IDENTIFICATION & PREVENTION: A LITERATURE REVIEW INVESTIGATING THE CLINICAL MANIFESTATIONS OF PHYSICAL CHILD ABUSE IN THE OUTPATIENT SETTING

Shelby Page, PA-S, BSc.

7740982

pages@myumanitoba.ca

Supervisor: Dr. Megan Cooney MD FRCPC

A capstone project submitted to the Faculty of Graduate Studies of The University of Manitoba in partial fulfillment of the requirements for the degree of **MASTER OF PHYSICIAN ASSISTANT STUDIES**

Department of Physician Assistant Studies
Max Rady College of Medicine and Faculty of Graduate Studies
University of Manitoba
May 13th, 2021

Table of Contents

Abstract

Objective: Characteristics and patterns of abusive injuries in children are controversial and not uniformly recognized across all healthcare providers (HCPs). The purpose of this study was to identify the most common clinical manifestations of physical abuse in children < 24 months old and provide a concise resource to help improve the identification and prevention of physical abuse in this age group.
Methods: A literature search using PubMed database was performed using key terms pertaining to "characteristics of abusive injuries," "red flags of child abuse," "clinical signs of child abuse," and "sentinel injuries." Eight articles were found to meet this inclusion criterion and were analyzed in this review.
Results: This review identified that bruising, burns, oral injuries and fractures are the most common clinical manifestations of physical abuse in children < 24 months old. Specific characteristics of these injury types can distinguish between accidental and non-accidental circumstances. These characteristics include bruising location and pattern, type and location of burns, oral injuries and fractures' number and location.
Conclusions: The specific patterns and characteristics of abusive injuries described in this review can aid in evaluating pediatric patients < 24 months old. This review aims to encourage the application of identification and prevention of physical child abuse into daily practice by improving the recognition of abusive injuries across all healthcare settings. All HCPs should maintain a low threshold to evaluate for abuse and report potential abuse at the first contact when clinical suspicion is present.

Introduction

The epidemiology of child abuse can be difficult to ascertain and may vary depending on which numbers are reported. For example, the number of reports to social services of suspected child abuse differs from substantiated maltreatment investigations, which differs from the number of criminal convictions for child maltreatment offences. Moreover, many cases of child abuse are undisclosed and reported. However, previous retrospective case studies estimate that roughly 1/3 of children experience some form of maltreatment throughout his/her childhood. (1) Within the spectrum of maltreatment lies both neglect and abuse. The Canadian Government defines physical child abuse as "the application of unreasonable force by an adult or youth to any part of a child's body." (1). The extent of child abuse in North America is significant, with over 117,000 cases and 583 deaths reported in 2015 in the United States alone. (2)

Identifying physical abuse in pediatric patients can be difficult for many reasons. For one, child victims often may not disclose their abuse due to verbal limitations or fear. (3) Secondly, children who live in an environment where abuse is normalized may not realize that abuse is occurring until much later on in life. Additionally, injuries associated with abuse can be very non-specific, making early identification and diagnosis challenging. (3) Therefore, healthcare providers (HCPs) must recognize the signs of child abuse and intervene appropriately to advocate for pediatric patients.

One of the more accepted approaches that healthcare providers can take to be vigilant of potential abuse in young children is identifying sentinel injuries. Sentinel injuries are diagnosed retroactively once an abusive mechanism of injury has been identified. Sentinel injuries are "minor injuries that carry a high risk for abuse and increase the probability of future injuries." (4). Furthermore, sentinel injuries must be visible and are sustained in a pre-cruising infant. These injuries are poorly explained and, therefore, suspicious of physical abuse. (5) Common abusive injuries in pre-cruising infants include bruising, intraoral injuries, radial head subluxation and minor burns (5). The evaluation of possible sentinel injuries is appropriate, as these injuries are infrequent in non-abused children and sentinel injuries are often identified before the presentation of severe physical abuse. (6) In 2013, in a retrospective study, Sheets et al.; concluded that sentinel findings preceded 27.5% of severe child abuse cases. (6)

