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The need for high ventilatory performance in anesthesia – perspectives from two clinicians in anesthesiology

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www.criticalcarenews.com
info@criticalcarenews.com

Per-Arne Lönnqvist, MD, PhD works as a pediatric anesthesiologist at Astrid Lindgren Children´s Hospital in Sweden.

The need for high ventilatory performance in anesthesia – perspectives from two clinicians in anesthesiology

Critical Care News has been lending its voice to intensive care doctors around the world in their efforts to publicize the many different research papers that bring to light the need for high ventilation performance in the ICU. Much progress has been made in this field over the last years, and the applications are many. In this respect, we wanted to raise the question of the same need in the field of anesthesia. That is why we met with two highly specialized clinicians and wanted to hear what they had to say about this.

The University Hospital or CHU of Montpellier, France, is a multi-disciplinary hospital with focus on education and extensive scientific research. Astrid Lindgren´s Children Hospital in Stockholm belongs to the internationally renowned Karolinska University Hospital.

Professor Capdevila has done extensive research in ventilatory mechanics and optimization of ventilation in anesthesia.

What, according to you, is high ventilation performance in anesthesia, and what are its specificities?

Professor Capdevila: That is, that respiratory management in anesthesia is making its baby steps, much in the same way as it was in intensive care, some 20 years ago. The two worlds are very different. In which way are they different? In intensive care, patients are in need of ventilatory assistance because of acute respiratory insufficiency, no matter what the cause. The world of anesthesia stands apart; why? Not only the ventilatory care of the patient is in focus, but also and foremost, the peri-operative care. Most of our patients, thankfully, have no major complications, and for these the main concern is to put them to sleep and to wake them up. However, some run greater risks and for these, the anesthesiologist has to take into consideration ventilatory, hemodynamic, neurological and renal aspects of care.

For many years, progress has been made in the field of monitoring hemodynamics and hypnotics, to the detriment of ventilation advances. What interested us was to have an SpO_2, $EtCO_2$ and maximal pressure. The second aspect, is the possibility of caring for a variety of patients, the one with ARDS, chronic bronchopathy, thoracic traumas, the one with severe asthma or sepsis; recent developments in the performance of anesthesia ventilators allow us today to give almost the same level of care as one gives with ICU ventilators in terms of pneumatic possibilities, with good trigger sensitivity, rapidly increasing pressure when in pressure modes. Today, anesthesia machines have pretty well all incorporated these features. This allows us to go much further in adequate care of these patients. In the past, these patients all had aggravated respiratory conditions upon leaving the operating room, with increased ARDS, an increase in pulmonary edema, diminished ventilation/perfusion ratio, etc. We have optimized this aspect of care today thanks to the advances made.

Xavier Capdevila, MD, PhD works at the University Hospital of Montpellier in France.

A recent survey tells about 95% of patients receiving anesthesia as being lung healthy individuals. Are you met with any challenges today in terms of ventilatory performance in anesthesia?

Professor Capdevila: Yes, there has been this recent survey done by the INSERM (French National Institute for Health and Medical Research) in France, relating that approx 95 % of the patients are healthy in their lungs. However, an ASA-2 patient could present a severe asthma, at a young age, and thereby be a concern for the anesthesiologist. In the same way, an ASA-1 patient who undergoes spinal surgery, or who lies prone for several hours, which also poses problems due to positioning and this can affect ventilation needs peri-operatively. The ventilator must then deliver the same tidal volume which one has preset, with the possibility to correct the internal compliance of the machine. There are augmentations in PEEP, variations in the delivery of fresh gases, variations in resistance which make that there are many ventilatory changes in anesthesia; in the span of 45 minutes, one can have six different ventilatory conditions. What are the important elements in an anesthesia ventilator? They are, dependability in the precision of volume delivery with a given pressure, adaptability with respect to patient specifics. An 84 year old COPD patient is not the same as an 8-month old infant, or a healthy 25 year old woman. Adaptability to varying surgical postures which can alter respiratory mechanics in the patient.

This brings us to ask the question concerning the needs and existing features of the modern anesthesia system versus the needs of ventilatory performance? What are the obstacles in increasing this performance?

Professor Capdevila: One very important aspect is simplicity. The anesthesiologist has several things to do at the same time. The anesthesiologist needs to look at the ventilation mode, fluids to be given, anesthetic and neurological parameters, and all this in concordance with the surgical constraints, and patient positions at a given point in time. The settings must be simple to make on the Interface, no sub.menus, or sub/sub-menus! They shall not be done in this case! But there is also an aspect relating to the modern-day anesthesiologist´s competence level and knowledge of ventilation.

