Clinical Case 1: USCOM in the Intensive Unit – Case Study

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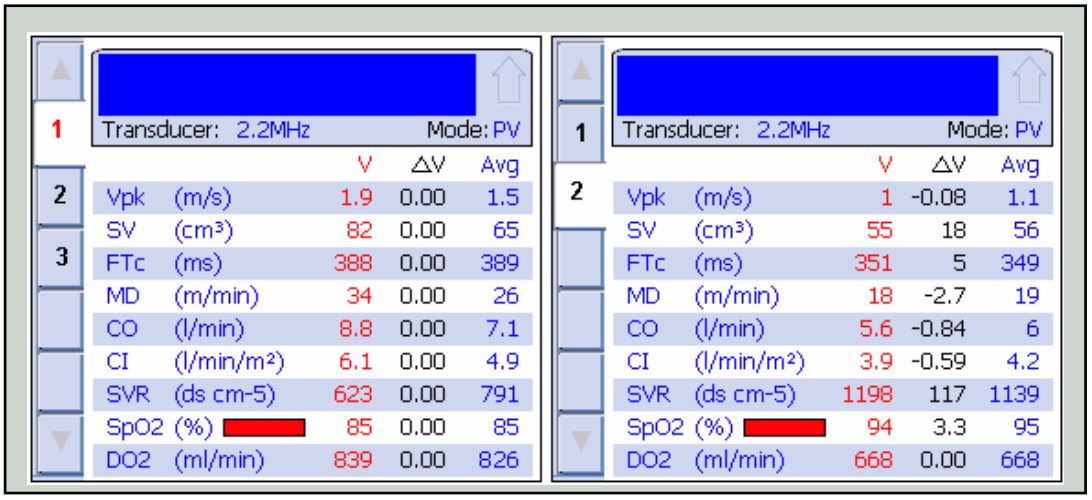
The measure of life.

Best PEEP?

In intensive care, we have to look at the patient's cardiopulmonary system as a whole rather than looking at individual parameters; it is all too easy to focus on one parameter but miss the big picture.

Here is a typical example of the interaction between ventilation and circulation.

The patient is a 67 year old female with pneumococcal pneumonia leading to bibasal consolidation.



On the left are her haemodynamics on SIMV with an inspired oxygen concentration of 70%. Her PEEP was at 5cm H_2O. Her SpO_2 was just 85% with a PaO_2 of 58mmHg. Her $PaCO_2$ was normal. This is a common problem that we all see regularly in ICU.

We have a number of choices. Do we a) increase her FiO_2? b) increase her PEEP? or c) leave well enough alone? I think most of us would opt for increasing PEEP from 5 to 10 or even 15cm H_2O? Our aim of course is to titrate PEEP to achieve the optimum result. But what exactly is meant by "optimum" or so-called "best PEEP"?

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In most ICU's the measure of improvement would be an increased SpO_2 / SaO_2, but with the USCOM we can do far better. We can look at oxygen delivery, DO_2, in real time. The prime function of the heart and lungs is to deliver oxygen to the body, so why settle for anything less than measuring it?

The right hand panel shows what happened when her PEEP was increased to 12cm H_2O. Her saturation certainly improved. Unfortunately, this is not the only thing that matters. Whilst the SpO_2 has risen by a little over 10%, (with a commensurate rise in her PaO_2), the cardiac output has gone down by over 35%. The net result of this is that her oxygen delivery, DO_2, has fallen by 20%.

The pulse oximeter and arterial gases may suggest that she's better on the higher PEEP, but the USCOM tells the real story. The search for "best PEEP" can be made easily and rapidly when you have the appropriate tools to measure the response to your manipulations, especially now that the USCOM can provide DO_2 on an immediate beat-to-beat basis. In fact, the optimum PEEP in this patient turned out to be just 5cm H_2O, a result that surprised us all. Incidentally, if you thought that her CO, CI, Vpk and MD were high, whilst her SVR seems low at 623, especially as she is 67 years old, then you were quite right. This is a classical high-output, low SVR septicaemia. What you weren't told is that increasing her PEEP from 5 to 12cm H_2O also dropped her blood pressure from 114/60 to 85/48, despite increasing her norepinephrine infusion rate from 400mcg/min to 700mcg/min.

We normally aim at a DO_2 of =>12ml/kg/min. This patient weighed 68kg. The minimum DO_2 we would like to see is 816ml/min. On 5cm H_2O PEEP we can just about achieve this, but on 12cm H_20 we fall short. You may not be surprised to learn that her lactate level rose from 0.7 to 3.2 when the higher PEEP was used. Her tissue oxygenation was inadequate, despite the better SpO_2 / SaO_2!

USCOM told us the truth about her cardiopulmonary system.

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