Vivo 50: Interest of the integrated $EtCO_2$

Advantage of expiratory CO_2 measurement integrated within the Breas Vivo 50 ventilator for adjusting and monitoring the ventilation parameters in a patient with severe chronic respiratory failure secondary to Duchenne de Boulogne myopathy.

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Introduction

Duchenne de Boulogne myopathy is a dystrophinopathy transmitted by the chromosome X which affects 1 boy in 3500. Its clinical expression takes various forms but inexorably leads to restrictive respiratory failure which ultimately requires the use of ventilatory assistance.
Ventilatory assistance carried out at the patient's home is intermittent at first, and takes place at night using non-invasive ventilation. Then, as the myopathy develops, very often ventilatory dependence increases, the daily duration of ventilation is extended and finally invasive ventilation via a tracheostomy replaces non-invasive ventilation.
The patient's gasometric data must be monitored in order to start ventilation, carry out respiratory monitoring of these patients with progressive respiratory failure and adjust the ventilator parameters. Repeatedly taking arterial or capillary blood gas samples for this purpose is particularly constraining for the patient. It is therefore advantageous to be able to replace the direct measurement of arterial or capillary blood gases with an indirect measurement. Even if for several years now it has been relatively easy to measure the oxygen saturation by using pulse oximeters, we need to know the level of arterial carbon dioxide to judge the inadequate or excessively high level of mechanical ventilation produced by the ventilator. We can do this by measuring the expired CO_2. Consequently integrated continuous monitoring of carbon dioxide can be carried out by the Vivo 50 and Vivo 60 respirator.

Clinical case:

Mr B.K. suffers from Duchenne de Boulogne myopathy, diagnosed at 3 and half years of age. He lost the ability to walk when he was 10 and is regularly monitored at multidisciplinary consultations for neuromuscular diseases. As the years have passed regular lung function tests have shown that pulmonary volumes and expiratory flow has reduced.
When the patient was 15 there were nocturnal respiratory functional signs consisting of poor quality sleep, morning headaches and reduced intellectual performance in a child receiving normal education. The results of the arterial blood gas analysis carried out in the course of a consultation revealed hypercapnia at 48 mmHg. At the same time, the lung volumes (VC and FEVS) were no more than 70%. The decision to start non-invasive ventilation using a nasal mask was then made. The ventilator used at the time was an Eole 3 XL for 12h/night.

Regular respiratory monitoring of the patient revealed:

- the onset of postprandial dyspnea and dyspnea after talking at length,
- the need to resume non-invasive ventilation for 1 hour after meals,
- followed by the need to lengthen the duration of ventilation during the day.

By the time the patient was 19, non-invasive ventilation was being performed from 20h to 11h and from 14h to 17h. The total duration of ventilation was therefore 18 out of 24 hours. Furthermore, problems with chewing worsened and difficulties with swallowing accompanied by inhalation were becoming increasingly frequent.

After discussing the matter with the patient and his family, it was decided to perform a tracheostomy. The ventilation was then carried out using a cannula with a non inflated cuff and a Vivo 50 ventilator.

Having changed the mode of ventilation, allowing for leaks to allow the patient to speak, and having changed the ventilator, meant that the clinical data, the extent to which the patient felt at ease when breathing and the blood gas results had to be compared so that the ventilation parameters could be adjusted in the best possible way.
In order to avoid repeating the blood gas analyses, the decision was taken to adjust the ventilation parameters, on the basis of the SpO_2 and on the value of expired CO_2 indicated by the capnography measurement on the Vivo50 ventilator.

Monitoring screen of the Vivo 50

Monitoring screen of the Vivo 50

The results of an initial arterial blood gas analysis during controlled ventilation with an FiO_2 of 0.21 are as follows: pH at 7.36, PaO_2 at 98 mmHg, SaO_2 at 100%, $PaCO_2$ at 48 mmHg, HCO_3- at 28 mmol/l. At the same time, the SpO_2 is at 99% and the expired CO_2 at 52 mmHg. The ventilation parameters are as follows: Vt at 8 ml/kg, f 18, I/E ratio

"Continuous monitoring of $EtCO_2$ using a capnograph integrated within the Vivo ventilator, offers several appreciable advantages."

