Assessment of shock in emergency: Narrative review

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ABSTRACT

Shock is an important clinical condition presenting to the emergency department. Pathophysiology of septic, cardiogenic, hemorrhagic, obstructive, and anaphylactic shock are different however clinical assessment tools are the same and limited. It is important to identify shock in its early phase or the patient at risk of shock in the emergency department. There is no accurate clinical tool to identify the early stage of shock. Moreover, it is also important to assess fluid responsiveness to shock, available clinical and biochemical parameters respond differently to fluid resuscitation and none of the tools had 100% sensitivity and specificity. Therefore, this article reviews the available clinical and biochemical parameters to assess and monitoring fluid responsiveness in shock.

Keywords: Assessment, fluid responsiveness, noninvasive, shock

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INTRODUCTION

Early identification of shock is very important in the emergency department. Blood pressure criteria have been taken as a landmark for identifying and managing shock. Septic shock is defined as hypotension requiring vasopressor therapy to maintain mean BP 65 mm Hg or greater and having a serum lactate level greater than 2 mmol/L after adequate fluid.[1] There are studies showing serum albumin <3.5 g/dL and emergency department (ED) triage diastolic blood pressure <52 mmHg independently predict early progression to severe sepsis or shock among ED patients with presumed sepsis.[2] However, the shock must be identified in its preliminary stage, before blood pressure falls. American college of cardiology has classified cardiogenic shock as Stage A to E where stage A is referred to as at-risk and stage E is referred to as extremes.[3] Likewise, another type of shock should be identified in the early stage of risk. According to the European society of hypertension criteria, all noninvasive pressure measurements did not correlate significantly with the invasive measurement.[4] Therefore there is a limitation in identifying the pre-shock stage accurately, moreover it is also important to identify fluid responsiveness during resuscitation. As guidelines for target blood pressure for initiating therapy are not available and blood pressure measurements have many limitations to assess tissue perfusion, therapy should be assessed by looking at the overall status of the patient.[5]

So, we depend more on noninvasive tools for assessment of shock and responsiveness to fluid. This review will discuss the evidence on various noninvasive and laboratory tools for assessment of shock and fluid responsiveness.

Skin

Cold and moist skin is a factor for a worse prognosis and has a higher rate of organ failure at 48 hours after resuscitation compared to a patient with normal skin temperature.[6-8] Patients with cold skin in extremities and knees have significantly lower central venous saturation and higher lactate level as compared to those who have normal skin temperature.[9]

Pulse Pressure and Shock Index

In mechanically ventilated patients with acute circulatory failure related to sepsis, change in pulse pressure (Systolic – Diastolic blood pressure) during the inspiratory and expiratory cycle is effective in measuring fluid responsiveness.[10] Moreover, pulse pressure along with shock index (Heart rate/Systolic Blood pressure) is early and accurate predictors of massive transfusion in trauma patient with hemorrhagic shock.[11]

Capillary Refill Time

Capillary refill time (CRT) provides information on microcirculation & skin perfusion but not cardiac output. Studies have shown that a prolonged CRT of more than 2 seconds in the nail can predict 14-day mortality in septic shock with sensitivity of 82%(95%CI=60-95) & specificity of 73%(95% CI=56-86). Similarly, CRT of more than 5 seconds in the knee has sensitivity 82%& specificity 84% in predicting mortality. Therefore, CRT has been a reliable triage tool that improves rapidly after resuscitation in septic shock.[12]

Capillary refill time and skin mottling may be correlated with the pulsatility index, a sonographic surrogate of vascular tone, of visceral organs in early septic shock and therefore is used to identify the critically ill patient at risk of adverse outcome.[12-13] Capillary refill time (CRT) may improve more rapidly than lactate in response to increments in systemic flow.[14] The CRT however cannot be used to replace lactate monitoring.[15]

Peripheral Perfusion Index (PPI)

The normal range is 0.02 to 20% and readings are available in most of the monitors and pulse oxymeters. It is useful in assessment & in the first 24 hours of resuscitation in shock. It is an early predictor of central hypovolaemia.[16] An observation study concluded that PPI was not significantly different between patients admitted to the hospital and patients discharged from the emergency department so, PPI should not be used as a triage tool in ED.[17-18] Moreover, PPI does not correlate with macro hemodynamics and it weakly correlates with organ failure as assessed by SOFA score.[19]

Postural Hypotension

Postural hypotension in drop in systolic blood pressure more than 20 mmHg and diastolic blood pressure more than 10 mmHg DBP after 3 minutes of standing. Postural hypotension is normally present in age more than 6o years of age and patients under certain medications, however, this is a reliable tool for assessment of volume loss.[20]

Altered Mental Status

Altered mental status is a very common symptom and an important sign of systemic hypoperfusion, low arterial pH has the strongest association with altered mental status. Therefore, altered mental status calls not only for symptomatic management but also for prompt action to improve organ perfusion.21

Urine Output
Oliguria <0.3ml/kg/hour urine output predicts shock. It can be used in the assessment of volume loss but it is not an early predictor. Three to five hours of consecutive oliguria in the patient with septic shock may provide an important clue to acute kidney injury.[22]

Table 1. Oliguria of less than 0.3ml/kg/hour for predicting acute kidney injury[24]

	1 hour (%)	3hour (%)	5hour (%)
Sensitivity	99	70	59
Specificity	16	75	90
Positive predictive value	28	49	67
Negative predictive value	98	88	87
Accuracy	37	74	82

Invasive BP Monitoring
Invasive blood pressure monitoring provides continuous mean blood pressure values and is better for guiding resuscitation of patients with circulatory shock but optimal MBP target remains a matter of debate and with correct interpretation, it can guide fluid therapy and vasoactive drug administration.[23]

