Shaken Baby Syndrome in South Africa: An initial exploration

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Word Count:

Abstract: 297

Main Body: 9,881

Abstract

Shaken Baby Syndrome (SBS) is a form of child abuse which occurs globally and is associated with significant morbidity and mortality rates. Incidence rates of SBS in high-income countries range between 25 and 34 cases per 100,000 children under the age of 1 year, and may yet be higher in developing countries. South Africa scores highly on a number of risk factors for SBS: poverty, violence and social isolation increase parents' and caregivers' levels of stress and frustration, known precipitants of SBS, putting them at greater risk for shaking their babies. However, to date, no published data on the prevalence of SBS in South Africa exists. This study aimed to determine the frequency of cases of SBS in a sample of trauma records from the Red Cross War Memorial Children's Hospital (RCH) in Cape Town, South Africa, and to identify associated risk or protective factors. A retrospective record review of data from the Childsafe South Africa database was conducted to investigate injuries in children younger than 3 years who presented to the RCH Trauma Unit between 1996 and 2015. Descriptive analyses were performed for demographic variables and cause of injury; a content analysis was performed on variables regarding the nature and circumstances of head injuries. Over the 20-year period, 52,165 injuries in children under the age of 3 were attended to, of which 7,004 were head injuries. Only 1 case of explicit shaking was identified during this period. An accurate estimate of prevalence of SBS in South Africa could not be determined from the data. It is hypothesized that this is due to poor detection of SBS, as current injury databases and information recording measures are inadequate to detect cases of shaking. SBS has devastating effects on children; it is, however, preventable and therefore warrants further investigation.

Keywords: Shaken Baby Syndrome; non-accidental head injury; abusive head trauma; child abuse; retrospective record review; Childsafe; Red Cross War Memorial Children's Hospital; prevalence; prevention

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Acknowledgements

I would like to express my sincere gratitude to my supervisor, Professor Ward, for her guidance and expertise throughout this process. Thank you for your patience and encouragement, and the significant contribution you made to this thesis through your insightful comments and critical advice.

I would also like to thank Kirsty Nefdt for her valuable comments on this thesis and lending a guiding hand in setting up the data collection process.

To my dear friends and classmates, Julia Standish-White and Vimbayi Chibambo, thank you for your support, reassurance and strength over the course of this year. I could not have done it without you!

Shaken Baby Syndrome in South Africa: An initial exploration

Shaken Baby Syndrome (SBS) refers to the violent and repetitive shaking of an infant, with or without impact, resulting in craniocerebral trauma (Barr et al., 2009, Le Roux-Kemp & Burger, 2014; Newton, 2011). SBS, also known as abusive head trauma, is a type of child physical abuse classified as non-accidental head injury, and is associated with high morbidity and mortality rates (Kelly, MacCormick, & Strange, 2009; Le Roux-Kemp & Burger, 2014). Shaking typically results in diffuse cerebral trauma which, when not fatal, can lead to a range of disabilities (Matschke et al., 2009; Newton & Vandeven, 2005). South Africa scores highly on a number of risk factors for SBS: Severe structural poverty, inequality and violence translate to low socioeconomic status, poor education and social isolation. These factors, in turn, increase parents' and caregivers' levels of stress and frustration, known precipitants of SBS (Carbaugh, 2004; Dawes, Long, Alexander, & Ward, 2006; Matschke et al., 2009; Richter & Dawes, 2008). Consequently, one might expect South Africa to have high rates of SBS. However, very little is known about SBS in South Africa, except that prevalence rates of SBS are believed to be "remarkably consistent across the world" (Kelly, et al., 2009, p.394), and possibly higher in developing countries (Runyan, 2008). SBS is preventable (CDC, 2012) – therefore, given the devastating lifelong effects that SBS can have on children, as well as the added strain placed on already burdened health systems in developing countries such as South Africa, it is important to determine the frequency with which SBS occurs in the South African population, so as to aid in implementing and assessing the efficacy of intervention and prevention programmes.

Epidemiology of Shaken Baby Syndrome

Child abuse is a global problem (Dubowitz & Bennett, 2007). International statistics indicate that of all non-accidental childhood deaths, death due to traumatic injury is the most common (Pinheiro, 2006). Head injuries are reported to be the most frequent cause of these infant traumatic deaths within high-income contexts such as the United States and the United Kingdom (Duhaime, Christian, Rorke, & Zimmerman, 1998; Matschke et al., 2009). In these regions, the annual incidence of SBS is estimated at 25 to 34 cases in 100,000 children younger than 1 year of age (Barr, 2012; Keenan et al., 2003; Minns, Jones, & Mok, 2008). Yet the incidence of SBS has been said to be "remarkably consistent across the world" (Kelly, et al., 2009, p.394). Indeed, shaking is viewed as an acceptable disciplinary practice throughout the globe, and is commonplace in low and middle income countries such as India, Chile, Egypt and the Philippines (Janssen, Van Dijk, Al Malki, & Van As., 2013; Runyan,

2008). One investigation revealed that the frequency of self-reported shaking was greater in these lesser-developed countries compared to the United States (Runyan, 2008).

SBS is responsible for injuries with devastating effects. Mortality rates for SBS are as high as 30%, and 70% to 85% of survivors suffer long-term impairments which may include neuropsychological deficits, blindness, seizure disorders, motor dysfunction, spasticity and cerebral palsy (Matschke et al., 2009; Newton & Vandeven, 2005; Talvik et al., 2007). Currently, however, figures for neither the morbidity nor mortality rate of SBS in South Africa are available.

Why we would expect Shaken Baby Syndrome in South Africa

Child maltreatment is believed to be common in South Africa (Mathews, Abrahams, Jewkes, Martin, & Lombard, 2013; Seedat, Van Niekerk, Jewkes, Suffla, & Ratele, 2009). In the period 2003/2004 alone, the South African Police Service reported 6,504 cases of child neglect and maltreatment (Gender Links, 2005). According to World Health Organisation statistics, the under-5 mortality rate of South Africa is 44 per 1,000 live births. This is markedly higher than the under-5 mortality rates of high-income countries such as the United Kingdom, Canada, New Zealand and the United States, which range from 5 to 8 deaths per 1,000 live births, respectively (WHO, 2015).

While childhood mortality in South Africa is predominantly attributed to infectious and diarrhoeal diseases, injury-related deaths account for 60 to 80 deaths per 100,000 in children younger than 5 years. Homicide accounts for 13% of these deaths, which amounts to 8 to 10 homicides per 100,000 in children younger than 5 years (Nannan et al., 2012). The first national child homicide study established that child abuse and neglect precedes nearly half of all homicides and approximately 80% of homicides in children younger than 5, which, in terms of percentage, is comparable to the United States. However, their estimate of 6.6 cases of fatal child abuse per 100,000 children younger than 18 years is significantly higher than the global rate of 2.4 per 100,000 (Mathews et al., 2013). Indeed, "a child growing up in Cape Town has a 25 times higher risk of being admitted to hospital with an injury than a child growing up in Birmingham, UK." (Van As, 2010, p.5).

Of a sample of cases of physical abuse in children admitted to the Red Cross Memorial Children's Hospital in Cape Town, the highest number of non-accidental injuries occurred in the 5 – 9 years age group, followed by the 0 - 4 years age group. Within the latter group, injuries to the head were the most frequent, although it was uncertain whether these were a result of shaking or direct trauma (Janssen et al., 2013).

However, these figures may not truly reflect the extent of the problem. Many cases of suspected child abuse and child homicide are thought to be under-detected due to under-reporting and concealment (Janssen et al., 2013; Makoae, Dawes, Loffell, & Ward, 2008; Mathews et al., 2013). Furthermore, head injury in children in South Africa has been described as "a silent or forgotten epidemic" (Semple, 1998, p.440). Due to the occult[1] nature of SBS injuries, milder cases may not be detected in clinical settings (Carbaugh, 2004), while the stigma associated with physical child abuse may prevent caregivers from coming forward in more severe cases. Moreover, there is no central SBS surveillance system in South Africa, thus the true incidence of SBS is unknown, and likely underestimated (Le-Roux Kemp & Burger, 2014).

These epidemiological data, in conjunction with global figures on child abuse and the high childhood injury statistics in South Africa, suggest that the prevalence of SBS in this country may be equal to, if not higher than, those in high-income settings. However, there is very little research published on this topic.

Risk factors for Shaken Baby Syndrome

Although not necessarily causally related, risk factors for child abuse and neglect are those associated with an increased likelihood of child abuse or maltreatment occurring (CDC, 2016). Identifying risk factors is an important tool in identifying high-risk groups and/or factors which may be targeted in intervention programmes (Makoae,et al., 2008).