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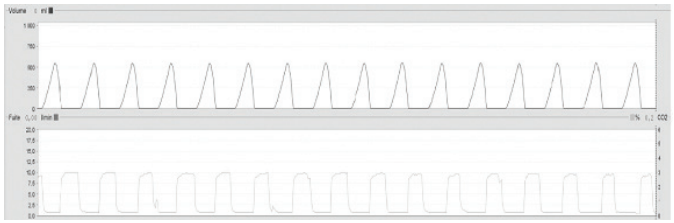
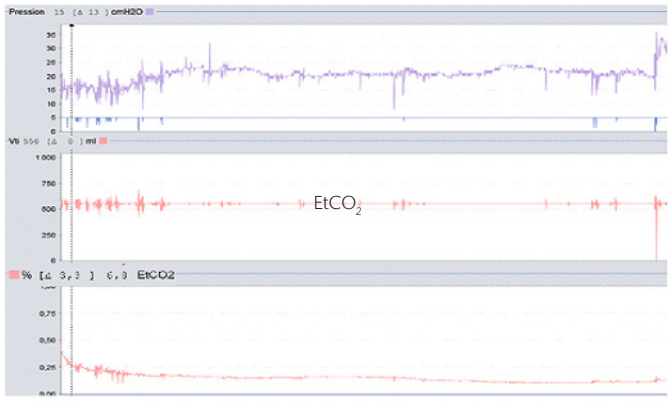
at 1/1.5, PEEP at 4 cmH_2O, square flow, Rise Time at 80% (adjustments identical to those of the Eole 3XL).

Considering the gradient of the alveolar/expired CO_2 to be cons-tant and not subject to variation, in the absence of any alveolar-expired gradient associated with obstructive lung disease or abnormalities involving the ventilation-perfusion relationship, the decision was taken to monitor the arterial gasometric para- meters indirectly via the SpO_2 and the expired CO_2 (ET CO_2).



Monitoring of Vt and ET CO_2

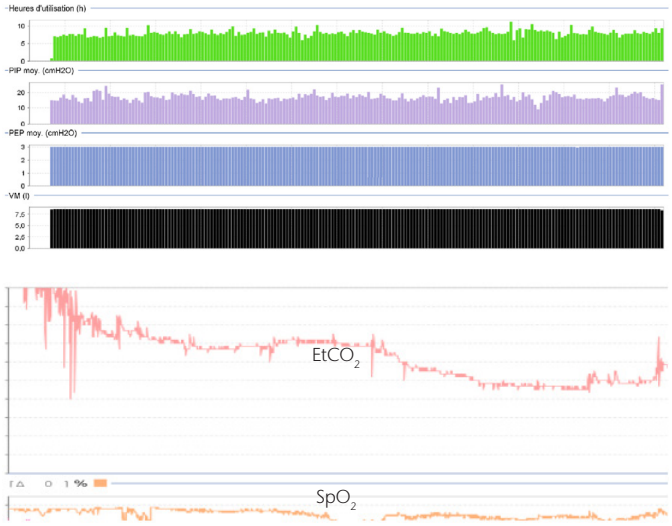
The gasometric results of the change of ventilatory parameters will then only be assessed by monitoring these parameters, thus avoiding the need to carry out repeated blood gas analyses.
The tidal volume was then increased to 10 ml/kg with respiratory frequency at 20, an I/E ratio of 1/1, a PEEP at 3 cmH_2O, square flow, a Rise Time at 80%. The patient then felt correctly ventilated. The SpO_2 was 100% and the expired CO_2 at 30 mmHg.
The ventilatory frequency was then reduced from 20 to 18. Expired CO_2, was 34 mmHg one hour after this change was made. It was then decided to reduce the tidal volume to 9 ml/kg. One hour after this new adjustment, the value of expired CO_2 was 36 mm Hg. The ventilator adjustments were not changed any more after this.



Follow-up of the $EtCO_2$ during set up of the ventilator

Over the next 10 days, the family was taught about bronchial aspiration, changing the tracheostomy cannula and using the Vivo ventilator.
An arterial blood gas analysis was performed on the day of discharge. The results were as follows: pH at 7.39, PaO_2 at 98 mmHg, SaO_2 at 99%, $PaCO_2$ at 41 mmHg, HCO_3- at 27 mmol/l. The measurement of expired CO_2 was then 37 mmHg.
The patient then left the department with the Vivo 50 ventilator equipped with its capnography.
The patient was seen regularly at consultations every month for 3 months. Then he was seen every 3 months, together with his Vivo 50 ventilator equipped with the capnography.

During the consultation, data taken from the Vivo and the capnograph were loaded onto a PC, displayed on the screen, saved and printed out if necessary. This allowed the doctor conducting the consultation to be fully aware of the next stages and the consequences of the ventilation implemented, possibly proceeding to carry out additional examinations and/or making changes to the ventilator settings.



Visualization of data during the consultations

In addition, a document for using the software for capturing and processing the data from the capnograph was given to the patient's family so that, in the event of a problem, the data from the Vivo ventilator could be downloaded and sent to the doctor dealing with the patient.

Conclusion

This clinical case clearly shows that, when providing ventilation at home for severe restrictive respiratory failure associated with chronic neuromuscular disease, continuous monitoring of $ETCO_2$ (1) using a capnograph integrated in the ventilator offers several very appreciable advantages:
- the possibility of adjusting the initial parameters of the ventilator and long-term ventilatory monitoring of the patient(2,3) without it being necessary to perform blood gas analyses(4) which is difficult and restrictive for the patient,
- guaranteeing secure ventilation for ventilator-dependent patients,
- the possibility of remotely monitoring the patients from a respiratory perspective.

References

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Breas Medical AB/2015/MAR-3318-v.2.0