



## Management of paediatric splenic injury in the New South Wales trauma system



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### ABSTRACT

Since the 1980's, paediatric surgeons have increasingly managed blunt splenic injury (BSI) in children non-operatively. However, studies in North America have shown higher operation rates in non-paediatric centres and by adult surgeons. This association has not been examined elsewhere.

**Objective:** To investigate the management of BSI in New South Wales (NSW) children, to determine the patient and hospital factors related to the odds of operation. Secondly, to investigate whether the likelihood of operation varied by year.

**Methods:** Children age 0–16 admitted to a NSW hospital between July 2000 and December 2011 with a diagnosis of BSI were identified in the NSW Admitted Patient Data Collection, and linked to deaths data from Registry of Births Deaths and Marriages, and Bureau of Statistics. The operation rate was calculated and compared between different hospital types. Univariable analysis was used to determine patient and hospital factors associated with operative management. The difference in the odds of operation between the oldest data (July 2000–December 2005) and most recent (January 2006–December 2011) was also examined. Multivariable logistic regression with stepwise elimination was then performed to determine likelihood of operative management according to hospital category and era, adjusting for potential confounders.

**Results:** 955 cases were identified, with 101(10.6%) managed operatively. On multivariable analysis, factors associated with operation included age (OR 1.11, 95% CI 1.01–1.18,  $p < 0.05$ ), massive splenic disruption (OR 3.10, 95% CI 1.61–6.19,  $p < 0.001$ ), hollow viscus injury (OR 11.03, 95% CI 3.46–34.28,  $p < 0.001$ ) and transfusion (OR 7.70, 95% CI 4.54–13.16,  $p < 0.001$ ). Management outside a paediatric trauma centre remained significantly associated with operation, whether it be metropolitan adult trauma centre (OR 4.22 95% CI 1.70–10.52,  $p < 0.01$ ), rural trauma centre (OR 3.72 95% CI 1.83–7.83,  $p < 0.001$ ) or metropolitan local hospital (OR 5.23, 95% CI 1.22–18.93  $p < 0.05$ ). Comparing the 2 eras, the overall operation rate fell, although not significantly, from 12.9% to 8.7% (OR 1.3, 95% CI 0.89–243  $p = 0.13$ )

**Conclusion:** While Paediatric Surgeons have wholeheartedly adopted non-operative management, away from paediatric centres, children in NSW are still being operated on for BSI unnecessarily. While the factors at play may be complex, further evaluation of the management and movement of injured children within the broad NSW trauma system is required.

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### Introduction

Injury is one of the biggest health issues for children. Globally, it is the leading cause of death and morbidity over the age of one [1]. Injury remained the leading cause of mortality in New South Wales (NSW) children and adolescents in 2014, accounting for 37% deaths [2].

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Most injuries are due to blunt trauma and up to 13% have an abdominal injury [3]. The most commonly injured organ is the spleen accounting for up to 46.7% of all abdominal injuries [4]. Injury can range from a small sub-capsular haematoma to complete disruption of the organ, and it is often associated with multiple other injuries in and outside of the abdomen [5,6].

How children are managed within trauma systems significantly influences morbidity and mortality [7]. The way Blunt Splenic Injury (BSI) is managed exemplifies this [8]. According to Ein, and now widely accepted by paediatric trauma surgeons, regardless of the grade and associated injuries, “preservation of the spleen in blunt trauma should not be in formalin but instead in the peritoneal cavity” [9]. The driving reason behind this view is twofold. Firstly, avoiding splenectomy avoids Overwhelming Post Splenectomy Sepsis (OPSI) [10]. OPSI is a particular risk for children, occurring at a rate of 2–4% with a mortality of up to 50% [11]. Secondly, avoiding operation avoids all of the potential adverse sequelae of surgery. The goal of management in BSI is therefore spleen preservation along with avoidance of the complications of laparotomy.

Following the first reports of successful Non Operative Management (NOM) of paediatric BSI in the 1960's and 70's [12–14], along with the advent of cross-sectional imaging and introduction of paediatric trauma centres [1,15], NOM gradually became the norm. This culminated in the publication of evidence based guidelines by the American Paediatric Surgical Association (APSA) in 2000 [16]. The benchmark for NOM is 89–95% for all BSI and 97–100% for isolated BSI [16,17].

