

## SHAKEN BABY SYNDROME: MAIN COMPLICATIONS AND HOW TO PREVENT THEM

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**Abstract:** Shaken child syndrome (abusive head trauma) involves serious health repercussions for children due to the act of shaking them with rapid, intense and repeated movements. This act of violence is usually carried out by guardians or caregivers in the face of an intense crying fit and can cause retinal hemorrhage, subdural hematoma and encephalopathy, elements that make up the triad that represents the main complications. Due to the severe consequences, many of which are irreversible, it is important to address the prevention of the syndrome in the health system, in addition to creating social measures that contribute to raising awareness among the general population, especially those who work with children. This work is an integrative review of the literature found on the electronic platforms Scielo, Pubmed and Lilacs, based on the selection by descriptors and application of inclusion and exclusion criteria. A total of 19 articles were selected and, after reading them in full, it is clear that this condition is still little discussed, and that it is essential to clearly address the syndrome and preventive measures during medical care, collective campaigns and through social networks, in order to reach a large audience. Health professionals must always be alert to the possibility of mistreatment, whether intentional or not. Preventive measures need to be addressed at a professional level in the health area and in the social sphere, in order to avoid head trauma and its harmful effects.

**Keywords:** Violent Head Trauma, Prevention, Shaken Baby

## INTRODUCTION

According to the United States Center for Disease Control and Prevention (CDC), violent head trauma, which confers shaken child syndrome, is defined as a head injury to a child up to 5 years of age by shaking the child, imposing brute movements and impacts (Lee et al, 2021).

In general, children up to 2 years of age are more affected, due to their great dependence on their caregivers and anatomical factors that are more specific to this age group. These children have a higher cephalic index and cervical fragility, in addition, the child's brain has a higher water to myelin ratio, compared to the brain of an adult. Thus, being more gelatinous and malleable, it collides very easily with the internal surface of the bones of the skull (Bragatto et al, 2010).

The main causal factor of this type of child abuse is crying, especially an intense crying fit, since it has the capacity to trigger negative feelings - frustration, stress, anger - in caregivers and legal guardians, emotions that can act as triggers for the occurrence of trauma and the consequent cranial injury (Lee et al, 2021).

The neurological and/or ophthalmological complications of the syndrome arise from the intense, rapid and repeated movements of acceleration and deceleration, flexion and extension, suffered by the child's head and neck, so that harmful consequences may arise, such as acute subdural hematoma, subarachnoid, intraparenchymal, intraocular or retinal hemorrhage, due to ruptures of cerebral and retinal blood vessels and mechanical trauma to the brain's neuronal content (Bragatto et al, 2010). Furthermore, these injuries to the central nervous system due to traumatic causes may manifest in important symptoms and changes in the child's normal and adequate development, such as vomiting, irritability, seizures, and

delayed neuropsychomotor development. This condition is associated with high mortality and morbidity, since violent head trauma can result in severe injuries or even death of the child. (Lee et al, 2021). Therefore, due to the serious consequences to the health of affected pediatric patients and the costly costs to the health system for diagnosis, treatment and follow-up of children with sequelae, this study sought to emphasize the prevention of shaken baby syndrome. The objective of this integrative review is to address preventive measures at a professional and social level, as well as the importance of this set of actions, to avoid the occurrence of such violent trauma.

Therefore, this review aims to contribute to social awareness about the syndrome, which must be broad, including parents, caregivers and professionals who work with children, in addition to raising awareness among medical professionals, especially non-pediatric professionals, aiming at early diagnosis, since there is a great deal of underreporting of cases due to lack of knowledge. This is especially important due to the reality of the Brazilian healthcare system, whether public or private, since, most of the time, a non-pediatric medical professional is responsible for the child's first care in the general emergency room, and is not able to immediately recognize changes that may indicate mistreatment and this specific condition.

## **MATERIAL AND METHODS**

This scientific article is an integrative review on "Shaken Baby Syndrome", created based on articles selected from the electronic platforms Scientific Electronic Library Online (SciELO), Latin American and Caribbean Literature in Health Sciences (Lilacs) and National Library of Medicine (PubMed). The health science descriptors "Shaken Baby Syndrome" were used during the initial selection process of the materials. Subsequently, the inclusion criteria

were applied, aiming to screen articles that were published in the last 10 years, written in English, Portuguese or Spanish. Then, the exclusion criteria were applied, so that materials that provided some sporadic citation without specifically addressing the subject in the body of the work, articles with non-free access and those coincidental found in the databases were discarded. Thus, a total of 19 articles were obtained as a result, which were fully read and analyzed for the preparation of this project.

