

## CAPÍTULO 1

# CRANEOENCEPHALIC TRAUMA IN PEDIATRICS, A PREHOSPITALARY PERSPECTIVE

*Marrugo-Puello Teresita de Jesús<sup>1</sup> / Sánchez-Becerra Jorge Antonio<sup>2</sup>  
Almanza-Parra Andrés Miguel<sup>3</sup> / Ramos-Monsalve Lorena<sup>4</sup>  
Hernández-Muñoz Andrés Felipe<sup>5</sup> / Cardona-Gómez Laura<sup>6</sup>*

## Summary

Cranioencephalic trauma (CET) is the leading cause of death by trauma in children, mostly affecting ages from preschool to primary school. It is considered one of the most significant injuries in the initial stage of an infant's life. The initial management given by the pre-hospital care technologist is decisive in a definitive diagnosis and in the sequelae that may develop in the future. Globally, Prehospital Care Emergency Medical Service (EMS) management, which should be provided after childhood CET, is an important area of study; however, little is known about current management and the development of protocols and guidelines for EMS.

**Objective:** The purpose of this article is to carry out a systematic review of pediatric CET literature and to specify prehospital management, sequelae, and causes in some countries of the world.

**Method:** The following databases were reviewed: Cochrane, Library, The Network, Scielo (Scientific Electronic Library Online), Medline (Pubmed), Redalyc, Ebsco and the Virtual Health Library. Collected articles were evaluated with Prism, Coreq and Strobe scales to recognize the feasibility of preselected items.

<sup>1</sup> Pediatrician and Pediatric Cardiovascular Intensivist.

<sup>2</sup> PhD in Biomedical Sciences.

<sup>3 4 5 6</sup> Prehospitalary Care Students.

**Key words:** Injury, brain injury, children, prehospital, Glasgow Coma Scale, cranioccephalic, paramedics.

## Introduction

Traumatic brain injury is a public health problem due to the high mortality rate and disability that it causes, especially in economically active age groups. (1) Triage of a traumatic brain injury victim requires rapid assessment and timely initiation of appropriate treatment to control primary injuries and their complications. The paramedic has an important role in the evaluation and initial management of an individual with head trauma, since he or she is the patient's first contact with the health system. Traumatic head injury can be a life-threatening emergency, however, the Health Professions Act (HPA) can be the first contact in less severe cases of head injury, so it is necessary to stay up to date on the most relevant aspects of the treatment of this condition. (1)

## Method

To develop this research, the Cochrane, Library, La red, Scielo (Scientific Electronic Library Online), Medline (Pubmed), Redalyc, Ebsco and Virtual Health Library databases were reviewed. The collected articles were evaluated with the Prisma, Coreq and Strobe scales to recognize the viability of the pre-selected articles.

## Project Methodology

A review of scientific articles published in Spanish and English was conducted using a combination of key words such as: pediatrics, child, preschool, infant, traumatic brain injury, pediatric traumatic brain injury, brain injury, Latin America, management, treatment, head trauma, pre-hospital, pediatric, Colombia, also, the use of connectors such as "and", "or" and search exceptions using the connector "not" were used in an effort to

further narrow the search field for the platform.

The reviewers then examined the most important articles with its titles and abstracts to identify relevant studies. If any study was selected, the full text was obtained, and the following exclusion criteria were studied: 1. articles not from the last 10 years, 2. articles whose full document was a guideline, book, 26 seminars and/or thematic presentations, 3. articles that did not allow access to the full document.

Scales were used to verify the reliability of the collected articles, the articles that complied with the following scores when filtering them in the tables were the final articles examined; strobe scale a minimum score of 25 points was used, on the prism scale a minimum score of 10 points, and on the Jadad scale a minimum score of 3 points was used.

The studies that met all of the above criteria were reviewed and evaluated according to the country where they were conducted, and considering specific points about management, causes, and sequelae reported by the studies, in order to make a more detailed approach to the data that would best serve for the development of future management protocols and guidelines for Colombia.

