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“"We create as much information in two days now as we did from the dawn of man through 2003” Eric Schmidt, CEO, Google, 2010.

It is difficult to capture in a single article all the respiratory equipment and devices that have emerged over the last 200 years or so. However, it is possible to create a suggested list of the “top 20 innovations” that have at each stage revolutionised our practice or even initiated whole new areas of respiratory medicine. Taking the HERMES (Harmonising Education in Respiratory Medicine for European Specialists) curriculum, the list of devices most widely used/taught in respiratory medicine can be used to draw up the list in table 1. Diagnostic devices outnumber therapeutic devices by about 2:1, which in part reflects the author’s preference but also the fact that diagnostics have often led to the discovery of new conditions, which in turn require the development of novel therapeutic interventions to cure them (especially surgery and medications). A further consideration is the absence of surgical devices and equipment, which, while often equally as important as medical devices, have been omitted here mainly because of the author’s limited knowledge of such a vast field.

The statistic that mankind has invented more in the last 100 years than in the previous 5000 years pays testament to the emergence of modern technology from the industrial revolution, mainly as the result of large-scale military conflict (the World Wars, the Cold War etc) and the Space Race, as well as a natural consequence of investing in innovation. The graph of the number of inventions over time is exponential and this process of device evolution is accelerating.

The 20th Century saw two key “innovation accelerators” which may not themselves have been used in all key new medical devices but which have certainly influenced their manufacture and development; namely the transistor (1947, John Bardeen and Walter Brattain, Bell Laboratories) and the microprocessor (1958, Jack Kilby, Texas Instruments). Arguably, the next great leap in technology, which is already happening and is taking us to the next level of innovation, is the three-dimensional (3-D) printer.

For the purposes of reviewing two centuries of the most important devices and equipment in respiratory medicine this article will consider the 20 key innovations and examine why they should be nominated for their contribution (table 1). Arguments will inevitably occur over who actually invented a particular device because, as we know from history, similar inventions have often evolved separately without the people inventing them being aware of each other. However, the purpose of this article is to stimulate thought and debate, as well as to allow reflection on where our common respiratory tools have come from.
Whilst the inventions in Table 1 are listed in the chronological order of their development, in order to provide perspective they can also be considered as reflecting the journey of a fictional obese patient with both chronic obstructive pulmonary disease (COPD) and lung cancer who has been referred to the respiratory team. Here, diagnosis (auscultation, imaging, lung function testing, and cardio-pulmonary exercise testing (CPET)) leads to surgery (ventilation, bypass and monitoring) and recovery, together with management of the long-term condition (COPD) using home oxygen and home ventilation together with monitoring by oximetry, blood gases and lung function.