Emergency and primary care providers represent the personnel most likely to encounter child abuse injuries. (2) Although, even in settings where healthcare providers are trained to recognize abusive injuries, such as in an emergency department, barriers to recognition and further evaluation remain a significant problem. (2) Previous studies show that sentinel injuries are not uniformly recognized and in these cases, further evaluation of injuries is often not

pursued. (2) In 2015, a Canadian Pediatric Surveillance Program survey was conducted to evaluate the awareness of sentinel injuries among healthcare providers and their significance in possible child abuse cases. The study showed that only 65% of pediatricians recognized intraoral injuries as a red flag for potential physical abuse. (8) In contrast, 91.9% of pediatricians identified that bruising in young children could result from physical abuse. (7) The ability to recognize common clinical manifestations of child abuse applies to all healthcare practitioners, including *physician assistants.*

The long-term consequence of failing to recognize child abuse is abundantly clear; chronic exposure to physical harm and possibly death. Head trauma is the leading cause of death in child abuse cases, with children between 0-3 years old having the highest risk of death. (8) A study by Dean et al.; showed that 54 of 173 children who presented with abusive head injuries were not recognized as victims of abuse on initial presentation to the ED. (8) This study shows the importance of early recognition and maintaining a high index of suspicion of non-accidental trauma. Clinical findings associated with traumatic head injury due to child maltreatment often include subdural hematomas and retinal hemorrhages, and the presence of these injuries should necessitate a prompt evaluation. (8)

The current Canadian guidelines for reporting child abuse are as follows: “it is the responsibility of the healthcare provider, or to whom there has been a disclosure, to report the suspected abuse” (9). As healthcare providers, we must act based on suspicion and a "reason to believe." HCPs are not required to have proof or be sure that abuse is occurring to report to the authorities but are expected to act within their clinical suspicion. No damages are brought to a person who reports child abuse unless they had knowingly made a false report. (9) Despite clear guidelines on reporting child abuse, barriers continue to remain in practice. Previous studies

indicate that four significant themes can impact a clinician's decision to report child abuse. The reoccurring themes include familiarity/unfamiliarity with a patient or family, specific elements of the case history, use of available resources and perception of expected outcomes of reporting to CFS. (10) In addition to the barriers that may inhibit clinicians from reporting suspected abuse, the awareness of common signs of child abuse amongst healthcare providers is limited in individual settings. The clinical manifestations of child abuse are not uniformly recognized amongst all healthcare providers and in all healthcare settings. Further education and research are essential for the intervention and prevention of child abuse.

This review aims to identify the most common clinical manifestations of child abuse injuries in children less than 24 months old in the outpatient setting. This review can be used to implement guidelines for the prevention and intervention of abuse in children of this age group.

Methods

Articles were broadly searched for using the PubMed database, and searches were restricted to full-text articles published in English between 2000-2021. Primary studies of any design were examined. Literature searches were aimed to explore clinical manifestations and sentinel findings in non-accidental trauma in children under 24 months old. Search terms included "sentinel injuries, child abuse, and "clinical signs of child abuse."

The search yielded a total of 32 papers, and abstracts were reviewed individually to determine if the articles were appropriate. Reference lists of articles were reviewed to identify additional relevant studies included in this project. Subsequently, eight articles were deemed suitable for use in this review. Studies from both the United States and Canada were included in this project.

Results

Bruising

Prior studies indicate that bruising is the most common external sign of physical abuse in children and might be the only visible sign of more serious internal injuries in abusive cases. (11) Bruising occurs commonly in children acquired from both accidental and non-accidental trauma, so it is critical to evaluate the mechanism of injury when abuse is suspected. Notably - in children who have bruises due to un-intentional circumstances, the bruising tends to be found over bony prominences such as knees, elbows, shins and forehead. (11)

Pierce et al.; conducted a retrospective case-control study of patients found to have both abusive or unintentional trauma admitted to hospital to determine bruising characteristics that can discriminate physical child abuse from accidental trauma. Criteria to predict abusive bruising patterns have been well established in pediatric patients– most notably the "TEN rule." (11). This criterion is utilized to suspect an abusive mechanism of injury when bruising is found on the torso (T), ear (E), and neck (N) regions. Using the TEN rule, Pierce et al.; adapted a statistical model to predict abusive bruising that used location and age as discriminating factors. Using age parameters (splitting criteria of age < 4 months), the model correctly captured seven additional patients with abusive trauma - that would have been missed based on location alone. (11) The study found that among the 95 patients included, several characteristics were more prevalent in bruising with an abusive mechanism of injury than accidental. The study found that of the 42 children within the abuse group, bruising to the ear (n=8, 19%), neck (n=18, 43%), hands (8, 19%), right arm (n=18, 43%), and chest (n= 13, 31%) were more predictive of abuse, and those with accidental injuries did not have bruises in these locations. (11) Additionally, bruising to the face, cheek, scalp, head, and legs was consistently found in both accidental and abusive trauma, so bruising to these areas was not discriminating. (11) They ultimately concluded that *any*

bruising in pre-cruising infants and bruising to the torso (including chest, abdomen, back, buttocks, genitals, hips), ears and neck in children less than four years – abuse should be suspected. (11)