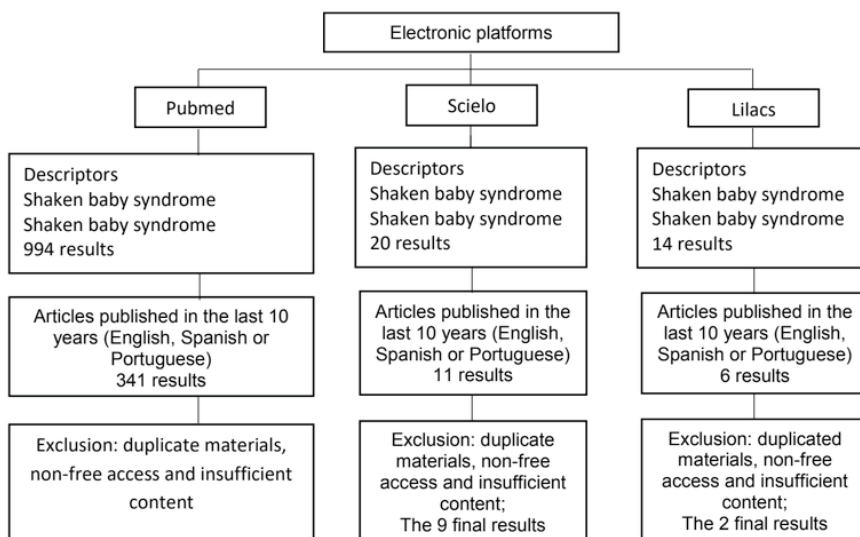
## **RESULTS AND DISCUSSIONS**

Among the set of materials found in the electronic searches, through the application of the inclusion and exclusion criteria, 9 of them were obtained from Scielo, 8 from Pubmed and 2 from Lilacs. Flowchart 1 configures the detailed steps of the selection process until the acquisition of the 19 articles in total.

From the analysis of the characterization of all literary works found, as represented in Table 1, 5 case reports, 6 literature reviews were obtained – one of which was a systematic review – and 8 different studies, including a retrospective cohort study, a randomized clinical trial, a descriptive observational study and an interventional experimental study, depending on the specific article.

After reading all the literature included in the results, it was found that there was a lack of preventive methods for the syndrome in question. This failure is evident both in the description and detailed explanation of such measures and in terms of their importance. The deficiency of this theme can be seen in Table 2, which aims to compare each selected article with the areas of knowledge that are addressed throughout the text (epidemiology, pathophysiology, clinical presentation, examinations, prognosis and prevention).

It was found that 6 studies dealt with the subject superficially, only mentioning the need