They have extensive theoretical knowledge, however, most anesthesiologists are light-years away from using special ventilatory modes, studies have shown this. Only 20% of patients have a PEEP level set, even though it has been proven that not setting a PEEP level leads to atelectasis already during the induction phase! Setting a PEEP level in the morbidly obese patient according to the size and weight is adopted knowledge that is in use; however, an active level of PEEP, that is to say 5 to 9 cmH_2O, is still only given in 7% of patients, thus exposing them to atelectasis and complicating their post-operative condition and rehabilitation. There is really a cleavage between the possibilities offered by anesthesia units today and the application thereof by clinicians. Of 3000 patients, only 25 are put on Pressure Support mode. Why? Because many anesthesiologists still think that Pressure Support is only a weaning mode used primarily in the ICU. It is nevertheless used widely with laryngeal masks; we know this to be good practice. We also know that many small elderly ladies are under ventilated, whereas the morbidly obese patient is often over ventilated. The settings are not made correctly, due to a lack of knowledge in the field of ventilatory mechanics, dynamics and control. One ends up with "trivial" settings, or inadequate default settings.

Maquet has conducted a survey about anesthesia segments. They divided up the anesthetic acts into Routine, Complex and Complex Advanced. What are your thoughts about this?

Professor Capdevila: I think one should not address the anesthetic act as being routine, complex or complex advanced, but rather the peri-operative care which includes the anesthetic care as being so. There is no small anesthesia, we have already spoken of how a seemingly straightforward act can be complicated by a sudden ventilatory occurance (asthma, laryngeal spasm or other). But this is a common question which we get from the Ministry of Health in France; we at the SFAR (Societe Francaise d´Anesthesie et Reanimation) explain to them that every act can become complicated and can turn to being problematic very fast!

What would you like to see as a development in anesthesia systems to meet your ventilatory needs?

Professor Capdevila: An anesthesia ventilator must be able to deliver precise volumes with certain given pressures, anesthetic gases, whatever the patient´s condition and surgical considerations. This is starting to become rapidly known as "normal ventilatory performance" in all existing units, from the small infant to the 250 kg patient. There are those exceptional cases –we have 3 cases a year – of the pre-term baby who has immature lungs, where we must bring in an ICU ventilator into the OR. But we manage most cases today. However, in the near future I would like to see target controlled ventilation with concentration objectives on all machines. Another development would be automatic FRC calculations which would give us a visual status of the patient´s lungs, with its compliance issues with respect to rising resistance values. It would allow adequate ventilation in the morbidly obese, the COPD patient, infants, etc. That should be the future of high performance ventilation in anesthesia.

Do you believe that high ventilation performance in anesthesia is important in your area of speciality?

Professor Lönnqvist: Yes, I do believe that ventilation performance in anesthesia today must pretty well match the quality of ventilation in intensive care. The patients I have are children where we do at times, use a very specific mode of ventilation, called High Frequency Oscillation; this is exceptional and I don't think that it would be necessary for anesthesia ventilators to offer this mode. However, Pressure Support is a must. But there is more than ventilatory modes to speak of. My speciality includes the very smallest pre-term babies, weighing between 500gr-1000gr. Some of these babies are born with a defect which comprises a hole between the pulmonary artery and the aorta due to incomplete closure during foetal life; they have to undergo a procedure called "closing of the ductus" if they are to survive. One must be able to ventilate these small babies who have tidal volumes between 5 and 10 ml. It is important to have access to a system capable of delivering such small volumes, while supplying with precision, inhalation gases. This combination can be a problem. We also have to provide anesthesia to patients coming from the ICU and who necessitate the same adequate ventilation during anesthesia as they receive in the ICU. This is a central question.

Are the current anesthesia systems you have adequate in supplying this level of ventilatory performance?

Professor Lönnqvist: Modern anesthesia ventilators offer good solutions for bigger patients all the way down to the full-term infant. The problems we encounter are when the babies are under 1500-2000gr; there exists today, no good alternative which can deliver good, precise ventilation with safety to this patient category. The SERVO 900-C has been used, even though it does not offer the more "modern" ventilation modes, because one can connect a separate fresh gas flow on the low-pressure inlet (usually, the high-pressure inlet is used), having the "overflow" of gases go out through the evacuation outlet. This has been a good solution, but there is the question of spare parts, which will be available for another 1 or 2 years, not more. The question of quality ventilation has to do with modes and precision of volume and pressure delivery. In pediatric anesthesia, Jackson-Reeves and other non-rebreathing systems work well. However, most anesthesia systems today are based on circle systems with re-breathing; most have solutions via outlets where one can connect Baines or Jackson-Rees. But this doesn´t solve anything! Why? It is only a solution during induction of anesthesia with inhalation gases. It offers no solutions under the maintenance phase, where it happens that we are forced to hand-ventilate our patient. One uses completely other pressures in hand ventilation than with an anesthesia ventilator; however, should you measure this pressure with a manometer, one would nevertheless be well above values one would be willing to condone if it were being delivered by the ventilator! Hand ventilation is used during the aforementioned ductus repairs, and

there is no way one can get an objective reading of pressures in this case.