A primary structural risk factor underlying child maltreatment is low socioeconomic status, measured by education, occupation and income (Winkleby, Jatulis, Frank & Fortmann, 1992). Poverty, social inequality, and the associated burdens of unemployment, low income and poor education, generate a stressful environment for parents and caregivers (Dawes et al., 2006; Makoae, et al., 2008; Thompson, 2015). SBS is a type of physical child abuse and therefore the same risk factors apply. Furthermore, a lack of knowledge of children's needs and normal development may lead to increased levels of caregiver frustration and stress in response to the behaviours of children (Carbaugh, 2004; Matschke et al., 2009). These indicators are typically much higher in low and middle income countries such as South Africa (Pinheiro, 2006).

SBS, however, occurs in all social strata, indicating that certain individual risk factors are also at play (Dubowitz & Bennett, 2007; Laurent-Vannier et al., 2011). SBS generally occurs under conditions of extreme stress, when the caregiver is frustrated, overwhelmed or

[1] Occult (adj.) not accompanied by readily detectable signs or symptoms (The American Heritage Medical Dictionary, 2007)

angry. In addition to the aforementioned societal factors, a number of infant and caregiver factors have been implicated in SBS; these may interact, putting certain individuals at greater risk of shaking their babies (Carbaugh, 2004). Depression, anxiety and substance abuse can alter the caregiver's perception of their child's behaviour. In addition, young maternal age, unmarried status and first child status further escalate the risk, due to social isolation and a lack of social and familial support. Poor impulse control, disinhibition and externalizing behaviours, such as aggression and conduct disorder, have also been implicated (Carbaugh, 2004; Li & Liu, 2012; Matschke et al., 2009).

Inconsolable infant crying is thought to be the primary trigger for shaking (Barr, 2012). Age-specific SBS incidence curves show a very similar pattern to crying displayed by normal infants (Barr, Trent, & Cross, 2006). The unpredictable, persistent patterns of crying during which infants are resistant to soothing may evoke significant frustration and helplessness in primary caregivers (Barr et al., 2009). Typically, young parents with high levels of stress and poor coping skills are more at risk of "snapping" (Le Roux-Kemp & Burger, 2014, p.1298) and then shaking their babies, either out of sheer frustration or in an attempt to stop the baby from crying (Carbaugh, 2004).

Prematurity, low birthweight and disability may also put infants at greater risk – these infants are less adaptable and have difficult temperaments, further adding to the stress-load of vulnerable caregivers. Interestingly, male infants are at greater risk than female infants. It has been postulated that this may be due to unrealistic expectations of the male child (Carbaugh, 2004).

The perpetrators of abuse are predominantly male. In international studies of SBS, the offender is most frequently the child's father or the mother's partner, and less so the mother or other female caregivers (Starling et al., 2004). In concert with international data, South African research has generally found that men typically are the perpetrators of abuse (Dawes et al., 2006). However, investigation of gender differences in homicides of children under the age of 5 years revealed that mothers were identified or suspected as the perpetrators in 71% of cases (Abrahams et al., 2016). This suggests that the number of female perpetrators of SBS may be higher in the South African context.

Protective factors for Shaken Baby Syndrome

By contrast, some resources may buffer the effects of risk factors and prevent or reduce the likelihood of child maltreatment and abuse (Dubowitz & Bennett, 2007). These include an education level above high school, parental recognition of problems and help-seeking, and access to mental-health care (Dubowitz & Bennett, 2007; Keenan et al., 2003).

Furthermore, it has been reported that mothers who have high levels of family and social support, especially from grandparents, have a reduced risk of child maltreatment (Dubowitz & Bennett, 2007; Li, Godinet & Arnsberger, 2011).

Due to the preponderance of structural and individual risk factors in South African society, it is important to understand the impact that these, as well as protective factors, may have on the frequency of SBS in the South African population.

Mechanism of injury and pathophysiology of Shaken Baby Syndrome

Unlike falls from a short distance and playful practises such as swinging/tossing a baby into the air or rocking them on one's lap, which are generally harmless, the type of shaking associated with significant brain injury is typically of a violent and repetitive nature. It involves holding the infant by the chest or extremities and shaking the infant back and forth with considerable force, causing a forward and backwards whiplash motion of the head (Carbaugh, 2004; Case, Graham, Handy, Jentzen, & Monteleone, 2001).

Shaking constitutes an acceleration-deceleration event with a marked rotary component. This causes vigorous movement of the intracranial compartments in relation to one another, which is thought to result in shearing forces that produce diffuse brain damage. The extent of the resulting craniocerebral injuries depends on the physiological characteristics of the child, the force and duration of the shaking and whether or not there has been impact to the child's head (Carbaugh, 2004; Case et al., 2001).

Infants are particularly susceptible to injuries from these forces due to the unique anatomic and physiological vulnerabilities associated with the immature brain: Small body size, large heads in relation to body size, weak neck muscles and ligaments, a soft and pliable skull with unfused sutures, a developing brain and the paucity of myelin sheaths around neuronal axons contribute to this vulnerability (Carbaugh, 2004; Matschke, 2009). Diagnosis often depends on the presence of a 'triad' of injuries which includes subdural haemorrhage, retinal haemorrhage and encephalopathy, typically in the absence of external signs of injury (Matschke et al., 2009; Matschke, Püschel, & Glatzel, 2009). See Appendix A for a description of the triad symptoms. Long bone fractures are often associated with SBS, as the child's arms and legs may be violently flung about during shaking. Similarly, ribs may be fractured due to the force of holding and lifting the child by the chest (Case et al., 2001).

The symptomology of SBS is a contentious matter. While the overwhelming majority of investigators believe this 'triad' to be conclusive of shaking having occurred, and these symptoms are found upon autopsy in the majority of cases with suspected, alleged and/or witnessed shaking, their mere presence does not provide conclusive evidence that the child

was shaken. Subdural haemorrhage, intraocular haemorrhage and encephalopathy can occur without shaking (Matschke et al., 2009; Matschke, Püschel, et al., 2009).Specific differential diagnoses include chronic subdural haemorrhage, accidental falls, hypoxia due to Sudden Infant Death Syndrome, congenital coagulation disorders, metabolic diseases and birth complications, all of which can produce the triad symptoms (Laurent-Vannier et al., 2011; Matschke et al., 2009; Squier, 2011).

Furthermore, impact with a hard surface typically produces considerably more damage, but there is evidence to suggest that shaking alone, i.e. without impact, can lead to this constellation of symptoms (Starling et al., 2004). This aspect of SBS remains controversial.

Clinical presentation of SBS

Immediate diagnosis of SBS is rare as initial symptoms are often nonspecific and resemble those of an infectious process, metabolic disorder or unusual neurological disorder. Shaken babies may present with a variety of symptoms which commonly include irritability, apnea, respiratory problems, weakness, lethargy, decreased tone, altered level of consciousness, seizures, poor feeding, vomiting, and constipation (Carbaugh, 2004; King, MacKay, Sirnick, 2003).

Due to the variable nature and presentation of SBS, diagnosing this form of abuse in any particular case may be challenging. In many instances, there may be no history of trauma, and the patient may present with mild injuries which appear unrelated to the symptoms experienced (Laskey, Holsti, Runyan, & Socolar, 2004; Newton & Vandevan, 2005). Furthermore, there is often no explanation provided for the injuries, and explanations when given are typically inadequate or inconsistent with the clinical presentation (Le Roux-Kemp & Burger, 2014). Frequently, confessions refer to the caregiver allegedly attempting to "wake an unresponsive child" (Le Roux-Kemp & Burger, 2014, p.1290). It is thus critical that investigators conduct careful medical examinations and obtain thorough clinical histories as well as perpetrator and witness accounts when children present to medical institutions. A conclusive diagnosis of SBS, therefore, rests upon sound medical examination and should be shown to either corroborate or refute witness testimony (Le Roux-Kemp & Burger, 2014; Newton & Vandevan, 2005).

The puzzle

Given that 23 million South Africans live in poverty with poor social support structures (and are therefore, at least theoretically, under great stress and at high risk of child maltreatment; Statistics SA, 2014), the relatively high global rates of SBS and the significant

number of injury-related deaths in South Africa in particular, it is curious that more cases of SBS do not appear to have been identified.

South African child homicide is predominantly caused by stab wounds and blunt force trauma, followed by strangling or asphyxiation, gunshot wounds and infant abandonment, yet SBS is not identified as a causal mechanism (Mathews et al., 2013). Fieggen and colleagues (2004) investigated a sample of 68 cases of children under the age of 3 with non-accidental head injury (NAHI) and identified the mechanism of injury to be SBS in only 1 of these cases. NAHI refers to craniocerebral injuries sustained in the context of child abuse (Fieggan, et al., 2004). However, the focus of the investigation was not on SBS specifically; rather, their use of diagnosed cases of NAHI may have resulted in more obscure or nuanced cases of SBS not being identified. Incidentally, these findings bolster the argument that SBS in South Africa appears to be overlooked somehow. If this rate of 1 in 68 cases is extrapolated, the incidence of cases in a defined hospital-based sample may be as high as 150 cases per 100,000.

Severe head trauma in a child is a devastating injury and its impact is widespread. Not only does it cause disability in the child, but it places an added burden on the family, medical profession and the State (Semple, 1998). It is, however, preventable. In order to determine the nature and impact of SBS in South Africa, an accurate estimate of prevalence must first be established.