Harper et al. conducted an observational study to investigate isolated bruising in infants and concern for abuse by examining additional occult injuries. (12) This study cohort consisted of 146 infants (< 6 months old) with isolated bruising, and the concern for abuse was perceived using a 7-point scale. Scores of 6 (substantial evidence of inflicted injury) and 7 (definite inflicted injury) were considered a high level of concern for abuse. In contrast, scores of 1 (definitely not inflicted injury) and 2 (no consideration for inflicted injury) represented a low concern for abuse. Of the 146 infants included in the study cohort, 73 infants were found to have additional injuries from abusive trauma discovered with diagnostic labs and imaging (skeletal survey, neuroimaging, and hepatic transaminases) (12). Of the 73 infants with additional injuries, bruising was found most commonly on the face/head (53.6%), trunk (47.8%) and extremities (53.8%). (12) Similarly to Pierce et al.'s study, Harper et al. also found that bruising to the torso, ear and neck in infants/toddlers was associated with a higher probability of abuse and should warrant further evaluation. Shape and pattern of bruising were also found to help distinguish between accidental and non-accidental trauma. The bruising patterns/shapes most notably worrisome for abuse in this study were hand shape, finger marks, bite marks, and belt buckle marks. (12) Specifically, of the infants included in this study with patterned bruising, 66.7% were associated with a high level of concern for abuse. (12) Harper et al. ultimately found that 50% of children (n=146) with isolated bruising included in the study were found to have additional injuries, such as occult fractures, identified through further diagnostic testing. (12) Of the infants with a single isolated bruise, 60% were found to have additional injuries signifying

that there was not a significant association between the number/location of bruises and the presence of additional injuries found in this study. (12)

Table 1. Bruising characteristics in accidental and abusive injuries

	Accidental MOI	**Abusive MOI**
Location of bruising	Knees, elbows, shins (11)	Ear, neck, torso (including the abdomen, back, buttocks, genitals, hip) (11)
Pattern	No obvious pattern (11)	Handshape, finger marks, bite marks, belt marks (12)
Number of bruises	No association between the number of bruises and mechanism of injury (12)	

Table 2. Characteristics of Harper et al.'s study group (n = 146) (12)

Ultimate level of concern for abuse	
1. Definitely not inflicted	n = 6
2. No concern for inflicted injury	n = 17
3. Mildly concerning for inflicted injury	n = 14
4. Intermediately concerning for inflicted injury	n = 16
5. Very concerning for conflicted injury	n = 20
6. Substantial evidence of inflicted injury	**n = 33**
7. Definite inflicted injury	**n = 40**

Oral Injuries

Oral injuries are uncommon in infants, and such, these injuries can be associated with physical abuse. Abusive oral injuries identified in infants are most commonly inflicted with utensils, forced bottle-feeding or hands and fingers. (13)

Dorfman et al.; conducted a secondary analysis of a prospective, observational study to investigate oral injuries sustained in children and determine the proportion of occult injuries identified in children evaluated for abuse. The study cohort consisted of 96 children with oral injuries (identified from an index group of 2890 children). Among the injuries, 44% were labial or lingual frenal injuries, 32% were lip injuries, 16% were oral or pharyngeal injuries, and 9% were gum/tooth injuries. (13) Using the same 7-point system to evaluate the level of concern for abuse as described above, based on history and physical examinations - 69% of children with oral injuries were perceived to have a high likelihood of abuse by expert assessors. (13) This study included 17 frenum injuries in children < six months old and 11 in children between 6-12 months. Among these age groups, 88% and 80% of oral injuries included in the study were associated with a high level of concern for abuse. (13) Additionally, of those with oral injuries, occult injuries were found in 38.4%, 25% and 24% of children using neuroimaging, skeletal survey and retinal exams, respectively. (13) Although oral injuries were infrequent, accounting for only 3.3% of injuries in the study cohort, Dorfman et al.; demonstrated that oral injuries could be a clinical manifestation of abuse in children under one year of age.