<table>
<thead>
<tr>
<th>Entry</th>
<th>Device/Innovation</th>
<th>Type</th>
<th>Year</th>
<th>Inventor</th>
<th>Nationality</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Stethoscopes</td>
<td>D</td>
<td>1816</td>
<td>René Laennec</td>
<td>French</td>
</tr>
<tr>
<td>2</td>
<td>Spirometers</td>
<td>D</td>
<td>1846</td>
<td>John Hutchinson</td>
<td>British</td>
</tr>
<tr>
<td>3</td>
<td>Nebulisers</td>
<td>T</td>
<td>1858</td>
<td>Dr. Sales-Girons</td>
<td>French</td>
</tr>
<tr>
<td>4</td>
<td>Bypass life support</td>
<td>T</td>
<td>1885</td>
<td>Maximilian von Frey</td>
<td>Austrian/German</td>
</tr>
<tr>
<td>5</td>
<td>Radiography</td>
<td>D</td>
<td>1895</td>
<td>Wilhelm C. Röntgen</td>
<td>German</td>
</tr>
<tr>
<td>6</td>
<td>Bronchoscopes</td>
<td>D</td>
<td>1897</td>
<td>Gustav Killian</td>
<td>German</td>
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<tr>
<td>7</td>
<td>Ventilators</td>
<td>T</td>
<td>1907</td>
<td>George E. Fell</td>
<td>British</td>
</tr>
<tr>
<td>9</td>
<td>Noninvasive ventilation</td>
<td>T</td>
<td>1940</td>
<td>Andre F. Cournand</td>
<td>French</td>
</tr>
<tr>
<td>10</td>
<td>Body plethysmography</td>
<td>D</td>
<td>1956</td>
<td>Arthur Dubois</td>
<td>French</td>
</tr>
<tr>
<td>11</td>
<td>Gas transfer testing</td>
<td>D</td>
<td>1957</td>
<td>Robert Forster</td>
<td>British</td>
</tr>
<tr>
<td>12</td>
<td>Peak flow meters</td>
<td>D</td>
<td>1959</td>
<td>Basil M. Wright</td>
<td>British</td>
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<tr>
<td>13</td>
<td>Ventilation/perfusion scanning</td>
<td>D</td>
<td>1964</td>
<td>James L. Quinn III</td>
<td>American</td>
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<tr>
<td>14</td>
<td>Laser surgery</td>
<td>T</td>
<td>1964</td>
<td>Charles H. Townes</td>
<td>American</td>
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<tr>
<td>15</td>
<td>Oxygen concentrators</td>
<td>T</td>
<td>1970</td>
<td>Union Carbide</td>
<td>American</td>
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<tr>
<td>16</td>
<td>Cardio-pulmonary exercise testing</td>
<td>D</td>
<td>1970</td>
<td>Fenyes und Gut</td>
<td>German</td>
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<tr>
<td>17</td>
<td>Magnetic resonance imaging</td>
<td>D</td>
<td>1971</td>
<td>Paul C. Lauterbur</td>
<td>American</td>
</tr>
<tr>
<td>18</td>
<td>Pulse oximeters</td>
<td>D</td>
<td>1972</td>
<td>Takuo Aoyagi</td>
<td>Japanese</td>
</tr>
<tr>
<td>19</td>
<td>Computed tomography</td>
<td>D</td>
<td>1972</td>
<td>Godfrey Hounsfeld/Allan Cormack</td>
<td>British/South African</td>
</tr>
<tr>
<td>20</td>
<td>CPAP therapy</td>
<td>T</td>
<td>1981</td>
<td>Colin Sullivan</td>
<td>Australian</td>
</tr>
</tbody>
</table>

CPAP: continuous positive airway pressure; D: diagnostic; T: therapeutic.

The most fundamental tool for respiratory investigation is the stethoscope, which was invented by René Laennec in 1816 in Paris, France. It was monaural and consisted of a wooden tube and was designed to help avoid touching the patient’s chest directly (Laennec was uncomfortable placing his ear on women’s chests to hear heart sounds). The first flexible stethoscope, described by Wilks in 1829, may have been a binaural instrument with articulated joints. However, in 1840 Golding Bird described a stethoscope which he had been using with a flexible tube. Bird was the first to publish a description of a flexible stethoscope but he suggested that there may have been an earlier design described as the “snake ear trumpet”. Bird’s stethoscope was monaural; however, by 1851 Leared
had invented a binaural stethoscope. This was further developed from 1852 by Cammann into a stethoscope for use in both ears intended for commercial production and which essentially became the device that we use today. Using this new instrument, Cammann went on to describe diagnosis by auscultation in great detail, supporting the notion that new devices generating new specialities is a common theme throughout the medical device sector. Rappaport and Sprague redesigned the stethoscope in the 1940s, their version consisting of two sides, one used for the cardiovascular system and the other (more importantly!) for the respiratory system. In 1962, Littmann produced the lightweight stethoscope which is familiar to doctors today.

THE PULSE OXIMETER

The method was invented in 1972 by Takuo Aoyagi, a bioengineer, while he was working on an ear densitometer for recording dye dilution curves. Susumu Nakajima, a surgeon, and his associates first tested the device in patients, reporting on it in 1975. A competing device was also introduced, tested and described in Japan. William New and Jack Lloyd recognised the potential importance of pulse oximetry and developed interest among anaesthesiologists and others concerned with critical care in the United States. Success brought patent production and which essentially became a life-saving device.

