

Critical Care News

Highlights from the European Conference on Pediatric and Neonatal Cardiac Intensive Care in Montreux

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Prof. Peter Rimensberger in intensive discussions following the NAVA symposium, at the Gruyere cheese factory.

Highlights from the European Conference on Pediatric and Neonatal Cardiac Intensive Care in Montreux

Montreux, Switzerland, is one of the most beautiful towns in the world. The view of snow on the mountains, in stark contrast to the palm trees and abundance of flowers by the lake, offers a breathtaking experience of beauty. In these gorgeous surroundings, there is not only a world famous Jazz Festival that is held regularly, but also a high level Pediatric and Neonatal Intensive Care Meeting.

In the year 2004, the European Conference on Pediatric and Neonatal Ventilation (EPNV), organized and chaired by Professor Peter Rimensberger from the University Hospital of Geneva, was organized for the first time in Montreux, and from then on this high

level educational meeting has been held bi-annually. Since 2009, a second conference, the European Conference on Pediatric and Neonatal Cardiac Intensive Care (EPNCIC), arranged in collaboration with the Working Group of Pediatric Cardiac Intensive Care

(WGPCIC) from the Association for European Pediatric Cardiology (AEPC) and the European Society of Pediatric and Neonatal Intensive Care (ESPNIC) has joined the program of "The Montreux Meetings" that has become highly recognized worldwide. The

common objective of both meetings, which alternate nowadays on a yearly basis, is to provide education on state-of-the-art practice and to discuss new available technology. The small format of the meeting, with a limit set at 250 participants, encourages discussions where experts and speakers are easily available. Discussions are frequent not only during sessions, but also informally, after presentations. The conferences also offer a variety of practical pre-conference workshops, most of them with hands-on possibilities, which are always highly appreciated by the participants.

As this year's meeting was more devoted to cardiac issues the next conference will again emphasize ventilation management in children and neonates. All meetings attended by Critical Care News have been highly thought-provoking and offer an excellent opportunity to acquire new knowledge while facilitating contacts and discussions with opinion leaders, and last but not least to experience the beauty of Montreux. MAQUET contributed at this year's meeting with three major events: two workshops on basic and advanced mechanical ventilation, including specific aspects of mechanical ventilation in the cardiac ICU setting, and a NAVA symposium stressing the importance of patient-ventilator interaction. The symposium focused on the problems associated with the very high incidence of asynchronous assist in pediatric and neonatal practice.

"You cannot beat physiology"

The workshops were led by Professor Peter Rimensberger who started off with the observation that the way mechanical ventilation is administered has a large impact on patient outcome. Still, the way it is practiced is largely influenced by old traditions and many extrapolations from old literature, primarily conducted on healthy adult patients undergoing general anesthesia. This promotes reliance on "cook-book medicine" with very little room for an individual approach based on patient physiology to the setting of the ventilator. Professor Rimensberger rebuked standard practice and offered an alternative approach



Discussions continue after the NAVA symposium.

based on the continuously changing lung mechanics of the patient, which requires continuous respiratory monitoring. His very persuasive argument for this view was that nobody would administer any inotropic drug without some hemodynamic monitoring, i.e. at least a continuous blood pressure reading. He promoted the view that just as the modification of inotropic administration is based on blood pressure readings, the ventilator settings must be carefully and repeatedly adjusted, not according to random numbers, but to changes in patient respiratory mechanics as principally characterized by the time constant (Resistance x Compliance) of the respiratory system. This is not as complicated as it may seem, and Professor Rimensberger gave a beautiful demonstration using a simple lung model to demonstrate how this can be easily accomplished at the bedside. In practice, through observation of flow at end-inspiration (should decelerate to a short zero period) and end-expiration (flow reverting to zero again, signaling absence of Auto-PEEP) cycle times can be optimized. This will allow for the identification of the individual maximal respiratory

rate for each patient. Correct settings according to the mechanical behavior of the patient's respiratory system, allow for the use of the lowest possible plateau pressure, coupled with the most efficient carbon dioxide removal. In this context he also emphasized the importance of patient and disease-specific tidal volumes (V_t), exemplified by the risk of standard settings (i.e. 5 to 6 ml/kg) for babies with diaphragmatic hernia who may have an important reduction of their total lung volume (i.e. severely reduced total lung capacity in relation to their body weight). These patients are severely at risk if standard V_t settings, according to body weight, were to be applied. The latter would, assuming a reduction of TLC by 50%, result in a situation similar to applying 10 to 12 ml/kg to a baby with normal sized lungs. An approach of 5 to 8 ml/kg or less was recommended (biology tells us that a physiologic tidal volume is about 6 to 7 ml in all vertebrates) with a reduction of this target for special circumstances, remembering that each restrictive lung pathology is associated with a reduced inspiratory capacity (i.e. the "baby lung concept" indicating that "stiff lungs" may not be