What problems are you confronted with on a daily basis?

Professor Lönnqvist: Our daily concerns in pediatric anesthesia often have to do with dead space volumes, due to bacterial filters, humidifiers and other additions, as well as with how to compensate compressible volumes in the machine. This latter problem can be solved by measuring the inspiratory and expiratory O_2 and CO_2, as well as working with pressure-volume loops. The limitation of working with these loops is, however, that one measures pressures inside the breathing circuit and not inside the patient. One can look at the difference between these pressures by inserting a catheter into the trachea, this has been done, and one would see how enormous these differences are! In bigger patients, these differences are much smaller.

What problems can you be confronted with during certain special surgical procedures?

Professor Lönnqvist: One-lung ventilation can be a probing challenge in the small pre-term baby population. Double-lumen tubes are usually used in older children and adults for this procedure, however, this solution does not exist for tiny babies. Catheters with a balloon to be blown up in the non-ventilated lung are used in this case, but these can move, allowing unwanted air into that lung, or even obstructing the airways entirely. Proper ventilation during endoscopic surgery of esophageal atresia is also very challenging.

Maquet has conducted a survey about anesthesia segments. They divided up the anesthetic acts into Routine, Complex and Complex Advanced. What are your thoughts about this?

Professor Lönnqvist: If you have a tiny patient and a complex procedure, this will entail anesthetic care which becomes complex advanced, for sure. If one has a very ill patient to treat, it is clear that even a so-called "routine" procedure will become extremely complex. The other aspect has to do with the development of older and older patients who are sicker than before, with less possibilities in their organ systems. This means that the "Complex" group will increase and even "overflow" into the "Complex Advanced" group. These are reasonable concepts. I guess we refer to general anesthesia; regional anesthesia patients belong to an entirely different group.

What functionalities would you like to see on anesthesia systems in the future?

Professor Lönnqvist: As I mentioned previously, it would be ideal if systems in general could address the tiny pre-term 500 gr baby. Otherwise, other gases such as helium and why not, xenon, could possibly have interesting applications. Even carbon monoxide in low doses, it is thought, could be of interest. Some studies have been done on small animals with a gas called "H_2S" (hydrogen sulphide) that have shown some very interesting results; how does it work? It blocks the mitochondria in the cell and causes it to diminish oxygen consumption, CO_2 production, as well as body temperature, making them go into hibernation, or "suspended animation" But in earlier phases of studies where nitric oxide blockers were administered to sepsis patients, one saw beneficial effects on low blood pressure by raising it, while causing interference with the immune response. Many of these patients died. This is an example to illustrate how important it is to have high respect for the different phases of research before administering medication or therapies to humans. Potency goes hand in hand with potent side-effects. Toxicity results in animals must be conclusive before one can conduct trials in humans. But these are, perhaps, "Star Trek" considerations. ■

Biography

Xavier Capdevila, MD, PhD
Anesthesiologist and Intensivist, as well as University Professor, Dr Capdevila has been working at the University Hospital of Montpellier in France (CHU) where he has been Head of the Department of Anesthesia and Intensive Care since 2001. On an institutional level, he is President of the Anesthetic Pole of the CHU, as well as President of the Scientific Committee of the SFAR (Societe Francaise d`Anesthesie etde Reanimation/French Association of Anesthesia and Intensive Care).

Dr Capdevila published a Science thesis in the Physiology of Respiration "Implications of Prolonged mechanical ventilation on respiratory muscles impairment and patient´s weaning from ventilator" and has worked both in the fields of intensive care and anesthesia, but became very interested in anesthesia about ten years ago. He began first by himself, then in collaboration with his colleague, Samir Jaber, MD, PhD, to look into the care of the patient in anesthesia from the points of view of the mechanics of respiration, ventilatory control and the optimization of ventilatory possibilities provided by these patients.

Xavier Capdevila has conducted and published extensivel scientific research in the field of ventilatory mechanics in anesthesia.

Per-Arne Lönnqvist, MD, PhD
Anesthesiologist and Intensivist since 1987, as well as Sweden´s only Professor in Pediatric Anesthesiology (since September 2007), Dr Lönnqvist works as a pediatric anesthesiologist at Astrid Lindgren Children´s Hospital.

Dr Lönnqvist has also spent a year at Portland´s University Hospital, in Portland, Oregon, where he worked with both pediatric and adult anesthesia. He has been very active in scientific research in ventilation mechanics, as well as the use of nitric oxide, among other aspects.