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Fundamentals of Critical Care - Interview with Michael Pinsky

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Why is it important to take an applied physiologic approach to understanding bedside pathophysiologic processes?

When trying to comprehend the problems that your patient is feeling in terms of their potential cardiovascular respiratory insufficiency, the only way to understand is to apply pathophysiologic principles at the bedside to identify that your patient has as their disease. If done using functional haemodynamic monitoring approaches, you can identify cardiovascular reserve or its lack and then treat the patient accordingly. If they are volume responsive and in shock, and if they need fluids, you know that they will get an increase in cardiac output in response to that fluid challenge. The whole concept of applied physiology at the bedside is what critical care medicine is. All we have simply done is codify it.

What are the most promising applications of functional haemodynamic monitoring?

Functional haemodynamic monitoring simply tells you the cardiovascular reserve of your patient, for example if the blood flow is adequate to meet metabolic demands, or if the cardiac performance is such that if you give volume cardiac output will go up, etc. It gives you a very intuitive way of understanding cardiovascular state, and can also in certain circumstances identify disease ideologies. It is a way of saying “If the patient has a certain disease can I predict how the patient will respond to treatments.” It should never be examined outside the context of the patient and their disease. For example, you are volume responsive now, but hopefully you are not in shock. So if I have assessed functionally that you are volume responsive but otherwise stable it would be inappropriate to resuscitate you with fluid. If I used functional haemodynamic monitoring to treat all healthy people, I would be giving them a large quantity of volume and I should not do that. But if I have a person who is sick I can use functional haemodynamic monitoring to identify which treatments will work and have a very good predictive value.

How has your research on heart-lung interactions translated into clinical practice?

I have been studying cardiopulmonary physiology since 1978, and our very first paper was published in the *New England Journal of Medicine* in 1979 (Buda et al. 1979). The study of heartlung interactions is the study of cardiopulmonary physiology, and it is the fundamental basis of why patients who have pulmonary embolism and hyperinflation go into heart failure. It includes the effects of spontaneous versus positive pressure breathing and ventricular-arterial coupling. It is the fundamental basis for functional haemodynamic monitoring. Without those studies on cardiopulmonary physiology, there would be no functional haemodynamic monitoring parameters today.

Research in that field now has gone from the left ventricle to looking at the right ventricle and ventricular-arterial coupling in the setting of pulmonary hypertension, thromboembolism, thrombectomy and right ventricular volume response.

You’ve written about the right ventricle: “The genie’s out of the bottle” (Pinsky 2014). Can you elaborate?

For many years, the cardiology literature has celebrated the left ventricle as the primary determinant of cardiovascular function, centred around the two primary issues of coronary disease and arrythmias, both of which can limit survival. What was known for many years, but not appreciated, is that the primary determinant of cardiac output is the right ventricle not the left. The right ventricle is profoundly limited by outflow pressure, and thus when we are trying to determine cardiovascular state, we now appreciate that understanding right ventricular function is by far and away more important to assess.

The most common form of heart failure today in the world is referred to as heart failure with preserved left ventricular injection fraction. Many of these cases represent right heart failure. Now we know that, and we can assess it with echocardiography and other monitoring approaches. Looking at right ventricular function as a primary way of accessing cardiovascular state is now a standard approach. The more people look at the right ventricle, the more they realise that it is the major determinant of cardiovascular response and survival. That’s what I meant when I said “the genie is out of the bottle”.

You noted in an editorial that there is a presumed bias against studies published more than 10 years ago (Pinsky and Lumb 2013). What is the solution?

The problem is that students (in the sense that we are all students) have a very superficial understanding of the fundamental scientific underpinnings of the fields they are studying. We teach more about phenomenology and representing a pattern in treating disease rather than understanding the disease process. Thus when students search the literature, they tend to go for the more recent papers, because they give them answers. They perceive that the latest paper is the latest science. Regrettably that’s almost never the case.

Initially the way the Google Scholar search engine worked was that the number of hits a site gets would determine its priority for being listed. If you put in heart-lung interaction, for example, or mitochondrial function and sepsis, you would get as the very first article, the article that has the most hits, which would usually be a recent paper from the last two years. We complained to Google that in fact most of these papers were simply modifying or reviewing the initial studies. Now in Google Scholar, you’ll see that the results you are viewing now show the older papers first; below that listing are the ones that cite those older papers.

You developed a professionalism and leadership curriculum for intensive care fellows at Pittsburgh. Is such a curriculum unusual? Is enough done to develop these skills?

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We developed the first leadership and professionalism course that is routinely taught to all fellows. It includes topics such as negotiating a salary, dealing with hospital infrastructure, conducting quality improvement initiatives, the nature of how you would fit into an academic or clinical job, dealing with families, etc. It covers the professional aspect of being a doctor in an acute care setting that is the epicentre of the hospital. The course director Jason Moore and I just published a position paper in the *Journal of Critical Care* (Moore and Pinsky 2015). We describe how we developed this course, how it is evolving and the feedback from the fellows, who are now in private practice, on how important they have found it in terms of practical applications.