Prof. Peter Rimensberger, course director.

stiff, but functionally small). Growing adult, pediatric and neonatal experience strongly indicates that an approach to limit inspiratory pressure to well below 30 cm H₂O (in patients with normal lungs even below 20 cm H₂O) might help in overcoming, in part, the difficulty of choosing the most appropriate lung protective tidal volume for any single patient at any stage of lung disease.

How to set PEEP?

Traditionally, the use of PEEP in controlled mechanical ventilation is regarded as the limiting factor for venous return and to increase pulmonary vascular resistance, thus additively exerting a negative influence on cardiac output. In this context, Professor Rimensberger discussed the observations from an echocardiography study by Vieillard-Baron A et al. (J Appl Physiol 1999; 87:1644-1650) which clearly indicated that right ventricular output depression does not take place during the PEEP phase, but during inspiration when intrathoracic pressure is at its peak.

With the advent of small V_t ventilation resulting in lower inspiratory pressures than the traditional, increasing PEEP levels, as might be required in some patients to restore normal physiologic Functional Residual Capacity (FRC), the lung volume at which Pulmonary Vascular Resistance (PVR) is lowest will in fact allow for the minimization of cardiopulmonary depression during

positive pressure ventilation. Hence, Professor Rimensberger argued forcefully on the importance of setting respiratory time cycles (i.e. T_i and T_e) and a “physiologically correct” PEEP properly to re-establish FRC in the diseased lung. He argued that optimal PEEP should be set after a slow and step-wise recruitment maneuver, best administered by first incremental then decremental PEEP-steps of 1 cm H₂O.

This can be easily achieved in the Pressure Control mode. A step-wise increase in PEEP resulting in a rising tidal volume should be interpreted as pulmonary recruitment, resulting in improvement in dynamic compliance and oxygenation, hence an incentive to further increase PEEP. As tidal volumes start to decrease with further increase in PEEP, this usually indicates that the flat part of the Pressure-Volume curve has been reached and further recruitment will be marginal, PEEP has to be titrated down again in small steps, until tidal volume, as a marker of worsening dynamic compliance, and saturation start to drop. This will indicate the beginning of important lung collapse (closing pressure) and PEEP should be set now after a second recruitment maneuver maximally 2 cm H₂O above this point of closing. After successful re-recruitment and setting the optimal PEEP level, V_t and cycle times and respiratory rates (because of induced compliance changes by recruitment) have to be re-adjusted, aiming again at the smallest V_t affordable. This will

result in low inspiratory pressures and subsequently minimized cardiopulmonary depression. In the acute phase of lung disease this may have to be done repeatedly as lung disease, like any other biologic function, will have an evolution, As put by Professor Rimensberger: “When the ventilator settings are still the same when I come in the morning as they were when I went home in the evening, I will get nervous as this implies that there was no progress in the patient, or more likely, that the status of the patient has not been re-assessed for the last 12 hours”. As alluded to previously, PEEP should be set with the objective to reach physiologic FRC, as this coincides with the lowest pulmonary vascular resistance and thus lowest right ventricular afterload. It is probably not a coincidence that in this situation the respiratory muscles will have optimal working conditions allowing for a better chance for the patient to succeed in being weaned from mechanical ventilation as early as possible.