THE SPIROMETER

A thorough history of spirometry by Gibson has described the early-to-modern development of this test, the most fundamental after measurement of peak flow. Although it is often described as a simple test, spirometry requires specific competence, maintenance of skills and careful interpretation to obtain reliable and acceptable results. The method has gradually moved from volume-measuring devices such as the water-seal spirometers created in Hutchinson’s era, through the rolling-seal and wedge-bellows devices of the 1960s and 1970s, to flow-measuring devices using turbines/rotating vanes, pneumotachographs and now ultrasonic devices. Developments have included the rapid analysis of quality, interpretation of results against reference values and the use of clear graphics and results to aid the diagnosis of common respiratory conditions. As the devices become more reliable and manageable, it is the limitation of interpretational skills that needs to be conquered next, perhaps using pattern recognition technology. The concept of the hand-held spirometer has moved from the clinical site to the patient’s home, as a self-monitoring aid, leaving diagnostics with quality-assured spirometry devices to qualified healthcare staff.

On receiving a referral, the consultant physician would inevitably refer the patient for a chest radiograph, a blood gas test (if the oximetry was abnormal) and perhaps a set of lung function tests (gas transfer and lung volumes) to confirm and quantify the COPD. After the clinical consultation and review of the radiograph and lung function tests, the physician may decide a magnetic resonance imaging (MRI) or computed tomography (CT) scan is relevant to detect tell-tale shadowing in the lungs. A sleep study (including overnight oximetry) would be ordered in the first tranche of investigations if the patient was excessively sleepy in the daytime.

THE BLOOD GAS MACHINE

The history of blood gas analysis has been well-described by Severinghaus over the years. The original platinum cathode for oxygen monitoring was described by Blinks and Skow in 1938 while they were studying plants. Their publication led to the tissue oxygen studies of Davies, Brink and Bronk; however, it was Clark’s adaptation, the covering of the cathode and the anode with a polyethylene membrane, which changed the polarographic cathode from a sensor of oxygen availability by diffusion to a measure of oxygen tension (PO₂) in solution and thereby changed the practice of respiratory physiology and blood oxygen after 1956. This electrode led to the development of the present commercial blood gas systems that measure pH, carbon dioxide tension (PCO₂) and PO₂. Variations on Clark’s electrode have led to the determination of oxygen content in the blood based on release of haemoglobin (Hb)-bound oxygen, measurement of PO₂ and an understanding of the Hb–oxygen curve. Further developments, including reducing the cathode diameter, allowed Staub and others to eliminate the need for stirring of a blood sample. In addition, by applying noninsulating but protein impermeable membranes to cathodes, as well as recessing cathodes into glass, measurement of PO₂ in tissues and fluids was permitted with micro-electrodes. The use of capillary blood gas sampling alongside arterial samples has expanded the utilisation of blood gases, by making the process safer and more comfortable for patients while allowing it to remain equally reliable in most clinical settings.
THE CHEST RADIOGRAPH (THE CHEST X-RAY)

The discovery of X-rays in 1895 by Wilhelm Conrad Röntgen began the science and specialism of radiology. Following Röntgen’s discovery that X-rays could identify bone structures, the new technology was tested out by doctors for medical imaging almost immediately, particularly in France. The first medical use was less than a month after his paper on the subject, where Antoine Béclère set up the first radiography machine, strapped a patient into it and moved them around to allow for examination of the chest. However, it appears that MacIntyre (1896) or Williams (1897) were the first to publish the chest radiograph as a technique. Since then the chest radiograph has become one of the backbones of current respiratory diagnostics, with billions of images having been taken in the last 120 years.

MAGNETIC RESONANCE IMAGING

Magnetic resonance imaging (MRI) originated from the complex world of theoretical particle physics and is perhaps one of the technologies that were a spin-off from both the Space Race and the Cold War of the 1950s and 1960s. In the 1950s, “spin echoes” were first detected by Hahn and this was followed by the production of a one-dimensional (1-D) nuclear magnetic resonance (NMR) spectrum by Carr. In 1960, Ivanov filed papers on his magnetic resonance imaging device, which was not approved until the 1970s. History tells us that MRI was invented by Paul C. Lauterbur in 1971, with the theory being published in 1973, although to claim that one individual invented this technology is probably not entirely correct. The path of innovation is convoluted and can run in parallel with similar science and technology. One pattern that is clear in medical science is that often the clinician/clinical scientist will think about using a device or piece of technology in a way that it was never originally intended for and which has subsequently produced a “leap into the dark” that has moved medical science forward in unequal strides across the centuries. The MRI scanner is in high demand and almost essential in the diagnosis and planning of modern cancer therapy. It has revolutionised how we think of cancer and, with improved imaging and signal analysis producing 3-D images of tumours, clinical decision making has become sharper and more accurate, with interventions becoming more focussed. Recently, the combination of MRI diagnostics with various treatment opportunities has expanded the potential of this technology.