Research Question and Aims

This study aimed to contribute to the broader literature on SBS and attempted to answer the overarching question of how frequently SBS occurs in South Africa. It also aimed to identify whether specific risk factors or triggers associated with SBS, as identified from the records, may exist and can be targeted in intervention and prevention strategies.

Specifically, I intended to determine whether cases of SBS have in fact been seen at the Red Cross War Memorial Children's Hospital (RCH), using a sample of medical records from the RCH Trauma Unit. This would allow for the possible identification of SBS in children who present injured but alive to a hospital. Previous studies (e.g., Mathews et al., 2013) have been reviews of homicide cases: While some of these children may have died in hospital, no study to date has explored cases where children may survive their injuries.

Methods

Design

Ideally, one would address these aims by collecting nationally representative data, or by collecting information from a series of sentinel cites. However, due to fiscal and time

constraints, this was not possible. Instead, as a first step towards determining the national prevalence rate of SBS, I obtained a sample from a single hospital in Cape Town, the RCH. The RCH, however, has special qualities that render this investigation more than a single city case study (as I will discuss below more fully).

I conducted a retrospective review of injury records from the Childsafe South Africa database. Childsafe South Africa is based at the RCH; it forms part of the Child Accident Prevention Foundation of Southern Africa and is a member of Safe Kids Worldwide. Since 1991, the organisation has systematically entered the hospital record of each patient presenting to the RCH Trauma Unit into a computerised database. Approximately 10,000 children are seen annually there, thus, to date, the database contains over 160,000 recorded cases of childhood injury (Childsafe South Africa, 2016a). The database, along with their other campaigns, advances their aim "to reduce and prevent intentional and unintentional injuries of all severity through research, education, environmental change and recommendations for legislation" (Childsafe South Africa, 2016b). The records included in the study cover the 20-year period from 1996 to 2015. The cases of all children under 3 years of age were reviewed and categorised according to the mechanism and circumstances of injury, in order to identify potential cases of SBS.

The RCH is the only dedicated children's hospital in South Africa and the largest independent tertiary hospital in sub-Saharan Africa. The catchment area of the hospital is considerable as referral hospitals and clinics across South Africa and greater Africa refer children there. Additionally, the hospital is home to the only dedicated paediatric trauma unit in South Africa. The trauma unit serves a major metropolitan area as the only tertiary-level treatment unit for children in the city of Cape Town. Any serious cases of SBS in Cape Town are likely, therefore, to be seen at the RCH. It is also the only hospital that, via Childsafe South Africa, maintains careful and accessible records of child injuries.

Measures

The Trauma Unit Record sheet (

Appendix A

Description of the SBS Symptom Triad

Subdural haemorrhage

Subdural haemorrhage refers to bleeding in the subdural space of the brain. Bridging veins, which connect the brain to the dura, are easily torn by mechanical forces and are most often causally related to this type of haemorrhage. The typical presentation of subdural haemorrhage in babies with the triad is a thin bilateral film over the cerebrum in the posterior interhemispheric fissure, rather than a large, space-occupying lesion commonly associated with trauma in adults. As a result, clinical manifestations may occur without obviously raised intracranial pressure (Squier, 2011).

Retinal haemorrhage

Retinal haemorrhage: unilateral or bilateral retinal and vitreous haemorrhages, retinal folds and retinoschisis are characteristic of SBS. The occurrence of retinal haemorrhage in 50% - 100% of SBS cases has led to an increased emphasis on the investigation of ocular pathology in identifying SBS (Gilliland et al., 2007).

Encephalopathy

Encephalopathy refers to a variety of pathologies, which can include, among others, parenchymal bleeding, hypoxic-ischemic injury, cortical vein thrombosis, diffuse intravascular coagulation, and traumatic brain injury (Squier, 2011). Infants with encephalopathy may suffer from non-specific neurologic symptoms such as irritability, lethargy, loss of consciousness and seizures (Le Roux-Kemp & Burger, 2014).

Appendix B), as captured in the Childsafe South Africa database was the primary source of data. A trauma record form is completed for each patient presenting to the RCH Trauma Unit, and their information is entered into the database upon discharge. The information retrieved from the database was organised and categorised using a Microsoft Excel spreadsheet (**Error! Reference source not found.**).

The Childsafe South Africa database is the only database of its kind in the country, functioning as a surveillance system of all childhood injuries seen at the RCH. It is considered to be one of the largest paediatric injury databases worldwide (Childsafe South Africa, 2016a) and has been used in previous studies of a similar nature (see Fieggen et al., 2004; Herbert et al., 2012; Timmers et al., 2012; Van As, Naidoo, Craig & Franklin, 2007; Wesson et al., 2013).

Case selection

For the 20-year period from 1 January 1996 to 31 December 2015, the Childsafe South Africa database contained 148,392 injuries. A total of 96,227 injuries were excluded. Of these, 2,491 were excluded because the patient was older than 18 years, or because the patient's age was either undetermined or upon calculation found to be an impossible value (such as where the date of injury was recorded to have occurred before date of birth, resulting in a negative age/ where the year in which the child was born/injured has not occurred yet); 93,736 injuries in children aged 3 to 18 years were excluded on the basis that these children were not in the age-group most vulnerable to SBS. The study was thus limited to children under the age of 3.

I then examined the remaining 52,165 injuries of children who met the inclusion criterion of age between 0 and 3 years in more detail. Children under the age of 3 are most vulnerable to SBS: due to unique behavioural and developmental changes (such as high rates of crying, small physical size and independency) the incidence of SBS is greatest during the first 3 years of life (Barr et al., 2006; Case et al., 2001; Carbaugh, 2004; Matschke, 2009).

It is important to note that Childsafe South Africa enters information into the database on an injury-by-injury method: Every entry in the database refers to an anatomical injury, rather than a single incident or individual. Thus, a single child may have multiple entries in the database which correspond to either one incident in which they received numerous injuries (for example, falling from the stairs, resulting in in a blow to the head and a fractured arm), numerous incidents which took place over time, or both. Therefore, when analysing the data, each 'case' referred to represents an injury, rather than an individual child.

The injuries were then categorised according to anatomical location, with a particular focus on all head injuries (any injury to the forehead, scalp, skull, or brain), as well as eye injuries related to head injuries.

Operationalisation

I had initially planned to use only the SBS triad and associated NAHI symptoms as the operationalisation of SBS, in order to identify diagnosed and/or potentially misdiagnosed cases of SBS from the database. The presence of any, or multiple, of the following (in the absence of another cause, such as a motor vehicle accident or burn) are identified in the literature as constituting a probable case of SBS:

- Triad symptoms
    - Subdural haemorrhage
    - Retinal haemorrhage
    - Encephalopathy
- Long bone fractures
- Absence of external trauma
- Concussive symptoms
    - Loss of consciousness
    - Disorientation
    - Drowsiness
    - Nausea and vomiting
- Injuries to the neck and spine
- Report of persistent crying prior to the incident (Case et al., 2001; Matschke, 2009; Matschke, Püschel, et al., 2009).

However, due to the limited information recorded by doctors during the consultation

(see

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Appendix B), and thus the limited or poorly captured information in the database, very specific clinical symptoms such as subdural haemorrhage, retinal haemorrhage and encephalopathy were not likely to be recorded. Instead, in most cases, doctors simply recorded that the child had obtained a head injury and the cause thereof. Therefore, all cases of head injury for which no clear differential diagnosis was available were noted.

In some cases, the doctor recorded additional information regarding the nature of the injury. These may have referred to more acute neurological symptoms (for example, "frontal hematoma", or "temporary loss of consciousness"), or details regarding how the injury occurred (for example, "fell off bed onto floor"). To make use of this qualitative information, I performed a manifest content analysis to identify cases of head injury which had no known cause but presented as possible cases of SBS, as well as those for which the cause was known, but where shaking may have been concealed or masked by other factors. As such, I attempted to identify cases with possible triad symptoms together with other long bone fractures and concussive or neurological symptoms.

Furthermore, I initially planned to divide these cases into two groups: injury due to accidental causes and non-accidental injuries, and to then investigate the NAHI in more detail. NAHI was defined as any injury to a child's head caused by an intentional action, such as being shaken, assaulted (with blunt or sharp force trauma), deliberately thrown to the ground or against the wall, or hit by an object. Unintentional injuries resulting from negligent supervision, gunshots or animal-related injuries, among others, were excluded from this definition.

However, determining whether a head injury was intentional or not proved to be rather difficult. While most cases were assigned a code for the cause of injury, these were not all self-evidently accidental or non-accidental; for example, in a number of cases, children were "dropped from their caregivers" arms', "kicked by another child" or "struck by an object". Therefore, unless the injury was obviously non-accidental (such as cases of physical and sexual assault) I coded the injury either as accidental or unknown. Only in instances where the doctor had noted an additional comment about the nature of the injury indicating that it had been intentional (such as "assaulted by uncle with spade", or "father hit her with a stick") and/or had been assigned a code for abuse, I coded the injury as non-accidental.

