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RETTUNGS  
MAGAZIN

# RETTUNG<sup>S</sup>

## MAGAZIN

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### Strandrettung auf Usedom Mit dem Quad zum Badeunfall

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CPAP therapy within rescue services

# Tubeless ventilation

In addition to supporting emergency physicians in CPAP therapy, modern emergency ventilators now offer non-invasive ventilation modes for intensive care procedures. To ventilate patients with dyspnea whenever and wherever they need it. Yet rescue services are also faced with the challenge of selecting a suitable non-invasive treatment. Two recommended treatments have proven their value in previous applications.

After the emergency call has been placed, the ambulance and emergency response unit (ERU) arrive at the couple's apartment at about the same time. The 64-year-old man is sitting half-upright in bed, with central or peripheral cyanosis, pursed lips breathing and audible expiratory wheezing: typical signs of obstructive pulmonary disease.

The woman confirms that her husband has suffered from chronic obstructive pulmonary disease (COPD) for many years, but he became much worse throughout the night.

The emergency physician quickly assesses the situation while the paramedics obtain the patient's vital signs: blood pressure 95/60 mmHg, pulse rate 108/minute and an oxygen saturation (SpO<sub>2</sub>) of 83 percent. The patient immediately receives 6 L/min oxygen via a mask. After gaining intravenous access via a peripheral vein, which is kept open using an electrolyte solution KVO, the physician administers 250 mg of cortisone. The man's oxygen saturation rate then increases to 89 percent, but his overall condition remains very poor.

After quick deliberation, the physician decides to supply the patient with oxygen using a mask without intubating him first. This supply is provided by a system that ensures continuous positive airway pressure: CPAP. The physician was able to successfully treat another patient's pulmonary edema the previous day using this therapy.

This patient also tolerated the mask, equipped with a PEEP valve of 7.5 cm H<sub>2</sub>O, quite well. Using the inspiratory oxygen measurement, the physician titrates the O<sub>2</sub> concentration to approximately 50 percent.

Although the SpO<sub>2</sub> value increases to 90 percent several minutes later, the patient's

condition seems to have worsened. It takes about 20 minutes to get to the hospital – too long to wait for a decision.

After the emergency physician has anesthetized his patient with midazolam and pro-



popol, he is able to intubate him without difficulty. Based on the man's weight (75 kg), the emergency physician sets a 500 mL tidal volume with respiratory rate of 12 cycles per minute and I:E of 1:2 on the ventilator. The first measured end tidal CO<sub>2</sub> value is 81 mmHg. Because the oxygen saturation increases to 94 percent, the inspiratory oxygen concentration can be decreased from 100 to 40 percent after just a few breathing cycles.

After the physician has increased the respiratory rate to 15/min, thus increasing the respiratory minute volume to 7.5 liters, the measured end-tidal CO<sub>2</sub> decreases to tolerable values. The patient's condition begins to improve.

### When the breathing pump fails

The fictional case described here shows that CPAP therapy can be successful with a pulmonary edema. However, with COPD, a ventilator needs to support or fully take over the respiratory work. The symptoms are sim-

ilar for both conditions. Therefore, a clearer picture can only be gained by looking more closely at the causes of the symptoms: with pulmonary edema, the gas exchange surface is reduced because of liquid in the alveoli – also known as alveolar flooding. Once the PEEP provides enough pressure to force the liquid out of the alveoli and maintain open alveoli – this increases the lung surface required for gas exchange.

COPD, on the other hand, is primarily characterized by the failure of the breathing pump. The diaphragm is so exhausted that it can no longer perform the required respiratory work. When this happens, CPAP therapy is of minimal assistance, or not at all, because the patient still needs to complete the respiratory work independently.

However, patients suffering from these two conditions do not necessarily need to be intubated. Patients with pulmonary edema or COPD can benefit from non-invasive ventilation, as recommended by the S3 guidelines for intensive care ventilation since 2008. Complications, as well as the patient's hospital stay and mortality rate, can all be reduced using non-invasive ventilation in preclinical care.

### Non-invasive ventilation in rescue services

To ensure that rescue services can use the two treatment methods presented, an emergency ventilator or mobile ventilator should provide pressure-assisted ventilation in addition to CPAP therapy. Furthermore, the device should offer a special NIV (non-invasive ventilation) mode, which guarantees that the device will function properly even in case of large leaks. Moreover, alarms should be able to be suppressed in non-critical situations, as necessary. According to DIN 75.079, this type of device is mandatory for newly purchased ERUs as of June 2009.

CPAP allows the patient to breathe spontaneously at an increased pressure level. This type of therapy can be realized using two methods: in a constant flow system, the gas continuously flows into a hose system that is connected to a Y-piece. A PEEP valve sits on the opposite limb of the Y-piece. The hose is fastened on the third connection, which leads to the tube or mask. As the gas flow builds up in this system, the PEEP valve ensures that the pressure is continuously maintained at the set value. The patient breathes at the PEEP level. The gas flow must be set at a level that ensures that the patient's needs are always met.



If the patient can no longer breathe sufficiently on their own, the mobile ventilator takes over this function, either partially or fully. To begin the process, the emergency physician sets a support pressure on the ventilator that is administered, in addition to the PEEP, each time the patient attempts to inhale.

If a patient on a constant flow system suddenly needs more gas, this short-term, increased consumption can be covered by opening another valve while adding drawn-in ambient air. A reservoir that fills up during expiration can be used to compensate the increased demand. On a constant flow system, gas consumption remains at a consistently high level if the settings are not changed.

