Topic: Lung protective ventilation

Graeme A'Court interviews Professor Andrew Bersten from Flinders University of South Australia. He has published over 170 clinical research papers based on critical care topics and mechanical ventilation and is well known and respected globally for his understanding and knowledge in these fields

Q1: Please tell me about how you developed an interest in this topic?

Answer: Obviously mechanical ventilation is fundamental to the practice of intensive care medicine, yet when I started to learn and practice in the area little attention was paid to the use of ventilatory assistance. Perhaps the 'light bulb' moment for me was reading a review by Roussos and Macklem entitled "The Respiratory Muscles". That led to an interest in the work of breathing, and ventilatory assistance and what clinicians were trying to achieve. As I started to understand some simple respiratory mechanics, the issues relating to lung stretch, recruitment and airway pressure became interesting and naturally helped with the key concepts in lung protective ventilation. Having been taught to use high tidal volumes (800 ml up to 1000 ml) and not initially associating that with poor outcomes, there's a lot to learn.

Q2: A: What are your thoughts on lung recruitment maneuvers and is there a place for them since the most recent publications have thrown some doubt on the overall benefit of them?
B: do you have these tools on the ventilators and are they used on a regular basis?

Answer: That's a big question! Firstly, one of the key outcomes from the ARDS Network original lower vs higher tidal volume study was the worse oxygenation in the lower tidal volume group during the first three trial days, suggesting that oxygenation is not a good surrogate for lung injury and survival. Despite that, many people titrate the ventilator to oxygenation; it's hard not to. In addition, if one considers the basic mechanisms of ventilator-induced lung injury (VILI) they are overdistension and cyclical collapse and recruitment.
Recruitment maneuvers are frequently done when oxygenation is poor, and that may be appropriate as recruiting collapsed lung units will lead to a larger lung volume in which tidal volume is dissipated; however, recruitment maneuvers risk increasing overdistension

In a clinical trial, despite attempts to study similar group of patients, there were significant differences so that while some patients may benefit, others may be harmed. As the take home from the recruitment trials is of overall harm, and we are not in a routine position to distinguish subgroups, I don't routinely use recruitment maneuvers. Generally, I prefer to titrate PEEP and be patient with repeated reassessment; however, there will be times when specific patient circumstances demand a recruitment maneuver.

The ventilators that I work with don't allow direct assessment of recruitment, and none do give a true balance of overdistension and recruitment. Noting I'm doing less clinical work and too much administrative work, my preference is to stay at the bedside and observe the mechanics and the curves.

Q3: What are your thoughts on the use of driving pressure, mechanical power, pressure limitation, 6 mls/kg or adjusting the tidal volume based on compliance

Answer: Lower tidal volume at 6 ml/kg of predicted body weight, noting this algorithm is based on data from 90 years ago when people were generally lighter, is a great place to start. After that there are aspects that I think related to what is usual practice in your Unit. If techniques only work when specific people are present, then I'm anxious as to what happens the rest of the time.

The driving pressure data are a very interesting observation, but I'm not sure what to do with them. The factors involved are interdependent; in the absence of a clinical trial with protocolization of driving pressure as a factor, that leads to improved patient outcomes, it doesn't drive my practice. However, many years ago we looked at the change in driving pressure as a method for PEEP titration – if the change didn't exceed 2 cmH_2O 20 minutes after a PEEP up-titration then it could be inferred that overdistension was not excessive. Another way of saying that is that PEEP titration that doesn't significantly reduce respiratory system compliance has some supportive physiologic data, again no outcome data.

Mechanical power is a more recent concept with laboratory data suggesting it helps define the extent of potentially damaging forces. Again, I think we need to wait for carefully designed trials with patient outcome data before embracing this technique. Supporting a long-term interest is the strong influence of inspiratory flow rate on power generation with higher flows leading to higher applied power. If that is accepted, then there are follow-on effects on inspiratory flow pattern where a constant flow pattern minimizes the peaks seen with either a decelerating flow pattern or a pressure-controlled modes of ventilation. Given there are laboratory data supporting this notion this might have implications for how controlled breaths are provided.