Renal Resistive Index
It is a rapid and non-invasive bedside tool useful to detect tissue hypoperfusion and oxygenation and to measure resistance to arterial blood flow in renal vessels. Sonographic index to assess resistance to flow in interlobar accurate or interlobar arteries.[24] Normal value is 0.6 to 0.7 and is the same for both kidneys. High RRI seen in vasoconstriction, decreased vascular compliance, and capillary rarefaction. The renal resistive index can be used to assess renal perfusion in different types of shock.[25] It is considered as a predictor of persistent acute kidney injury (AKI) and its reversibility in critically ill patients. RRI was significantly sensitive to hypoperfusion, and commonly determines renal injury and heart failure.[26] In the case of a hemodynamically stable person with cardiogenic shock, RRI can be used as an early predictor before systolic and diastolic blood pressure falls.[27] A decrease in RRI value during resuscitation is associated with an increase in mean arterial pressure in patients with septic shock. RRI can be used as an indicator of microcirculatory perfusion in the treatment process and volume assessment of patients with septic shock. RRI changes can be used during the treatment of patients with septic shock to monitor the treatment development.[9]

Ejection Fraction
Low ejection fraction reflects left ventricular systolic dysfunction, left and right ventricular ejection fractions are significantly impaired in critical patients with sepsis compared to trauma patients.[28] Impaired left ventricular systolic function is a predictor of mortality in patients with sepsis[29], however, this is neither specific nor sensitive.[30]

Measuring left ventricular size, inferior vena cava diameter and its variation with respiration and change in stroke volume by endogenous preload challenge test i.e. passive leg rising test followed by measurement of stroke volume and cardiac output help in intravenous fluid responsiveness and shock assessment.[31] However, this requires basic level 2D and M mode echocardiography which requires basic critical care echocardiography competency. [32]

Inferior Vena Cava
Measurement of inferior vena cava (IVC) diameter and its relationship with volume status suggest its use in guiding fluid resuscitation.[33] However, respiratory variation in IVC diameter has limited ability to predict fluid responsiveness, particularly in spontaneously ventilating patients.[34-35] Abdominal aorta and inferior vena cava diameter index of 1.14 can be used as a parameter for detecting the early phase of (Class 1) hypovolemic shock.[36-37]

Leg Raise Maneuver
This accurately predicts volume responsiveness. This maneuver to detect a change in a hemodynamic variable; the aortic blood flow, as determined by echocardiographic velocity-time integral.[38]

Serum Lactate
High lactate and decrease clearance are associated with increased mortality in patients with shock.[39] Lactate of more than 4 mmol/L was found to be an early predictor of high-risk condition in the trauma patient. Similarly, in trauma patients in shock,

lactate clearance of less than 20% at 6 hours was associated with morbidity and mortality.[40]

Base Deficit

Base deficit is useful biochemical markers of shock, it predicts mortality and morbidity specially in hypovolemic shock.[41] Base deficit of less than or equal to -6 increases the risk of the high-risk condition in the trauma patient.[42] Base deficit was found to be a better predictor than vital signs in pediatric hemorrhagic shock.[43]

DISCUSSION

Identifying patients who are at risk for shock is important in the emergency department, timely resuscitation decreases mortality.[44] Risk stratification is important in predicting high-risk patients who can potentially go into shock. High-risk conditions for various types of shock are different.[45-46] Assessment of risk factors in a combination of clinical parameters and biochemical parameters be helpful in predicting patients at high risk for shock. This category patient needs timely intervention, and the clinician should not wait for clinical shock. Fluid responsive is another part, that must be monitored meticulously, this is "the last hope for patient's better outcome".

Assessment of shock can be categorized as assessment of cardiac pump which can be done by ejection fraction and cardiac index; volume assessment can be done by IVC diameter, caval index, and pulse pressure; peripheral perfusion can be assessed by mental status, urine output, peripheral pulse index, skin mottling and capillary refill time; sympathetic response to the shock can be assessed by heart rate and blood pressure. Besides clinical parameter biochemical parameters like lactate and base deficit are important in the assessment of shock.[40-43] After the initial resuscitation, assessment of peripheral perfusion which physical examination can identify the hemodynamically stable patient with severe organ dysfunction and higher lactate. Therefore a patient with abnormal peripheral perfusion following initial resuscitation can be taken as a risk factor for worsening organ failure.[8] Usually, available guidelines take heart rate, mean arterial pressure, central venous pressure as a target for resuscitation, however, this does not take into account microcirculatory blood flow, therefore capillary refill time, the extent of mottling and peripheral perfusion index help identify a patient with severe organ failure and at high risk of mortality.[12] Moreover peripheral perfusion targeted resuscitation was found to have lower mortality and faster resolution of organ dysfunction when compared to lactate targeted resuscitation strategy.[47]

Tools available for assessment of shock and fluid responsiveness range from "low cost and simple" "to high cost and requiring competency". High cost and competency should not be a limiting factor for the assessment of shock, so a clinician should take into account the available resource to set up the local protocol for the assessment of shock. Using capillary refill time, skin mottling scores, passive leg raise test can be used to guide fluid resuscitation in resource-limited settings.[48] Moreover, due to rush and time limitations in the emergency department all modalities of assessment cannot be used for a patient, therefore it is of utmost necessary to understand the type of shock and clinic-biochemical parameter that is most effective in the particular condition.

CONCLUSION

In resource limited setup, we recommend using clinical history, pulse, blood pressure, capillary refill time, urine output, mental status, and serial serum lactate for identifying high-risk patient and responsiveness to fluid resuscitation in the patient with shock.

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