Flowchart 1: Eligibility criteria used in literature selection

Source: Prepared by the authors

Authors	Title	Place and year of publication	Type of study	Language
Consuelo Luna-Muñoz et al	Is convulsive crisis or child abuse?	''Rev. de la Facultad de Medicina Humana/2021''	Case report	Spanish
Kun-Long Hung	Pediatric abusive head trauma	''Biomedical journal/2020''	Literature review	English
Luis P. Orozco-Gómez, et al	Ocular repercussions following abusive head trauma	''Rev. Mexicana de Oftalmología/2021''	Retrospective Study	Spanish
Nahara Rodrigues Laterza Lopes, et al	Assessment of a Brief Intervention with Parents to Prevent Shaken Baby Syndrome	''Paidéia/2018''	Randomized clinical trial	English
Risa Takeda, et al	Post-Traumatic west syndrome due to abusive head trauma in two infants with different brain imaging findings	''The Tohoku Journal of Experimental Medicine/2020''	Case report	English
Katharina Feld, et al	Fractures and skin lesions in pediatric abusive head trauma: a forensic multi-center study	''International Journal of Legal Medicine/2021''	Retrospective cohort study	English
Arturo Loredó-Abdalá, et al	Shaken baby syndrome: clinical framework and evolution of 17 cases at the National Institute of Pediatrics	''Acta Pediátrica de México/2015''	Retrospective cohort study	Spanish
Takeo Fujiwara, et al	Effectiveness of an educational video in maternity wards to prevent self-reported shaking and smothering during the first week of age: a cluster randomized controlled trial	''Prevention Science/2020''	Randomized controlled trial	English
Raquel Ferreira, Marta Silva	Síndrome da Criança abanada: abordagem diagnóstica	''Arquivos de Medicina/2013''	Literature review	Portuguese
Nahara R.L. Lopes, et al	Abusive head trauma in children: a literature review	''Jornal de Pediatria/2013''	Literature review	Portuguese
Imen Ksiaa, et al	Swept-source OCT findings in shaken baby syndrome: case report	''BMC Ophthalmology/2020''	Case report	English
Seokwon Yoon	Neonatal abusive head trauma without external injuries: suspicion improves diagnosis	''Children (Basel)/2022''	Case report	English
Isadora Froeder Oliveira, et al	Shaken Baby Syndrome - A Case Report	''Rev. Pediatria SOPERJ/2019''	Case report	English
Ulf Hogberg, et al	Infant abuse diagnosis associated with abusive head trauma criteria: incidence increase due to overdiagnosis?	''European Journal of Public Health/2018''	Descriptive observational study	English
Jan Peter Van Zandwijk, et al	Modeling of inflicted head injury by shaking trauma in children: what can we learn?	''Forensic Science, Medicine and Pathology/2019''	Systematic review	English

Göran Elinder, et al	Traumatic shaking: the role of the triad in medical investigations of suspected traumatic shaking	``Acta Paediatrica/2018``	Literature review	English
Dres. R. P. Quercia	Shaken Baby Syndrome or Shaken Baby Syndrome: Eye injuries	``Medicina Infantil/ 2015``	Descriptive and retrospective study	Spanish
Vanessa Thomazini Cardoso, Caroline Guisantes de Salvo Toni	Shaken Baby Syndrome: knowledge of early childhood education professionals	``Psicologia Argumento/2020``	Interventional experimental study	Portuguese
Young Ho Kwak	Diagnosis of abusive head trauma : neurosurgical perspective	``Journal of Korean Neurosurgical Society/ 2022``	Literature review	English

Table 1: Characterization of the literature found

Source: Prepared by the authors

Title	Epidemiology	Pathophysiology	QC	Exams	Prognosis	Prevention
Convulsive crisis or child abuse	YES	YES	YES	YES	YES	NO
Pediatric abusive head trauma	YES	YES	YES	YES	YES	SUPERFICIAL
Ocular repercussions following abusive head trauma	YES	NO	YES	YES	NO	NO
Post-Traumatic west syndrome due to abusive head trauma in two infants with different brain imaging findings	NO	YES	YES	YES	NO	NO
Assessment of a brief intervention with parents to prevent shaken baby syndrome	YES	YES	NO	NO	YES	SUPERFICIAL
Fractures and skin lesions in pediatric abusive head trauma: a forensic multi-center study	NO	YES	YES	YES	NO	NO
Shaken baby syndrome: clinical presentation and evolution of 17 cases at the National Institute of Pediatrics	YES	NO	YES	YES	YES	NO
Effectiveness of an educational video in maternity wards to prevent self-reported shaking and smothering during the first week of age: a cluster randomized controlled trial	NO	NO	NO	NO	NO	DEEP
Shaken Child Syndrome: diagnostic approach	YES	YES	YES	YES	YES	SUPERFICIAL
Abusive head trauma in children: a literature review	NO	YES	YES	YES	YES	SUPERFICIAL
Swept-source OCT findings in shaken baby syndrome: case report	NO	NO	YES	YES	NO	NO
Neonatal abusive head trauma without external injuries: suspicion improves diagnosis	NO	NO	YES	YES	YES	NO
Shaken Baby Syndrome - A Case Report	YES	YES	YES	YES	YES	NO
Infant abuse diagnosis associated with abusive head trauma criteria: incidence increase due to overdiagnosis?	YES	NO	YES	NO	NO	NO
Modeling of inflicted head injury by shaking trauma in children: what can we learn?	NO	YES	YES	NO	NO	NO
Traumatic shaking: the role of the triad in medical investigations of suspected traumatic shaking	NO	YES	YES	YES	NO	NO
Shaken Baby Syndrome or Shaken Baby Syndrome: Eye injuries	YES	YES	YES	YES	YES	NO
Shaken Baby Syndrome: knowledge of early childhood education professionals.	YES	NO	NO	NO	NO	SUPERFICIAL
Diagnosis of abusive head trauma : neurosurgical perspective	NO	NO	YES	YES	NO	NO