While there has been a clear and almost universal adoption of NOM in paediatric centres, the operation rate across the North American health system is reported to remain high, and mainly involves children managed outside of paediatric trauma centres [6,8,18–20]. The factors at play may be complicated but include patient characteristics [6,18,21–28], hospital characteristics [6,8,18–21,29,30] and surgeon practices [23,30–34].

NSW is the most populous state in Australia and has three paediatric trauma centres (PTC's), 17 adult trauma centres, ten of which are regional or rural, and over 200 metropolitan or rural hospitals where injured children may also present. In 2011, Fick reviewed 69 cases of BSI managed in a single NSW PTC over 10 years and found an overall NOM rate of 91% [26]. However, the extent to which paediatric trauma management occurs outside of NSW paediatric trauma centres, and specifically, the extent to which the guidelines for NOM of BSI are observed, has not been studied.

This study aimed to describe the incidence and management of BSI in children aged 0–16 across the state of NSW, over the ten years following the publication of the BSI NOM guidelines by Stylianos [16], with particular attention to the patient and hospital factors that may be associated with operative management, and whether the odds of operation varied by year. We hypothesised that the odds of operation would be higher outside of major paediatric centres, in more severely injured children, and in earlier years. The findings will have implications for the wider management of children within the NSW trauma system.

The study was approved by both the NSW Population and Health Services and Aboriginal Health and Medical Research Council Ethics Committees.

## Methods

The study was a retrospective cohort study from 1st July 2000 to 31 December 2011. Children aged 0–16 years with a diagnosis of Splenic Injury (SI) were included. Cases were identified from records within the Admitted Patient Data Collection (APDC). This database is maintained by the NSW Ministry of Health. It contains

information on all NSW hospital admissions, and contains data on demographics, facilities, diagnoses, external causes, procedures and destination on discharge. Diagnoses, external causes and procedures were coded according to the International Classification of Diseases, 10th revision, Australian Modification (ICD-10-AM). These records were linked to NSW mortality data contained in Registry of Births, Deaths and Marriages (RBDM) and the Australian Bureau of Statistics (ABS) death registration. Data was accessed through, and linked by, the NSW Centre for Health Record Linkage (CHeReL) and provided to researchers in a de-identified format.

Data was cleaned to remove duplicates, patients where date of death preceded admission or separation date, ages outside of the study range and cases where the external cause code indicated a penetrating injury, including those due to firearms ( $n=4$ ).

Outcome and explanatory variables used in the analysis are described in Table 1.

## Outcomes

The primary outcome was management of children with BSI categorised as operative management (OM) or Non Operative management (NOM). OM was defined using the ICD-10-AM codes for laparotomy, with or without splenectomy or another spleen-preserving procedure such as partial splenectomy or splenorrhaphy.

## Explanatory variables

Explanatory categorical and continuous variables were extracted or created using raw data in the three datasets.

The main explanatory variable was the trauma centre type. Facilities were categorised according to the trauma centre designation assigned by NSW Ministry of Health Institute of Trauma and Injury Management (ITIM) as (1) paediatric trauma centre (PTC) –which was further subcategorised in to primary presentation and transfer to a PTC-, (2) metropolitan adult trauma centre (MATC), (3) rural trauma centre (RTC), (4) metropolitan local health facility (MLH) and (5) rural local health facility (RLH).

Total length of stay (LOS) in days was calculated by combining all the records for one period of stay, which may have included transfer between hospitals. Intensive care (ICU) length of stay was separately recorded in hours. Death within 30 days was obtained from the APDC mode of discharge code and correlated with the deaths data. Other categorical variables were formulated by grouping relevant date, demographic, facility, diagnostic, external cause and procedure codes. The ABS Socio-economic Index for Advantage and Disadvantage (SEIFAD) classifies NSW localities into 10 deciles, with the first decile representing the most socioeconomically disadvantaged and the least advantaged and the 10th representing the least disadvantaged and the most advantaged. SEIFAD was assigned according to postcode. External causes, injuries and procedures, including operations and transfusion, were grouped using the ICD-10-AM codes. External causes were grouped in to common mechanism categories. While spleen injury grading according to the American Association for the Surgery of Trauma is not coded in the APDC, spleen injuries were grouped in to mild (haematoma or capsule tear) equating to grade I–III, moderate (laceration extending in to parenchyma) equating to grade II–IV, severe (massive splenic disruption) equating to grade IV–V, and unspecified [35].

Associated major injuries were grouped according to body region. Minor soft tissue injuries and sprains/strains were excluded. Because mapping of Injury severity scores to ICD-10-AM was not available to us, injury severity was represented by the

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