In 2007, a case report conducted by Dr. JD Thackeray demonstrated the association of frenal injuries attributable to physical abuse in children. The case report examined three cases of pre-cruising infant patients who were evaluated with frena tears in the emergency department. These three infants subsequently returned to the hospital with severe abusive injuries. In the first two case reports, Thackeray et al. described a 40-day old and a three-month infant who presented with tears to the upper labial frenum with overlying infection in the ER weeks before admission for severe non-accidental head trauma. (14) The third case report describes a 4-month infant presented to the emergency department for a lingual frenulum laceration two weeks before

returning for abusive head trauma. The ED staff presumed that the child had torn her frenum with her fingernail, and the hospital initiated no further workup for abuse at that time. (14) Like Pierce et al.'s study, Thackeray et al. concluded that oral injuries (specifically frena tears) should be concerning for abuse in pre-cruising infants and failure to recognize and intervene appropriately can lead to devastating injuries.

Burns

Burns may represent injuries found in both accidental and non-accidental circumstances. Intentional burns are a severe form of physical abuse, and the rapid identification of a possible abusive mechanism of injury in these cases is critical.

Pawlik et al. conducted a retrospective secondary analysis to characterize burns and scalds in children, to determine the likelihood of abuse and identify associated injuries. The study cohort consisted of 215 children aged 0-10 years, presenting with burns from accidental and non-accidental causes. Children aged 0-24 months made up 57.7% of the study cohort, including n=30 children 0-6 months old, n= 28 aged 6-12 months and n=66 children between 12-24 months. (15) The predominant burn type found amongst the participants were scalds (contact with hot liquids) and contact burns (contact with hot objects). The study found that burn location and burn type differed significantly between accidental and non-accidental circumstances and these factors helped to discriminate between the injuries attributable to physical abuse. (15)

In those found to have accidental scald burns, the burns were associated more frequently with "pull-over" injuries (knocking hot food or beverage onto self). They were restricted to upper limbs (62.9%), face/neck (58.7%), and anterior trunk (63.8%). (15) Rarely did accidental scald burns lead to injuries to the genitals, buttocks and perineum. Similarly, accidental contact burns

were found most commonly on the hands, indicating that grabbing a hot item was the likely injury mechanism in these cases. (15)

Eighty-eight children, among the 215 included in the study, had burn injuries associated with a high likelihood of abuse based on the specific burn characteristics identified. Amongst this group, scald burns were identified most commonly on the legs (35.4%), buttocks/perineum/genitals (29.2%) and trunk (26.6%). Contact burns were the second most common burn type in the study cohort and were frequently found to be on the legs, arms and hands in both accidental and non-accidental groups. No specific location of contact burns was associated with a higher likelihood of abuse in this study. However, a bilateral pattern of contact burns was associated with a higher probability of abuse amongst the study cohort (OR = 2.17). (15)

Other features that made abuse more likely in this study include an inadequate explanation as to how the burn occurred, hot water immersion (OR = 1.78), total body surface area of burns > 10% (OR = 2.64) and full-thickness burns (OR = 2.69). (15) Also, for burn victims with additional injuries, including cutaneous injuries (26.5% n=55) and fractures (7.9% n=17), the perceived likelihood of abuse was significantly higher than those with an isolated burn. (15)

Table 3. Characteristics of accidental and non-accidental burn injuries			
Scald Burns			
Non-accidental		**Accidental**	
MOI*: Immersion	Location: legs, buttocks/perineum, genitals and trunk (15)	MOI: "pull-over" or "knock-over"	Location: upper limbs, face/neck and anterior trunk (15)
Contact Burns			
Non-accidental		**Accidental**	

MOI: infliction of hot item onto the skin	Location: Hands, arms (15)	MOI: grasping hot item	Hands and arms (15)

*MOI refers to the mechanism of injury

Fractures

Although not considered a sentinel injury as non-visible, fractures are common pediatric injuries encountered in the ER and primary care settings. In addition, fractures are often diagnosed as occult injuries identified with imaging and can further help diagnose abuse in children presenting with external injuries.