Table 2: Comparison between the works

Source: Prepared by the authors

to establish prevention methods, but without detailing them; 12 articles did not even address prevention in the text. Only 1 study presented the prevention of shaken child syndrome in depth. In this study, Lopes (2013) mentioned a partnership between the Westmead Children's Hospital in Sydney, Australia, and Brazilian study centers: UFSCAR in São Carlos; the Center for Integrated Studies in Childhood, Adolescence and Health in Rio de Janeiro; the Zero to Six Institute in São Paulo; and the Special Interest Group on Child and Adolescent Health of the University Telemedicine Network. This partnership resulted in the translation and adaptation of the video "Responding to a crying baby" into Portuguese. The animated video, created by "The Shaken Baby Prevention Project" at Westmead Children's Hospital, shows a couple trying to deal with a crying baby. Information about crying patterns is also provided and it is mentioned that babies must not be shaken.

Caffey (1946 apud HUNG, 2020, p. 241) was the first to associate the occurrence of cases of children with long bone fractures, the presence of chronic subdural hematoma and retinal hemorrhage with the act of shaking the child, and came to designate the term "Shaken Baby Syndrome" in 1974. For decades, this term was used to describe the triad of injuries resulting from the act of violently shaking the baby, especially in the first months of life. Subsequently, the American Academy of Pediatrics (2009 apud HUNG, 2020, p. 241) recommended the term Abusive Traumatic Brain Injury (ABT), which encompasses both neurological injuries caused by mechanisms that do not involve direct impact against a solid surface and those that do.

According to Hung (2020), the act of repeatedly imposing flexion and extension movements of the head and neck causes the brain to collide with the inside of the skull, damaging blood vessels and causing

bleeding, with subdural hematoma being one of the elements that make up the triad of the disease. This is partly explained by the normal anatomical and physiological characteristics of newborns and infants: the head/body ratio is greater, the head being heavier, the cervical muscles are weakened and underdeveloped, not allowing adequate head support, in addition to there being a greater amount of intracerebral fluid.

Quercia (2015) also explains that the base of the brain of babies and infants is flatter and the skull is thinner, which means that the forces suffered are better transmitted to the brain, in addition to the brain not being completely myelinated. In addition to the internal trauma caused directly by the contact of the brain with the internal surface of the skull, there is also the possibility that the shaking could cause direct contusion against a solid external environment, which could lead to skull fractures.

The second core of the TCA triad is the occurrence of encephalopathy. Quercia (2020) argues that encephalopathy is caused by diffuse axonal damage, a consequence of the whiplash mechanism with acceleration and deceleration of the head. In contrast, Geddes et al (2001 apud FERREIRA and SILVA, 2013, p. 146) postulates that encephalopathy is caused by an ischemia mechanism, due to episodes of apnea due to brainstem injury. After hypoxia, cerebral edema and increased intracranial pressure develop. As a result of encephalopathy, irritability, dyspnea, refusal to eat, crying, vomiting, drowsiness, loss of consciousness, lethargy, seizures, coma and, in extreme cases, death may occur. In addition to encephalopathy and cerebral hemorrhage, retinal hemorrhage completes the classic TCA triad. Eye injuries result from traction induced on the retina by the vitreous, with rupture of the final layers and collection of blood in the resulting cavity (Quercia, 2015). Therefore,

