Intensive Care Med
DOI 10.1007/s00134-015-3802-5

WHAT'S NEW IN INTENSIVE CARE

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Ten reasons to be more attentive to patients when setting the ventilator

Received: 20 February 2015
Accepted: 4 April 2015

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Unlike spontaneous breathing or negative pressure ventilation like the one provided by iron lungs, mechanical ventilation used today is a form of externally assisted ventilation that delivers positive pressure throughout the respiratory cycle. Our means of setting ventilators are far from optimal and most recent advances on mechanical ventilation have involved mitigation of its side effects, especially ventilator-induced lung injury. Given the disease and delirium that weaken his/her physical and psychic status, the patient is often unable to indicate the best adjustment done by the clinician. Misak has reported a personal view on her critical care experience while she was intubated [1]. "I was a psychological mess and should not have been taken to be fit to participate in decisions". We wish, however, to detail ten reasons why we should be more attentive to the patient when setting the ventilator, once he/she has recovered his/her spontaneous breathing (Table 1).

First reason: to find the optimal flow rate adjustment

When breaths are patient-triggered, direct peak-flow rate adjustment is the key setting in assist-control ventilation (ACV). For this reason, the ventilator should no longer be adjusted with an inspiratory-to-expiratory time ratio of 1:2 so as to avoid particularly long insufflation times and, consequently, insufficient flow rates. With a respiratory rate of 20 breaths per minute and a tidal volume of 500 ml, the insufflation flow rate is only 30 L/min, directly causing patient discomfort and leading to a marked increase in the effort of breathing [2]. The optimal value of peak-flow rate is likely to be better adjusted according to the patient's needs, which can be estimated by carefully looking at the distortion of the airway pressure tracings on the ventilator screen, the patient's accessory muscle activation and other indexes like the occlusion pressure (now provided by several ventilators). Clinicians should be aware that a flow rate around 60 L/min usually suffices to meet patient's ventilatory demand and that this setting can be used a default value.

Second reason: to eliminate double-triggering

Use of low tidal volumes and high flow rates can lead to short insufflation times, with the risk of double-triggering

Published online: 30 April 2015

Table 1 The ten reasons to be more attentive to patients when setting the ventilator

Why should we be more attentive to the patient?	How to optimize the ventilator settings?
(1) To find the optimal flow rate adjustment	Do not adjust an inspiratory-to-expiratory time ratio of 1:2 in ACV. Direct flow rate adjustment around 60 L/min should be preferred to avoid increased effort of breathing
(2) To eliminate double-triggering	By switching from ACV to PSV, or by switching from constant-flow ACV to a decelerating flow, by reducing peak-flow and/or adding a pause, or by using paralytic agents in more severe patients requiring strict control of tidal volume
(3) To promptly switch from ACV to PSV	By switching from ACV to PSV earlier in the course of weaning in order to hasten extubation
(4) To adjust the right dose of ventilation	Dyspnea felt by the patient could allow to select the right level of pressure-support according to his/her ventilatory needs
(5) To select the right PEEP level	By setting external PEEP below intrinsic PEEP
(6) To improve patient–ventilator synchrony	By reducing pressure-support level. Ineffective efforts, which are frequent and entailed by excessive ventilatory assistance, can be limited by reducing pressure-support level
(7) To improve sleep quality	By reducing pressure-support level. Excessive ventilatory support entails central apneas and sleep fragmentation
(8) To use a mode directly proportional to his/her effort	By switching from ACV or PSV to PAV+ or NAVA modes
(9) To hasten extubation	By detecting earlier weaning criteria and better predicting extubation success
(10) To improve tolerance to NIV	By reducing inspiratory pressure to limit prolonged inspirations and by increasing inspiratory trigger threshold to limit auto-triggering
There may be situations where it's not a good idea…	Addition of pressure-support may lead to particularly high tidal volumes in patients, thereby generating huge efforts entailing increased risk of ventilator-induced lung injury

ACV assist-control ventilation, *PSV* pressure-support ventilation, *PEEP* positive end-expiratory pressure, *PAV* proportional-assist ventilation, *NAVA* neurally adjusted ventilatory assist, *NIV* non-invasive ventilation

if the patient continues his/her effort beyond ventilator insufflation time. Double-triggering must imperatively be eliminated to avoid deleterious high tidal volumes, and the best way to do this is to switch from ACV to pressure-support ventilation (PSV), while increase in sedation has no effect [3]. However, in the most severe patients, the tidal volumes generated in PSV can become excessive and it may be necessary to return to ACV for a strict control of tidal volume. In this situation, ACV with a longer inspiratory time, either by switching from constant-flow ACV to a decelerating flow, by reducing peak-flow and/or adding a pause, may avoid the need for using paralytic agents.