Leventhal et al. conducted a retrospective study to assess the proportion of children < 36 months old with fractures attributable to physical abuse. The most common injury mechanism in these children presented with fractures was falling (50.42%), although physical abuse accounted for 12.08% of the study's total injuries, based on medical records. (16) The study identified 5850 fractures in children aged between 0-11 months. Of the 5850 fractures, 24.9% of fractures in the age group were attributable to abuse. (16) Fractures to the ribs, radius/ulna and tibia/fibula were associated with a higher probability of abuse in this population. Greater than 50% of children with these fracture subtypes were later determined to have been physically abused. (16) In contrast, only 30.5% of femoral, 28.1% of clavicular and 17.1% of skull fractures were attributable to physical abuse in this age group. (16) In children aged 12-24 months, only 7.2% of the 2677 fractures identified were linked to physical abuse, and no specific fracture type was associated with a higher incidence of abuse in this age group. (16) Additionally, Leventhal et al. discovered that in children who had more than three fractures (versus those with only 1), the probability of abuse increased by 4-6x. In children age 0-12 months – 18.5% of 5076 children were diagnosed with abuse with one fracture, 55.1% of 477 children with 2, and 85.4% of 298 children with > 3 fractures. (16)

Table 4. Causes of fractures in children < 36 months (n=15143) (16)	
Cause	%
Fall	50.42%
Abuse	12.08%

Table 5. The proportion of fractures related to abuse by age and bone (16)				
	0-11 months		12-23 months	
	# of fractures	% of abuse	# of fractures	% of abuse
Ribs	809	*69.4 %*	96	28.5 %
Radius/Ulna	261	*62.1 %*	103	19.8 %
Tibia/Fibula	493	*58 %*	192	16.1 %
Humerus	518	43.1 %	545	6.8 %
Femur	1257	30.5 %	761	4.8 %
Clavicle	227	28.1 %	65	16.7 %
Skull	3363	17.1 %	948	8.6%

Table 6. Number of fractures and likelihood of abuse in children < 12 months (16)	
# of Fractures	Diagnosis of abuse (16)
1 fracture	18.5% (n=5076)
2 fractures	55.1% (n=477)
3 fractures	85.5% (n=298)

Pandya et al. conducted a retrospective review comparing injuries in patients with accidental and non-accidental trauma at an American pediatric trauma center. The study cohort consisted of 500 children diagnosed with abusive physical injuries, including 377 children < 18 months. Injuries found were compared to a control group comprised of 985 children who had injuries due to accidental circumstances, including 425 children < 18 months old. Among the study cohorts, the most common injury encountered was non-bony head injuries (including bruising, contusions, and concussions), present in 42.6% of children in the abuse group and 33.4% in the control group. Pandya et al. found that among children < 18 months, the most common fracture types in the abusive group were skull (24.4%), rib (22%) and femur (17.5%). (17) Among the injuries found in the abuse group, all fractures had a higher incidence in children

less than 18 months, except for foot, hand, spine, and clavicle, where there was no discernible difference between age categories. (17) By having a control group, Pandya et al. were able to calculate an odds ratio for the likelihood of abuse with certain fracture types identified. The study estimated that rib fractures, tibia/fibula, and humeral fractures had an odds ratio of 23.7, 12.8, and 2.3, respectively, for physical abuse. (17) In contrast, Leventhal et al. showcased fracture subtypes' attribution to abuse based on the proportion of injuries alone. Both studies ultimately showed that rib, humeral and femoral fractures had a higher incidence in abusive trauma than in accidental circumstances in children under 24 months of age.

Table 7. Injury pattern among children < 18 months in abuse and control cases (17)

Injury	Abuse group*	Control group *
Non-bony head injury	46.7 %	44%
Skull fracture	24.4%	33.2%
Rib fracture	22%	1.2%
Femur fracture	17.5%	10.6%
Tibia/fibula fracture	13.3 %	1.2%
Radius/ulna fracture	5%	4.5%
Clavicle fracture	4.2 %	0.7%
Foot fracture	0.8 %	0%
Spine fracture	0.8 %	0.7%
Hand fracture	0.3%	0.7%

*Abuse group (n=377) *Control group (n=425)

Table 8. Odds ratios comparing a subset of children with fractures in abuse vs. control group in patients less than 18 months old (17)

Injury	Odds Ratio for abuse
Rib fractures	23.7
Tibia/Fibula fracture	12.8
Humeral fracture	2.3
Femoral fracture	1.8

Non-accidental trauma leading to death

In 2003, it was reported that at least 59 Canadian children were killed due to non-accidental trauma. More than half of these fatalities were committed by a family member. (1) Recognizing abusive injuries at first contact, intervening, and preventing further harm in

pediatric patients has been a reoccurring theme in this review. However, when abusive injuries go unrecognized for some time, fatal presentations of non-accidental trauma may occur.