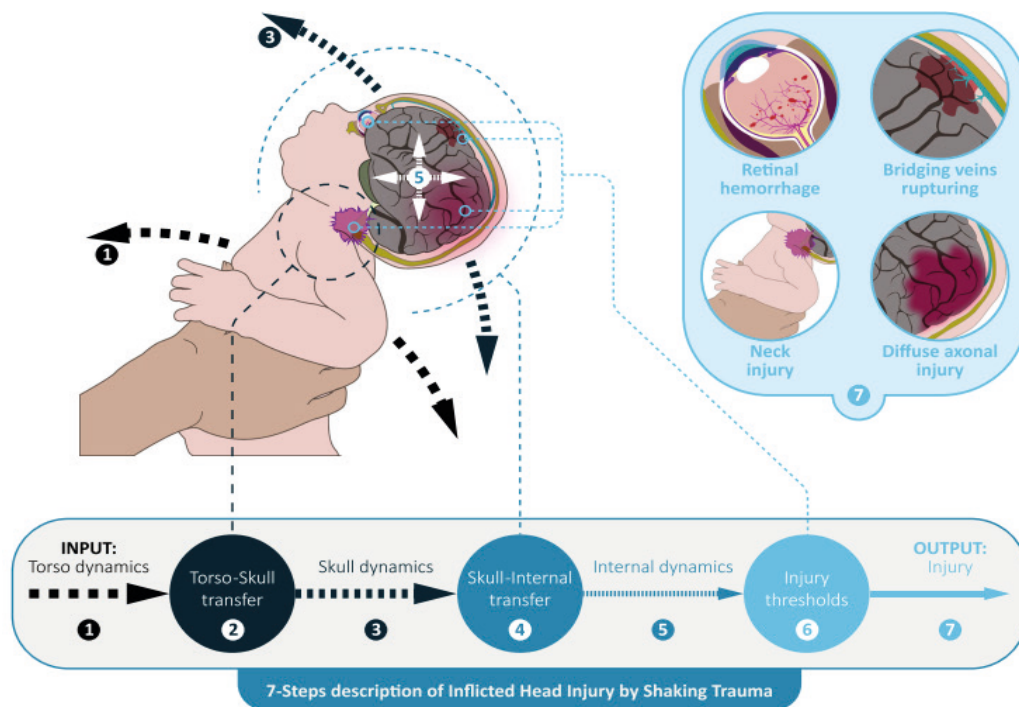


Figure 1: Mechanism of head injury inflicted by shaking in children

Source: Zandwijk (2022). (1) Application of force to the trunk (2) The force is transferred to the head and from there to the skull (3) (4) and brain (5). In this case, due to the characteristics mentioned in the text, there is an internal collision of the brain with the internal face of the skullcap (6) causing injuries: retinal hemorrhages, ruptured veins, neck injury and diffuse axonal injury (7)

a consultation with an ophthalmologist is essential in cases of suspected trauma, and the initial examination performed is fundoscopy with or without mydriasis. In cases of TCA, the rate of retinal hemorrhage is very high, approaching 100% (Orozco-Gomes, 2020). It is noteworthy that the prognosis for this syndrome in question is bleak, with many children presenting irreversible neurological and visual sequelae (Ferreira and Silva, 2013).

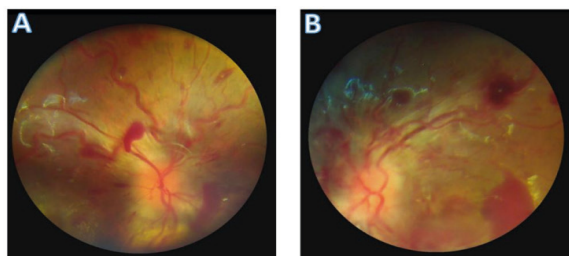


Figure 2: (A) Fundus of right eye, (B) Fundus of left eye

Source: Hung, 2020. Diffuse intraretinal and preretinal hemorrhages, with some cotton wool spots and moderate papilledema, more on the left.

Non-contrast computed tomography is the initial imaging test to detect the neurological changes described, with hyperdensity, isodensity and hypodensity on brain tomography suggesting an acute, subacute or chronic case, respectively. If necessary, magnetic resonance imaging may be requested, with the diffusion phase

being particularly useful for a more accurate diagnosis of parenchymal ischemic changes in the acute phase (Hung, 2020). Furthermore, if ACT is suspected, general radiological examinations must also be requested to look for evidence of old fractures in long bones and laboratory tests – complete blood count with platelet count, prothrombin time, partial thromboplastin time, chemistry panel, among others – aiming to exclude alternative diagnoses that may predispose to bleeding and incur in incorrect diagnosis (hemophilia, blood dyscrasias, metabolic disorders), in addition to referring the patient for a consultation with a pediatrician and ophthalmologist. (Hung, 2020; Loredo-Abdalá et al, 2015).

