

Traumatic Head Injury Due to Child Maltreatment (THI-CM): A Literature Review

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The Saskatchewan Prevention Institute provides services to all those living on Treaty Lands 2, 4, 5, 6, 8, and 10, the ancestral territories of the Nêhiyawak, Nêhithawak, Nêhinawak, Anishinabek, Nakawe, Dakota, Lakota, Nakota, Dene, and the homeland of the Métis. We recognize that these lands are currently inhabited by Indigenous people from across Turtle Island including many other First Nations and Inuit peoples and acknowledge the importance of the treaties, the lasting impacts of colonization, and continued inequities. We are dedicated to moving forward on a shared path of reconciliation and partnership. We are all Treaty people and are grateful to live, work, and play on this land.

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1. Key Findings

- Traumatic head injury due to child maltreatment (THI-CM) affects infants and children up to five years of age, with infants most impacted.
- THI-CM in Canada is relatively infrequent; however, with challenges in diagnosis, incident rates are likely underestimated.
- Crying is the most significant trigger for abusive behaviours that lead to THI-CM. Additionally, several situational and caregiver characteristics are associated with an increased risk, in particular factors that increase parental stress.
- Parental education programs that teach caregivers when frustrated with crying to put their child in a safe place (e.g., a crib) and walk away until they are calm again have been linked to a reduction in the likelihood of THI-CM occurring.
- Early diagnosis is important to prevent repeat injuries and/or further harm to the victim. Several evidence-based clinical tools exist to aid health professionals in diagnosis. Specifically, the *4-Variable Abusive Head Trauma Clinical Prediction Rule* and *Ontario Triad*.

2. Introduction

Traumatic head injury due to child maltreatment (THI-CM) is characterized by a range of injuries caused by blunt impact, violent shaking, or other forms of physical abuse to infants and young children (Joyce et al., 2023; Public Health Agency of Canada [PHAC, 2020b]). Despite its relatively low incidence, THI-CM is the leading cause of morbidity and mortality among child maltreatment cases. Survivors often experience long-term neurological, cognitive, and physical impairments (Jackson et al., 2021; Joyce et al., 2023; Lind et al., 2016; Narang et al., 2020; PHAC, 2020b; Shouldice et al., 2024). THI-CM is often underreported and misdiagnosed because early symptoms are subtle. This misdiagnosis complicates prevention and early intervention efforts (Jenny 2022; Otterman & Palusci, 2020; PHAC, 2020b; Shouldice et al., 2024). Understanding the mechanisms of injury, risk factors, and role of health professionals is critical to help THI-CM prevention and intervention efforts. This literature review is based on recent evidence-based literature and will cover multiple aspects of THI-CM, including mechanism of injury, risk factors, diagnosis, long-term outcomes, and strategies for prevention.

3. Definition and Prevalence

Several terms have been used to describe traumatic head injury due to child maltreatment, including "shaken baby syndrome," "abusive head trauma," "non-accidental head injury," and "inflicted traumatic brain injury" (Shouldice et al., 2024). Historically, the Canadian Paediatric Society first replaced the term "shaken baby syndrome" with "abusive head trauma" in 2007 to recognize that the mechanism of injury was not limited to shaking. In 2015, the Public Health Agency of Canada revised its published *Joint Statement on Shaken Baby Syndrome* by an Expert Advisory Committee consisting of professionals within the medical, legal, law enforcement, judicial, child welfare, public health, and health promotion sectors (PHAC, 2020b). It was recommended that the terminology of "shaken baby syndrome" and "abusive head trauma" be changed to reflect the language currently used in healthcare, research, public health, and policy (PHAC 2020b). The term "traumatic head injury due to child maltreatment" or "THI-CM" serves

to distinguish a traumatic head injury where the underlying cause is child abuse from other incidents of head injury (PHAC, 2020b).

THI-CM can be diagnosed in children up to five years of age; however, it is most common in infants under the age of one (Joyce et al., 2023). According to the Public Health Agency of Canada, THI-CM in Canada is relatively infrequent; however, it is a difficult condition to diagnose and is often not recognized or misdiagnosed as other conditions (PHAC, 2020b). As a result, THI-CM incidence is likely underestimated (PHAC, 2020b). The Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP) reported from 2011 to 2017 that 7% of traumatic head injuries were cases of child maltreatment (PHAC, 2020a). From 2001 to 2011, Statistics Canada reported that THI-CM was the leading cause of death due to homicide among infants under the age of one with 31% of victims succumbing to their injuries (Sinha, 2013). These data likely underestimate the true incidence of THI-CM due to diagnostic challenges and underreporting.