I think that such courses should be given nationally and internationally. The strength of the University of Pittsburgh is that we have 60 faculty and we cover all aspects of professionalism. I got immediate buy in from our faculty. Most training programmes don't have that luxury. The way forward is providing webbased materials as CME, or running courses in the critical care society meetings.

A Pittsburgh team reported research this year on a machine learning approach that is able to distinguish between real and artifact alarm alerts (Hravnak et al. 2015). Is this going to be commercialised?

When you are taking care of critically ill people, you are trying to assess if they are stable or unstable. We look at the haemodynamic monitoring of our patient and if the values that they get exceed what we consider to be normal, alarms go off. Regrettably over 50% of alarms that go off are not due to true physiologic alerts, but are due to pure artifacts — the probe comes off the finger, the ECG electrode falls off or the patient has Parkinson's disease and their hand is shaking. If you have ever seen a movie in which they have an ICU, you always hear alarms going off in the background. It is part of the acoustic wallpaper of the ICU, and accordingly alarm fatigue is thought to be one of the primary safety hazards in the hospital setting, specifically in the ICU (ECRI Institute 2015).

We reasoned that the structural pattern of the alarm itself in real time as a biological signal would be significantly different from the actual shape of that alarm if it was due to artifact. Using machine learning approaches over the last three years we have been able to accurately identify those alarms that are artifacts. At the European Society of Intensive Care Medicine 2015 meeting we presented an abstract showing that in a prospective analysis of one year's worth of data, we were able to accurately eliminate in real time 90% of the artifact (Hravnak et al. 2015). If this was made available in a commercial device as machine algorithms, it would mean that if an alarm goes off now it is real. That would solve a fundamental safety issue. We started this initially because we were looking at patterns of disease and trying to identify instability, and we discovered very early on that we had to first filter out the artifacts. The algorithms have been published and the University of Pittsburgh and Carnegie Mellon University are talking to industry about using these. I am sure it will become commercially available.

What would you like to learn about longterm outcomes from critical illness? Why am I treating my patients?

I am treating them to make them go back and have a productive life and be happy. To the extent that I can save a person from acute illness does not mean that they have gone back to be happy. Dr. Lakshmipathi Chelluri was the principal investigator of a study that we did at the University of Pittsburgh in which we looked at long-term outcome from prolonged mechanical ventilation (> 2 days) as a surrogate of acute illness (Chelluri et al. 2004). What we found was that there was profound morbidity in the patients up to a year afterwards. Furthermore the families' harm, which we call collateral damage, in terms of economic loss, depression and for example leaving college to stay home and help their loved one, was amazing. That was a landmark study. There is a profound economic impact of critical illness that goes far beyond the walls of the ICU. It is not the cost of ICU care, when that patient leaves the unit; they are taking with them for up to a year the morbidity and the mortality associated with that. Its impact on the family even if they have socialised medicine is overwhelming. Since one fifth of all the patients that are in the hospital are in the ICU, the economic impact that this has on society as a whole is absolutely profound. I am studying it, because it is the right thing to do. It is the reason why I am a doctor.

This interview will be in our Emergency Medicine (EM) & Trauma issue. How can EM physicians and intensivists work better together?

In the old days, emergency medicine was considered to be an outpatient field. When a patient was critically ill they needed to be admitted to the ICU or hospital. The emergency medicine doctor would simply call the ICU doctor and walk away from the patient. We know from the early goal-directed therapy studies onwards that this is associated with a very bad outcome. The Australasian Resuscitation in Sepsis Evaluation (ARISE) (ARISE Investigators et al. 2014), Protocolized Care for Early Septic Shock (ProCESS) (ProCESS Investigators et al. 2014) and Protocolized Management in Sepsis (ProMISe) trials (Mouncey et al. 2015) all documented the exact same thing. That is why we now have a tighter link between the emergency room and the ICU in terms of the continuity and aggressiveness of resuscitative care. Manny Rivers' original study (Rivers et al. 2001), though the specific treatment protocol was proven not to be needed, has been a godsend in terms of changing the practice and attitude in the emergency departments and linking more closely ICU to emergency medicine.

At the University of Pittsburgh six of our attending physicians in critical care medicine have emergency medicine as their primary training. We consider the management of the patient, though they are still in the emergency department, the domain of the ICU. This change has significant implications in terms of continuity of care.

Trauma has always done this. When a patient comes in with trauma, they call the trauma team; they go to the trauma room in the emergency department and from there on the trauma team is managing them whether they are in the emergency room, operating room or the ICU. So now we are doing the same with sepsis and acute respiratory failure.

See Also: Zoom On: Michael Pinsky

See Also: I-I-I Interview: What Are the Goals of Resuscitation?

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