Discrepancies among the reviewers were resolved by consensus or by a methodological and thematic advisor. In addition, study references were examined to identify other potentially relevant studies. (8)

## **Development**

In reviewing the different studies, it was found that in some countries such as Cuba, severe head trauma is one of the main causes of hospitalization and mortality in children over one year of age. The groups most vulnerable to suffering head trauma are male children over 5 years of age, and the main cause of head trauma is, among accidents, falls from heights. (2) Males are most affected because their sports activities and play in general tend to be more intense or violent.

Traumatic brain injury or ECT is the leading cause of death in children in the United States. Each year, 37,200 children suffer a severe traumatic brain injury, with up to 1.3 million lives potentially affected negatively. (3)

In a developed country like Korea, head trauma in infants occurs mainly after falls, while older children suffer from transportation accidents and sports-related injuries. In India, traumatic brain injury in children is a major cause of morbidity and mortality, with falls being the most common type of injury, followed by motor vehicle accidents and child abuse between the ages of 1 to 8. In countries such as Peru, Guatemala and Bolivia, the most frequent cause of ECT is falls (67.1%), followed by traffic accidents (18.0%). The most frequent gender was male (53.6%) and the most affected age group was 0-4 years. Falls at home are the main cause of ECT where children under 5 years old are the most affected. (4)

In Ecuador, head trauma is the leading cause of death. In this country, falling from heights is the main cause of death in children under 9 years of age, with injuries to the lower limbs and spine being the most frequent. The anatomical region that is most involved is related to age ranges, with the head region being predominant between the ages of 0-2. Sixty percent of those involved are male. (5)

In Colombia, pediatric patients present more frequently with cranioencephalic injury, especially when the patient is younger, because they contain a proportionally larger cranial surface, relatively weak cervical musculature, a thinner and deformable bone plane, and they can develop hemorrhagic and ischemic shock (6) The main cause of trauma in a study done in Colombia was falls (75%), followed by traffic accidents (13.3%). The most frequent place where the trauma occurs is at the patient's home during weekday afternoon hours (7)

Focal lesions are due to direct forces transmitted through the skull and are divided into several types: contusion and scalp laceration. The National Pediatric Trauma Registry and the National Trauma Data Bank of the American College of Surgeons continue to

identify blunt trauma as the most common mechanism of injury, while penetrating trauma only represents 10% of cases (7), the average age was 4.5 years.

The use of the Glasgow Coma Scale, endotracheal intubation and mechanical ventilation in severe traumatic brain injury is essential in the management of ECT because it protects the airway, allows sedation, prevents hypoxemia by maintaining adequate oxygen blood pressure, and prevents hypoventilation. The first objective in the management of acute injuries is to promote neuroprotection and brain perfusion. (8)

Therefore, traumatic brain injury produces a series of pathophysiological events that evolve over time. In ECT, these include cerebral edema, intracranial hypertension and secondary brain injuries of systemic cause. Brain edema is defined as the increase of the cerebral parenchyma at the expense of interstitial or intracellular fluid, producing an increase in ICP (intracranial pressure) due to mass effect.

Physical and emotional deficits may be evident for years after the injury occurs such as dysautonomia, post-traumatic seizures, and dyspraxia which is a sensory processing disorder of front parietal brain injury resulting in poor performance of motor skills tasks. (3)

In Korea generally post-trauma children have a permanent neurological disability. Immediate resuscitation and prompt treatment of ICP are essential to obtain favorable results in patients. (9) While in India, sequelae such as anisocoria.

## Discussion

Prehospital care is an important factor in the management of children with ECT, but prehospital protocols and guidelines have not been developed solely for the management of pediatric ECT. Research and the creation of training materials for prehospital care technologists will help to reduce future sequelae, morbidity, and mortality in children with ECT. Parents are the first ones to have contact with their child who has suffered ECT, so they should be trained and given information on how to prevent this type of accident and

on what actions they should take before the HPA arrives, all of which will increase the survival of the child suffering from ECT.

More research should also be done on health-related quality of life, since it is important to know the consequences of adequate management and how this increases the chances of child survival, in order to reduce pediatric morbidity and mortality.