Data collection

Data collected from the trauma sheet included information regarding the patient's demographic information, such as age, race and gender, date and time of presentation to the trauma unit, number of hours that had passed since the injury, cause of injury, place and area

code of where the injury occurred, admission status and discharge status of the patient, and medical status of the patient at the time of presentation, for instance, whether they were unconscious, in shock, required resuscitation or anaesthetic, whether the injury was self-inflicted or whether there was any suspicion of abuse. Furthermore, information regarding the details of up to four injuries could be provided, including the following details: anatomical location, pathology, Abbreviated Injury Scale score (see **Error! Reference source not found.**; Association for the Advancement of Automative Medicine, 2016), and the course of treatment followed. Any additional comments noted by the doctor were included. Refer to **Error! Reference source not found.** for more details.

Race has been included in this study purely in an attempt to identify risk factors which typically cluster around the notion of race and related socioeconomic status. The terms used here refer solely to those artificial categories which were developed under apartheid law and are currently employed in legal and governmental literature and research (Coovadia, Jewkes, Barron, Sanders, & McIntyre, 2009). I do not condone the use of such categories. Though, they have pragmatic use in that the "artificial racial boundaries created by apartheid have had a devastating and long-term public health impact" in South Africa, the effects of which are still evident today (Mathews, Naeemah, Jewkes, Martin, & Lombard, 2009, p.2). Race is a reliable proxy for socioeconomic status and is therefore useful in describing access to primary health care services and resources, as well as the stressors associated with inadequate access to such services (Coovadia, et al., 2009; Harris et al., 2011).

Procedure

All cases of children aged between 0 and 3 years, who were seen at the RCH Trauma Unit between 1996 and 2015, were included in the sample. The Childsafe South Africa files were cleaned and recoded in some instances before being transferred into SPSS files for analysis. Cleaning of data included ensuring that all Childsafe South Africa codes corresponded to the trauma unit record sheet by removing impossible or illegal values and recoding them as missing data. For instance, where the child's gender was reported to be 'female', but their numerical race/gender code indicated that they were male; or any codes which did not fall within the categories allowed by a specific scale, for example, a code of 0 on the Anatomy, Pathology and Treatment scales, all of which had a minimum value of 1. Cases which were coded with a specific anatomy, pathology or treatment code but which did not correspond with the comment made by the doctor were also recoded: a number of cases were coded as head injuries (injury to the forehead, scalp, skull, or brain), but the doctor had noted that, for example, the child had a "marble stuck in their nostril" or "foreign body in the

eye". In these instances, the doctors' comments were given preference and the anatomy codes changed accordingly (for example, to nose or eye, respectively).

Once all head injuries had been identified, the cause codes were recoded according to categories which I had established in order to isolate possible cases of SBS. These included, among others, shaking, being thrown, hit by/blunt assault, and neurological causes. For the complete list and a description of each category, see **Error! Reference source not found.**.

Data Analysis

I used the IBM SPSS Statistics 23 software package to calculate statistics that describe the frequency of cases of SBS, as well as to assess basic hypotheses about the impact of the age, race and gender of the patient, and other variables captured through a content analysis of the hospital records.

Content Analysis. A manifest content analysis was performed with the aim of identifying risk factors which may be associated with SBS, through determining the frequency with which certain information regarding the nature and circumstances of head injuries appeared in the trauma records. Content analysis refers to a number of qualitative and quantitative methods for collecting and analysing textual data (Cavanagh, 1997). Content analysis has been widely applied in the health literature, particularly within nursing research (Hsieh & Shannon, 2005), and is a technique which allows for the systematic and objective quantification of qualitative data (Downe-Wamboldt, 1992; Krippendorff, 1980). It is, therefore, a useful tool in a retrospective review of medical records.

The particular method applied in this study is referred to as manifest content analysis. Manifest content analysis involves identifying and quantifying the frequency with which certain words or terms appear in a given sample of text (Hsieh & Shannon, 2005; Kondracki, Wellman, & Amundson, 2002; Potter & Levine-Donnerstein, 1999). The factors included in the content analysis are as follows:

- Whether additional comments were noted by the doctor
- The presence of acute neurological symptoms
    - Concussive symptoms (including vomiting and nausea as a result of, or related to, head injury)
    - Loss or altered state consciousness
    - Scalp/brain hematoma
    - Brain haemorrhage

- Whether the incident occurred in the context of interpersonal violence or domestic dispute
- Where an injury was inflicted upon the patient by another individual (perpetrator), any available information regarding that individual was recorded, such as:
    - Their relationship to the patient
    - Whether the perpetrator was under the influence of alcohol or drugs at the time of the incident
    - Whether the child was the intended victim of injury or not

These variables were then entered into a SPSS file for analysis.

Ethical Considerations

Ethical approval was granted by the University of Cape Town Research Ethics Committee. Written, informed consent was obtained from Childsafe South Africa, allowing the use of their data for research purposes (Appendix F).

Although the inclusion of patients' record forms in this study posed no considerable risk to their wellbeing, the highly stigmatised nature of the collected data was considered. To this end I did not record the names of any patients, potential perpetrators or collaterals included in the study population, and ensured that all patient hospital and folder numbers were kept strictly confidential, only to be viewed by myself and my supervisor for the purposes of this study.

Significance

As many children survive being shaken, an accurate prevalence rate for SBS cannot be determined solely through mortality statistics – reviews of medical records are also necessary. The significance of this study is that, to date, it is the only study which has attempted to address the issue of SBS in South Africa, as well as its use of data gathered from the Childsafe South Africa database to identify cases of SBS in children presenting to the RCH Trauma Unit. Hospital records contain considerable information about the outcomes of victims of SBS, and provide an expedient way to gather data on this condition. Furthermore, it allows for stratification of cases by age, gender, race and similar variables, so that we may be better able to identify children at greater risk.

As this research has not been done before in South Africa, this study is breaking ground. An analysis of medical records, focusing on clinical manifestations and pathological outcomes, may provide a mechanism to identify diagnosed and potentially overlooked cases of SBS and attempt to unpack the puzzle that is SBS in South Africa.

Through describing the data, this study can provide valuable insight into the phenomenon of SBS and the nature of its prevalence in the country. Careful epidemiological investigation of the demographic profile and specific risk and/or protective factors will contribute to establishing the extent of the problem, as well as guide decision making regarding the necessity and feasibility for intervention strategies. If a high prevalence rate is found, potential programmes should focus on the prevention of SBS, education about SBS, and strengthening of parenting skills; a low prevalence rate could imply special protective factors in the South African population which may be useful in other, more affected settings.

Results

A sample of 52,165 injuries in children between the ages of 0 and 3 years, over a span of 20 years, was investigated. The data was grouped according to major causes of injury: Burns, Motor Vehicle Accidents (and other transport related incidents), Falls (from various heights), Assaults, Miscellaneous and Unknown Cause injuries. An important source of information was the doctor's comments, which, in some cases, provided more insight into the circumstances and nature of the injuries than from the codes recorded in the database alone.

Overall, of those injuries with a known cause, burns were the most frequent cause of injury, comprising 34.4% of all injuries. This can be seen in Table 1. This was closely followed by injuries due to falls from various heights and miscellaneous injuries, which accounted for 26.1% and 24.5% of the sample, respectively. Assaults, on the other hand – the category where cases of shaking would have likely been found – accounted for only 2.6% of injuries, while injuries due to unknown causes accounted for a further 4.6% of injuries.

Table 1
Total number of injuries by major cause of injury in children aged 0 - 3 years

Cause of injury	n	% of total
Burns	17,946	34.40
Falls	13,602	26.07
Miscellaneous	12,785	24.51
Motor Vehicle Accidents	4,100	7.86
Unknown Cause	2,402	4.60
Assaults	1,353	2.59
Total	52,165	100

Explicit evidence of SBS

Just three cases of explicit shaking were reported between 1996 and 2015. Of these, only 1 resulted in an injury. The three cases are described in more detail below.

Case 1. A 3-and-a-half month old male coloured infant was admitted to the RCH Trauma Unit on 6 June 1999 after being shaken by his mother. The comment made by the doctor was that "mother squeezed and shook baby". The incident occurred at the child's home in Heideveld, Athlone after which he was brought in to the trauma unit within an hour of the incident, and subsequently admitted. At the time of examination he was conscious and not in shock, but had obtained a closed tissue injury to the eye. The attending physician treated the patient, offering either advice or medication (Hypoxic Inducing Factor). The child was then discharged and sent home, or referred to the family's general practitioner.

Case 2. A 3-week-old female baby of unknown race was seen at the trauma unit on 1 February 2008. She was allegedly "shaken by dad during a fight with mom". The incident occurred at the child's home, in Bokmakierie, Athlone. However, she was only brought to hospital six days after the event. Although the doctor made a note of child abuse in the file, the child was conscious, not in shock, and had no injuries at the time of her examination. She was therefore not admitted to the trauma unit, but referred to the out-patients unit at the RCH.

