

Oxygen delivery and venous oxygen saturation monitoring

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Maintenance of adequate oxygen delivery is essential to ensure survival from shock, critical illness and major surgery. Impaired oxygen delivery can result in tissue hypoxia, anaerobic metabolism, lactic acid production and oxygen debt. If sustained, this sequence of events can lead to multi-organ failure and death.

MEASURING OXYGEN DELIVERY

Clinicians frequently use heart rate, blood pressure and central venous pressure to assess the adequacy of resuscitation, but tissue hypoxia may be present even when these variables are normal. Measuring cardiac index and oxygen delivery provides indices of blood flow but does not provide information about whether this is sufficient to meet the metabolic needs of the body (Vincent and De Backer, 2002).

Mixed venous oxygen saturation

Mixed venous oxygen saturation (SvO₂) may be used as a measure of adequacy of oxygen delivery. It reflects the balance between oxygen delivery and extraction, and the normal range is between 65 and 75%. SvO₂ has been shown to have diagnostic, prognostic and therapeutic use in the management of a wide range of critical illnesses and in major surgery (Polonen et al, 2000), but it necessitates the placement of a pulmonary artery catheter. Controversy surrounding the safety of pulmonary artery catheters and the availability of non-

invasive methods of cardiac output determination may result in the less frequent use of pulmonary artery catheters.

Most critically ill patients and those undergoing major surgery will have a central venous catheter inserted. But can central venous oxygen saturation (ScvO₂) be used as a surrogate for SvO₂ and can its measurement guide interventions that improve outcome?

Central venous oxygen saturation

In shocked patients the ScvO₂ in the superior vena cava is higher than the SvO₂ (Lee et al, 1972). Furthermore, a close correlation between ScvO₂ and SvO₂ has been demonstrated across a broad range of haemodynamic variables (Reinhart et al, 1989). In shock, an abnormally low ScvO₂ indicates an even lower SvO₂ and thus significantly impaired oxygen delivery. In the presence of a normal haemoglobin level and arterial oxygen saturation, the low ScvO₂ implies an inadequate cardiac index regardless of its absolute value.

The clinical utility of ScvO₂ monitoring in the assessment of haemorrhagic, cardiogenic and septic shock has been demonstrated in several studies. One tested the effectiveness of early goal-directed therapy guided by ScvO₂ in the treatment of severe sepsis and septic shock in a prospective randomized control trial (Rivers et al, 2001).

Standard therapy in both the control and early goal-directed therapy groups consisted of fluids and vasoactive agents to achieve a central venous pressure of 8–12 mmHg, a mean arterial pressure of >65 mmHg and a urine output >0.5 ml/kg/hr.

In the early goal-directed therapy group, in addition to red cell transfusions, the ScvO₂ was continuously monitored and inotropes were used to achieve a ScvO₂ >70%. This approach resulted in an in-hospital mortality of 30% in the early goal-directed therapy group compared to 46% in the standard therapy group. Improved mortality was probably attributable to improved oxygen delivery at an early stage in the disease process.

CONCLUSION

SvO₂ monitoring is an important marker of the adequacy of oxygen delivery. In the absence of a pulmonary artery catheter, ScvO₂ may be an acceptable surrogate for SvO₂. The use of ScvO₂ to guide early goal-directed therapy in patients with severe sepsis and septic shock appears to improve outcome. **HM**

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