Med Intensiva. 2017;41(1):44–52

medicina intensiva

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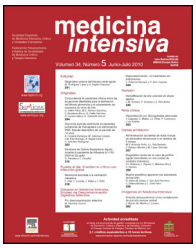

REVIEW

Microcirculatory monitoring in septic patients: Where do we stand?

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Received 9 September 2016; accepted 13 November 2016
Available online 17 January 2017

KEYWORDS
Microcirculation;
Videomicroscopy;
Near-infrared spectroscopy;
Shock

Abstract Microcirculatory alterations play a pivotal role in sepsis-related morbidity and mortality. However, since the microcirculation has been a ''black box'', current hemodynamic management of septic patients is still guided by macrocirculatory parameters. In the last decades, the development of several technologies has shed some light on microcirculatory evaluation and monitoring, and the possibility of incorporating microcirculatory variables to clinical practice no longer seems to be beyond reach. The present review provides a brief summary of the current technologies for microcirculatory evaluation, and attempts to explore the potential role and benefits of their integration to the resuscitation process in critically ill septic patients.

PALABRAS CLAVE
Microcirculación;
Videomicroscopia;
Espectroscopia de luz en el espectro cercano al infrarrojo;
Shock

Monitorizando la microcirculación en el paciente séptico: ¿en qué punto estamos?

Resumen Las alteraciones microcirculatorias juegan un papel fundamental en la morbimortalidad asociada a la sepsis. Sin embargo, puesto que la microcirculación ha sido una «caja negra», el manejo hemodinámico actual del paciente séptico sigue basándose en la corrección de parámetros macrocirculatorios. Durante las últimas décadas, el desarrollo de diferentes tecnologías ha permitido arrojar algo de luz sobre la posibilidad de evaluar y monitorizar la

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microcirculación, y a día de hoy, la incorporación de variables microcirculatorias a la práctica clínica ya no parece una quimera. El presente trabajo de revisión presenta, de forma sucinta, las diferentes tecnologías que permiten evaluar la microcirculación, y pretende explorar el posible papel, así como los potenciales beneficios, de la integración de estas tecnologías en el proceso de reanimación del paciente crítico séptico.

Bedside microcirculatory monitoring in sepsis

The microcirculation is altered in sepsis

Sepsis is associated with high morbidity and mortality rates, and its management represents a difficult challenge for the clinician. Septic shock is usually characterized by hemodynamic impairment, classically defined by a decreased vascular tone with some degree of hypovolemia, leading to circulatory failure. In current international sepsis guidelines, hemodynamic management pivots on supporting this failing circulation, aiming at correcting global markers of tissue oxygenation[1,2] (specifically, lactate and central venous oxygen saturation −$ScvO_2$−) via the optimization of oxygen delivery. Lactate has been proposed as a clinical marker of anaerobic metabolism, and $ScvO_2$ as a marker of oxygen transport and oxygen consumption imbalance. However, these parameters allow an evaluation of tissue wellness or adequacy of perfusion from a global perspective, and may be of limited usefulness in diseases such as sepsis, where an important heterogeneity in tissue perfusion has been demonstrated. Furthermore, signs of tissue hypoperfusion may still persist even when these global flow parameters seem to be corrected. Indeed, available evidence strongly suggests that the principal motor of sepsis is microcirculatory dysfunction.[3] These microcirculatory alterations may produce tissue hypoxia, as a result of oxygen supply-demand imbalance at the cellular level, leading to the development of cellular and organ dysfunction and potentially, death of the individual.[4] Although until recent times microcirculation has been a ''black box'' because of technological limitations, development of microcirculatory evaluation techniques has allowed direct study of this phenomenon.

Microcirculation is considered to be the main responsible for ensuring tissue wellness. Its principal objective is to transport oxygen and nutrients to tissue cells and thus preserve organ function. It consists of a complex network of small blood vessels (<100 μm diameter) such as arterioles, capillaries and venules. Arterioles are responsible for maintaining vascular tone, and respond to extrinsic and intrinsic stimuli to modulate local arteriolar tone to match local metabolic demands. Capillaries act as the primary exchange place for supplying oxygen and receiving metabolic cell waste products. These capillaries converge into the venules, where leukocyte interactions and vascular permeability changes take place. Moreover, the microcirculation is a complex system that also involves different cell types with different functions such as endothelial cells inside the microvessels, smooth muscle cells (mostly in arterioles), red blood cells, leukocytes, and plasma components in blood. All these elements interact between them and are regulated by different complex mechanisms controlling microcirculatory perfusion.[3]

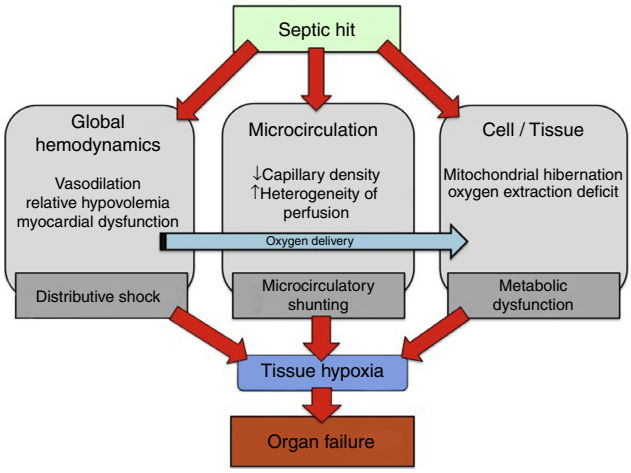

Figure 1 Physiopathology of oxygen transport alterations in sepsis. Sepsis may induce complex alterations at different levels (including global hemodynamics, microcirculation, and cell metabolism) of the oxygen transport ''cascade'', leading to tissue hypoxia and the consequent development of organ failure.

Recent experimental and clinical studies have reported microcirculatory alterations in sepsis. These studies observed a decrease in capillary density that determines an increase in the diffusion distance of oxygen to tissues,[5] and furthermore an increase in heterogeneity of perfusion was also described.[6] Overall, this microcirculatory derangements involve the consequent presence of under or not perfused capillaries in close proximity to well perfused capillaries. Therefore, these functionally vulnerable microcirculatory areas may become hypoxic, resulting in an oxygen extraction deficit. This phenomenon has been termed ''microcirculatory shunting'' and plays a major role in the pathophysiology of sepsis and multi-organ failure[3,5] (Fig. 1). Of note, in clinical practice, systemic hemodynamic- and global oxygen-derived variables may fail to detect this phenomenon.

According to current evidence, bedside evaluation of microcirculation may complement our current approach in the management of septic patients.