Ortega et al.; conducted a retrospective review of deceased pediatric patients at two urban pediatric ER departments to compare injuries associated with abusive and accidental trauma fatalities. Of the 124 deaths included in the study, 55 (44.4%) were abusive. These deaths were attributed to abuse if there were any suspicion, confessions, or a consensus between medical professionals documented in the medical record. (18) Those who had abusive fatal injuries tended to be younger than (mean age of 1.63 vs. 5.62) those with accidental injuries. (18) Ortega et al. found that 50.9% of children who died from their abusive injuries presented to a clinic or ER within two months of their death. (18) The most common type of fatal injury seen was submersion injuries found in both accidental and abusive trauma. (18) Within the abused group, 56.4% of fatal presentations were due to shaken baby syndrome or head trauma. Head trauma in these cases, were evaluated using CT scans – which showed intracranial findings in 100% of the cases where abuse was confirmed. (18) The most common intracranial result found on CT was the presence of subdural hematomas. 82% of patients with fatal injuries from abuse had evidence of subdural hematomas on CT. In contrast, only 7.2% of patients with accidental injuries were found to have subdural hematomas on imaging. (18) Ortega et al. found that patients with subdural hematomas were more likely to have succumbed to abusive fatal injuries than accidental circumstances, with a risk ratio of 6.67. In addition to intracranial findings, 50% of patients with abusive injuries were identified to have retinal hemorrhages on formal eye assessment. (18) Children who died from physical abuse were more likely to have retinal hemorrhages (with a risk ratio of 3.47) than from accidental trauma. (18)

Discussion

A review of current literature reveals that the most common clinical manifestations of physical child abuse in children < 24 months old can be grouped into four main categories. These categories are bruising, burns, oral injuries and fractures.

Data suggests that bruising found on the ears, neck, and torso has a higher predictive value of abuse than bruising found over bony prominences such as elbow, knees or shins. (11) Additionally, bruising that takes the shape of finger marks, bite marks and belt buckles is more concerning for an abusive mechanism of injury. There is no association between the number of bruises on an infant and the likelihood of abuse. (12) A study published in 2017, that investigated characteristics of accidental bruising, reported that bruising is likely the most overlooked and underappreciated injury in abuse. (19) Bruising is common, rarely requires medical intervention, and, in most cases is found to be due to accidental circumstances in mobile children. (19) Therefore, it is often a large undertaking to conclude whether bruising is due to one stated mechanism. (19) However, the results from the reviewed literature support the notion that bruising in pre-mobile infants that are poorly explained should warrant suspicion for child abuse, and additional investigations to assess for internal injuries should be pursued.

Oral injuries, although uncommon, are concerning for physical abuse in young children. Studies show high rates of occult injuries are identified in children with oral injuries, and failure to intervene upon the identification of these injuries can lead to severe manifestations of abuse. Frenum tears and lip injuries inflicted with forced bottle-feeding or other objects are associated with abuse, and suspicion about physical abuse concern should increase when these injuries are seen. (13)

Burns are a severe manifestation of abuse in children; location and mechanism of injury can help discern between accidental and non-accidental circumstances. Data from previous literature indicate that scald burns to legs, buttocks/perineum, and genitalia are highly concerning for abuse. (15) These injuries often indicate immersion as a mechanism of injury – i.e. placing a child into a hot water bath, for example. Scald burns in accidental circumstances are often related to a child pulling over or knocking down hot liquids onto themselves. These injuries can be found on the face, anterior trunk, hands and arms. (15)

The characteristics of contact burns in accidental and non-accidental circumstances are not universal in published literature. Contact burns in abusive cases can be found anywhere on the body, as the injury mechanism is the physical infliction of a hot object to that area. Patterned burns such as burns in the shape of cigarettes or hot irons are associated with a higher likelihood of abuse. (15) In accidental contact burns – injuries are more likely to be found on the hand to indicate grasping a hot item was the mechanism of injury. Additional features, including a poorly described explanation of how the burn occurred, > 10% of total surface area and full-thickness burns, make abuse more likely. (15)