4. Mechanism of Injury

THI-CM can occur when an infant or young child is forcefully shaken, hit with an object or against a surface, or forcefully dropped or thrown (Joyce et al., 2023). The primary mechanism of injury in THI-CM is the sudden acceleration-deceleration force caused by shaking or impact, which disrupts the delicate brain structures (Raza et al., 2022). When infants experience shaking, their heads and necks undergo rapid repetitive movements (rotational, back and forth, and side-to-side) (Joyce et al., 2023). This “whiplash effect” can cause the brain to move within the skull, even when no external signs of trauma are present.

These forces can tear blood vessels, nerves, or surrounding tissue, resulting in subdural hemorrhage, bruising, and diffuse brain injury (Cleveland Clinic, 2022; Joyce et al., 2023). Swelling of the brain may increase intracranial pressure and restrict blood and oxygen flow, leading to cerebral hypoxia or death if untreated (Cleveland Clinic, 2024; Joyce et al., 2024). Because infants have proportionally larger heads, weaker neck muscles, and softer skull structures, these physiological effects occur more easily and with greater severity (Joyce et al., 2023).

The same acceleration-deceleration forces can also affect the eyes, resulting in damage to small vessels in the retina, bleeding in multiple retinal layers (retinal hemorrhage), and possible impairments to the infant’s vision (Joyce et al., 2023). When the head is struck against an object, additional injuries may be seen (e.g., lacerations, bruises, fractures); however, there are frequently no obvious external signs of injury (Joyce et al., 2023). Importantly, these injuries cannot be caused by activities such as play, an accidental fall, bouncing an infant on a knee, riding in a bumpy car, or a resuscitation effort (Cleveland Clinic, 2022).

5. Risk Factors

Risk factors of THI-CM can be divided into three risk factor categories: infant, situational, and caregiver.

5.1 Infant Risk Factors

Excessive crying, which typically peaks at six to eight weeks of age, is considered the most common trigger for THI-CM incidents (Joyce et al., 2023). As a result, THI-CM occurs across all socioeconomic, cultural, religious, and ethnic groups (Joyce et al., 2023). Research shows that caregivers often misinterpret inconsolable crying as intentional behaviour by the infant, which can trigger shaking out of frustration and feeling overwhelmed (Barr et al., 2006). Additional infant risk factors include colic, gastroesophageal reflux, prematurity, disabilities, other health-related conditions, feeding issues, toilet-training, and separation anxiety (Biswas & Shroff, 2021; Hung, 2020; Joyce et al., 2023). These factors can be challenging for caregivers to manage, causing frustration and prolonged periods of distress that may lead to abusive behaviour (Joyce et al., 2023). In particular, premature infants, infants with disabilities, and those with medical conditions may require more intensive care and exhibit crying patterns that are difficult to soothe, increasing caregiver stress and the likelihood of THI-CM (Hung, 2020; Joyce et al., 2023).

5.2 Situational Risk Factors

Situational risk factors for THI-CM include housing instability, financial stress, large household size, unknown number of adults in the home, young parental age, lack of social support, and inaccessible prenatal care (Joyce et al., 2023; Notrica et al., 2021; Zolotar et al., 2015). Situational stressors such as poverty, unemployment, or unstable housing can increase caregiver stress, impair coping strategies, and cause barriers to accessing perinatal care, which elevates the risk of THI-CM (Zolotar et al., 2015). Additional situational factors associated with a lack of social support such as single-parent homes and family isolation can further increase risk (Joyce et al., 2023). For example, single parents or families living far from relatives may experience isolation and chronic stress due to a lack of support making abusive behaviours more likely. These situational risk factors can exacerbate caregivers' frustration, especially when they are overwhelmed by multiple responsibilities and/or are left without support from partners or family members. The degree of frustration and tension exhibited by a perpetrator of THI-CM often corresponds to the level of shaking or force used (Joyce et al., 2023). Limited access to healthcare is also a risk factor, including prenatal and postnatal care, as it prevents families from receiving crucial education about safe caregiving practices and how to handle common infant behaviours, such as crying, without violence (Parks et al., 2012).

5.3 Caregiver Risk Factors

Caregiver characteristics that are significant predictors of THI-CM include lack of knowledge about normal crying patterns, lack of knowledge about the risk of shaking, unrealistic expectations about their child's development, and low educational attainment (Joyce et al., 2023). These factors may reduce a caregiver's ability to respond appropriately to infant distress. Caregiver frustration intolerance, psychological disorder, history of intimate partner violence, and/or history of substance use are also linked to abusive behaviours with their children and an increased risk of THI-CM (Joyce et al., 2023; Notrica et al., 2021).

