



Non-invasive Monitoring for the Postoperative Heart

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Short Communication

The problem with invasive monitoring is evident in the name. In spite of that, Pulmonary Artery Catheter (PAC) remains the gold standard for hemodynamic monitoring in postoperative cardiac surgical patients and is used routinely in many centers. It allows measurement of right atrial pressure and cardiac output which can be used to derive the systemic vascular resistance. Pulmonary capillary wedge pressure is an indirect surrogate for left atrial pressure, left ventricular end diastolic pressure and left ventricular preload. These measurements provide intermittent or continuous hemodynamic data which can be used to guide haemodynamic management. PAC has limitations including erroneous data in certain cardiac disease states (for example mitral and tricuspid regurgitation), when the catheter tip is located in an under-perfused area of lung and misinterpretation of PAC data may occur by inexperienced physicians. Pressure based monitoring of left ventricular preload is dependent on left ventricular compliance which is often abnormal after cardiac surgery.

Physician performed ultrasound on the other hand, has proved to be safe and effective and has been used by physicians as an adjunct to their clinical evaluation. It started out in the Emergency Department setting with Point-Of-Care Ultrasound (POC US) [1]. Its success led to the other application that stood the test of time, Focused Assessment with Sonography for Trauma (FAST) a term coined at the International Consensus Conference in 1996 to describe an integrated, goal-directed, bedside examination to detect fluid, which is likely to be hemorrhage in cases of trauma [2]. Then came the extended FAST (e-FAST) that added examination of the chest for pneumothorax [3].

Impact of Ultrasound on Critical Care

After the unprecedented success of (POC US) and (FAST) it was only natural for ultrasound to be integrated into the critical care environment. That road was plagued with legal battles about who has the right to use it by the patient's bedside. The ease with which it is now used is the result of the hard work of the earlier physicians who fought for this privilege [4]. Echocardiography has become a vital tool in the diagnosis of critically ill patients. The use of echocardiography by Intensivist has been increasing since the 1990's. Physicians with basic training in echocardiography, both from intensive care unit, anesthesiology or emergency department, can assess left ventricle function with good accuracy. More interesting is what I came across in my readings that a medical student with echo is more accurate than a cardiologist with a stethoscope. The change of treatment approach based on echocardiographic findings is commonly seen after examination of unstable patients. Post-operative care for cardiac surgery is taking note of all these changes. Cardiac surgeons however, do not like to change for the sake of change. They like to do that on very solid grounds of evidence and this is ingrained in our training.

The Birth of an Idea

Use of ultrasound and echocardiography for monitoring the post-operative heart was an idea that we felt should be tried. Our partners in research at the University of Melbourne in Australia were just as strong believers. That is how the ITRACS project came into being. The word itself "ITRACS" is an acronym that stands for: "Impact of Transthoracic Echocardiography & Respiratory Ultrasound Assessment in Cardiac Surgery". Postoperative clinical patient assessment for significant cardiac and pulmonary disorders by the treating physician was recorded at 3 time points (day after surgery, after extubation and removal of chest drains and at discharge). Using conventional monitoring and chest X-ray. After each assessment, transthoracic echocardiography and lung ultrasound were performed, and differences in diagnosis from conventional assessment were recorded. Transthoracic echocardiography was interpretable in at least 1 echocardiographic window in 99% of examinations. Transthoracic echocardiography and/or lung ultrasound changed

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the diagnosis of important cardiac and/or respiratory disorders in 61 patients (67%). New cardiac findings included cardiac dysfunction (38 patients), pericardial effusion (5), mitral regurgitation (2), and hypovolemia (1) new respiratory findings included pleural effusion (30), pneumothorax (4), alveolar interstitial syndrome (3) and consolidation (1). Hemodynamic state interpretability varied over time and was highest before surgery (90%) and lowest on the first postoperative day (49%) ($p<0.01$). This variation in interpretability over time was reflected in all 3 transthoracic windows, ranging from 43% to 80% before surgery and from 2% to 35% on the first postoperative day ($p<0.01$). Image quality scores were highest with the apical window, ranging from 53% to 77% across time points, and lowest with the subcostal window, ranging from 4% to 70% across time points ($p<0.01$) [5]. Hemodynamic state can be determined with TTE in a high proportion of cardiac surgery patients after extubation and removal of surgical drains. This study has proved that routine repeated monitoring with cardiac and lung ultra sound after cardiac surgery is feasible and frequently alters diagnosis of clinically important cardiac and respiratory pathology [6].

Making the Transition

Transthoracic and Trans-esophageal echocardiography are increasingly used as tools to improve clinical assessment following cardiac surgery. However, most physicians are not trained in echocardiography, and there is no widespread agreement on the feasibility, indications or effect on outcome of transthoracic or Trans esophageal echocardiography for patients after cardiac surgery. We performed a systematic review of electronic databases for focused transthoracic and transoesophageal echocardiography after cardiac surgery which revealed 15 full-text articles. They consistently reported that echocardiography is feasible, whether performed by a novice or expert, and frequently resulted in important changes in diagnosis of cardiac abnormalities and their management. However, most were observational studies and there were no well-designed trials investigating the impact of echocardiography on outcome [7].

Judging by our experience, that took the above factors into consideration in addition to human nature, we did not set a specific date for the change. The change is coming gradually. Some of surgeons

who resisted it first are starting to accept it. When we started looking at the ITRACS project I realized that my knowledge of ultrasound was pretty basic. I took quite a few courses. I found the American College of Surgeons course to be particularly useful although it has tough prerequisites to meet. I can only expect other surgeons would feel the need to learn more about US and that would mean allowing time for that to take place. I believe that the winds of change are blowing and it is a matter of time before it becomes the standard of care and patients would be asking for it. Many of my colleagues in the US asked me how they can bill for it. I am sure that would happen in due course. The insurance companies like to study the issue and once they realize its value and that it is a potential money saver it will be covered.

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