If respiration fails

The history of ventilation

From our first cry at birth to our very last breath, we breathe. That’s because our body needs oxygen. At rest, we need about 200 to 300 milliliters a minute. That’s enough to fill a wineglass. But when we’re under strain, we need a lot more.

Breathing is so normal for us that we don’t even think about it. But how does respiration actually work?

When we inhale, our respiratory muscles create a negative pressure. The lungs expand, and air flows in through the mouth and nose and down through the trachea. Millions of little pulmonary alveoli take up oxygen from the air we breathe and pass it along to our cells via our blood circulation. Oxygen is essential to our survival. Without it, our cells aren’t able to function. The metabolic process creates carbon dioxide: a waste product that is poisonous for humans in high concentrations. That’s why we have to exhale it. Our blood circulation brings carbon dioxide back into the lungs so that we can breathe it out.

But what happens when we are no longer able to breathe on our own, for example if an illness attacks and paralyses the respiratory muscles? The lack of oxygen would cause us to pass out – our cells would eventually die. Our bodily functions would cease until our heart stops beating.

In an emergency, every minute counts. The body needs to be supplied with oxygen again as quickly as possible. Every human being is capable of keeping another human being alive without any equipment whatsoever – thanks to mouth-to-mouth resuscitation.

One day, Johann Heinrich Dräger was in London and saw someone being manually ventilated. Right before his eyes, a young man was pulled from the Thames and resuscitated. That very moment inspired him to further develop the idea of ventilating people mechanically. His vision was to bring people back to life with a machine right at the scene of an accident. So he developed the world’s first ventilator: the Pulmotor.

The technology behind the Pulmotor was incredibly simple and remained the basis of mechanical ventilation for decades. The device provided breathing gas until a certain pressure had been reached in the lungs. Then it switched over to exhalation.

After the Second World War, a serious polio epidemic broke out. The disease attacks the nerve cells of the spinal cord and can cause lasting paralysis. In the worst case, it also damages the respiratory muscles permanently. Thousands of children and adults therefore faced a painful death by suffocation.

The ventilators available at the time were not designed for long-term use. So Dräger produced the iron lung based on an American model: a large, heavy metal cylinder in which patients lie with only their heads free. The machine created alternating negative and positive pressure, which moved the lungs, helping the patient inhale and exhale. Especially in the post-war years, the iron lung saved countless lives.
Starting in the 1950s, Dräger worked to develop other ventilators designed for long-term use. They did not create a negative pressure, but blew air into patients’ lungs. This technology made it possible to better manage the volume of air. After all, ventilation is supposed to provide patients with enough oxygen without overstretching their lungs. What’s more, for the first time, the new devices were capable of reacting if patients spontaneously started breathing on their own again – a real revolution! That’s because it results in acute stress for patients when mechanical ventilation suppresses their own breathing.

In the 20th century, electronic and digital technology changed the world. Starting in the 1980s, ventilators were increasingly equipped with electronic components that made ventilation more and more precise. For the first time, the devices were capable of displaying airway pressure, flow of breathing gas, and other vital information on a monitor as ventilation waveforms. They analyzed the data, adjusted patients’ ventilation to match their breathing, and reacted immediately to changes. The devices also used special ventilation methods to train patients’ respiratory muscles and, in doing so, wean them off mechanical ventilation.

These developments were a major benefit, especially for premature babies. That’s because their lungs are even more sensitive than adults’ lungs. They only need about enough air to fill a thimble. It wasn’t until modern measurement and control technology came along that it became possible to regulate such small quantities of air. For more than 20 years, the Babylog 8000 represented the principle of gentle ventilation: These little patients are able to determine for themselves when and how much air they breathe in and out.

The technical possibilities are growing steadily. Nowadays, it’s even possible to make ventilation visible. The PulmoVista 500 lung-function monitor shows how air is distributed within the lungs – constantly and in real time. This new information helps doctors adjust ventilation to fit the patient optimally and check whether treatment has been successful.

In the future, engineers and doctors will continue to work towards a common goal: short-term ventilation that is gentle on the lungs. So that patients can breathe again without any assistance as quickly as possible.