Fractures, although non-visible, can be significant predictors of abuse in infants. Fractures to the ribs, radius/ulna and tibia/fibula can be associated with abuse in infants 0-11 months. (16) No specific fracture types in children 12-24 months were more associated with abuse, as this age group is cruising, and the injury mechanism is more commonly accidental. Rib fractures, specifically, had the highest association with physical abuse in infants, showcasing the importance of a skeletal survey to assess occult fractures when evaluating abuse. (16) The presence of multiple fractures or the presence of other injuries increases the likelihood of abuse. (17)

Non-accidental trauma leading to death is more common in young children, with a head injury and shaken baby syndrome as the leading cause of death in this population. (18) Over half of the fatal presentations of abuse included in Ortega et al.'s study represented children who presented to ER with sentinel injuries within two months of their death. (18) Subdural hematomas and retinal hemorrhages were the most common injuries identified before the death of abused children. (18) This study showed that fatalities from abusive injuries are preventable and further supports the need for education and child abuse prevention strategies.

All healthcare practitioners play an essential role in evaluating and managing non-accidental trauma. It is imperative that HCPs feel confident in recognizing abusive injuries and report injuries when abuse is suspected. When an infant presents to a medical facility with an injury, we should maintain a low threshold to be suspicious of the possibility of abuse and obtain a complete medical and psychosocial history. Further imaging, including a CT scan and skeletal survey, can be utilized when appropriate to look for occult injuries to aid in the diagnosis of abuse. The compiled results in this review can impact healthcare professionals, including physician assistants, who work in general and specialized pediatric practices by providing a concise resource for identifying and preventing child abuse in this age group. This review aims to encourage the application of identification and prevention of abuse into daily practice by improving the recognition of abusive injuries across all healthcare settings.

Limitations

The paper's focus is limited to children under 24 months of age. However, as defined in this paper and as described throughout, sentinel injuries are limited to pre-cruising infants, typically under 12 months. This age criterion was chosen to allow for a broader scope of articles to be included. A complete and exhaustive list of abusive injuries in children of this age group

was not fully explored nor would be possible given this project's limitations. Additionally, any injury to a child can be abusive if the injury was caused by an abusive mechanism (ex. hitting a child). Thus, this review was unable to encompass all clinical manifestations of abuse in this age group.

Furthermore, the majority of the studies used in this paper are retrospective analyses that reported on encountered injuries once the diagnosis of abuse had already been made. The data used in retrospective analyses are limited to the data available in medical records and may not apply to all infants < 24 months old. Many studies included in this paper explored the "perceived likelihood of abusive injuries," in which the probability of abuse was based on the assessors' expert opinions. Therefore, the results of these studies are subjective and may contain circular reasoning.

Another limitation in this project is that the proportion of injuries and their significance to child abuse are likely underappreciated. Labelling injuries as abusive based on their mechanism of action can often be misleading. In these cases, an injury may be labelled as accidental that is abusive or vice versa. For example, a fracture that results from a child falling on an outstretched hand (FOOSH injury) would look identical to the FOOSH injury of a child that was pushed. Likewise, a spiral fracture of the radius could get labelled abuse when there may be a plausible accidental mechanism.

The studies included in this review focused primarily on urban American populations, and consequently, the data may not apply to rural/remote communities or Canadian people.

Prospective Investigations

Future investigations could include a survey of Canadian health practitioners to explore their knowledge/confidence in identifying and reporting abusive injuries in children. This study

would be beneficial to identify specific barriers regarding reporting child abuse in Manitoba and Canada. Another interesting angle to explore in future investigations would be to examine the bias of identifying minor abusive injuries in children. For example, whether sentinel injuries are more likely to be missed by HCPs in white, middle-class families than other various family dynamics.

Conclusion

In summary, physical child abuse can manifest in unique ways. Bruising, intraoral injuries, burns and fractures represent the most frequently encountered injuries in physically abused children < 24 months old. The specific patterns and characteristics of abusive injuries described in this review can assist in improving the recognition of abusive injuries across all healthcare settings. Additionally, reprimands for inaccurate reporting of child abuse are minimal, and thus, we should encourage HCPs to report potential abuse at the first contact when clinical suspicion is present.

