Dräger

Case Study – Long-Term Ventilation With Variable PSV

Case: A 73-year old male patient, while working in his garden, fell about 12 feet from a ladder. He was found by his wife who called an ambulance. When the paramedics arrived, he was observed to have an oxygen saturation SpO_2 of 65 %. The patient was then intubated and ventilated.

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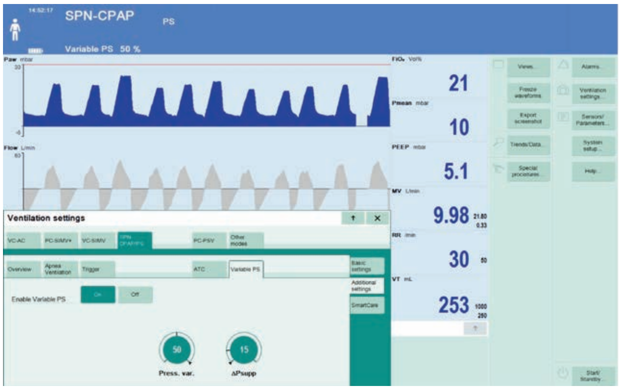
DIAGNOSIS AND INITIAL TREATMENT

Due to a suspected right-sided tension pneumothorax, thoracic suction was applied and the patient brought to the emergency department of the University Hospital Dresden, where a radiological examination was performed. The examination revealed a right-side hemopneumothorax, bilateral rib fractures, a sternal fracture, and fractures of thoracic vertebra T4 and T11. After surgical treatment and internal stabilization of the 11th thoracic vertebra, the patient was moved to the surgical intensive care unit where volume-controlled ventilation was applied.
He was placed under the care of an intensivist. As a result of the pleural effusions, atelectasis, and tracheobronchitis, the patient started showing signs of respiratory insufficiency with pronounced hypoxemia (PaO_2/FiO_2=173).
As expected, proper oxygenation and ventilation would be difficult to maintain because the multiple fractures, unstable thorax, and resultant paradoxical breathing.

METHOD

The spontaneous breathing of the patient was first supported with conventional pressure support ventilation (PSV) and a constant support pressure of 10 cmH_2O, flow trigger = 3.0 l/min, PEEP = 12 cmH_2O and FiO_2 = 0.4. This made it possible to achieve an average tidal volume of 514 ml and a respiratory frequency of 21/min, which in turn resulted in a minute volume of 10.8 l/min, a PaO_2/FiO_2 of 250 and a $PaCO_2$ of 53.1 mmHg. Given the reduced variability in tidal volume, which was about 10 % and thus significantly lower than the variability of the tidal volume in spontaneously breathing patients (approximately 26 %)[1], as well as the difficulty of finding the right support pressure for the patient, which at the same time provided some relief and allowed an adequate gas exchange, the ventilation mode was switched to variable pressure support.



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Window for activating Variable Pressure Support in the Evita Infinity V500 ventilator. In addition to setting the support pressure (ΔPsupp), as with conventional pressure support ventilation, the variability of the pressure support (Pressure Var.) can be set in a range from 0-100%. Pressure Var. (in percentage) refers to the range in which ΔPsupp can vary.
Since ΔPsupp values are subject to normal distribution, the coefficient of variation is approx. 17% (50%/3) at a Pressure Var = 50%.

The chest x-ray revealed a left-side pleural effusion with adjacent partial atelectasis, right basal partial atelectasis, a right thorax suction drainage with the tip projecting toward the right midfield and right thoracic subcutaneous emphysema.

Six weeks after the previous admittance and assisted spontaneous breathing with pressure support ventilation, the lung conditions improved and the patient was transferred to a rehabilitation clinic.

Mechanical ventilation was supported with a Dräger Evita Infinity V500 SW 2.n* ventilator. The ventilator is equipped with the new Variable Pressure Support option. Variable pressure support provides the ability to apply distributed pressure support within defined limits stochastically, i.e., randomly, as described by Gama de Abreu and coworkers[2]. In case of variable pressure support, the desired degree of pressure support variability is set in addition to the usual pressure support parameters (e.g., ramp, cycle off criterion, trigger and pressure support). This results in a breathing pattern where the level of pressure support varies from breath to breath.

The support pressure variability was initially set to 90 % (range adjustable from 0-100 %). With a value, for example, of 100 %, the pressure support would amount to a minimum of 0 cmH_2O and a maximum of twice the pressure support value, with the extreme values occurring only very rarely. The specified pressure support variability of 90 % resulted in a coefficient of variation of 30 % in the support pressure. The reason for this is that, with a normal distribution, these two variables (variability of the support pressure and coefficient of variation) have a ratio of about 3:1. Since all the other ventilator settings remained unchanged, this setting resulted in a tidal volume of approximately 530 ml (average).

* in countries the product name ist Infinity Acute Care System Workstation Critical Care

RESULT

Compliance was improved by approximately 20 % during the initial first hour, while the gas exchange parameters with a PaO_2/FiO_2 of 248 and a $PaCO_2$ of 50 mmHg remained almost constant. Over a period of approximately seven hours, the pressure support variability was reduced to 60 % and maintained at that level.

Over a period of ten days, the patient was treated successfully with a variable pressure support of 8 cmH_20 and variability in the range of 40-60 % while continuing to suffer from persistent thoracic instability. The patient was tracheotomized before his transfer to a rehabilitation hospital. Conventional pressure support ventilation was used then only intermittently to reduce the work of breathing, since the severly fatigued respiratory muscles would recover over a lengthy period of time.

SUMMARY

The critical finding of this case is that while using variable pressure support - different, randomly generated pressure support values could be applied during a long-term weaning period. This was made possible in spite of the variability of the patient's spontaneous breathing being affected by the unstable thorax. The use of variable pressure support avoided having to make frequent changes to the ventilator settings to ensure the patient felt comfortable, the gas exchange was adequate, and compliance of the respiratory system improved as well.

Key conclusions:

- Variable pressure support leads to increased variability of the tidal volume which is similar to spontaneous respiration variability.
- Using variable pressure support required fewer ventilator adjustments and thus relieves staff from constant need to adjust parameters.
- With variable pressure support, it was possible to cover a wide range of ventilation pressures by optimizing the gas exchange and increasing patient comfort levels.

Expectations for the future use of variable pressure support

- Variable pressure support makes it possible to reduce pressure support compared to traditional pressure support ventilation, thus allowing for faster weaning.
- Since different pressure support values are generated, the always changing needs of the patient could be better met in terms of respiratory support.
- Variable pressure support could help to reduce the number of necessary assisted ventilation adjustments.
- Variable pressure support could replace traditional pressure support ventilation.

Brief description of the general research situation

According to experimental studies, variable pressure support leads to better oxygenation, lower airway pressures, and fewer ventilator-associated lung injuries compared to traditional pressure support ventilation. [2, 3, 4]

Additionally, the breathing effort with variable pressure support is lower than with traditional pressure support ventilation and proportional assist ventilation (proportional pressure support).[5]

Early clinical experiences suggest that variable pressure support can cover a wide range of pressure support to meet the needs of the patient.

LITERATUR

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