Allowing for spontaneous breathing during high-frequency oscillation: the key for final success?

RIMENSBERGER, Peter

Abstract

In the present issue of Critical Care, van Heerde and colleagues describe a new technical development (a flow-demand system during high-frequency oscillation) that may have an important impact on the future use of high-frequency ventilation in children and adults. Flow compensation on patient demand seems to reduce the imposed work of breathing, may therefore increase patient comfort, and should theoretically allow for maintaining spontaneous breathing while heavy sedation and muscular paralysis could be avoided. With further technical development of this concept, high-frequency oscillation can finally be added to the techniques of mechanical ventilatory support that maintain, rather than suppress, spontaneous breathing efforts. Furthermore, this concept will give high-frequency oscillation the chance to prove its potential role as primary therapy in patients with acute lung injury/acute respiratory distress syndrome, the chance to reduce the incidence of high-frequency oscillation failure for patient or physician discomfort as reported in so many clinical trials in the past, the chance to most probably allow successful [...]
Commentary
Allowing for spontaneous breathing during high-frequency oscillation: the key for final success?
Peter C Rimensberger

University Children’s Hospital of Geneva, Pediatric and Neonatal ICU, Geneva, Switzerland

Corresponding author: Peter C Rimensberger, Peter.Rimensberger@hcuge.ch

Published: 31 July 2006
This article is online at http://ccforum.com/content/10/4/155
© 2006 BioMed Central Ltd
See related research by van Heerde et al. http://ccforum.com/content/10/4/R103

Abstract
In the present issue of Critical Care, van Heerde and colleagues describe a new technical development (a flow-demand system during high-frequency oscillation) that may have an important impact on the future use of high-frequency ventilation in children and adults. Flow compensation on patient demand seems to reduce the imposed work of breathing, may therefore increase patient comfort, and should theoretically allow for maintaining spontaneous breathing while heavy sedation and muscular paralysis could be avoided. With further technical development of this concept, high-frequency oscillation can finally be added to the techniques of mechanical ventilatory support that maintain, rather than suppress, spontaneous breathing efforts. Furthermore, this concept will give high-frequency oscillation the chance to prove its potential role as primary therapy in patients with acute lung injury/acute respiratory distress syndrome, the chance to reduce the incidence of high-frequency oscillation failure for patient or physician discomfort as reported in so many clinical trials in the past, the chance to most probably allow successful weaning from high-frequency oscillation to extubation, and, ultimately, in analogy to what has been reported from the experience with other ventilator modes that allow for maintaining spontaneous breathing, the chance to decrease ventilator days in patients with acute lung injury/acute respiratory distress syndrome.

High-frequency oscillatory ventilators were initially designed for neonatal application. With the recognition of the role of ventilator-induced lung injury in the morbidity and mortality of patients with acute lung injury, there has also been increasing interest in the use of high-frequency oscillatory ventilation (HFOV) in adult patients, since it theoretically offers, by design, an ideal mode for lung protection. The need to suppress patients’ spontaneous breathing activity with heavy sedation and muscle paralysis because of patient discomfort, due to a significantly increased level of imposed work of breathing (WOB), however, has so far limited the use of HFOV in larger pediatric patients and in adult patients. In the present issue of Critical Care, van Heerde and colleagues [1] describe a new flow-demand system that significantly allows for reducing WOB during HFOV. This new concept, so far tested in a bench test, gives the potential for adult intensive care physicians to more often use HFOV and to further investigate HFOV.

High-frequency oscillatory ventilators can be seen as continuous positive airway pressure (CPAP) devices that allow generation of pressure oscillations around a continuous distending pressure, which will facilitate CO₂ elimination mainly by accelerating the molecular diffusion processes. Accepting HFOV as such a ‘super-CPAP’ allows one to realize that maintaining spontaneous breathing during HFOV should be nothing other than natural. This maintenance is possible and well tolerated in newborns, and was probably a significant contributor to improved pulmonary outcome in this patient group [2].

As previously shown by van Heerde and colleagues [3], the imposed WOB for a neonate or an infant (up to a bodyweight of 10 kg) on HFOV is considerably low (<0.5 J/l or <1.0 J/l, respectively) during spontaneous tidal breathing with physiologic or smaller tidal volumes between 7 ml/kg to 5 ml/kg – and this is independent of endotracheal tube size. With increasing patient size and weight, the imposed WOB increases fast above 1.0 J/l. Increasing the fresh gas flow rate allows one to reduce the imposed WOB, but not to an acceptable level in the large child or in the adult [3] necessitating heavy sedation, analgesia and often neuromuscular blockade [4]. Using the new flow-demand system, the imposed WOB can be considerably reduced to a maximum of 0.5 J/l during shallow or normal breathing. What could this theoretically mean for HFOV apart from an improvement of patient comfort?

On the basis of currently available data from the experience with airway pressure release ventilation or biphasic positive

CPAP = continuous positive airway pressure; HFOV = high-frequency oscillatory ventilation; WOB = work of breathing.
pressures to achieve the same oxygenation goals. This may benefiting from spontaneous breathing for better recruitment dynamic side effects to a maximum. With the possibility of mean airway pressures [2,12,13] while reducing hemo-

volume curve, which often allows substantial reduction of distending pressure can be titrated up the inflation limb (to In the heavily sedated and paralyzed patient, the continuous ventilation of preterm infants. Am J Respir Crit Care Med 1996, 157:1213-1218. 12. Rimensberger PC: ICU cornerstone: high frequency ventilation is here to stay. Crit Care Med 2003, 7:342-324. 13. Ferguson ND, Chiche JD, Kacmarek RM, Hallett DC, Mehta S, Findlay GP, Granton JT, Slutsky AS, Stewart TE: Combining high-frequency oscillatory ventilation and recruitment maneu-