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ORIGINAL ARTICLE

Shaken Baby Syndrome: Diagnosis, treatment, prevention, through a multidisciplinary approach

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Dominika PRŮCHOVÁ

Department of Clinical Disciplines, Health and Social Studies, University of South Bohemia, Ceske Budejovice, Czech Republic.

Key words: **shaken baby syndrome; neurological complications; brain damage; retinal hemorrhage; multidisciplinary team**

ABSTRACT

The incidence of shaken baby syndrome (SBS) has been mapped in detail in a number of advanced countries throughout the world, with very detailed data being available from the USA, New Zealand, Japan, etc. Unfortunately, data related to the prevalence of this syndrome are not available in the Czech Republic. It is estimated that 21–74/100,000 children worldwide fall victim every year. SBS refers to a collection of symptoms that occur in children traumatized by being shaken. Most frequently, the victims are infants younger than one year of age, usually between 5 and 6 months old.

The damage is primarily neurological in nature when brain tissue, blood vessels and nerve junctions are traumatized. The characteristic clinical findings in shaken baby syndrome are retinal hemorrhage and subdural or subarachnoid bleeding with no external evidence of head injury. The biomechanics of such trauma are also well understood. Victims of SBS suffer high morbidity and mortality rates, particularly in infants younger than six months of age. Children who survive SBS often develop long-term consequences, the nature of which depends on the degree of trauma sustained. Such consequences require long-term monitoring and treatment by a multidisciplinary team of experts actively involved in the process from the time of the child's admission to hospital. The role these physicians, medical staff and medical social workers play in the recovery process is both invaluable and irreplaceable.

Correspondence to: Mgr. Dominika Průchová, Zámek 110, 379 01 Třeboň, Czech republic.
TEL: +420 602474744; E-MAIL: dpruchova@seznam.cz

The aim of this publication is to provide a comprehensive overview of shaken ba syndrome in response to related research that has been published abroad. A large porti will be dedicated to the diagnosis and long-term treatment of the consequences resulti from SBS, as provided through the cooperation of the multidisciplinary team.

SHAKEN BABY SYNDROME

Shaken baby syndrome (SBS) results from an infant being held by the trunk, sho ders or limbs (arms) and vigorously shaken (Caffey 1972; 1974). From a biom chanical perspective, it can be defined as the result of, centripetal and centrifu forces tearing, or otherwise damaging, intracranial vessels and cortical nerves. T sudden cessation of head movement whilst bent in a backward position generat tremendous force on delicate intracranial structures without producing extern injury. Victims of SBS suffer high morbidity and mortality rates, particularly infants younger than six months of age. It is estimated that 21–74/100,000 childr worldwide fall victim to the syndrome every year. Most frequently, the victims a infants younger than one year of age, usually between 5 and 6 months old. (Min & Brown 2006; Deyo *et al* 2008; Palmer 2009; Reith *et al* 2009).

FAMILY RISK FACTORS

According to statistics compiled by the United States Department of Health 1996, the persons most commonly responsible for causing SBS are either paren (77%) or relatives (11%). Numerous family risk factors are associated with in dents of infanticide. Single-parent families are a factor in the prevalence of ch abuse. The mother's age, as well as her level of education, plays a role as well. high frequency of head injuries can be seen in children of single parents who a younger than 18 years of age and did not complete high school, and have not be acquainted with the principles of healthy living through social services offer through child protection agencies. A greater risk can also be linked to a mothe low level of education in conjunction with her own young age. In cases of sin mothers, the presence of a male partner (whether boyfriend or step-father), is a a risk factor because they are often the offender. Alcohol, drugs, a previous histo of abuse and the single-parent's partner (whether male or female) are the most f quently documented risk factors. Additionally identified risk factors include: familial structure: (a) single-father households, (b) families with more than th children, [2] demographic factors: (a) a mother's low level of education, (b) l levels of religious cohesion, (c) a mother's young age, (d) single parenthood, positive socioeconomic conditions (welfare), [3] family factors: (a) early sepa tion from the mother, (b) maternal dissatisfaction, (c) serious illness in the moth (d) maternal sociopathy (Lazoritz & Palusci 2002; Peinkofer 2002).