Case 3. A 6-and-a-half month old female infant of unknown race was seen at the trauma unit on 28 February 2009. According to the doctor's remark, she was allegedly "shaken by [another] child" at her home in Crawford. She arrived at the trauma unit within an hour of the incident, but was not admitted. The child was conscious at the time and was not in shock; no injuries were noted. The attending physician treated the patient with advice or medication (Hypoxic Inducing Factor), and then referred her home or to the family's general practitioner.

While the doctors' comments in these cases explicitly refer to the child having been shaken by another individual, it is likely that more cases of SBS exist where testimony or witness accounts of shaking were not forthcoming. In order to identify these potential cases of SBS, all head injuries in children under the age of 3 were investigated. While burns and motor vehicle accident injuries could easily be ruled out, there is reason to believe that cases of SBS may be obscured within the falls, assaults, miscellaneous cause, and unknown cause injuries. This is due to the occult nature of SBS, which often results in its symptoms being masked by, or mistaken for, other causes of injury, or simply labelled as "unknown". Therefore, all head injuries within the falls, assaults, miscellaneous and unknown cause categories were investigated together using the SBS symptomology – namely the triad symptoms (subdural haemorrhage, retinal haemorrhage and encephalopathy), the absence of external trauma, long bone fractures, concussive symptoms, injuries to the neck and spine and reports of persistent crying prior to the incident.

Implicit/Circumstantial evidence of SBS

The subgroup containing falls, assaults, miscellaneous and unknown cause injuries consisted of a total of 30,142 injuries. Of these, head injuries accounted for 7,004 injuries, nearly one quarter of the sample. In addition, 24 cases of eye injury related to head injury were identified – since SBS can include retinal haemorrhages, these were included here. This can be seen in Table 2.

In the 4,289 instances in which there was no injury, children had presented at the Trauma Unit but upon examination were found to have sustained no serious injury warranting further observation or treatment.

Table 2
Location of injury in Falls, Assaults, Miscellaneous and Unknown Cause injuries in children aged 0- 3 years

Cause of Injury	n	% of total
Injury to other body part	18,608	61.73
Head Injury	7,004	23.24
No Injury	4,289	14.23
Presence/absence of injury not recorded	220	0.73
Eye injury related to head injury	21	0.07
Total	30,142	100

Demographic prolife of head injuries

Overall, more injuries occurred in male infants (N=4,154) than female infants (N =2,823), with missing gender data in 27 injuries. This finding is in line with international literature.

Race was not recorded for 5,596 of the 7,004 cases (80%), thus making it impossible to draw any conclusions. This is due to the fact that Childsafe South Africa or the RCH Trauma Unit stopped recording this information during the year 2000. Any analysis based on such a small proportion of the data would be significantly biased, skewing the interpretation of the role, if any, that race might play in these results. Therefore this finding was not discussed further.

Table 3 shows that the number of head injuries sustained by children under the age of 3 is relatively stable over the different age-groups. The number of infant head injuries hovered around 1,000 cases in each of the 6-month developmental periods, peaking slightly in the 6 to 11 month period with a maximum frequency of 1,593 head injuries.

Table 3
Head injuries in children under 3 years disaggregated by Age and Gender

	Gender			Total
	Male	Female	Missing data	
0-5 months	553	466	5	1,024
6-11 months	941	643	9	1,593
12 - 17 months	760	521	5	1,286
18 - 23 months	660	450	1	1,111
24 - 29 months	674	400	5	1,078
30 - 35 months	567	343	2	912
Total	4,155	2,823	27	7,004

Head injuries in children under the age of 3 are predominantly caused by falls from various heights, as can be seen in Table 4. Falls accounted for nearly 75% of the entire sample of head injuries. Injuries to the head due to being struck by/against something accounted for 10% of the sample, followed closely by 5% of injuries due to intentional hitting or blunt assault. The remaining categories together comprised 10% of head injuries, with a single case of reported shaking.

Table 4
Causes of head injuries in children under 3 years

	Frequency	Percent	Cumulative Percent
Falls	5,148	73.50	73.50
Struck by/against	738	10.54	84.04
Hit by/Blunt assault	342	4.88	88.92
Unknown	197	2.81	91.73
Bumped own head	156	2.23	93.96
Other	129	1.84	95.80
Stabbed/sharp assault	76	1.09	96.89
Seizure/fitting	57	0.81	97.70
General assault	42	0.60	98.30
Thrown onto floor	37	0.53	98.83
Dropped	25	0.36	99.19
Caught between	22	0.31	99.50
Pushed	17	0.24	99.74
Kicked	12	0.17	99.91
Rape/sexual assault	5	0.07	99.99
Shaking	1	0.01	100.00
Total	7004	100.0	

Of the 7,004 head injuries, 6,034 were accidental (the majority of which can be accounted for by falls). This represents 86.15% of the sample. Non-accidental injuries occurred only 246 times, representing 3.51%. The remaining 724 cases (10.34%) could not be determined as either accidental or non-accidental.

Content Analysis

A content analysis of the qualitative information from the doctor's comments was performed. Table 5 shows that only 839 (11.98%) of the cases had no additional doctor's comments. However, of the remaining 6,165 cases (88.02%), only 218 comments in total provided any meaningful information regarding the nature or circumstances of the injury.

The identity of the perpetrator was mentioned in only 212 cases. Of these, fathers and other male family members were responsible for 125 of the head injuries, while mothers and other female family members were responsible for 37 of the head injuries. The remaining 50 injuries were caused by other children, caretakers or strangers.

In 64 instances, injuries occurred during some form of dispute – the majority of these were domestic disputes, between parents and/or family members, while the balance constituted cases of civilian fighting and interpersonal violence. Of those 64 injuries, 45 injuries occurred in children who were allegedly not the intended target. In other words, most children were caught in the cross fire, while their parents or others were fighting, and injured by flying objects or by getting in the way. Furthermore, in 21 of 212 injuries of which the perpetrator's identity was known, the perpetrator was under the influence of alcohol or drugs at the time of the incident. These children were typically dropped, fallen over or hit with an object by the intoxicated individual.

Finally, in addition to their primary injury, such as a scalp laceration or skull fracture, 1,711 cases were noted to have additional neurological symptoms. These included concussion-related symptoms such as nausea and vomiting, loss or altered states of consciousness, or a request for a CT scan and neurological observation by the doctor. Of those, 320 had no official concussion diagnosis, only the aforementioned symptoms, whereas 1,391 had a diagnosed concussion and/or additional symptoms.

It is important to note that a certain degree of overlap exists in these results. For example, in some instances the comment may have said something along the lines of "Father accidentally hit child on head with beer bottle while fighting with friends". From this we know the identity of the perpetrator, that the injury occurred during a non-domestic dispute

and that the child was not intentionally hurt. In other cases, only one or two variables may have been mentioned.

Due to the isolation of head injuries from other injuries, and the fact that information recorded in the Childsafe South Africa database is not aggregated by incident, rather each injury forms a separate entry in the database, it was not possible to identify cases in which children with head injury also had long bone fractures or injuries to the neck and spine. In addition, there were no recorded instances of persistent crying prior to the incident.

In conclusion, 52,165 injuries in children between the ages of 0 and 3 years were investigated. Only 1 case in which shaking was reported to be the cause of injury was identified. Of the 7,004 head injuries and 21 eye injuries related to head injury that were investigated, 197 instances had no known cause attributed to the injury, and a further 6,786 contained no additional information regarding the nature or circumstances of the injury. Therefore, given the limited available information and the occult nature of SBS, one can assume that any number of cases of SBS may be concealed within this category.

Table 5

Content analysis of qualitative data in N = 6,165 cases, where doctor recorded additional comments

Perpetrator's Identity*	Known	Father	99
		Another child	29
		Mother	23
		Male family member	14
		Brother	12
		Other, known to family	11
		Other, unknown to family	8
		Female family member	8
		Sister	6
		Nanny/caretaker	2
		Total	**212**
	Unknown		5953
Injury occurred in context of interpersonal violence*	Known	Domestic dispute	53
		Other dispute	11
		Total	**64**
	Unknown		6101
Child was not intended target*	Known	Yes	**45**
	Unknown		6959
Perpetrator was under influence of drugs or alcohol*	Known	Yes	**21**
	Unknown		6983
Patient showed other acute neurological symptoms (e.g. /LOC/hematoma/vomiting)	Known	Yes	**1711**
	Unknown		4454

* A total of N=218 injuries contained a comment about at least one of these variables

Discussion

On the basis of a systematic investigation of trauma records over a 20-year period at a major South African children's hospital, SBS appears to be a rare phenomenon in South Africa. An investigation of over 50,000 head injuries in children under the age of 3 years who presented to the RCH Trauma Unit revealed only 1 injury that was confirmed to have been a result of shaking. The identification of only 1 case of shaking in a sample of roughly 50,000 injuries in children under the age of 3 over a 20-year period is insufficient to establish a prevalence rate for SBS in South Africa. However, it implies one of three things: (1) either SBS is simply not occurring in South Africa, (2) it is not being detected, or (3) it is not being recorded as SBS by doctors.