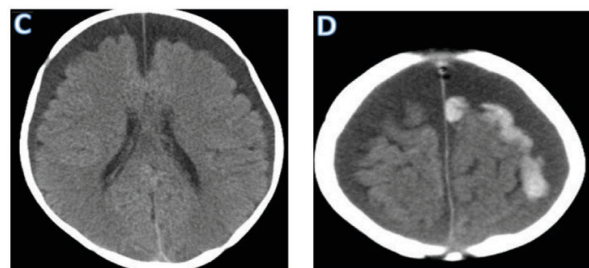


Figure 3: Computed Tomography in a child victim of TCA

Source: Hung, 2020. (C) Initial CT showed bilateral chronic subdural effusion plus (D) acute left subdural hematoma.

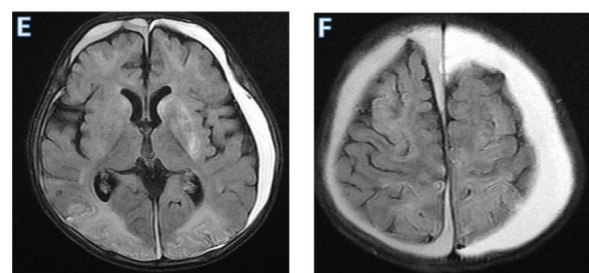


Figure 4: Nuclear Magnetic Resonance of the same patient

Source: Hung, 2020. Flair MRI (E) and (F) taken 2 weeks after bilateral subdural drainage demonstrated asymmetric subdural fluid collections as well as multiple parenchymal ischemic changes in the frontal lobes, basal ganglia (leftmost), and posterior lobes.

The occurrence of TCA must be suspected in cases of clinical history that is not compatible with the severity of the injuries, such as a history of a fall from a low height with multiple or severe fractures, a history of previous family violence, the presence of bilateral retinal hemorrhages or cerebral hemorrhage in children up to 1 year of age, the parents' lack of interest in the child's condition, and a delay in seeking medical care. In addition to these, another important warning sign is the report given by the guardian that undergoes changes during the consultation (Hung, 2020; Ferreira and Silva, 2013). However, it becomes a difficult diagnosis to suspect, even among pediatricians, when there are no clear signs of child abuse. In general, in most Brazilian cities, the gateway to child care is provided by the general practitioner, who rarely has the knowledge and experience to distinguish suspected cases of TCA. Therefore, awareness campaigns dedicated to professionals working in emergency and urgent care units are essential for recognizing the syndrome and making a diagnosis possible. Reference centers must be prepared to receive and evaluate any suspected case for its correct elucidation, not failing to diagnose specific cases of child abuse due to the dramatic consequences that involve it: activation of the child protection council, loss of child custody and criminal proceedings. According to Luna-Monoz (2021), regardless of the signs and symptoms that led the child to the emergency department, the health professional must always be alert to the possibility of mistreatment.

Lopes et al (2016) described crying as the main trigger for shaking a child. According to Hung (2020), babies cry most frequently between 6 and 8 weeks of age, the peak occurrence of ADT. It is considered normal for a child to cry for 2 to 3 hours a day, and crying is not necessarily linked to some basic need of the child, as many people think. Infant crying



is the baby's way of communicating with the external environment (Lopes et al, 2013). However, during crying spells, the caregiver may lose control and shake the child, holding him or her by the shoulders, in an attempt to make him or her stop crying.

Given the immense damaging potential of acute trauma, its irreversible consequences, possibility of death, impact on society, and the costs associated with diagnosis and treatment, it is essential to consider guidance programs aimed at stopping the act that causes the injury. Thus, two aspects deserve to be highlighted when considering strategies to reduce the incidence of EAT: better knowledge of the target audience (fathers, mothers, caregivers) about the nature of infant crying and the harm that shaking the baby can cause. Cardoso and Toni (2020) reinforce the option of, during a crying fit, leaving the child in a safe and appropriate place, while the caregiver leaves for a few minutes so that the child has time to calm down. There was great resistance to this practice, which is seen as harmful, but in fact, it is the best course of action on occasions when the caregiver is at the point of exhaustion and about to lose his or her cool, as it avoids giving in to the impulse to shake the baby. Luna-Munoz (2021) cites factors that can deteriorate the mother-child bond, culminating in reduced care and a predisposition to child aggression: insecurity, irritability, fear, stress, postpartum depression, and sociocultural factors. Therefore, it is extremely important to investigate these emotions and circumstances during the child's consultation, as well as to instruct on how to deal with and resolve them.