COMPUTED TOMOGRAPHY

Computed tomography (CT) was invented in 1972 by engineer Godfrey Hounsfield and physicist Allan Cormack, who were later awarded the Nobel Prize for their contributions to medical science. Like MRI, tomography (or “slice describing”) has enabled us to visualise tissues within the body. The first clinical CT scanners were operational in the mid-1970s and were initially dedicated to head imaging only. However, whole-body imaging soon became available and CT has become widely available with about 30000 devices installed worldwide today. The early CT scanners took several hours to acquire the raw data for a single “slice” and took days to reconstruct a single image from this raw data. Now, most multi-slice CT systems can collect up to 4 slices in 350 ms and can reconstruct a 512x512 matrix image from millions of data points in less than 1 s. An entire chest (40x8 mm slices) can be scanned in 5–10 s using the most advanced multi-slice CT system. Improvements in speed, patient comfort and resolution also mean that as CT scan times have decreased, so more anatomy can be scanned in less time. Faster scanning also helps to eliminate artefacts from patient motion such as breathing or peristalsis.

VENTILATION/PERFUSION SCANNING

The ventilation/perfusion lung scan (the $V'/Q'$-scan) is a form of medical imaging that uses scintigraphy, where medical radioisotopes are used to evaluate the circulation of both air and blood within a patient’s lungs. By measuring isotope levels for both air and blood it is possible to show the relative contributions of each in order to determine the ventilation/perfusion ratio. The ventilation part of the test looks at the ability of air to reach all parts of the lungs, while the perfusion part evaluates how well blood circulates within the lungs. However, it is the relative distribution, or the lack of distribution that gives rise to the effective use of $V'/Q'$-scans in respiratory medicine. Usually, a gaseous radionuclide (e.g. xenon or technetium diethylentriaminopentaacetic acid (DTPA)) is inhaled in an aerosol form while the perfusion phase of the test involves the simultaneous intravenous injection of radioactive technetium macro-aggregated albumin (Tc99m-MAA). Both isotopes are tracked using a gamma camera. The initial technique has been accredited to Knipping et al. in 1955; however, the first clinical use (by Quinn et al.) wasn’t reported until 1964. It is now the definitive test for detecting pulmonary embolus.

BODY PLETHYSMOGRAPHY

Body plethysmography (the “body box”) is a novel technique for measuring lung volumes devised by DuBois in 1956. The principle measurements of the body box are volumes (thoracic gas volume (TGV), functional residual capacity (FRC) and lung volume subdivisions), resistances (airway resistance ($R_{aw}$) and specific airway resistance ($sR_{aw}$)) and conductances (airway conductance ($G_{aw}$) and specific airway conductance ($sG_{aw}$)). The history of body box has been covered elsewhere and the first whole body plethysmograph was made and sold in 1969. The principle of the measurement is the application of Boyle’s law and the relationship between volume and pressure in a closed system. It is considered to be a rapid test and one that is simple for the patient to perform. It is used extensively in North America and Europe as the principle method to measure lung volumes and has been adapted to conduct measurements in infants. Furthermore, it doesn’t require the use of expensive gases, which is beneficial if testing in remote areas of the world.
GAS TRANSFER TESTING

Of all the routine lung function tests used throughout the world, the only true test of gas exchange function is the (single breath) diffusing capacity of the lung for carbon monoxide (DLCO), otherwise known as the transfer factor of the lung for carbon monoxide (TlCO) and the transfer coefficient of the lung for carbon monoxide (KCO) from which it is derived.

Gas-transfer physiology was determined by the French scientist Marie Krogh in her work during the First World War. However, it wasn’t until 1954 that the test was improved, when Forster et al. added an inert gas to the carbon monoxide uptake gas to determine alveolar volume at the point of inhalation. This led Ogilvie et al. to standardise the technique still further to give what is fundamentally the same test as today, albeit without modern gas analysers and collection systems.

