# Bedside assessment of tissue oxygenation and perfusion in septic patients.

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In septic patients the pathogenesis of organ dysfunction is multi-factorial. In the early stage (decompensated phase), organ dysfunction occurs mainly because of an inadequate $O_2$ availability at tissue level. After an adequate resuscitation, dysregulation in organ microcirculation (microcirculatory hypoxia) and impairment in cell metabolic pathways (cytopathic hypoxia) may lead to the persistence of organ dysfunction in spite of high level of $O_2$ delivered to tissue (1). In this latter phase, the monitoring of conventional hemodynamic, respiratory and metabolic parameters (e.g.venous $O_2$ saturation in pulmonary artery or in superior cava and blood lactate concentration) are scarcely sensitive and specific in the assessment of changes in tissue perfusion and oxygenation (2). For these reasons, a bed-side monitoring that allows the measurement of oxygenation and perfusion at the tissue level, with early and reliable indicators of tissue hypoxia, is mandatory in septic patients. To this objective, the available techniques are mainly two. The first one is based on the use of Clark type electrodes that provide a direct measurement of tissue $O_2$ partial pressure ($PtO_2$). This technique still represents the gold standard for tissue oxygenation assessment, but its use in clinical practice is limited because it is invasive and expensive. The second technique exploits the optical properties of haemoglobin for measuring tissue $O_2$ saturation ($StO_2$), myoglobin or cytochrome *aa3*. Near-infrared spectroscopy (NIRS) has been largely used to measure cerebral oxygenation, metabolic and micro-circulatory responses in selected patients populations (2-3). Distinctive features of NIRS technique are: non-invasive and simple application, low signal interference during movement and potential capacity of space and time discrimination. The following paragraphs are devoted to a brief description of our personal experience with Clark type electrodes and NIRS technology in patients with septic shock.

*$PtO_2$*: in septic shock patients we measured intramuscular (quadriceps femoris) $PtO_2$ by means of a miniaturized polarographic catheter before and during recombinant human activated protein C (rhAPC) administration. PtO2 increased by about 50% after 24 hours of rhAPC therapy and at the end of treatment it was two-fold larger than the initial values. The $PtO_2$ increasing was concomitant with an improvement in organ functioning. These preliminary results indicates that rhAPC seems to induce an improvement in tissue oxygenation and perfusion with organ function amelioration.

*$StO_2$ monitoring*: we compared the muscle blood flow and oxygen consumption, measured by means of NIRS technique in association with pneumatic cuff venous occlusion, of well resuscitated septic shock patients with those obtained in critically ill non-septic patients and healthy volunteers. Blood flow and oxygen consumption resulted systematically higher in septic patients than in non-septic patients and healthy volunteers. Oxygen extraction fraction was substantially the same in the 3 groups. We concluded that in adequately resuscitated septic shock patients tissue oxygen flow is not a limiting factor for oxygen consumption (4).

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