One possible explanation for this surprising finding is that South African society is characterised by extended family structures and distributed care and support networks (Amoateng, Heaton, & Kalule-Sabiti, 2007)). The presence of additional carers, especially females such as sisters, aunts and grandmothers, in the home may provide additional childcare and parental support and is a known protective factor for SBS (Dubowitz & Bennett, 2007). In having other supportive adults around during times of stress, parents and caregivers may not only be provided with emotional and psychological support, but have someone who can take care of the child when they experience high levels of stress and frustration, or are overwhelmed (Thompson, 2015).

This may well reduce the incidence of SBS, however, it is unlikely that SBS does not occur in South Africa, due to the very high national rates of child abuse, and rapidly changing family structures with fewer relatives living in the household (Amoateng et al., 2007; Kalule-Sabiti, Palamuleni, Makiwane, & Amoateng, 2007). The high rates of child abuse and injury in South Africa suggest that children are being injured far too often and that parents may not be coping as well as they should (Janssen et al., 2013; Matthews et al., 2013; Nannan et al., 2012). Furthermore, low socioeconomic status is an underlying risk factor for child maltreatment and generates a stressful environment for parents and caregivers (Makoae et al., 2008). Given the high rates of poverty, violence and social isolation and low levels of education in South African society (StatsSA, 2014; Mathews et al., 2014), as well as inconsolable infant crying being a primary trigger for shaking (Barr, Trent, & Cross, 2006), one would expect more parents to be under undue stress, putting them at greater risk of shaking their babies.

Thus a second potential explanation for these results would focus on the data as a symptom of the poor quality of detection in South Africa. First, poor detection may be a

result of the challenge of diagnosing SBS. No specific diagnostic neuropathology exists for SBS. The presentation and symptomology is nuanced, combining very specific neurological symptoms, such as subdural haemorrhage and retinal haemorrhage, with the more non-specific symptoms of generalised encephalopathy (Carbaugh, 2004; King, et al., 2003; Laskey, et al., 2004; Newton & Vandevan, 2005). In addition, the presence of long bone, neck or rib fractures and the absence of external trauma are not significant factors on their own, but contribute to a diagnosis of SBS only when these factors are identified collectively. The information recorded by the doctors on the Trauma Sheet, however, does not lend itself to detecting SBS. Doctors are simply required to record the code which corresponds to, among other factors, the cause of injury, anatomical location, type of pathology and treatment administered per injury. With regards to the cause of injury, 'shaking' is not a predefined category, requiring doctors to actively record this in the comments section; something they are only likely to do in cases where an admission of shaking is forthcoming, or when the doctor believes shaking to be the most likely cause of injury. Instead, we find nearly 3% of the sample with an unknown cause of injury, suggesting that doctors may be unwilling to guess or make unfounded assertions.

Second, while explicit cases of SBS may not be identifiable in the Childsafe South Africa database, the causes of the 7,004 head injuries and the additional 21 eye injuries related to head injuries suggest that we may be overlooking something. An overwhelming majority of these injuries were reportedly caused by children falling from various heights, as well as being struck or hit by different objects. Within the literature, numerous differential diagnoses are provided for cases which appear to SBS but simply present with the same symptoms. These include medical disorders such as chronic subdural haemorrhage or hypoxia, congenital coagulation disorders, metabolic diseases or birth complications, as well as accidental falls (Laurant-Vannier, 2011;Matschke et al., 2009; Squier, 2011). The logic of this argument can be reversed, with injuries labelled as hypoxic or chronic subdural haemorrhage, or due to an accidental fall, in fact masking real cases of SBS.

Moreover, the occult nature of SBS may simply mean that milder cases are not detected in clinical settings (Carbaugh, 2004). Therefore, without parents or caregivers admitting to having shaken their child, any number of SBS cases could fly under the radar, masked by more severe injuries. Of note is that 57 injuries involved the child having a seizure or neurological fit some time before, during, or as a result of their head injury, and a further 1,711 injuries (nearly 25%) in the database had some acute neurological symptoms recorded in the comments. These could have been caused by shaking the child.

A fourth contributing factor may be the Childsafe database itself. The design of the Childsafe South Africa database is problematic - rather than entering the data into the database on a case-by-case basis, each entry correlates to a single injury. When conducting large-scale reviews of this data, injuries that cluster together from one incident, for example a concussion, brain injury and long bone fracture caused by shaking, are separated. This distorts the number of poly-trauma cases and reduces the likelihood that a multi-symptom syndrome like SBS would be detected.

While the content analysis provides interesting descriptive data, only a small proportion of the doctor's comments provided any useful information. The sample is therefore too small to draw any conclusions. Nonetheless, it is noteworthy that of the 212 injuries in which the identity of the perpetrator was documented, more than half were caused by male family members, and just over three quarters were caused by a member of the child's family. These findings appear to be in line with existing literature (Abrahams et al., 2016; Dawes et al., 2006; Starling et al., 2004). Furthermore, a number of children were injured in the cross-fire of interpersonal violence, with 70% of those injured accidentally.

The number of head injuries sustained by children under the age of 3 is relatively stable over the different age-groups. Children aged 6 to 17 months appear to be injured slightly more often than those aged 0-5 months and 18 months to 3 years. This may be due to developmental achievements such as increased mobility and exploratory behaviour as children begin to crawl and walk over this time, often falling and hurting themselves in the process (Agran et al., 2003)

Conclusion

In conclusion, this study was unable to determine a prevalence rate of SBS from a sample of children presenting alive but injured to the RCH Trauma Unit. However, given that incidence rates of SBS in high-income countries range between 25 and 34 cases per 100,000 children under the age of 1 year, and may yet be higher in developing countries, given the high rates of child maltreatment and neglect in South Africa, and given the fact that South Africa scores highly on a number of risk factors for SBS – poverty, violence and social isolation increase parents' and caregivers' levels of stress and frustration, known precipitants of SBS – there remains the possibility that South African children are being shaken by their parents. We simply do not know how often this happens.

Through describing the profile of head injuries in children under the age of 3 years presenting to the RCH Trauma Unit, this study contributed towards the body of literature on SBS in South Africa. It highlighted the fact that our current injury databases and information

recording systems are inadequate to detect cases of SBS which present to a tertiary level paediatric trauma unit, and that doctors may not be diagnosing head injuries appropriately. SBS remains a problem internationally and is likely a latent social malady in our own country. Children who survive being shaken have to learn to cope with devastating disabilities, while an added burden is placed on their families, the community and the State. For that reason, SBS in South Africa warrants further investigation - future research should be used to inform policy and ultimately reduce the greater burden of child abuse in South Africa and throughout the world.

Limitations of the study

The most significant limitation of this study is the use of data on reported injuries. As not all injuries are presented to hospitals, clinics or healthcare centres, the exact number of trauma cases in children under 3 years is unknown. In addition, the data is limited to the population of the RCH Trauma Unit, excluding all the many cases which may not have been referred there or presented to other wards. The retrospective nature of the study poses a further limitation. When conducting archival research one is limited to the information that has physically been captured. Thus any data not captured in the Childsafe South Africa database was not reflected in this study.

Finally, as noted in another study using the Childsafe South Africa database, doctors in the Trauma Unit have limited time to spend on documentation due to their high caseloads, resulting in a lack of detail on the record forms (Timmers et al., 2012). While the trauma record covers a range of possible reasons for presentation to the trauma unit, it was not designed specifically to register details on head injuries, let alone SBS. Furthermore, the trauma record forms are manually entered into the computerised database without any organised quality control mechanisms (Timmers et al., 2012), therefore data entry errors arise due to human error.

Recommendations for Future Research

Recommendations for future research involve a three-pronged approach. First, it would be greatly beneficial to conduct a real-time study of children who present to the Trauma Unit. This would allow for researchers to interact with patients, their families and the attending physicians, so as to gather more direct, detailed and comprehensive information about the cause and nature of the children's injuries. Survey-based research should be conducted within local communities to ask parents whether they shake their children, and to investigate which risk or protective factors may contribute to this practise, as well as with the RCH Trauma doctors to better understand how they deal with and investigate head injuries.

In order to determine an accurate prevalence rate, it is also important to conduct population-based research.

Second, this study is limited to children who presented alive to the Trauma Unit. Due to the extensive injuries which can occur in moderate to severe cases of SBS, many children may die as a result. Conducting a retrospective review of mortuary data or inquest files from the South African Magistrates courts may provide information on the morbidity rates of SBS in South Africa.