One of the strongest predictors that has been consistently associated with increased likelihood of THI-CM is a history of prior involvement with law enforcement and/or child protective services (Joyce et al., 2023; Kelly et al., 2019; Notrica et al., 2021; Rebbe et al., 2021). This association likely reflects the cumulative impact of chronic stress, prior maltreatment, and limited access to support resources.

Additionally, male caregivers are disproportionately more likely to be involved in THI-CM cases, accounting for approximately 65% to 90% of identified perpetrators. These cases often involve fathers, stepfathers, or the mother's partner, highlighting the importance of including all caregivers in prevention and education efforts (Joyce et al., 2023).

6. Prevention

Crying is a normal behaviour in all infants, particularly in the first few months of life. However, as discussed above, excessive, inconsolable, and/or prolonged crying has been identified as the main trigger for abusive behaviours leading to THI-CM (Biswas & Shroff, 2021; Joyce et al., 2023). Infant crying can cause extreme frustration in caregivers, especially if they are unprepared for the intensity and/or duration (Joyce et al., 2023). Therefore, evidence-based parental education programs are central to THI-CM prevention by educating caregivers on how to respond to crying (PHAC, 2020b).

Recent research has shown that infants of caregivers who received the *Take 5 Safety Plan for Crying* program were 79% less likely to experience THI-CM than infants whose caregivers did not receive this information (Bechtel et al., 2020). The *Take 5* program involves teaching caregivers five steps to take when they become frustrated with an infant's crying (see Table 1; Bechtel et al., 2020).

Table 1. Steps for the *Take 5 Safety Plan for Crying* program (Bechtel et al., 2020)

If a caregiver becomes frustrated with an infant's crying:
1. The caregiver should put the infant down on their back on any fixed, firm surface (e.g., crib or bassinet) so that the infant will not fall.
2. The caregiver should then walk out of the room, away from the infant.
3. The caregiver is encouraged to do something to relax or calm down (e.g., meditating, listening to music, doing house chores).
4. The caregiver is encouraged to call a friend, family member, or the infant's doctor for support, or to ask someone to temporarily watch the infant if the caregiver wants to leave the house to calm down.
5. The caregiver is advised not to return to the infant until he or she is calm enough to care for the infant safely.

Steps from the *Take 5* program align with current Canadian prevention resources. For example, My Health Alberta resources educate caregivers that it is safer to step away than to respond impulsively to a crying infant or child because shaking them, even just once, can lead to brain injury or death (Ignite Healthwise, 2024). They also instruct caregivers to place their infant in a safe place, like a crib, and to take time to calm down, reassuring them that this will not hurt their

child. Caregivers should check on their infant every 10 minutes but should not pick up their child until they feel calm enough to care for their child safely (Centers for Disease Control and Prevention [CDC], 2024; Ignite Healthwise, 2024). Caregivers are also encouraged to call a friend, family member, neighbour, doctor, and/or a support hotline to reach out for immediate help.

There are numerous other parenting programs that teach caregivers about normal infant crying patterns, how to comfort a crying baby, as well as self-regulation and/or coping mechanism that have been found to increase caregiver knowledge (PHAC, 2020b). However, these parenting program have not explicitly been shown to reduce rates or likelihood of THI-CM (Dias, 2021; Raza et al., 2022; Scott et al., 2022). Programs such as the widely recognized *Period of PURPLE Crying* program, aim to educate caregivers, though evidence on their effectiveness in reducing THI-CM remained mixed (Groisberg et al., 2020; National Centre on Shaken Baby Syndrome, n.d.; Raza et al., 2022). Overall, prevention efforts are most effective when they directly target parents' and caregivers' responses to infant crying.

7. Detection

According to the Public Health Agency of Canada, THI-CM is a difficult condition to diagnose and is often not recognized and/or misdiagnosed as other conditions (PHAC, 2020b). The early symptoms are often subtle and nonspecific, which can delay treatment and intervention (Joyce et al., 2023; Shouldice et al., 2024). There is no hallmark injury or standardized process used to identify THI-CM. Due to these challenges, by the time a correct diagnosis is obtained, the infant or child may have sustained additional abuse (Otterman & Palusci, 2020).

