The usefulness of the shock index and the modified shock index in predicting patient outcomes in a tertiary emergency department in India

In this issue of *AJTCCM*, Surendhar *et al*.[1] present their findings validating the complementary value of using a triage tool to determine the state of circulatory failure in patients seen at a busy tertiary emergency department (ED) in India. Circulatory failure is crudely defined as the inability of the body to maintain cellular oxygenation – a syndrome defined as 'shock'.[2] It is a common condition, with approximately one-third of patients presenting to an ED with this syndrome requiring admission to a high-dependency unit or an intensive care unit (ICU) for supportive care.[3]

Shock is defined physiologically by the equation: Delivery of oxygen = cardiac output × arterial oxygen content.[4] Decreased oxygen delivery is termed hypoxia, as opposed to a decrease in oxygen saturation alone, which is termed hypoxaemia. There are a multitude of different pathologies that result in a state of shock or tissue hypoxia. These are crudely defined by pathophysiological aetiology into the hypovolaemic form, in which there is internal or external fluid loss, cardiogenic, arising from cardiac pump failure, obstructive, arising from impaired venous return, and distributive, caused by a loss of vascular tone with vasodilation.[3] However, in most patients presenting to an ED, several of these mechanisms may overlap even if there is a single underlying disease process, making the distinction between them difficult.[5]

The primary physiological manifestations of the shock state are hypotension and tachycardia, and these are accompanied by secondary features of tissue hypoperfusion, which include cold and clammy skin with decreased capillary blood flow, reduced urinary output due to renal hypoxia, and altered mentation due to cerebral hypoxia. The easiest and most objective way to measure this physiological state is with the blood pressure and heart rate. A systolic arterial pressure <90 mmHg or a mean arterial pressure (MAP) <70 mmHg with associated tachycardia defines a low cardiac output state.[3] This pathological state with a decreased cardiac output and the associated compensatory response with tachycardia are the two main constituents of the shock index (SI) used by Surendhar *et al*.[1] as a triage tool.[6] A modified version of the shock index (MSI), using the ratio of the heart rate to the MAP, was also used in this study to ascertain whether either had a better predictive value when used in the ED to predict in-hospital outcomes.[7]

The major finding reported was that an SI ≥0.9 and an MSI ≥1.3 predicted in-hospital mortality ($p<0.05$) and ICU admission ($p<0.05$). There was no significant superiority of the MSI over the SI in predicting mortality, although the MSI was a better surrogate marker for ICU admission. However, the study did exclude patients who were on heart rate-regulating drugs and those who had atrioventricular block, cardiac arrhythmia or spinal cord injury, which is a major limitation of the universal applicability of the SI or the MSI as triage tools. Many patients who present to the ED are on medication that affects the physiological response of the heart, and the different pathophysiological mechanisms causing shock are often associated with some form of cardiac dysrhythmia.

Furthermore, the study reported sensitivity and specificity of the SI of 100% and 23%, respectively, in predicting mortality, whereas the MSI was reported to have sensitivity and specificity of 98% and 23%, respectively, in predicting mortality. The poor specificity of the SI and the MSI, with very low negative predictive values, while superior to blood pressure and heart rate individually, mean that they offer little additional benefit as screening or triage tools. The main reason for these findings is the heterogeneous nature of the illnesses in patients presenting to the ED, as well as the unpredictable physiological response in critical illness.

These findings have been corroborated in a comprehensive literature review by Koch *et al*.[8] on the SI, concluding that the SI should never be used in isolation to diagnose or rule out critical illness. Rather, it could be part of a triage bundle in clinical decision-making in the ED around the need for admission and the likelihood of mortality.[8]

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