

Mechanism of Pediatric Shock and the Stepney Analogy

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ABSTRACT

Shock is a common paediatric emergency. A deep understanding of its mechanism is important for a favorable outcome. Use of analogy can be a useful teaching tool.

The stepney (spare wheeled-tire) is a widely known accessory in a motor vehicle. It serves as a temporary replacement for regular tires in emergency situations. Such a role is similar to the compensatory phase of shock.

The stepney analogy would be a useful learning aid for medical students and resident medical doctors. It would facilitate the understanding of shock pathophysiology and the need for prompt intervention.

KEYWORDS: Stepney; Shock; Compensatory phase; Management

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INTRODUCTION

Successful management of diseases requires understanding of relevant concepts. Since the advent of modern medicine, analogies have been used as teaching aids to illustrate medical concepts and pathophysiologic mechanisms.^{1,2,3,4} For example, anchovy sauce, rice water, red currant and pea soup have been used to describe the stools of amoebic dysentery, cholera, intussusception and enteric fever, respectively.² Also, the diving reflex observed in some mammals has been used to explain the physiologic response to *drowning*, and the efficacy of *ice-to-face* in the treatment of supraventricular tachycardia.^{5,6,7}

Prompt recognition and treatment of shock in children are key to survival. A clear understanding of the concept is thus crucial. This paper aims to relate the role of a stepney (spare wheeled-tire) to the pathophysiology of shock. This would facilitate a deep understanding of how to approach shock management. The ubiquitous nature of stepney also obviates the common cultural constraint in comprehending metaphorical descriptions.

DEFINITION OF SHOCK

Shock is a clinical syndrome of impaired tissue perfusion that compromises oxygen delivery into tissues.⁸ It is also described as tissue oxygen delivery (DO₂) less than tissue

oxygen uptake (VO₂).⁹ The endpoint is acute cellular hypoxia, causing tissue acidosis, cell death and organ dysfunction.⁹ Death often occurs when the early compensatory phase is missed and shock becomes irreversible.

TYPES OF SHOCK

Shock can be hypovolemic, cardiogenic, distributive, obstructive or dissociative.⁹ In hypovolemic shock, the intravascular volume is contracted. Cardiogenic shock involves myocardial dysfunction, while distributive shock is characterized by vasoplegia and fluid maldistribution. Blood flow is limited in obstructive shock, while oxygen release is impaired in dissociative shock.

MECHANISM OF SHOCK

In the early phase of shock, a compensatory drive is activated to restore tissue perfusion and improve oxygen delivery.⁹ Restoration of tissue perfusion hinges on maintaining the blood pressure (a product of cardiac output and systemic vascular resistance) and intravascular volume. To achieve this, the sympathetic nervous system releases catecholamines that increase the vascular tone, systemic vascular resistance and the heart rate; the venous reservoir is also constricted. These responses preserve the systolic blood pressure in a bid

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to restore tissue perfusion. Renal hypoperfusion activates the release of angiotensin, aldosterone and vasopressin. These hormones do not only restore intravascular volume; they also enhance normalization of blood pressure. In addition to tachycardia, the child presents with agitation, pallor, cold extremities, prolonged capillary refill time and reduced urine output.

If the compensated phase is missed, microvascular hypoperfusion worsens and anaerobic metabolism ensues; this generates most of the energy.⁹ The accompanying lactic acidosis depresses myocardial contractility and impairs myocyte response to catecholamines. Depressed sensorium and acidotic breathing are additional clinical findings at this stage. Without intervention, tissue damage, multiple organ dysfunction and death become inevitable.

THE STEPNEY

The stepney is a vital accessory in motor vehicles. It is a spare wheeled-tire that readily replaces a regular one in emergency settings such as flat tire and tire blow-out. The word 'stepney' is commonly used in India, Pakistan, Bangladesh and Malta. It was invented by Thomas Davies and Walter in Llanelli, Wales in 1904 to save the time consumed on tire repairs.¹⁰ The stepneys of many vehicles have limited use – they are also called space-savers, compacts, donuts, or temporary spares. They are smaller than regular tires and are designed to have a short life expectancy and low speed rating.¹¹ Hence, stepneys can only be used for a short period and over a short distance.

THE STEPNEY ANALOGY

If we assume that a damage to the tire of a moving vehicle is 'shock', the stepney is analogous to the early compensatory response. As a temporary measure, the stepney needs prompt replacement with a regular tire; otherwise, the spare-tire fails and the journey ends on the way. Similarly, the early phase of shock needs prompt intervention with mostly isotonic fluid. Otherwise, the compensatory drive fails and the consequence is death.

CONCLUSION

The early phase of shock can also be referred to as the "stepney phase". Such analogy will underscore the imperative of recognizing compensated shock and the need to intervene promptly.

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