7.1 Signs

Infants and children who have sustained a THI-CM may present with symptoms including irritability, poor feeding/sucking, vomiting, seizures, bulging of the fontanelle, and/or frontal bossing (protruding forehead) (Joyce et al., 2023). These physical symptoms are early indicators of brain swelling, fluid accumulation (hydrocephalus), and increased intracranial pressure (Lindberg et al., 2015). Additional signs include altered levels of consciousness, respiratory distress, and bradycardia, which may indicate brainstem compression (Joyce et al., 2023). Retinal hemorrhages are present in most cases of THI-CM and are typically observed in multiple retinal layers (Binenbaum & Forbes, 2014). Other clinical signs include asymmetric pupil size, lethargy, decreased muscle tone, increased sleeping, sleep apnea, hypothermia, and failure to thrive (Joyce et al., 2023; Narang et al., 2020).

THI-CM can also lead to notable psychological and behavioural symptoms. Infants may become less responsive to stimuli and/or demonstrate a lack of social interaction, which can be mistakenly attributed to developmental delays or other medical conditions (Joyce et al., 2023; O'Meara et al., 2020). Sudden behavioural changes following unexplained injury should prompt careful assessment and referral for appropriate physical and psychological evaluation and support (O'Meara et al., 2020).

7.2 Diagnosis

A diagnosis of THI-CM is critical for preventing repeat of injury and/or additional harm to the infant or child. Symptoms like vomiting, lethargy, and irritability are often misattributed to less serious conditions, contributing to delayed diagnosis and increased risk of subsequent injury (Joyce et al., 2023). The subtle and variable presentation of THI-CM makes diagnosis challenging (Jenny 2022; Otterman & Palusci, 2020; PHAC, 2020b; Shouldice et al., 2024). Approximately 25%-31% of cases are not correctly diagnosed upon first presentation (Jenny, 2022). Numerous publications from the United States, France, and Australia across various clinical settings report similar diagnostic delays, suggesting that missed diagnosis is frequent and widespread (Otterman & Palusci, 2020).

In the absence of a standardized process for diagnosing THI-CM, clinicians and researchers have developed various structured tools to aid in evaluation and diagnosis of THI-CM. The first is the *4-Variable Abusive Head Trauma Clinical Prediction Rule*, which was developed by Hymel and colleagues (2014). They found the tool to have high sensitivity with correct identification of 96% of clinical cases in which patients were later diagnosed with THI-CM after a thorough evaluation. Subsequent validation using an independent sample demonstrated sensitivity of 72% and specificity of 86%, confirming the tool's utility in distinguishing THI-CM from non-abusive head injuries (Cowley et al., 2015).

The *4-Variable Abusive Head Trauma Clinical Prediction Rule* is designed to help health professionals identify patients who should receive further evaluation for potential THI-CM (see Table 2).

Table 2. The *4-Variable Abusive Head Trauma Clinical Prediction Rule* (Hymel et al., 2014)

To minimize missed cases, every acutely head-injured infant or young child ^a hospitalized for intensive care who presents with ≥ 1 of these 4 predictor variables should be thoroughly evaluated for abuse:	
i.	Any clinically significant respiratory compromise ^b at the scene of injury, during transport, in the emergency department, or before admission
ii.	Any bruising involving the child's ears, neck, or torso ^c
iii.	Any subdural hemorrhage or fluid collection that is bilateral or involves the interhemispheric space
iv.	Any skull fractures other than an isolated, unilateral, nondiastatic, linear, parietal skull fracture

^a Less than 3 years of age, not injured in a collision involving a motor vehicle.

^b Defined as infrequent or laboured respirations, apnea, or any need for intubation or assisted ventilation.

^c Including the patient's chest, abdomen, genitourinary region, back, or buttocks.

Several triads (sets of symptoms) have also been developed to help health professionals differentiate between cases of THI-CM and non-THI-CM (Hymel et al., 2022). Three triads are most frequently used: *The Ontario Triad*, *The Triad*, and *The Triad + the absence of signs of impact*.

The Ontario Triad refers to the presentation of the following three clinical findings (Hymel et al., 2022):

- any subdural hemorrhage(s) or fluid collection(s)
- severe retinal hemorrhages(s) described by an ophthalmologist as dense, extensive, covering a large surface area, and/or extending to the ora serrata
- absence of signs of impact, including craniofacial soft tissue injuries (e.g., bruising and lacerations), subgaleal or cephalohematomas, skull fractures, or epidural hematomas at the scene of injury, during transport, in the Emergency Department, or prior to hospital admission

Similarly, *The Triad* and *The Triad + the absence of signs of impact* include the following clinical findings with the latter also including absence of signs of impact (Hymel et al., 2022):

- subdural hemorrhage(s)
- severe retinal hemorrhage(s)
- alteration or loss of consciousness occurring in the absence of craniofacial soft tissue injuries, subgaleal or cephalohematomas, skull fractures, and epidural hematomas

Each triad has been found to be “highly specific and predictive [of THI-CM], supporting an impression that concern for abuse is clearly warranted when young, acutely head-injured patients present for intensive care with these constellations of findings” (Hymel et al., 2022, p. 7). Therefore, it is recommended to continue using the *4-Variable Abusive Head Trauma Clinical Prediction Rule* and triads to help in the detection and diagnosis of THI-CM.

