

## **Expanded Case Summary 3: The utility of cardiac output monitoring and focused echocardiography in septic shock.**

*This case report details the management of a patient admitted to ICU with rapidly evolving multi-organ failure and septic shock from presumed meningococcal bacteraemia. The addition of cardiac output monitoring and focused echocardiography (FICE) allowed targeted inotrope use and improved tissue perfusion.*

### **Clinical Problem**

A 56-year old previously healthy female was brought into the emergency department by ambulance with a 3-day history of headache, sore throat and coryzal symptoms. The critical care team were immediately contacted as she was profoundly unwell with gross physiological upset.

The patient was tachycardic, tachypnoeic, hypothermic, confused and peripherally shut down. In the emergency department blood cultures were obtained, two litres of crystalloid infused and broad-spectrum antibiotics were administered to cover potential CNS infection.

Her oxygen requirements rapidly increased and there was evidence of acute kidney injury with a profound metabolic lactic acidosis. She was therefore immediately transferred to ICU for multi-organ support.

Word Count – 104

## **Management**

She was intubated due to worsening gas exchange and confusion. Due to rapidly evolving multi-organ failure, raised inflammatory markers and cerebral irritation we suspected meningococcal septicaemia. Lumbar puncture was not performed due to coagulopathy and instead empirical antibiotic therapy was commenced.

Despite five-litres of crystalloid her acid-base failed to improve and she remained grossly vasoconstricted. Unusually she was relatively hypertensive with low SpCVO<sub>2</sub> despite no exogenous cardiovascular support. Given this atypical physiology a focused echocardiogram (FICE) was performed which demonstrated a grossly hypokinetic and dilated left ventricle.

Cardiac output monitoring (LiDCO) was utilised which confirmed low cardiac output (cardiac index 1.4 L/min/m<sup>2</sup>) and grossly elevated SVR. On this basis we commenced dobutamine, targeted to increasing cardiac index aiming to achieve improved capillary perfusion. This was successful and led to improved acid base balance with falling lactate.

Interestingly 24-hours later there was a marked and sudden change in her physiology as she appeared warm and vasodilated with refractory hypotension despite fluid resuscitation. Cardiac output monitor confirmed high cardiac index and low SVR. Dobutamine was stopped and substituted with noradrenaline, vasopressin and hydrocortisone infusions which successfully restored her physiology.

Our patient had a prolonged ICU stay complicated by digital perfusion defects, ischaemic CVA, dialysis, tracheostomy and delirium but was eventually discharged from hospital having made a full recovery.

Word Count – 216

## **Discussion:**

Classically septic shock in adults presents with warm, vasodilatory shock. I had only witnessed cold septic shock with peripheral vasoconstriction in the paediatric population. The use of cardiac output monitoring in the general ICU population is a contentious issue with some units abandoning their use completely. Anecdotally we only believe the derived data if it supports our clinical assessment.

Traditionally cardiac output monitoring with PA pressure measurement was achieved utilising a pulmonary artery catheter (PAC). PAC's allow detailed physiological data to be derived, theoretically allowing targeted inotrope therapy to optimise tissue perfusion. Their use has declined since the PAC-Man study by Harvey et al in 2005<sup>[1]</sup>. In this trial 1014 patients were randomised to either have their inotrope therapy guided with or without a PAC. No difference in either primary (inpatient mortality 66% vs 68%) or secondary (ICU mortality or length of stay) endpoints were observed. PACs were associated with a 10% complication rate including arrhythmia and haematoma. Interpretation of this study is difficult due to its pragmatic design, which allowed clinicians to act independently on derived physiological data with no standardised treatment in the study groups. Yet, it could be argued that this simply reflects what may happen in reality.

In my opinion cardiac output monitors can be useful but only for a defined purpose. The use of PACs in cardiac surgery allow targeted vasopressor and inotrope therapy and can be an early indication to involve cardiac surgeons if there is a deteriorating clinical picture. Alternative the use of non-calibrated pulse-contour analysis devices can be helpful to determine fluid responsiveness and have the benefit of being minimally invasive.

The most helpful tool in this case was focused echocardiography. This facilitated the early diagnosis of cardiac dysfunction and appropriate inotrope therapy. I believe echocardiography together with clinical assessment would have been enough to change management. LiDCO only served to reassure us and provide physiological data to target treatment. Zhang et al reported that intensivists can successfully perform focused echocardiography with only 12 hours of teaching, leading to a change in patient management in 22% of cases (fluid challenge/change in inotrope). FICE can provide clinical information regarding cardiac function and fluid filling rapidly but it must be remembered that it is only a screening tool and the potential pitfalls such as missed pathology need to be kept in mind. An article Glen et al highlights the importance for cardiology engagement and expert referral, particularly when scans are abnormal. There is no literature to correlate the use of FICE to ICU

outcome despite an increasing amount regarding its utility. With regards to minimally invasive cardiac output monitoring such as LiDCO, there are no studies that support a mortality benefit. The literature is currently mixed with regards to their validity in providing robust physiological parameters by comparison to PAC's. I imagine the variety of devices that exist does not help form a standardized approach.

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## **Lessons learnt**

In my experience sepsis related cardiomyopathy is often overlooked and if not addressed may lead to cardiovascular collapse particularly if the wrong vasoactive drug is utilised. This case demonstrated the use of targeted cardiac output monitoring together with echocardiography to guide physiological manipulation. In future I will ensure that I remain an open-minded clinician and take account of all aspects of my patient's physiology. I do believe that cardiac output monitoring can be useful in ICU but so long as it is used in conjunction with clinical judgement and not as a substitute for it.

Word Count – 95

## **References**

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