After the MRI/CT results, it becomes wholly evident that bronchoscopy (perhaps using endobronchial ultrasound (EBUS)) is required prior to making a decision on surgery. Naturally ultrasound (EBUS) is required prior to deciding on surgery. Naturally, ultrasound is required prior to making a decision on surgery. Naturally, ultrasound is required prior to making a decision on surgery. Naturally, ultrasound is required prior to making a decision on surgery.

THE BRONCHOSCOPE

The first bronchoscopy is purported to have been performed in 1897 by a German, Gustav Killian, using a rigid bronchoscope to remove an inhaled animal bone. The procedure, using a rigid bronchoscope, was performed almost exclusively in a conscious patient using local anaesthetic until the 1970s. However, in the USA, Chevalier Jackson, refined the rigid bronchoscope in the 1920s to visually inspect the trachea and main bronchi. Later, the British laryngologist Victor Negus improved the design to give what came to be called the “Negus bronchoscope”. Finally, in 1966, Shigeto Ikeda from Japan invented the flexible bronchoscope. This endoscope used fibre-optic bundles which needed an external light source and had an external diameter of about 5 mm with the ability to flex 180 degrees and to extend 120 degrees. This scope enabled entry into lobar and segmental bronchi and has largely remained unchanged until today, although the use of digital technology and recording has improved the quality of the procedure. The use of ultrasound-guided bronchoscopy (endobronchial ultrasound or EBUS) is a more recent and widespread refinement of this fundamental technique and is an essential skill in the training of respiratory physicians.

THE CARDIO-PULMONARY EXERCISE TESTING SYSTEM

One piece of equipment that exemplifies the gradual shift from a series of simultaneous measuring systems into a single integrated assessment tool is the development of the cardio-pulmonary exercise testing (CPET) system (also known as the “metabolic cart”).

Essentially, the system measures expired volume and inspired and expired breath to calculate oxygen uptake and carbon dioxide production. From these two parameters it is possible to calculate energy expenditure and substrate utilisation, the outcome measurements of indirect calorimetry, hence the name metabolic cart. The research of many physiologists including Jones, West, and Wasserman/Whipp led to the development of new approaches to assessing cardio-pulmonary fitness, response to exercise challenge and capability; however, while many exercise research centres developed their own makeshift systems assembled from gas analysers, a volume measurement method, an electrocardiograph and a variety of facial/oro-nasal interfaces, it wasn’t until 1970 that a German company (Fenyves und Gut) offered a complete commercially available CPET system. This system, the Pulmosport, allowed respiration without the use of valves and moved away from the use of cumbersome Douglas bags and gas meters. The next evolutionary step in CPET was the introduction of breath-by-breath analysis and also the development of portable indirect oximeters, such as the Oxylog and Cosmed Q4 systems, which enabled sports medicine research to literally expand “into the field”. CPET really came of age with the work of Older et al., where it was used as a pre-operative assessment tool by anaesthetists for cardiothoracic surgery initially and then for all major surgery. Its application in cardio-respiratory medicine makes CPET an important diagnostic technique that is perhaps still widely misunderstood by many clinicians, such that attention to quality and accuracy can leave a lot to be desired. However, it should remain an important over-arching diagnostic tool in the respiratory physiology armoury.