CHILDREN AS VICTIMS

In the USA, more than 1 million child victims of battery have been taken into custody by Child Protection Services, with 50,000 cases of SBS being reported in a single year (Fedor *et al* 2009). Nearly 78% of the children were younger than five years of age and 38% of them were younger than one year. Boys are more frequently affected than girls, with most cases occurring in children younger than five years of age. The age and gender of male victims are highly significant risk factors. The relationship between a victim's age and the gender of the offender was also examined: men's victims were usually infants and women's victims were usually of neonatal age. Lazoritz & Palusci (2002) reported that 1.3/100,000 newborns and 4.3/100,000 infants were abused in 1997.

Victims of SBS are usually infants younger than one year of age; typically between 5 and 6 months of age. They also usually come from families with parents who (a) have low levels of education, (c) are younger than 18 years of age, (d) have poor socioeconomic living conditions and low incomes and (e) have ethnic minority parents. Boys, children born prematurely, children with a higher order of birth/child born after one or more children have been born in the family, without prenatal care. Unfortunately, detailed statistics such as these are lacking in European Union countries. (Lazoritz Palusci 2002; Stanková 2007).

The trigger for an SBS incident is usually a crying child, even though it is the child's only means of communication. During this moment, the caregiver fails to respond properly to the child's crying. Crying has its own course of development in accordance with a child's age. The "Crying Curve" begins to increase at around 2 to 3 weeks of age and peaks at around 6 to 8 weeks of age (Lazoritz & Palusci 2002). The peak of the crying curve is called the "Period of Purple Crying" (Barr *et al* 2009a; 2009b; Talvik *et al* 2008).

SBS SYMPTOMS

Symptoms are very often non-specific – excitability, problems with feeding or eating problems, vomiting, diarrhea, irritability, lethargy, apnea, seizures and other minor injuries. These symptoms are also present in other illnesses such as viral infections, colic or diet intolerance. For this reason, the identification of these children is often very difficult or delayed. Family history is important in revealing the likelihood of physical violence (Peinkofer 2002).

Research from abroad has revealed certain facts: in 23% of cases, the primary symptoms were vomiting and irritability. The infant's profile: Age – younger than 180 days; Race – most commonly Caucasian children; Family composition – two-parent household (Lazoritz & Palusci 2002).

DIAGNOSIS AND TREATMENT

This article is comprised of aspects involving a multidisciplinary approach in the cases of children suffering from the neurological consequences of shaken baby syndrome.

Case-history is a very important factor in revealing the truth behind incidences of suspected child abuse. It is necessary to have an understanding of the biomechanics of injuries in order to differentiate between traumatic and non-traumatic head injury. Both the biomechanical evaluation and case history should be complementary and should be examined together, as case-histories alone can sometimes be unclear and misleading. It is also helpful to have an understanding of force and experimental models. No manner of common force which causes turning/rotation of the head can cause a diffuse injury. Falls or other accidental head injuries usually involve lower speeds, and these injuries cause a lesser degree of brain damage. (Felekis *et al* 2008; Matschke *et al* 2009).

The role played by social services/social agencies which identify risk factors and collect the child's family history involves obtaining: previous medical documentation, family history, social history, and a complete environmental background (socioeconomic status, prematurity, large families, young parents, disabilities).

Shaken baby syndrome is associated with injuries of the central nervous system. Non-traumatic head injury is usually found in 10% of injured children who are younger than two years of age. Cranial vault fractures, subdural bleeding, localized parenchymal bleeding, diffusion axonal injury and spinal cord injury may be present in shaken baby syndrome. Retinal bleeding is usually present in 65–100% of violent head injury cases in children. The severity of neurological impairment correlates with the degree of retinal hemorrhage. Cranial fractures intersecting with cranial suture lines, multiple fractures and bilateral fractures are found much more frequently in violent head injuries, as opposed to those of an accidental nature.. Brain injury can be acute or chronic.

