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A SAVING LOOK INTO THE LUNGS

Does artificial ventilation harm Covid-19 patients more than it benefits them? Imaging processes could settle this debate, which has been ongoing among medical professionals since the start of the year. It also proves that research must still be conducted into certain aspects of SARS-CoV-2.

TEXT RALF GRÖTKER PHOTOS PATRICK OHLIGSCHLÄGER

At the end of April 2020, an alarming report was circulating: “New coronavirus study: Almost 90 percent of ventilated patients in New York die.” Even though it soon transpired that the figures were incorrect, doubts started to emerge in the course of increasing experience with artificially ventilated Covid-19 patients as to whether everything had been done correctly in the first months of the pandemic.

The general consensus in the beginning was that coronavirus patients exhibiting serious progression of the disease were suffering from the clearly defined medical condition ARDS (acute respiratory distress syndrome), but over time it became apparent that the patients were exhibiting completely different symptoms, making it necessary to draw up an individual treatment plan. What has surprised the doctors is the fact that the lungs are often still functioning in cases of Covid-19, although the necessary exchange of oxygen and carbon dioxide is impaired to such a considerable extent that they are no longer able to absorb sufficient quantities of oxygen. The patient’s respiratory drive and thus the respiratory rate increasingly rises, and they need to be supported by a ventilator. The likely cause of this is fluid retention in and between the alveoli, which then stick together, thereby hindering gas exchange in the lungs. Doctors are now even considering that the virus SARS-CoV-2 essentially causes a vascular disease rather than a pulmonary disease. Other organs – and especially the heart – are also affected, as a team led by Dr. Zsuzsanne Varga, senior consultant at University Hospital Zurich in Switzerland, has confirmed. The big question remains: Which is the right ventilation strategy for Covid-19 patients?



BESIDES REAL-TIME VISUALIZATION, the machine also works out the extent to which areas of the lungs are overdistended or collapsed

If the problem consists of the lungs being unable to absorb oxygen, is it then even necessary to supply the lungs with high doses of oxygen by means of artificial ventilation?

The first person to raise doubts in public was the Italian anesthetist Prof. Luciano Gattinoni in various professional journals*. The task force leader who works in the Department of Anesthesiology at the Medical University of Göttingen came to the conclusion from observing patients in Italy that artificially ventilating patients at high pressure is not very promising in many cases. Instead, he recommended ventilating them at low →

*SOURCES: U.A. DOI.ORG/10.1007/S00134-020-06039-2; DOI.ORG/10.1164/RCCM.202003-0817LE; DOI.ORG/10.1001/JAMA.2020.6825



WHO IS RIGHT: THE GUIDELINES OR AN ITALIAN PROFESSOR?

pressure less frequently. The recommendations certainly sparked lively debates among the medical community – since certain aspects of the recommendations put forward by the globally acknowledged expert on respiratory failure actually contradicted medical guidelines in some aspects. Yet doctors are increasingly recognizing that it shouldn't be a case of either/or when making therapy decisions, but rather a continuum of variants that must be carefully balanced with each other and individually adapted during the therapy.

EIT (electric impedance tomography) plays a significant role here. “It is usually only possible to observe how the lung volume changes – depending on the ventilator settings,” explains Serge Heines, ventilation expert at Maastricht University Medical Center in the Netherlands. Even though the lung volume is an indicator of whether the alveoli are active, increased lung volume can be a sign of a reopening of collapsed regions with imploded alveoli, but it may also be due to dangerous overdistension of already opened alveoli. “With EIT we can literally see what is happening in the lungs. We not only obtain an overall picture, but can also examine individual areas more closely – and optimize the therapy accordingly.”

The Covid-19 patients in Heines' intensive care unit are mostly placed into an artificial coma, intubated, and mechanically ventilated in the emergency room. The central parameters

that determine how the ventilator settings are optimized are the air pressure while inhaling and exhaling and the breathing rate. The aim is to use targeted distension maneuvers with high ventilation pressure on an ad hoc basis to make lung regions that have already collapsed accessible for gas exchange once again and subsequently stabilize them by applying lower pressure during the exhalation phase. In normal times, Maastricht University Medical Center has four intensive care units with a total of 33 beds. Another ten have been added since March of this year. By late summer, around 150 patients had been admitted to the ICU to be ventilated. During the peak period, around 50 were on the unit at the same time. “In normal circumstances, a nurse will look after two patients who are being mechanically ventilated,” adds Heines. “In 90 percent of the cases, the patients were suffering from an extreme lack of oxygen; some of them also had overly high carbon dioxide levels – so it wasn't a question of whether or not we should ventilate them. We would otherwise have had to resuscitate them,” says Heines. “We were not able to observe the fact that no high pressure was needed. On the contrary – high pressure was essential during the exhalation phase in most of the cases.”