BYPASS LIFE SUPPORT

The physiologist Maximilian von Frey constructed an early prototype of a heart-lung machine in 1885 in Leipzig. However, without heparin to prevent coagulation such devices were not feasible until after 1916. This was followed by the work of Sergei Brukhonenko who developed a heart-lung machine in 1926 for whole body perfusion in experiments on dogs. In 1951 Clarence Dennis led the team at the University of Minnesota Hospital who conducted human cardiotomy surgery with the temporary mechanical takeover of both heart and lung function. Although the patient failed to survive the surgery because of an unexpected complex congenital heart defect, the “Iron Heart” bypass was actually successful and the first open-heart surgery was performed that year in Utah by Nelson. The first instance of successful left-ventricular function mechanical support was performed in 1952 by Dodrill using a machine, the Dodrill-GMR, co-developed with General Motors. The machine was later adapted to support right-ventricular function. The first successful open-heart procedure on a human being utilising the heart-lung machine was performed by Gibbon in 1953, where he repaired an atrial septal defect in a young woman. Gibbon’s machine became a reliable system through the mid-1950s. Although the 19th century saw the development of bubble oxygenators which had no intervening barrier between blood and oxygen, such “direct-contact oxygenators” had their limitations. The development of membrane oxygenators,
which introduced a gas-permeable membrane between blood and oxygen, decreased the level of blood trauma compared to direct-contact oxygenators. From the 1960s onwards research into overcoming the gas-exchange handicap of the membrane barrier eventually led to the development of high-performance, microporous, hollow-fibre oxygenators that replaced previous oxygenators in cardiac theatres. The role of the “perfusionist” in using the bypass machine subsequently developed and is largely seen as an almost background function in cardiac surgery; however, the enormity of the challenges and the complexity of the technology cannot be underestimated.

THE VENTILATOR

The history of ventilators has been extensively discussed elsewhere by Young and Sykes. They reviewed how automatic artificial ventilators were first suggested by Fell and then made available commercially by Draeger in 1907. These were mainly devices for resuscitation as part of mines rescue equipment but adaptation by medical and surgical teams clearly revolutionised our ability to treat acute infections and trauma, as well as peri-operative recovery from cardio-thoracic surgery. The complexity of ventilators has increased and they now utilise pressure, flow, volume and gas analysis signals using complex algorithms to ensure fully automated and appropriate ventilation occurs by assessing oxygen uptake, monitoring change in lung compliance and ensuring patient synchronicity if required. Older volume cycling ventilation has been largely replaced by pressure cycling ventilation but many ventilators cleverly use volume and pressure modes to ensure optimal delivery. This has led to the development of noninvasive ventilation (NIV) which will be discussed later.

LASER SURGERY

Theodore H. Maiman created the first laser out of ruby in 1960 and 2 years later a dermatologist named Leon Goldman came up with a way to remove unwanted tattoos which became the first medical use of lasers. Within a further 2 years the laser scalpel was invented by Charles Townes, who shared the 1964 Nobel Prize in Physics for this invention. In soft tissue laser surgery, the laser beam vaporises the soft tissue with either a diode, Nd:Er:YAG or carbon dioxide laser. Carbon dioxide lasers are the best for cutting soft tissue because their wavelength is mostly absorbed by water with little thermal damage to surrounding tissues. Indeed, the carbon dioxide laser remains the gold standard for soft tissue surgery because of the ease of simultaneous photothermal ablation and coagulation thus stabilising the tissue instantaneously. The development of laser bronchoscopy surgery has produced effective and versatile interventions in upper airway disorders and reduces the risk to patients of having to have more radical surgical procedures for tumour removal.

NONINVASIVE VENTILATION

In discussing noninvasive ventilation (NIV) it is apparent that its developmental evolution occurred essentially because of two key advances, namely 1) the patient/device interface and 2) the development of “blower-type ventilators” to deliver respiratory support. Noninvasive ventilation has developed in parallel with invasive ventilation since the 1940s and has been brilliantly evidenced elsewhere by Pierson who makes the very salient point that there is “…a distinction between efficacy, which is what is demonstrated under the structured conditions of a clinical study, and clinical effectiveness, which is what happens in ordinary, everyday practice…”. It is this balance of research and applied innovation that blurs the history of the development of many clinical devices but which, on a practical level, inspires clinicians to try out a new innovation in a safe way.

The concept of portable ventilation away from the critical care setting and the later development of home ventilation have produced changes in respiratory care previously unimagined. It is likely that NIV was tried in several places before papers on its use, for example in COPD, were published. Indeed, ventilation via mask probably preceded intubation and it was the patient/ventilator interface that really established the treatment. Motley et al. can probably be assigned as the “inventors” of NIV in 1940 when they experimented with nasal positive pressure ventilation. However, it wasn’t until the 1980s that the technique really took off as the first-line ventilator treatment in Type-2 respiratory failure. The use of home NIV in paediatrics has changed the course of several patient pathways including cystic fibrosis, Duchenne muscular dystrophy or any condition resulting in chronic respiratory failure. Indeed, COPD guidelines now recommend the use of home NIV, a technological leap that has occurred in less than 20 years with dramatic results.