Examinations must be thorough and multifaceted. All findings should be documented using detailed diagrams and scans. Special attention must be paid to vital signs, such as hypothermia, bradycardia and irregular breathing, which are commonly linked to intracranial injuries associated with shaken baby syndrome.

CT examination findings include subdural hemorrhage, particularly that of acute subdural interhemispheric or localized parenchymal bleeding. Magnetic resonance imaging (MRI) can reveal subdural hematomas, cortical contusions and lacerations. Acute subdural hematomas are usually associated with severe neurological decompression, encephalitis or death. An ophthalmological examination is also important due to retinal bleeding. Retinal hemorrhaging is found in more than 95% of SBS cases. Ophthalmological diagnosis is one of the most important tools, as it is able to differentiate between injuries caused by shaking, non-violent injuries, or injuries sustained during the birth process (Lazoritz & Palusci 2002; Peinkofer 2002; Mraz 2009).

Among other injuries associated with violence are bone fractures. Fractures are particularly prevalent – metaphyseal and costal fractures in specific, which are more frequently found in younger children. In older children, such injuries are usually not that serious but in SBS can lead to behavioral issues, etc..

In the most serious of cases, initial treatment consists of endotracheal intubation, manual ventilation, resuscitation and possible use of anticonvulsive therapy. Surgical treatment is usually associated with the presence of extensive acute intracranial hematoma (with infants <6 months being the most vulnerable). In these cases, the prognosis is very unfavorable (Christian & Block 2009).

The consequences of SBS include mortality in 7–30% of cases, cognitive and neurological deficits in 30–50%, and complete recovery in 30%. A study conducted by the Children's Hospital of Wisconsin indicated that 78% of deaths involving children between the ages of birth and two years were due to non-traumatic head injuries. Age, therefore, plays an important role. Shaken baby syndrome is not significantly associated with damaged to other organs (Lazoritz & Palusci 2002; Peinkofer 2002).

PROGNOSIS

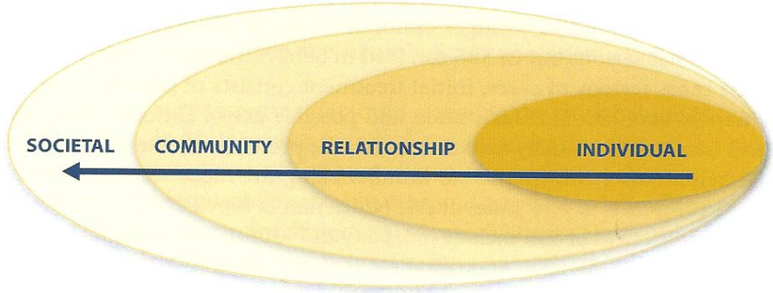
SBS is associated with a high incidence of mortality and neurological morbidity in surviving patients. Published reports estimate that SBS is present in 10–12% of all cases in which a child dies as the result of physical shaking or abuse. Approximately 25% of all clear SBS victims die of resulting injuries. 57% of SBS survivors will develop neurological complications. These children can experience motor or sensory impairment, growth and developmental delays and blindness; additionally they can experience associated symptoms such as, impaired vision, epilepsy, hemiparesis, psychomotor retardation, psychiatric problems, mental retardation, and learning disorders. A misdiagnosis occurs in approximately 31% of cases. .

ECONOMIC COSTS

Financial costs related to shaken baby syndrome include such things as hospitalization, follow-up visits with a doctor, physiotherapy, educational therapy, behavioral therapy, legal fees related to custody and court proceedings, as well as subsequent social services as required by the family and child. In the United States, care for the victims affected by SBS (and their families) is calculated to be between 1.2 and 16 billion USD every year. In some cases, additional costs can include loss of productivity and wages from work, as well as the cost of judicial prosecution and imprisonment of the family member responsible for the act itself (Lazoritz & Palusci 2002).

The average cost of an emergency room visit in the USA can be up to 30,000 USD. For SBS victims with severe long-term consequences (paralysis, spasms, learning disabilities, hearing and vision impairments, etc.), these costs can be as high as 3,000,000 USD during the first five years of the child's life (Lazoritz Palusci 2002; Peinkofer 2002).