It is also important that health professionals and service providers are knowledgeable about their legal duty to report any reasonable suspicion that a child’s physical and/or mental health and/or welfare has been, or may be, impacted by abuse or neglect to a local Ministry of Social Services Child Protection Office, First Nations Child and Family Services Agency, or the police (PHAC, 2020b). Refer to Saskatchewan’s Child Abuse Protocol 2023 for more information (<https://publications.saskatchewan.ca/#/products/12574>).

8. Outcomes

Since early symptoms are often subtle, delayed diagnosis can lead to repeated injury, which contributes to the severe long-term outcomes observed in THI-CM survivors. In Canada, THI-CM accounts for approximately one-third (31%) of all infant deaths due to homicide (Sinha, 2013). The majority of those who survive suffer serious, long-term health consequences (PHAC, 2020b). The outcomes are affected by the duration, force, and frequency of the trauma. THI-CM is particularly harmful to infants due to the brain's vulnerability at that stage of development (Joyce et al., 2023). Specifically, infants are most at risk for serious injury because of their fragile developing brains, proportionately larger and heavier heads, malleable skull bones, underdeveloped neck muscles, and the significant size and strength difference between themselves and the perpetrator (Joyce et al., 2023).

THI-CM survivors often experience a spectrum of neurological impairments that can range from mild cognitive deficits to severe, debilitating conditions (Joyce et al., 2023). Cognitive and intellectual disabilities are among the most common outcomes, including problems with memory, attention, problem-solving, executive functioning, speech, and overall development (Jackson et al., 2021; O’Meara et al., 2020). These challenges often impact educational performance and may require specialized support.

Motor impairments are also prevalent. Cerebral palsy, spasticity, ataxia, and hemiplegia are common following severe brain or associated neck/spinal injuries (Lind et al., 2016). Many survivors develop epilepsy or other seizure disorders that appear soon after the injury or emerge later due to disrupted neural pathways (Jackson et al., 2021).

Moreover, sensory deficits further contribute to long-term disability. Vision impairments such as cortical blindness and visual field loss often result from retinal or optical nerve damage associated with shaking (Lind et al., 2016). Hearing loss and altered physical sensation are also reported (Joyce et al., 2023).

The cumulative impact of these disabilities often results in a decreased quality of life. Many survivors require ongoing medical care, rehabilitation, and specialized educational, social, child welfare, and legal supports (PHAC, 2020b).

9. Conclusion and Recommendations

The long-term impact of THI-CM extends far beyond the initial injury, often resulting in severe long-term neurological, cognitive, and physical disabilities that affect not only the survivors but also their families (Jackson et al., 2021; Joyce et al., 2023; Narang et al., 2020; PHAC, 2020b). Therefore, prevention and early intervention are crucial, especially for families identified as high-risk due to factors including financial stress, young parental age, lacking social support, and/or history of involvement with child protective services (Joyce et al., 2021; Kelly et al., 2019; Rebbe et al., 2021). Health professionals, social workers, and those working with children and families should be trained on the risk factors for THI-CM (Joyce et al., 2023; PHAC, 2020b). Once identified, it is critical for prevention that these caregivers receive evidence-based parent education on how to handle infant and child crying. Current evidence-based parent education strategies to reduce the likelihood of THI-CM include the steps outlined in the *Take 5 Safety Plan for Crying* program (see Table 1; Bechtel et al., 2020). As infant and child crying is the main trigger for abusive behaviours leading to THI-CM occurring across all demographic groups (Biswas & Shroff, 2021; Joyce et al., 2023), it is recommended that all caregivers be taught these strategies. Lastly, early detection and diagnosis of THI-CM is critical in preventing repetition of this injury and/or further harm to the child. The subtle nature of early THI-CM symptoms highlights the critical need for evidence-based diagnostic strategies (PHAC, 2020b). The following practices are recommended: the *4-Variable Abusive Head Trauma Clinical Prediction Rule* and *The Ontario Triad*.

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