Prevention is a fundamental part of preventing children from dying from ECT. If more consent campaigns are conducted for parents and caregivers on how to avoid this type of injury, the lives of millions of children around the world who are affected by ECT can be saved. Since falls are the main cause of pediatric ECT, they can be more easily avoided by parents, with proper monitoring and attention at the child's developmental ages, and therefore the incidences of this type of injury can be reduced.

## Limitations

The lack of information on the subject concerning prehospital care is a limitation for the advancement of research, due to the facts that this subject has been studied more in the intrahospital realm, and that the articles found discuss diagnostic aids and medicines, which are tools not available in the prehospital domain. For the research we used exclusion criteria regarding on the years of publication of the articles that were in the databases, and we did not consult articles published before 10 years ago. Consequently, at the time of reviewing the articles we saw the limitation that many of the articles did not meet this criterion and therefore could not be used in the systematic review, thus reducing the number of articles that would serve for research.

## Conclusion

With the information given above, in all countries ECT continues to be the leading cause of pediatric death, predominantly in children between 2 and 8 years of age, with males being more affected than females. Childhood trauma is predominantly caused

by falls, traffic accidents, abuse and violence; the most frequent injury mechanism was closed trauma, causing cerebral edema, intracranial hypertension and secondary brain injuries of systemic cause that greatly affect child survival, and ultimately bring neurocognitive sequels altering its normal development. According to the complications that ECT can trigger, prehospital personnel can prevent complications such as cerebral hypoxia and increased intracranial pressure by performing additional maneuvers to permeate the airway or provide oxygen, with quality care, seeking to increase the chances of survival and prevent sequelae in children.

## Bibliography

1. Marcela A, López C, Valladolid A, Angélica C, Ambriz A, Yanin L., et al. Abordaje del paciente con traumatismo craneoencefálico. 2020. [cited 2020 Apr 17]. Available from: <http://dx.doi.org/10.22201/facmed.14058871p.2019.1.67714>
2. Rodríguez V, Tena M, Viamontes W, Gallo B, Montejo J, Pérez Y. Evaluación de las secuelas intelectuales en niños con trauma craneoencefálico severo. *Revista Cubana de Pediatría* [Internet]. 2014 [cited 2020 Apr 16]. 86(3):336–43. Available from: [http://scielo.sld.cu/scielo.php?script=sci\\_arttext&pid=S0034-75312014000300008&lang=pt](http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S0034-75312014000300008&lang=pt)
3. Popernack M, Gray N, Reuter-Rice K. Moderate-to-Severe Traumatic Brain Injury in Children: Complications and Rehabilitation Strategies. *J Pediatr Health Care* [Internet]. 2015 [cited 2020 Apr 20]. May 1; 29(3): e1–7. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4409446/>.
4. Luis M, Iván O, Guillén-Pinto D, Zea-Vera A, Guillén-Mendoza D, Situ-Kcomt M. Traumatic brain injury in children attending a national hospital in Lima, Peru 2004-2011. *Rev. Perú. Med. Exp. Salud Pública* [Internet]. 2013 [cited 2020 Apr 15]. Vol. 30 No. 4 Lima oct./dic. Available from: [http://www.scielo.org.pe/scielo.php?script=sci\\_arttext&pid=S1726-46342013000400015](http://www.scielo.org.pe/scielo.php?script=sci_arttext&pid=S1726-46342013000400015)
5. Ger B, Ortiz H. Incidencia de lesiones en niños de 0 a 9 años con traumatismos por caída de altura, atendidos por el personal prehospitalario de las alfas “11” y “12” Distrito 17D07 del Distrito Metropolitano de Quito, en el periodo enero 2015 a diciembre 2016. [Internet]. *Dspace.uce.edu.ec*. 2018 [cited 27 Apr 2020]. Available from: <http://www.dspace.uce.edu.ec/bitstream/25000/16430/1/T-UCE-0020-CDI-035.pdf>
6. Macias R, Cantuña M. Análisis de las principales causas de traumatismo craneoencefálico en niños de 1 a 14 años de edad, atendidos por el personal prehospitalario y recibido por el servicio de emergencias del Hospital Pediátrico Baca Ortiz en el periodo de enero a diciembre. Trabajo de titulación previo a la obtención del Título de Licenciado en Atención Prehospitalaria y en Emergencias. Carrera de Atención Prehospitalaria y en Emergencias. Quito: UCE. [Internet]. *Dspace.uce.edu.ec*. 2018 [cited 27 Apr 2020]. Available from: <http://www.dspace.uce.edu.ec/handle/25000/16437>