Creating a framework for prevention



Explanation:
INDIVIDUAL - The Individual Level
RELATIONSHIP - The Relationship Level
COMMUNITY - The Community Level
SOCIETAL - The Societal Level

This model serves as a practical framework for compiling prevention strategies. Activities, partnerships and political recommendations are specified in the model, building on each of the four levels of the framework. In addition, we can also use the model as an instruction manual on how to utilize resources and address the public at different levels (Lazoritz & Palusci 2002).

- *Individual Level Strategy* – the aim is to implement change in the knowledge and skills of parents and caregivers.
- *Relationships Level Strategy* – the aim is to change the interactions between people – parents and children, caregivers and children, parents and caregivers, and parents and healthcare providers.
- *Community Level Strategy* – the aim is to reduce the characteristics of community activities that lead to violence, and/or increase those that help prevent violence (e.g. resolving the social or economic factors, accessibility and availability of parental support programs, early child care services).
- *Societal Level Strategy* – the aim is a change in the cultural norms relating to parenthood, as well as laws and politics focused on parental support (Peinkofer 2002).

THE ROLE OF THE MEDICAL SOCIAL WORKER

Social work is the only health care occupation which examines roles, relationships, resources and their impact on life. Thus, evaluations within the field of social work are critical to the identification of psychosocial factors which impact health care interventions. While a hospital evaluation automatically presupposes a medicinal model which tends to view abnormal behavior as a consequence of disease, the social model regards behavior as a result of learned behaviors and environmental

conditions. Within the hospital setting, these two models should both intersect and complement each other through the work of a multidisciplinary team and through the medical social worker, in particular. Of all the duties and responsibilities assigned to medical social workers in the hospital setting, one unifying principle is the most important: "What is best for the child?" It is in these cases, where the victim is an infant with suspected shaken baby syndrome, that this statement and principle are absolutely crucial. The tiny victim in these cases is defenseless, vulnerable, totally innocent and, unfortunately, incapable of testifying about his or her life experiences. The social worker should examine, monitor, collect and analyze and evaluate everything available in order to put plans and processes into motion that will lead to the best reintegration of the abused child (Lazoritz & Palusci 2002; Peinkofer 2002).

THE NEED FOR FUTURE RESEARCH

Scientific evaluation is an important criterion for management and policy determinations. The field of child advocacy needs to adopt a scientific paradigm and plan of action to stabilize the system. It should include data system applications with identification systems, restraining systems, internal feedback, follow-up and long-term results. Additional research is also needed in the areas of diagnostics, treatment and prevention. There is also a need for more researched-based longitudinal studies, which already exist in some countries. The "LONGSCAN" study focuses on the issue of child abuse and neglect and may, in the future, prospectively identify the incidence and financial costs of shaken baby syndrome for the whole population. Until this estimation is made, primary and secondary prevention (prevention programs) is invaluable (Lazoritz & Palusci 2002). There is a particular need for such research in the Czech Republic (Truellová 2008; Průchová & Velemínský 2010).

CONCLUSION

In the Czech Republic, the issue of shaken baby syndrome has rarely been studied and little has been published on the subject; furthermore there is little or no data regarding incidence and prevalence. Instead, the SBS issue appears only occasionally in the media when there is a case of child abuse and this type of injury is suspected. (Doležel 2007; Fedor *et al* 2009). Diagnosis is difficult for the physician due to the fact that parents (or responsible caregiver) are often completely unaware that their actions could harm the child. Symptoms are often non-specific and therefore many cases can be misdiagnosed. Parents have almost no awareness of this syndrome, and thus they need to be properly informed. Approximately 25% of all SBS victims die as a result of its consequences. 57% of those who survive SBS develop neurological complications. These children may experience motor or sensory impairment, developmental retardation, etc. The follow-up care of these

children is very important, but is it also financially and organizationally challenging. With regards to prevention, the education of the families and caregivers is especially important; at the same time, the identification of high risk families is crucial so that they can receive assistance and proactive interventions to prevent SBS (Lazoritz & Palusci 2002; Truellová 2008; Průchová & Velemínský 2010).

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