OFTEN SIMULTANEOUSLY: TOO MUCH AND TOO LITTLE PRESSURE

On the EIT machine (Type: Dräger PulmoVista 500), Heines and his colleagues can monitor what is happening in individual regions of the lungs. If too little pressure is built up through the ventilation, the alveoli collapse. They implode like a balloon from which the air is escaping. Too much pressure leads to overdistension and irritation and can even directly trigger cardiac problems. Both phenomena, alveolar overdistension and collapse, can often be simultaneously observed in different lung regions. Doctors and



LABOR-INTENSIVE TREATMENT saves lives in critical phases: With the aid of EIT, the Maastricht doctors and nurses can track precisely when it is necessary to change the settings on the ventilator

nurses can use EIT to track these events more closely and then adjust the ventilator accordingly to the optimal settings. Besides visualizing ventilation distribution in the lungs, the machine also works out the proportion of the lung regions with overdistension or even at risk of collapse. In professional literature it is now considered more or less certain that Covid-19 patients go through two or more phases in the critical stage. These phases manifest themselves in various ways and require different approaches to ventilation therapy. With the help of EIT, the doctors and nursing staff in Maastricht can see when it is necessary to change the ventilator settings. “Most of our patients are ventilated for one to two weeks,” says Heines. “Then there is a turning point: They either gradually start to breathe independently again, or the effects of the virus strikes for a second time.” Then the patients stay on the ventilator for up to 70 days or more. According to the results of a study involving over 10,000 Covid-19 cases treated in German hospitals, 53 percent of all patients who were invasively ventilated died. Among the casualties, patients aged 80 or older were particularly strongly represented, but also dialysis patients, while the risk for patients aged 60 or younger was much reduced. In view of the high risks that appear to be associated with invasive artificial ventilation, some doctors in Germany have decided to ventilate their Covid-19 patients using non-invasive methods. Instead, they use nasal masks or other apparatus that do not have to be inserted into the trachea and do not require the patient to be placed in an induced coma. Two establishments in Germany that have taken this path claim to have lost virtually no ventilated patients thus far. It may well be the case, as in Maastricht, that they haven’t had to treat patients who were already in a very advanced stage of the disease.

For Serge Heines, the non-invasive approach was not an option at that time. “There has been a clear message from the

steering committee in the Netherlands that the risks associated with non-invasive ventilation are simply too high for the clinical staff,” says Heines. When using nasal masks or other equipment, it is very difficult to prevent the exhaled air, which contains viruses, from circulating in the treatment room. The German guidelines also stress these risks. Nonetheless, the guidelines published at the end of April 2020 by the German Respiratory Society state the following: “Fear among medical staff of a Covid-19 infection should [...] not be a primary reason for intubation.” In other words, it is not a reason for mechanical ventilation that involves placing the patient in an induced coma. Even in Germany, however, relatively few hospitals opt for non-invasive ventilation.

BETTER CHANCES OF SURVIVAL WITH EIT?

The use of EIT could potentially improve the success rate of invasive mechanical ventilation. Initial observations of patients who have been artificially ventilated while using EIT monitoring have been described by Serge Heines’ cooperation partners at University Medical Center Rotterdam in a professional paper** published in May. “At the present time, we are unable to say whether the survival chances of patients who are invasively ventilated are actually any better when the therapy is monitored by EIT,” says Heines. “Many of the patients who we ventilate are problem cases who have been referred to us from other hospitals. They are naturally not representative as a group.” The scientists are currently working on a new study in which the progress of 100 patients who were ventilated using EIT is being evaluated.

It is already possible to say the following: As the various treatment approaches and experiences show, there is probably no single remedy for ventilating Covid-19 patients. The different ways in which the disease has progressed and the circumstances in the hospitals treating these patients are simply very diverse. It is also for this reason that EIT could prove to be such a promising technology. The fact that the procedure provides detailed live information about the condition of the lungs means that the ventilation of patients can be individually adjusted – which in turn is a very good prerequisite for promising treatment. ◀