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Review

Paediatric trauma systems and their impact on the health outcomes of severely injured children: An integrative review

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ABSTRACT

Background: Injury is a leading cause of death and disability for children. Regionalised trauma systems have improved outcomes for severely injured adults, however the impact of adult orientated trauma systems on the outcomes of severely injured children remains unclear.
Aims: This research aims to identify the impact of trauma systems on the health outcomes of children following severe injury.
Methods: Integrative review with data sourced from Medline, Embase, CINAHL, Scopus and hand searched references. Abstracts were screened for inclusion/exclusion criteria with fifty nine articles appraised for quality, analysed and synthesised into 3 main categories.
Results: The key findings from this review include: (1) a lack of consistency of prehospital and inhospital triage criteria for severely injured children leading to missed injuries, secondary transfer and poor utilisation of finite resources; (2) severely injured children treated at paediatric trauma centres had improved outcomes when compared to those treated at adult trauma centres, particularly younger children; (3) major causes of delays to secondary transfer are unnecessary imaging and failure to recognise the need for transfer; (4) a lack of functional or long term outcomes measurements identified in the literature.
Conclusions: Research designed to identify the best processes of care and describe the impacts of trauma systems on the long term health outcomes of severely injured children is required. Ideally all phases of care including prehospital, paediatric triage trauma criteria, hospital type and interfacility transfer should be included, focusing on timeliness and appropriateness of care. Outcome measures should include long term functional outcomes in addition to mortality.

Contents

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Introduction

Internationally, injuries are a leading cause of death and disability for children, with an estimated 950,000 children fatally injured every year [1] accounting for more childhood deaths than measles, diphtheria, polio, pertussis and tetanus combined [2]. Disability from severe injury is estimated to occur tenfold for each child injury mortality [1]. Injured children with lifelong disability often require ongoing care impacting individual opportunity, families and the community [1]. Childhood injury is predicted to rise with increased urbanisation and motorisation in low-to-middle income countries.

Trauma systems are designed to facilitate treatment based on the recognition of the complexity, severity, and time-critical nature of severely injured patients [3]. The integration and evolution of trauma systems have resulted in improved mortality and functional outcomes in adults [4]. There remains limited evidence describing the impact of trauma system on the health outcomes of injured children.

Major injuries affect adults and children differently. The anatomical, physiological and psychological management of injured children varies significantly compared to adults [5,6]. Recognition of these differences, including age specific injury patterns and appropriate care of children's families, are required to provide optimal management of injured children [7,8]. It is unknown whether children with severe injury should be transferred to specific paediatric facilities, bypassing adult trauma facilities, or receives initial stabilisation at an adult trauma centre [9,10].

Several studies have attempted to clarify the best hospital type and treatment pathways for severely injured children. A review conducted in 2007 by Ochoa et al. [11] compared children receiving trauma care at paediatric trauma centres (PTCs) to those who received care at adult trauma centres (ATCs) and found children treated in PTCs had an overall mortality benefit, decreased operative management of blunt abdominal trauma, and improved functional outcomes. A review by Stylianos et al. [12] in 2008 comparing processes of paediatric trauma care concluded that additional education of adult general surgeons caring for injured children on the management of blunt splenic injury may eliminate the differences in outcomes based on hospital type. In 2013, Mitchell et al. [13] identified that injured children who received definitive treatment at a PTC were three to six times more likely to survive their injuries, although the reasons for this survival benefit were less obvious. No definitive answer on optimal care for severely injured children were possible from these reviews, as prehospital care, triage and transfer processes were not examined.

The impacts of prehospital triage and transportation destination decision making on the outcomes of severely injured children are also unclear. Optimal transport time for severely injured children is not known although prehospital policy tends to be aimed at rapid triage, treatment and transportation [10]. Which hospital an injured child receives treatment typically has been governed by trauma triage protocols and criteria. There is great variation in the levels of training for providers of emergency medical services (EMS), which has particular implications for countries with large geographical distances, such as Australia, Canada and the US. There are high rates of overtriage and undertriage of severely injured children reported internationally [14,15]. This has been attributed to the lack of reliable and validated prehospital triage trauma tools specifically based on child physiology. Valid and reliable quality indicators for paediatric trauma are varied, based on limited evidence and at times contradictory [16].

The purpose of this review was to determine the existing knowledge of the impacts of paediatric trauma systems on the outcomes of severely injured children.

Methods

The integrative review method was used to allow the identification and synthesis of different types of study designs including both experimental and non-experimental research. The inclusion of a wide range of study design was required given the limited research on the impact of paediatric trauma systems on children's health outcomes. The Whittemore and Knafl [17] framework was used as the methodological approach for conducting this review.

Definitions

For the purpose of this review a child was defined as anyone aged less than 18 years. While this is not an ideal age for consideration of physiological differences in a child compared to that of an adult, if the age was lowered to those aged less than 16 years, a large number of articles would have been excluded as many studies defined children as aged 0 to 19 years. Severe injury is defined as those with an ISS $\geq$ 15. Trauma systems are defined as a coordinated response to the severely injured. It includes a prehospital phase (EMS, ambulance service, ground and air retrieval, triage criteria), hospital phase including hospital type (ATC, ATC with paediatric specialty [ATC AQ], and PTC), interfacility transfer (from an ATC to PTC via air or ground services), contexts of care (triage and treatment differences based on hospital type including adult and paediatric comparisons) and rehabilitative and discharge phases. Impact is defined as patient outcomes including