“New trends and development in mechanical ventilation”

This symposium was arranged outside of Montreux in the famous Gruyere cheese factory. Chairing the session, Professor Peter Rimensberger also gave the introductory talk entitled “Assisting Spontaneous Ventilation”. He described the chain of events leading to respiratory muscle activation in health and disease and the principal concepts of various ventilatory assist modes. He continued by explaining the most frequently occurring types of asynchrony during ventilatory assist. Examples of missed efforts, out of phase cycling, auto-cycling, and inappropriate flow termination (cycle off) settings leading to inappropriate tidal volumes, increased respiratory rate with sometimes even double cycling events, increased work of breathing, and patient discomfort during pressure support ventilation. He stressed the fact that, although it is sometimes very difficult from the classic ventilator display of pressure and/or flow readings, to determine the incidence, it has been shown that the occurrence of asynchrony is intimately linked to patient



Dr. Davide Colombo.

outcome. The introduction of Neurally Adjusted Ventilatory Assist (NAVA) in clinical practice represents a big leap forward in the treatment of children with respiratory failure, as it can assure proportional synchronous assist to every patient effort, allowing, already in a first step, the improvement of patient comfort, resulting in the possibility to reduce sedation. He reported that in his experience the reaction of parents is often one of astonishment after their baby has been started on NAVA, as improved comfort in the baby is obvious.

“NAVA: Experience from the CICU”

Doctor Philippe Pouard from Bordeaux France gave the second presentation in this symposium. His group has extensive clinical experience with NAVA in the CICU setting, having data from more than 50 patients in an ongoing study. He sees the possibility to monitor the Electrical Activity of the Diaphragm (Edi) as a breakthrough in postoperative care, as it allows for the monitoring of sedation and analgesia, and can also be used as a guide for weaning. He stated, that in a baby in whom it is not possible to close the chest after cardiac surgery “it is the ideal tool for monitoring the respiratory function”.

As tidal volume, driving pressure and FiO_2 are generally lower during NAVA, still resulting in normal or slightly reduced PaCO_2 , when compared to pressure support or controlled ventilation, he



Prof. Eduardo LaCruz and Prof. Ricardo Munoz.

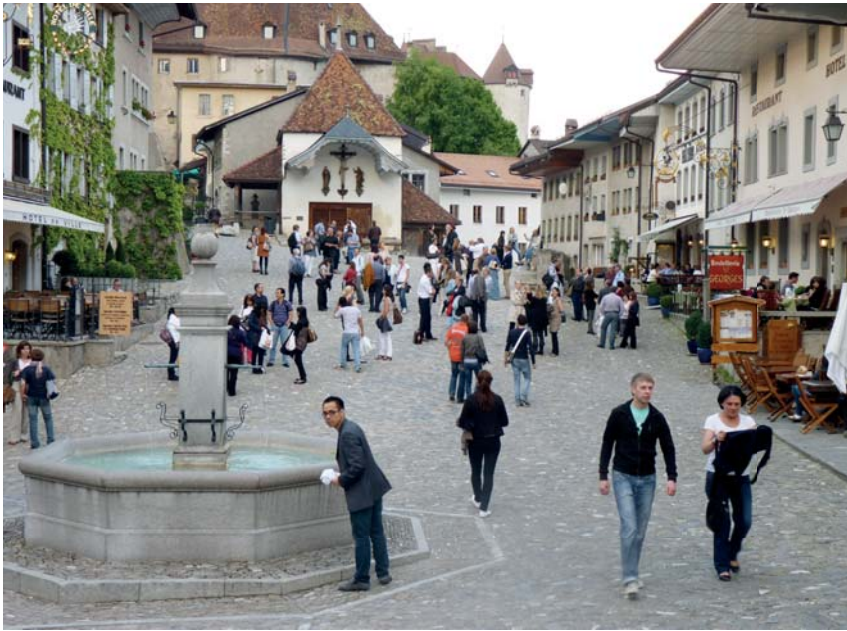
argued that NAVA fits well in the actual concepts of lung protective mechanical ventilation, which ultimately may lead to a decline in Acute Lung Injury (ALI) and Bronchopulmonary Dysplasia (BPD). In babies with single ventricle hearts undergoing a Fontan procedure, ventilator assist by NAVA is an important asset as pulmonary flow is inversely related to intrathoracic pressure. Doctor Pouard advocated the use of NAVA after cardiac surgery, stressing how its use in neonates will allow improvements in monitoring and outcome.

