation of volume and pressure waveforms. Negative pressure mechanical ventilators are still in use, notably in polio wing hospitals in the UK. The prominent device of this type used today is the cuirass, which has a polycarbonate shell, creating negative pressure to the chest only. The device has a high-pressure oscillation pump in order to carry out biphasic cuirass ventilation. Its main use is in patients with neuromuscular disorders who have some residual muscular function.

When the time comes to replace a respiratory ventilator, purchasing a new one is not necessarily the only option available. Due to the high initial capital outlay required for the purchase of a new ventilator, refurbishment of an existing ventilator is a viable and increasingly common option. Some hospitals choose to have their own ventilator refurbished, while others may prefer to purchase a refurbished mode in preference to a new model.

Ventilators have not changed fundamentally over the past 15-20 years, and many of the features of the earlier models are still available in contemporary models today. For example, the Puritan Bennett 840, which is marketed today, is not fundamentally different to its predecessor, the Puritan Bennett 740, which is around 12 years old, and the two models share many of the same features:

- Both are equipped with a high-performance gas-delivery system combined with frictionless piston and flow triggering to respond to a patient’s breathing efforts without the need for a compressed air source.
- Both offer volume controlled ventilation (VCV) in A/C or synchronous intermittent mandatory ventilation modes, and both offer pressure support ventilation (PSV) in spontaneous or synchronous intermittent mandatory ventilation modes.
- The respiratory rate, support pressure and positive end-expiratory pressure (PEEP) are similar between the two models (1-70/min, 0-70 cm H2O and 0-35 cm H2O, respectively, for the Puritan Bennett 740 compared with 1-100/min, 5-90 cm H2O and 0-45 cm H2O, respectively, for the Puritan Bennett 840).
- Both models are suitable for all patients, from infants to adults.

The cost of a refurbished Puritan Bennett 740 is around 40% less than the cost of a brand new ventilator when they are purchased from companies such as General Biomedical Service Inc., the Kenner, LA-based provider of refurbished respiratory therapy and anesthesia equipment (which specializes in ventilators). “Depending on the reseller, the refurbished unit may come with a warranty ranging from six months to a full year” said GBS sales manager Ana Ortega.

According to the website www.usedventilators.com the common steps taken when refurbishing a respiratory ventilator include:

1. Replacement of batteries and hoses (where applicable)
2. Replacement of seals and gaskets
3. Use of a preventive maintenance kit (10,000-hour kit), which usually contain specific rubber goods
4. Calibration to manufacturer’s specifications (where applicable)
5. Painting of the structure
6. Replacement of labels
7. Replacement of castors
8. Replacement of knobs or other external components

When you next need to replace your respiratory ventilator, remember to take time to research the advantages of a rebuilt or refurbished model, and you may find you can have all that you need for a significantly reduced outlay.