Third reason: to promptly switch from ACV to PSV

PSV is increasingly used during the weaning period and often much earlier, while the patient is still ventilated with FiO_2 of 60 % and a positive end-expiratory pressure (PEEP) level up to 8–10 cmH_2O [4]. The best time to switch from ACV to PSV to hasten weaning is unknown, but could be proposed when the majority of the ventilator cycles are triggered by the patient him/herself. If the patient is not "triggering", however, clinicians should know that this is almost always caused by (an excess of?) sedation or an excess of ventilation.

Fourth reason: to appropriately adjust the dose of ventilation

One of the main objectives of mechanical ventilation is to reduce the effort of breathing, but also dyspnea which can occur even with full ventilatory support [5]. Therefore, the pressure-support level may be adjusted to attenuate accessory muscle activation (e.g. neck muscles), or according to intensity of dyspnea expressed by the patient, or quantified using surface electromyograms of extra-diaphragmatic inspiratory muscles or direct electrical activity of the diaphragm [6]. Alternatively, switching to assisted modes where the level of work of breathing is easily quantified may become a more widely accepted solution in the future [7, 8].

Fifth reason: to select the right PEEP level

Many patients can develop intrinsic PEEP, especially those suffering from chronic obstructive disease. Application of external PEEP reduces the effoty of breathing so as to trigger the ventilator and lowers the risk of ineffective triggering [9]. In order to further increase hyperinflation, external PEEP should nonetheless not exceed intrinsic PEEP, which may vary from one cycle to another and cannot be measured at bedside without physiologic tools. Whereas PEEP level may be titrated reducing ineffective triggering [9] or airway occlusion pressure [10], one can imagine that perhaps the best PEEP level is one that minimizes dyspnea.

Sixth reason: to improve patient-ventilator synchrony

Patient–ventilator asynchronies are frequent during assisted mechanical ventilation, one example being ineffective triggering, a result of excessive ventilatory assistance, and are associated with prolonged mechanical ventilation [11]. Reduction of PS levels could, in the majority of the cases, completely eliminate the ineffective efforts generated by the patient that are not detected by the ventilator [12].

Seventh reason: to improve the patient's sleep quality

An excessive level of PS not only contributes to ineffective efforts but also entails central apneas during sleep due to a reduction in metabolic needs and subsequent relative hypocapnia [13]. Indeed, the $PaCO_2$ threshold below which central apneas occur is increased during sleep, thereby altering sleep quality through numerous arousals and awakenings [14].

Eighth reason: to use a mode of ventilation proportional to the patient's effort

Neurally adjusted ventilatory assist (NAVA) and proportional-assist ventilation (PAV) are ventilatory modes giving control to the patient as regards breathing patterns and respiratory muscle work. Indeed, NAVA and PAV deliver a dose of ventilation directly proportional to patient effort; moreover, we have discovered that tidal volume is the main target controlled and possibly preferred by the patient [15].

Ninth reason: to hasten extubation

Daily screening of weaning criteria followed by systematic weaning trials is likely to hasten extubation and to avoid unnecessary prolongation of mechanical ventilation. Whereas caregivers are unable to accurately predict the risk for extubation failure [16], the patient's confidence in being able to breathe without the ventilator is a good predictor of extubation success [17].

Tenth reason: to improve tolerance to non-invasive ventilation (NIV)

Comfort and the patient's tolerance to NIV may be markedly improved by reducing leaks, which can occur either during inspiration entailing prolonged inspirations or during expiration entailing auto-triggering [18]. After better adjusting of the mask, prolonged inspirations may be less frequent by reducing the inspiratory pressure level, whereas auto-triggering may be eliminated by increasing the inspiratory trigger threshold.

There may be situations where different objectives may be conflicting…

Patients with acute lung injury have a particularly high ventilatory demand and can generate huge efforts, leading to high transpulmonary pressures and, subsequently, to large tidal volumes [19]. In this situation, both in intubated patients and in those receiving NIV, the addition of pressure-support may further increase transpulmonary pressure and heighten the risk of ventilator-induced lung injury. Even though this represents a physiologic response to pulmonary aggression, it could not only be deleterious per se but also liable to be markedly worsened by ventilatory assistance [20].

Acknowledgments We wish to thank Jeffrey Arsham, an American medical translator, who has reread and reviewed our original English-language text.

Conflicts of interest A.W.T. and F.R.C. declare they have no potential conflict of interest in relation to this manuscript. L.B.'s research laboratory has received research grants for ventilator companies (General Electric, Maquet, Covidien, and Dräger) and medical equipment companies (Philips, Fisher Paykel, Vygon).

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