Finally, the Childsafe South Africa database is the only one of its kind in South Africa and acts as a surveillance system for paediatric injuries. It is a database which has contributed greatly to reducing childhood injury through its utilization in clinical and epidemiological research (Childsafe, 2016a). It does, however, have the potential to do more. In order to be better able to detect SBS from Trauma Unit records, the information recorded by the trauma doctor's and nursing staff, as well as the information recorded in the database needs to be reviewed. I would recommend that the Trauma Unit record sheet is adapted to collect more injury-related details, and lists a number of questions which can be asked to the patient and their family during consultation. These include:

- How did the injury happen?
- Who injured your child?
- Did you shake your child?
- If so, what led to this?
- How did you shake your child? (Demonstrate)

In order to detect SBS, the trauma record sheet should also include more specific injury codes for children with head injuries, such as numerical codes for nausea and vomiting, retinal and subdural haemorrhage, and encephalopathy. These changes could be brought about by Childsafe South Africa, in association with the RCH, as part of their campaign to reduce the number and severity of childhood injuries in South Africa.

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Appendix A

Description of the SBS Symptom Triad

Subdural haemorrhage

Subdural haemorrhage refers to bleeding in the subdural space of the brain. Bridging veins, which connect the brain to the dura, are easily torn by mechanical forces and are most often causally related to this type of haemorrhage. The typical presentation of subdural haemorrhage in babies with the triad is a thin bilateral film over the cerebrum in the posterior interhemispheric fissure, rather than a large, space-occupying lesion commonly associated with trauma in adults. As a result, clinical manifestations may occur without obviously raised intracranial pressure (Squier, 2011).

Retinal haemorrhage

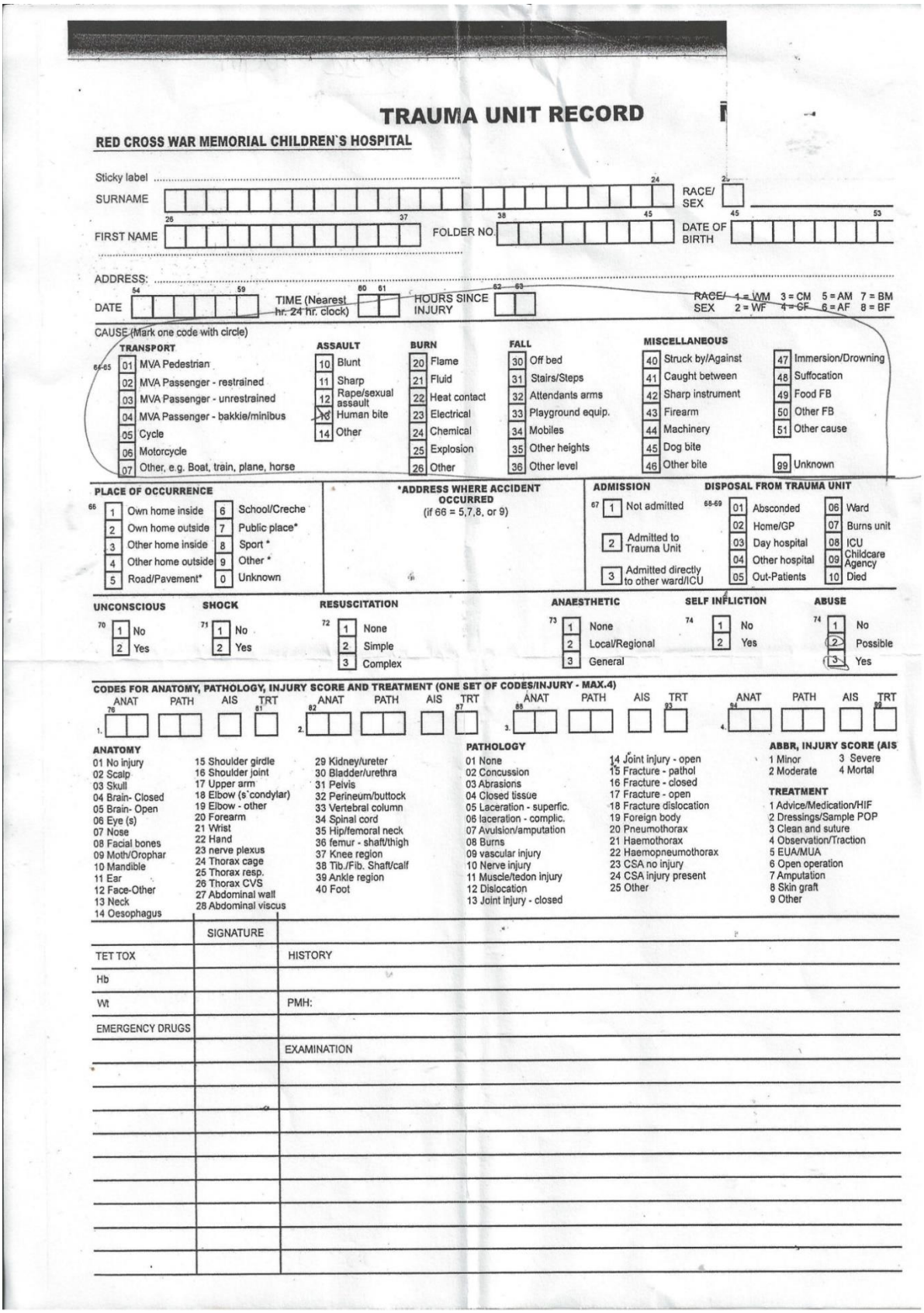
Retinal haemorrhage: unilateral or bilateral retinal and vitreous haemorrhages, retinal folds and retinoschisis are characteristic of SBS. The occurrence of retinal haemorrhage in 50% - 100% of SBS cases has led to an increased emphasis on the investigation of ocular pathology in identifying SBS (Gilliland et al., 2007).

Encephalopathy

Encephalopathy refers to a variety of pathologies, which can include, among others, parenchymal bleeding, hypoxic-ischemic injury, cortical vein thrombosis, diffuse intravascular coagulation, and traumatic brain injury (Squier, 2011). Infants with encephalopathy may suffer from non-specific neurologic symptoms such as irritability, lethargy, loss of consciousness and seizures (Le Roux-Kemp & Burger, 2014).

Appendix B

Red Cross War Memorial Children's Hospital Trauma Unit Record Form



TRAUMA UNIT RECORD

RED CROSS WAR MEMORIAL CHILDREN'S HOSPITAL

Sticky label .....

SURNAME (24) RACE/SEX (25)

FIRST NAME (26–37) FOLDER NO. (38–45) DATE OF BIRTH (45–53)

ADDRESS: .....

DATE (54–59) TIME (Nearest hr. 24 hr. clock) (60 61) HOURS SINCE INJURY (62 63)

RACE/SEX 1 = WM 3 = CM 5 = AM 7 = BM 2 = WF 4 = CF 6 = AF 8 = BF

CAUSE (Mark one code with circle)

TRANSPORT (64-65)
01 MVA Pedestrian
02 MVA Passenger - restrained
03 MVA Passenger - unrestrained
04 MVA Passenger - bakkie/minibus
05 Cycle
06 Motorcycle
07 Other, e.g. Boat, train, plane, horse

ASSAULT
10 Blunt
11 Sharp
12 Rape/sexual assault
13 Human bite
14 Other

BURN
20 Flame
21 Fluid
22 Heat contact
23 Electrical
24 Chemical
25 Explosion
26 Other

FALL
30 Off bed
31 Stairs/Steps
32 Attendants arms
33 Playground equip.
34 Mobiles
35 Other heights
36 Other level

MISCELLANEOUS
40 Struck by/Against
41 Caught between
42 Sharp instrument
43 Firearm
44 Machinery
45 Dog bite
46 Other bite
47 Immersion/Drowning
48 Suffocation
49 Food FB
50 Other FB
51 Other cause
99 Unknown

PLACE OF OCCURRENCE (66)
1 Own home inside
2 Own home outside
3 Other home inside
4 Other home outside
5 Road/Pavement*
6 School/Creche
7 Public place*
8 Sport *
9 Other *
0 Unknown

***ADDRESS WHERE ACCIDENT OCCURRED** (if 66 = 5,7,8, or 9)

ADMISSION (67)
1 Not admitted
2 Admitted to Trauma Unit
3 Admitted directly to other ward/ICU

DISPOSAL FROM TRAUMA UNIT (68-69)
01 Absconded
02 Home/GP
03 Day hospital
04 Other hospital
05 Out-Patients
06 Ward
07 Burns unit
08 ICU
09 Childcare Agency
10 Died

UNCONSCIOUS (70)
1 No
2 Yes

SHOCK (71)
1 No
2 Yes

RESUSCITATION (72)
1 None
2 Simple
3 Complex

ANAESTHETIC (73)
1 None
2 Local/Regional
3 General

SELF INFLICTION (74)
1 No
2 Yes

ABUSE (74)
1 No
2 Possible
3 Yes

CODES FOR ANATOMY, PATHOLOGY, INJURY SCORE AND TREATMENT (ONE SET OF CODES/INJURY - MAX.4)

	ANAT	PATH	AIS	TRT
1.	(76)			(81)
2.	(82)			(87)
3.	(88)			(93)
4.	(94)			(99)