Post-operatively the patient receives NIV on the ward after critical care and the discharge plan includes continuous positive airway pressure (CPAP) therapy, long-term oxygen therapy and nebulisers. However, after the first few out-patient reviews, it becomes evident that NIV will be better than CPAP given the patient’s co-morbidities.

CONTINUOUS POSITIVE AIRWAY PRESSURE

Sullivan’s seminal paper on the use of nasal continuous positive airway pressure (CPAP) for obstructive sleep apnoea (OSA) probably ranks as one of the most significant step-changes in both a respiratory condition and its treatment. Whilst his device was a research development, within months ResMed had developed their first “Sullivan CPAP machine”. This was closely matched by Respironics, a company already established in the ventilation field, and who developed and marketed their own device. These two rival companies now dominate a multi-billion global market in CPAP treatment. In fact, the whole field of OSA and the establishment of sleep apnoea services in most countries of the world are entirely due to the invention of the CPAP machine. Sleep disordered breathing was something discovered during research in the 1970s but without a significant effective treatment (tracheostomy was the main therapy) it remained an intellectual
The first ever recorded use of oxygen for a medical purpose was in 1885 where it was used to treat a patient with pneumonia. This revolutionary treatment was pioneered by George Holtzapple and, within 2 years, an oxygen cylinder was invented that could store enough oxygen for intermittent use. The 1970s were a revolutionary period for advancement in medical-grade oxygen therapy and patients began receiving their own oxygen therapy units at home; bulky, heavy devices available from cylinder suppliers. This advancement in oxygen therapy was extraordinary because the concentrator purified oxygen within itself. It was the invention of the molecular sieve in the 1950s by Union Carbide Corp (UCC) which made these devices possible. UCC also invented the first cryogenic liquid home medical oxygen systems in the 1960s. Today, the size of concentrators has decreased exponentially and portable oxygen concentrators give patients the flexibility to help them lead more independent lives.

**THE OXYGEN CONCENTRATOR**

The first ever recorded use of oxygen for a medical purpose was in 1885 where it was used to treat a patient with pneumonia. This revolutionary treatment was pioneered by George Holtzapple and, within 2 years, an oxygen cylinder was invented that could store enough oxygen for intermittent use. The 1970s were a revolutionary period for advancement in medical-grade oxygen therapy and patients began receiving their own oxygen therapy units at home; bulky, heavy devices available from cylinder suppliers. This advancement in oxygen therapy was extraordinary because the concentrator purified oxygen within itself. It was the invention of the molecular sieve in the 1950s by Union Carbide Corp (UCC) which made these devices possible. UCC also invented the first cryogenic liquid home medical oxygen systems in the 1960s. Today, the size of concentrators has decreased exponentially and portable oxygen concentrators give patients the flexibility to help them lead more independent lives.

**THE NEBULISER**

The first nebuliser was actually produced in 1858 by a French inventor named Sales-Girons. His nebuliser was unique in that it had a pedal that acted like a bicycle pump which, when pulled up, forced air through an atomiser to create a mist that was to be inhaled. In the early 1930s a first compressor nebuliser, the Pneumostat, was manufactured in Germany. This device had a rheostat for the power supply allowing adjustment of the compressor. Furthermore, the London Inhalatorium offered a treatment room that used a nebuliser powered by a cylinder of compressed oxygen for inhalation of medications including adrenaline, menthol, eucalyptus and turpentine, as well as other substances. Nebulisers are used both at home and in healthcare settings across the world. It would be difficult not to mention the metered dose inhaler (MDI), which probably accounts for more airway medication than nebulisers, but has been discussed elsewhere in great detail by Sanders.

**SUMMARY**

In one referral pathway, albeit for a variety of respiratory conditions, our hypothetical patient has spanned 200 years of respiratory technology and equipment. It is difficult to predict what the next 200 years will hold for future patients; however, it is perhaps inevitable that better identification of conditions and targeting of therapeutics using outputs from genomics, or innovation using complex imaging analysis or new technologies utilising more powerful signal analysis, may sharpen the blade of medical technology and may create new specialities as yet unknown.

**CONFLICT OF INTEREST**

None declared.

**RECOMMENDED READING**


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