In the demand flow system on most emergency respirators, for example the Dräger Oxylog emergency ventilators or mobile ventilators, the device's breathing hose is directly connected to the tube or mask. The emergency physician sets the PEEP directly on the device while sensors monitor the pressure. If the set value decreases in the hose system because the patient breathes in, the device delivers the corresponding gas later in order to maintain the pressure level. However, no gas may flow in during breathing breaks or when the patient exhales.

Thus, gas consumption depends on the set oxygen concentration, the patient's respiratory minute volume and leaks, which may need to be compensated. This is particularly advantageous in preclinical care because the oxygen may only be available in limited quantities during rescue services.

## Effectively ventilate patients using mobile devices

If the patient can no longer breathe sufficiently on their own, the mobile ventilator takes over this function, either partially or fully. To begin the process, the emergency physician sets a support pressure on the ventilator that is administered, in addition to the PEEP, each time the patient attempts to inhale. However, the patient independently determines the respiratory rate and duration of the inhalation and exhalation.

The technical basis of this process is flow control, during which the device "remembers" the initially generated peak flow. If the lungs are filled, less and less gas is required – the gas flow decreases. If the flow decreases

to a set percentage of the peak flow (PIF), the device stops the pressure support and returns to PEEP level.

The most frequently set abort criterion is approx. 25 percent of the peak flow, which is fully sufficient for most patients. However, problems may occur if a leak exceeds the abort criterion: the gas flow may not decrease to the abort criterion and the device will continue to apply pressure support even though the patient has already exhaled.

To solve this problem, the abort criterion can be individually set on many devices. As soon as a leak has exceeded the abort criterion, the user can change the setting to, e.g., 40 percent. On Oxylog ventilators, for example, the leakage flow can also be compensated as a result of technical developments. The cut-off criterion remains constant and does not need to be manually changed.

Yet, the patient can also benefit from an adjustable cut-off criterion. If the patient inhales earlier, the therapist can increase, or reduce, the criterion.

The slope or flow slew rate can be set on many mobile ventilators. This parameter defines how quickly the device switches from the PEEP level to the support pressure level. If the patient becomes short of breath, a very quick rate must be selected to immediately provide the patient with the highest gas flow. A time interval of approx. 0.2 seconds has proven adequate for patients who are breathing normally: The breathing gas does not immediately "shoot" into the patient; it is administered more slowly. A longer ramp time is not recommended for patients who are breathing spontaneously because air hunger frequently occurs and the patient senses the delayed delivery of gas.

The adjustable trigger defines the sensitivity of the device when the patient attempts to inhale. A low trigger value means very high sensitivity: The device detects and responds to the smallest inspiration efforts. Of course, false triggers can also occur as a result of vibrations or leaks. The device then starts the pressure support even though the patient does not want to inhale. Although a high trigger value makes the device less sensitive, this also means more respiratory work for the patient before the support starts. As a rule, the trigger value should be set as sensitive as possible and as high as necessary.



On Oxylog ventilators the leakage flow can be compensated as a result of technical developments.

## The optimal setting

Depending on the patient's condition, one can generally say that patients with restrictive illnesses who need mask ventilation



For some indications, the NIV could be used more frequently than is currently the case. The available data indicates a clear trend toward optimal ventilation results, even with non-invasive ventilation.

(e.g., pulmonary edema) are more likely to benefit from PEEP and generally require a small amount of pressure support. On the other hand, patients with obstructive illnesses such as COPD frequently require basic PEEP but more pressure support.

Assessment criteria for appropriate mask ventilation include:

- SpO<sub>2</sub>: increase
- Respiratory rate: decrease
- Pulse rate: decrease
- etCO<sub>2</sub>: decrease
- Alertness: improved

The last resort for experienced users is switching to a classic, pressure-controlled mode such as BIPAP. This mode does not require spontaneous breathing from the patient as the device provides fully controlled ventilation.

As a rule, work should be carried out according to a clear algorithm. If non-invasive measures are not successful after a defined period of time, the emergency physician should switch to an invasive procedure – intubation and controlled ventilation – as

described above. Waiting too long and attempting different methods can make the situation unnecessarily worse.

## Ensure the mask is correctly positioned

The main requirements for selecting a mask are minimization of leaks and a low dead space. Leaks occur more frequently if the design of the mask does not allow it to be flexibly adjusted to the shape of the patient's head. The use of disposable masks with wide, inflatable rubber pads is on the rise. As a rule, the bottom of the mask cushion should be placed under the lower lip and the cushion should then be "rolled up" the nose. Furthermore, the mask should be as small as possible, but fit well, and should not touch the nostrils or cover the mouth. It should be adjusted as tight as necessary yet as loose as possible.

During preclinical use of non-invasive ventilation, the emergency physician or paramedic continuously holds the mask in a standard C-grip. Bands or covers can be used to keep the mask in place for longer periods of transport.

However, treatment of patients is the decisive factor. Explanation, persuasion and sometimes also quickly moving forward, helps patients accept the NIV. Emergency patients with obstructions frequently have a very high end-tidal CO<sub>2</sub>, which can significantly impair their alertness. Even somewhat significant NIV ventilation cycles with a mask increase CO<sub>2</sub> elimination, which leads to improved patient cooperation.

Even though non-invasive ventilation is not a substitute for required intubation and controlled ventilation: for some indications, the NIV could be used more frequently than is currently the case. The available data indicates a clear trend toward optimal ventilation results, even with non-invasive ventilation – optimal results have already become common practice in clinical applications.

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**Note:** The metering and therapy information discussed in the text are only included as examples and do not represent a binding treatment recommendation or therapy recommendation.