“Non-invasive Ventilation – Synchronisation with NAVA”

Doctor Davide Colombo showed, in the final presentation of this symposium, that non-invasive ventilation (NIV) is now an accepted treatment in both adults and children. In the adult field, COPD and cardiac failure are the current primary indications for NIV, and this is accepted almost universally. Although some centers have reported success with NIV in hypoxic respiratory failure, this latter indication remains controversial. In babies, a trial of CPAP and/or NIV seems to be indicated in most cases of acute respiratory failure before proceeding to intubation. After presenting the literature in support of these conclusions, Doctor Colombo went on to describe some of the problems with interfaces during NIV. He stated that patient acceptance of the chosen interface is critical and that patient acceptance is significantly

correlated to the outcome of the treatment. For long-term treatment, skin abrasions and eye irritation are major reasons for a patient’s non-acceptance of NIV, hence he proposed the helmet as the interface of choice in situations where patient adaptation is problematic.

Doctor Colombo indicated that asynchrony is another big problem associated with NIV. In fact, Vignaux et al. (Intensive Care Medicine 2009 May) showed recently that a high Asynchrony Index (AI) $>10\%$ was found in 43% of the patients on NIV. Such a high AI is mainly associated with leakage at the patient interface and results in a lack of patient compliance with NIV. With NIV NAVA, the presence of a leak will not have the same deleterious influence, as ventilator triggering does not depend on a pneumatic signal but on recognition of the excitation of the diaphragm muscle. This will virtually eliminate the incidence of various types of asynchrony events. Hence with NAVA, leakage is not a limiting factor for using NIV and the trigger delay, usually an important problem with the helmet, due to the high capacitance of the device, can be minimized. It is frequently maintained that NIV is associated with an increased workload for the staff. Doctor Colombo refuted this, claiming that if the patient is properly introduced to the treatment, the time needed for the nurse to spend with the patient becomes limited, mainly because the patient can be kept awake and cooperative.



The medieval town of Gruyere.

Doctor Colombo finished his presentation by stressing how hard it is to diagnose patient-ventilator asynchrony by showing data from a recent study, which has just been accepted for publication in *Critical Care Medicine*. Analyzing strips of pressure and flow gave a correct assessment in less than 50% of the cases, even for specialists of mechanical ventilation. Properly detecting asynchrony early in the course of mechanical ventilation may be an important improvement in the care of patients with respiratory failure. The Edi signal is currently the best tool available for diagnosing patient-ventilator asynchrony.

During the questions following the session, the audience was interested in methods for weaning patients after NIV. Doctor Colombo recommended incremental periods without assist and strict evaluation of the patient response to the withdrawal. If the patient has an Edi catheter in place this is of course very easy to follow as the Edi signal will allow for indirect quantitative evaluation of the patient's respiratory work.

Some highlights of the sessions

Other sessions in the main conference program covered early heart transplant, ECMO, care of the baby with a single ventricle physiology, brain protection (did you for example know that erythropoietin may be an effective brain protecting agent?) and peri- and postoperative care following repair of congenital heart disease.

As editor of *Critical Care News*, one presentation was of special interest to the readers. Professor Desmond Bohn from the Sick Children's Hospital in Toronto discussed the current recommendation of cooling patients after cardiac arrest. He delivered a word of warning that the practice, which is an extrapolation from the adult field, may

not show the outcome we might expect as the pathophysiology of cardiac arrest is totally different between children and the adult population. Adults usually suffer a cardiac arrest as a result of a primary cardiac problem. In this situation – the tissue is still normally oxygenated when the heart stops. In contrast to this, the most common situations where the heart of a baby will arrest is either after an unobserved period of apnea (sudden infant death syndrome) or a severe hypoxic event due to acute respiratory failure, ultimately leading to an ischemic insult not only to the heart, which subsequently stops, but also to the brain. Therefore the neurologic outcome of pediatric cardiac arrest is extremely poor. This topic has been one of the special interests of Professor Bohn for a long time. His arguments were substantiated by previous research, and he pointed out the fact that there is ongoing research in this area which may give a definite answer to the concerns.

The Montreux Meetings (EPNV and EPNCIC) with speakers and lectures at the frontier of pediatric and neonatal intensive care practice are highly recommended, not only to trainees, but also to fully trained intensive care specialists working in a PICU, CICU or NICU. The beautiful setting definitely adds an extra dimension. ■



Prof. Philippe Pouard and Prof. Peter Rimensberger.

Selected references:

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