Q4: **A:** How do you set optimal PEEP and is this based on improving the PaO_2 or based on trying to have an open lung strategy?
B: do you have these tools on the ventilators and are they used on a regular basis?

Answer: I think I have covered this briefly earlier. I am still persuaded that reducing overdistension is the key target, yet this needs to be done while providing adequate gas exchange.

Q5: A: Thoughts on the use of using esophageal pressure monitoring as part of the lung protective strategy?
B: do you have these tools on the ventilators and are they used on a regular basis?

Answer: About 12-18 months ago a colleague did a straw poll around numerous countries and centers – outside of the research environment almost no-one was using esophageal pressure monitoring. That would be generally true of practice here where it would be very infrequent to insert an esophageal balloon for routine care. That makes it difficult as it does take practice to place the balloon correctly and be confident with the data.

Q6: Thoughts on what mode you use for lung protection, and would you consider the newer modes of ventilation that so called closed loop that automatically adjust to match the changes of the patient's lungs?

Answer: Looking back over the last 30 years, the key improvements have focused on the use of safer tidal volumes and distending pressures with the use of moderate PEEP. Given that the distending pressure with pressure-controlled modes is the same as with volume-controlled modes, albeit the resistive pressure is dissipated during tidal ventilation with pressure control, tidal stretch is thought to be the same. As discussed earlier both theoretical models (such as the power approach) and laboratory data suggest that higher flows are injurious. If that is accepted then constant low flow tidal ventilation may be preferred, noting this may tend to greater asynchrony without adequate sedation and or paralysis.

Q7: Thoughts on the use of muscle relaxants and permissive hypercapnia as part of your ventilation management for lung protective ventilation

Answer: Ventilation-induced lung injury is much more likely to occur in injured lungs. The corollary is that early protective ventilation is critical while the initiating insult is being addressed. On that basis I don't have much concern with paralysis when needed in the early stages of initiation of ventilation for ARDS, but I'd expect by 48 h there would be minimal use. The argument that permissive hypercapnia is protective needs to be disarticulated from protection due to ventilatory strategies. I am not particularly concerned with moderate degrees of acidemia, but I do worry about possible effects on pulmonary hypertension and right ventricular function.

Q8: Thoughts on proning in your ICU practice

Answer: The often-uncelebrated aspect of this discussion is that careful management of the underlying condition and early attention to lung protection reduce the need for therapies such as prone position. Of course, sometimes we are presented with, or have patients who progress to moderate-to-severe ARDS when prone position should be considered. In COVID-19 ARDS there appears to be a real role, but not all patients benefit. Looking at the trials, patients were enrolled with moderate-severe disease, yet sometimes we use prone position as rescue therapy in patients with profound hypoxemia. Talking with people who have many years of experience in high volume centres, this has been performed without significant increase in complications, but I suggest caution when there is a less experienced team.

Q9: Is ECMO or ECCO2r a solution for many patients with ARDS or are they overused due to the lack of understanding optimal PEEP and lung recruitment?

Answer: Flinders is a low-volume ECMO site, and then the majority have been V-A ECMO not V-V ECMO cases. Having said that, and accepting the morbidity and mortality that accompany ECMO, there have been patients who would not have survived otherwise. One final plug for careful early management of critically ill patients which I think can reduce the need for more complex and risky interventions such as ECMO. I don't have any experience with ECCO2R, and while the idea that we can be ultraprotective seems appropriate, the recent RCT in JAMA (2021; 326(11):1013-1023.) was not supportive.

Q10: How do you think we should create more interest on how we should ventilate.

Answer: Education is a relatively weak intervention in changing what we do. It's easy to suggest better understanding with the equation of motion and lung pathophysiology as key aspects, but if we want to change what we do then it's likely to be more effective if we achieve consensus on standards of care and then measure what is actual being done followed by repeated improvement journeys. I'd suggest that the cultural change associated with that process would lead to greater interest and reduced variation.