Initiatives similar to those reported by Lopes (2013), with more modern language and better emphasizing the consequences of shaking the baby, could be carried out today, a measure that would have a much better impact on contemporary society due to the modern characteristics of social networks, impacting a

greater number of people and bringing more knowledge about ACT. Such initiatives could include, at low cost:

a) Awareness campaign on the day to combat child abuse, created on June 4, 1982 by the UN (United Nations) that aims to alert the conditions of violence that children are subjected to around the world. Brazilian medical societies, especially pediatrics, could use the date to publish posts on their social networks about the syndrome and its harmful effects. Influencers could help to disseminate the information and, thus, reach a greater number of people. b) Likewise, the day could be used to raise awareness among professionals working in emergency services about cases of TCA, its clinical presentation, diagnosis and the importance of seeking pediatric, neurological or ophthalmological evaluation if there is a suspicion of aggression.

Other opportune moments in which the population could be raised awareness and knowledge about the syndrome could be spread would be:

- a) Prenatal consultations – Provide guidance to future mothers on the harmful effects of shaking a child, and emphasize that TCA does not necessarily refer to violence per se. The act of making a child fall asleep on your lap with sudden movements may be enough to cause injury.
- b) Upon discharge from the maternity ward: a newsletter could be given with basic guidelines and explanations about baby crying, its characteristics, and about the syndrome and the dangers of shaking a child.
- c) Vaccination campaign – Children are required to receive vaccinations in the first, second, fourth and sixth months of life. This period is critical due to the anatomical characteristics of the child who is still developing and because it is a period in which crying is prevalent.

Therefore, this moment could be used to reinforce the guidance given to mothers before discharge from the maternity ward. In addition, the vaccination booklet, which already contains information about nutrition and growth, could also contain guidance on child abuse and ways to avoid it. d) Disseminate information about the syndrome in childcare follow-up, both in consultations carried out by general practitioners in the public sector and in specialist care in the private sector.

It is very common for babies to be affected, so it is important to assess, within the physical examination, the child's neurological examination (presence of primitive reflexes and whether there is adequacy of the respective ages of disappearance, characterization of motor tone, state of reactivity and responsiveness). Furthermore, as explained by Ferreira e Silva, violent head trauma can cause damage in the various areas that include neuropsychomotor development, and it is important to assess whether there is adequate acquisition of developmental milestones, since cognitive, linguistic, behavioral and motor changes can last for years.

e) Mental health clinics can be responsible for guiding pregnant patients regarding childcare in order to avoid the syndrome, since, theoretically, this is a more sensitive population, subject to mood swings and irritability, depression and anxiety when the baby reaches its peak of crying around 2 months.

f) It is extremely valuable to train health professionals working in primary care through the "Child Development Monitoring Course in the Context of IMCI (Integrated Care for Childhood Illness)", so that they have sufficient basic knowledge to adequately assess child

development. The proposed material provides information on risk factors, family relationships, behavioral aspects, anthropometric assessment, and physical examination in different age groups. Such training can be based on the practice of written exercises and the transmission of explanatory videos to professionals to didactically elucidate the syndrome and its prevention. g) Finally, educational actions seeking to instruct schools, daycare centers, and childcare providers. As Cardoso and Toni (2020) point out, many parents need to leave their young children in daycare centers or educational centers due to work demands. Therefore, guidance in this professional segment is essential to prevent the occurrence of child abuse, since both public and private school educators demonstrated very little knowledge of the existence of ACT, according to research conducted by the authors.

## CONCLUSION

Shaken baby syndrome is a condition that is still little known and discussed in the literature and in the medical field, facts that hinder diagnosis and encouragement for prevention. Patients who are affected by the aggression and the clinical manifestations and complications that result from it may present serious consequences throughout their lives, for example, delays in neuropsychomotor and emotional development and irreversible visual impairment. Therefore, it is of utmost importance to explain what the syndrome consists of and its causes, and to address preventive measures at a professional level in the health area (prenatal and childcare consultations, or in any other general or emergency care) and in the social sphere, including awareness campaigns for the general population, to prevent the occurrence of this trauma and its repercussions.

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