ANATOMY
01 No injury
02 Scalp
03 Skull
04 Brain- Closed
05 Brain- Open
06 Eye (s)
07 Nose
08 Facial bones
09 Moth/Orophar
10 Mandible
11 Ear
12 Face-Other
13 Neck
14 Oesophagus
15 Shoulder girdle
16 Shoulder joint
17 Upper arm
18 Elbow (s`condylar)
19 Elbow - other
20 Forearm
21 Wrist
22 Hand
23 nerve plexus
24 Thorax cage
25 Thorax resp.
26 Thorax CVS
27 Abdominal wall
28 Abdominal viscus
29 Kidney/ureter
30 Bladder/urethra
31 Pelvis
32 Perineum/buttock
33 Vertebral column
34 Spinal cord
35 Hip/femoral neck
36 femur - shaft/thigh
37 Knee region
38 Tib./Fib. Shaft/calf
39 Ankle region
40 Foot

PATHOLOGY
01 None
02 Concussion
03 Abrasions
04 Closed tissue
05 Laceration - superfic.
06 laceration - complic.
07 Avulsion/amputation
08 Burns
09 vascular injury
10 Nerve injury
11 Muscle/tedon injury
12 Dislocation
13 Joint injury - closed
14 Joint injury - open
15 Fracture - pathol
16 Fracture - closed
17 Fracture - open
18 Fracture dislocation
19 Foreign body
20 Pneumothorax
21 Haemothorax
22 Haemopneumothorax
23 CSA no injury
24 CSA injury present
25 Other

ABBR, INJURY SCORE (AIS
1 Minor
2 Moderate
3 Severe
4 Mortal

TREATMENT
1 Advice/Medication/HIF
2 Dressings/Sample POP
3 Clean and suture
4 Observation/Traction
5 EUA/MUA
6 Open operation
7 Amputation
8 Skin graft
9 Other

	SIGNATURE	
TET TOX		HISTORY
Hb		
Wt		PMH:
EMERGENCY DRUGS		
		EXAMINATION

Appendix C

Microsoft Excel Spreadsheet for Data Capture

Folder number	Date of admission	Demographics				Place of occurrence	Hours since injury	Cause of injury					Admission status	Discharge status
		Date of Birth	Age	Gender	Race			Transport	Burn	Assault	Fall	Miscellaneous		

Medical status					Abuse?	Injury details			
Unconscious?	Shock?	Resuscitation?	Anaesthetic?	Self-inflicted?		Anatomy	Pathology	AIS Score	Treatment

	Content Analysis						
Location of Injury	Non-accidental	Identity of Perpetrator	In context of IPV	Child not intended victim	Perpetrator under influence of drugs or alcohol	Additional neurological symptoms	Additional fractures

Appendix D

Information recorded in Childsafe South Africa Database

The following information was recorded for all cases:

- Folder number
- Date of presentation to trauma unit
- Time of presentation to trauma unit
- Demographic details of the child
    1. Date of birth
    2. Gender
        1. Female
        2. Male
    3. Race
        1. White
        2. Coloured
        3. Asian
        4. Black
- Number of hours since injury
- Cause of injury
    1. *Motor Vehicle Accidents*
        1. Motor Vehicle Accident (MVA) Pedestrian
        2. MVA Passenger - restrained
        3. MVA Passenger – unrestrained
        4. MVA Passenger – bakkie/minibus
        5. Cycle
        6. Motorcycle
        7. Other e.g. Boat, train, plane, horse
    2. *Assault*
        1. Blunt
        2. Sharp
        3. Rape/sexual assault
        4. Human bite
        5. Other

3. *Burn*
    1. Flame
    2. Fluid
    3. Heat contact
    4. Electrical
    5. Chemical
    6. Explosion
    7. Other
4. *Fall*
    1. Off bed
    2. Stairs/steps
    3. Attendant's arms
    4. Playground equipment
    5. Mobiles
    6. Other heights
    7. Other level
5. *Miscellaneous*
    1. Struck by/against
    2. Caught between
    3. Sharp instrument
    4. Firearm
    5. Machinery
    6. Dog bite
    7. Other bite
    8. Immersion/Drowning
    9. Suffocation
    10. Food foreign body
    11. Other foreign body
    12. Other cause
6. *Unknown*

- Place where injury occurred
    0. Unknown
    1. Own inside home
    2. Own outside home

3. Other home inside
4. Other home outside
5. Road/pavement
6. School/crèche
7. Public place
8. Sport
9. Other

- Area code of where the accident occurred
- Whether the child was admitted to the Trauma Unit or not
    1. Not admitted
    2. Admitted to trauma unit
    3. Admitted directly to other ward/ICU
- Discharge of patients from Trauma Unit
    1. Absconded
    2. Home/GP
    3. Day hospital
    4. Other hospital
    5. Medical Out Patients Department
    6. Ward
    7. Burns unit
    8. ICU
    9. Childcare agency (Social Work)
    10. Died
- Whether the child
    - was unconscious
        1. No
        2. Yes
    - was in shock
        1. No
        2. Yes
    - required resuscitation
        1. None
        2. Simple

3. Complex
   - required anaesthetic
     1. None
     2. Local/regional
     3. General
   - had self-inflicted injuries
     1. No
     2. Yes

- Whether abuse has taken place/ is suspected
  1. No
  2. Possible
  3. Yes
- Details of injuries (for up to 4 injuries), including:
  1. Anatomical location
  2. Pathology
  3. Abbreviated injury score*
     1. Minor
     2. Moderate
     3. Severe
     4. Mortal
  4. Course of treatment followed
     1. Advice/Medication/Hypoxic Inducing Factor
     2. Dressing/Sample POP
     3. Clean and suture
     4. Observation/traction
     5. Examination under anaesthetic/Manipulation under anaesthetic
     6. Open operation
     7. Amputation
     8. Skin graft
     9. Other

*The Abbreviated Injury Score is an "anatomically based, consensus derived, global severity scoring system that classifies an individual injury by body region according to its relative severity on a 6 point scale (1=minor and 6=maximal)", which functions as an

internationally recognised measure for ranking injury severity (Association for the Advancement of Automative Medicine, 2016, para.1)

Appendix E

List of categories of head injuries

- *Unknown* - No known cause of injury
- *Shaking* - Child was intentionally shaken by parent/caretaker
- *Falls* - Child tripped and/or fell whilst walking/running; fell from various heights; slipped in bath; parents/caregiver were holding child and tripped/fell with child. Unless specified otherwise, all falls assumed to be accidental
- *Dropped* – Dropped from parent/attendant's arms
- *Thrown down/against*
- *Pushed/knocked over* - Child was pushed or knocked over – both intentional and unintentional
- *Kicked*
- *Hit by/blunt assault* - Purposeful and intentional assault with a blunt object
- *Sharp assault* - Injury due to sharp object
- *Struck by/against* - Non-intentional injury by blunt object; for example, something may have fallen on the child/ child may have been hit by a flying object
- *Bumped head/ran into* - Child accidentally walked/ran into wall or furniture etc.
- *General assault* - Other forms of assault, for example attack by intruder, mugging, physical abuse etc.
- *Rape/Sexual assault*
- *Other* - Animal and human bites, ingestion of foreign substances, gunshot wounds, miscellaneous, etc.
- *Neurological* - Seizures/fits/convulsions before/during or as a result of head injury
- *Caught between* - Caught between two objects, for example head caught between bars of gate

Appendix F

Consent form from Childsafe South Africa

UNIVERSITY OF CAPE TOWN

H. Rode
Charles FM Saint Professor &
Head of Department
A.J.W. Millar
Professor & Principal Specialist
Head: Transplantation
A.B. van As
Senior Lecturer & Head: Trauma Unit
A. Numanoglu
Senior Lecturer
L. Jee
Senior. Lecturer & Head: Urology
R.A. Brown
Honorary Senior Lecturer
S. Cywes
Emeritus Professor

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TEL: +27 21 658-5012
Fax: +27 21 685- 66 32

Sebastian.vanas@uct.ac.za

Re: Legal undertaking regarding confidentiality

I, *Frances Mattes*, of *the University of Cape Town*, hereby declare that I will practice absolute confidentiality with the research regarding non-accidental injured children at the Red Cross Children's Hospital. This data will be used *to determine the prevalence rate of Shaken Baby Syndrome in a sample of cases from the Red Cross War Memorial Children's Hospital Trauma Unit*.

I further declare that I will at no time provide anybody outside the hospital with any information collected from our research.

I am fully aware that the medical information we will work with is extremely sensitive and that any misuse of information will lead to immediate expulsion from the hospital and termination of our research project and is likely to have medico-legal consequences.

We further agree to acknowledge Childsafe / Child Accident Prevention Foundation of Southern Africa as a source of this data and make a copy of the study or summary report available to Childsafe / CAPFSA by *31 October 2016*.

Frances Mattes (Signature) **Date**: *3 May 2016*

Name: *Frances Mattes* **ID / Passport**: *9407130416082*

Address & Contact detail: *6 Mount Road, Newlands; 0824557400*

childsafe
KEEP KIDS FREE FROM HARM

A Member Of
Safe Kids
WORLDWIDE