References

1. Child Maltreatment in Canada - Canada.ca [Internet]. [cited 2020 Nov 11]. Available from: https://www.canada.ca/en/public-health/services/health-promotion/stop-family-violence/prevention-resource-centre/children/child-maltreatment-canada.html
2. Eismann EA, Shapiro RA, Thackeray J, Makoroff K, Bressler CJ, Kim GJ, et al. Providers' Ability to Identify Sentinel Injuries Concerning for Physical Abuse in Infants. Pediatr Emerg Care. 2018;Publish Ah(00):1–6.
3. Christian CW. CLINICAL REPORT Guidance for the Clinician in Rendering Pediatric Care The Evaluation of Suspected Child Physical Abuse. 2015; Available from: www.pediatrics.org/cgi/doi/10.1542/peds.2015-0356
4. Kairys S. Child Abuse and Neglect: The Role of the Primary Care Pediatrician. Pediatr Clin North Am [Internet]. 2020;67(2):325–39. Available from: https://doi.org/10.1016/j.pcl.2019.11.001
5. Petska HW, Sheets LK. Sentinel injuries: Subtle findings of physical abuse. Pediatr Clin North Am [Internet]. 2014;61(5):923–35. Available from: http://dx.doi.org/10.1016/j.pcl.2014.06.007

6. Sheets LK, Leach ME, Koszewski IJ, Lessmeier AM, Nugent M, Simpson P. Sentinel injuries in infants evaluated for child physical abuse. Pediatrics. 2013;131(4):701–7.
7. Afifi TO, Taillieu T, Cheung K, Katz LY, Tonmyr L, Sareen J. Substantiated reports of child maltreatment from the Canadian incidence study of reported child abuse and neglect 2008: Examining child and household characteristics and child functional impairment. Can J Psychiatry. 2015;
8. Paul AR, Adamo MA. Non-accidental trauma in pediatric patients: a review of epidemiology, pathophysiology, diagnosis and treatment. Transl Pediatr. 2014;3(3):195–207.
9. PACCA. Reporting of child protection and cihld abuse. 2013; Available from: www.pacca.mb.ca
10. Jones R, Flaherty EG, Binns HJ, Price LL, Slora E, Abney D, et al. Clinicians' description of factors influencing their reporting of suspected child abuse: Report of the child abuse reporting experience study research group. Pediatrics. 2008;122(2):259–66.
11. Clyde Pierce M, Kaczor K, Aldridge S, Lorenz DJ. Bruising Characteristics Discriminating Physical Child Abuse From Accidental Trauma. Pediatrics [Internet]. 2010;125(1):67–74. Available from: www.pediatrics.org/cgi/doi/10.1542/peds.2008-3632
12. Harper NS, Feldman KW, Sugar NF, Anderst JD, Lindberg DM. Additional injuries in young infants with concern for abuse and apparently isolated bruises. J Pediatr [Internet]. 2014;165(2):383-388.e1. Available from: http://dx.doi.org/10.1016/j.jpeds.2014.04.004
13. Dorfman M V., Metz JB, Feldman KW, Farris R, Lindberg DM. Oral injuries and occult harm in children evaluated for abuse. Arch Dis Child. 2018;103(8):747–52.
14. Thackeray JD. Frena tears and abusive head injury: A cautionary tale. Pediatr Emerg Care. 2007;23(10):735–7.
15. Pawlik MC, Kemp A, Maguire S, Nuttall D, Feldman KW, Lindberg DM, et al. Children with burns referred for child abuse evaluation: Burn characteristics and co-existent injuries. Child Abus Negl [Internet]. 2016;55:52–61. Available from: http://dx.doi.org/10.1016/j.chiabu.2016.03.006
16. Leventhal JM, Martin KD, Asnes AG. Incidence of Fractures Attributable to Abuse in Young Hospitalized Children: Results From Analysis of a United States Database. 2008; Available from: www.pediatrics.org/cgi/doi/10.1542/
17. Pandya NK, Baldwin K, Wolfgruber H, Christian CW, Drummond DS, Hosalkar HS. Child abuse and orthopaedic injury patterns: Analysis at a level I pediatric trauma center. J Pediatr Orthop. 2009;29(6):618–25.
18. Ortega HW, Velden H Vander, Kreykes NS, Reid S. Childhood death attributable to trauma: Is there a difference between accidental and abusive fatal injuries? J Emerg Med [Internet]. 2013;45(3):332–7. Available from: http://dx.doi.org/10.1016/j.jemermed.2013.03.020
19. Pierce MC. Bruising characteristics from unintentional injuries in children: the 'green flag' study. Arch Dis Child [Internet]. 2017 Dec 1;102(12):1097 LP – 1098. Available from: http://adc.bmj.com/content/102/12/1097.abstract