7. McLaughlin A. Manejo del trauma pediátrico en el ámbito prehospitalario en Colombia. Una revisión sistemática de la literatura. IEEE Commun Surv Tutorials. [Internet]. 2018 [cited 2020 Apr 16]. 15(4): 2046–69. Available from: <https://repository.ces.edu.co/bitstream/10946/3774/2/Manejo%20Trauma%20Pediatico.pdf>
8. Wani A, Sarmast A, Ahangar M, Malik N, Chhibber S, Arif S, et al. Pediatric head injury: A study of 403 cases in a tertiary care hospital in a developing country. J Pediatr Neurosci [Internet]. 2017 [cited 2020 Apr 18]. Oct 1;12(4):332–7. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5890552/>
9. Chong S, Lee K, Lee J, Ong G, Ong M. Pediatric head injury: a pain for the emergency physician? Clin Exp Emerg Med. 2015 Mar 31; 2 (1): 1–8.
10. Jiménez-Aguilar D, Montoya-Jaramillo L, Benjumea-Bedoya D, Castro-Álvarez J. Pediatric Traumatic Brain Injury. General Hospital of Medellin and Clinic Somer of Rionegro, 2010-2017. Traumatismo craneoencefálico en niños. Hospital General de Medellín y Clínica Somer de Rionegro, 2010-2017. Iatreia. 2020;33(1):28–38.
11. Gutiérrez-Ruiz K, Luna D, Mosquera Y, Zuleta J. Revisión sistemática de la calidad de vida relacionada con la salud en niños latinoamericanos con trauma craneoencefálico. Acta Neurológica Colombiana. 2017; 33(4):286–98.
12. Urrutia, M. Evolución neurológica del paciente pediátrico con trauma craneoencefálico. (Maestría). Universidad de San Carlos de Guatemala. [Internet]. 2014. [cited 2020 Apr 15]. Available from: [chrome-extension://dagcmkpagilhakfdhnbomgmjdpk-dklff/enhanced-reader.html?pdf=http%3A%2F%2Fwww.repositorio.usac.edu.gt%2F1526%2F1%2F05\\_9433.pdf](chrome-extension://dagcmkpagilhakfdhnbomgmjdpk-dklff/enhanced-reader.html?pdf=http%3A%2F%2Fwww.repositorio.usac.edu.gt%2F1526%2F1%2F05_9433.pdf)
13. Carpio-Deheza G, Luizaga-Sierra M, Lafuente-Riverola VH, Vásquez-Ríos JC. Clinical and epidemiological analysis of presentation and evolution of head injury in children under 15 years in HNMAV. Rev Méd-Cient “Luz Vida”. 2012;3(1):36-41. [Internet]. [cited 2020 Apr 11]. Available from: <https://www.redalyc.org/pdf/3250/325028226008.pdf>
14. Recalde B, Montoya J. Análisis de supervivencia al trauma craneoencefálico moderado y grave, asociado al tipo de atención inicial prehospitalaria y sus complicaciones en los servicios de emergencia y la unidad de cuidado intensivos del hospital “Carlos Andrade Marín” Quito. [Internet]. Repositorio.puce.edu.ec. 2020 [cited 2020 Apr 27]. Available from: <http://repositorio.puce.edu.ec/bitstream/handle/22000/12636/>

TESIS%20VERONICA%20RECALDE%20Y%20DAMIAN%20MONTOYA.pdf?sequence=1&isAllowed=y 41 2016.

15. Suarez JI. Manejo del traumatismo craneal cerrado. *Rev Neurol*; 2001;32(3):289–95.
16. Popernack ML, Gray N, Reuter-Rice K. Moderate-to-Severe Traumatic Brain Injury in Children: Complications and Rehabilitation Strategies. *J Pediatr Heal Care*. 2015 May 1;29(3): e1–7.
17. Minsalud. Ministerio de Salud y Protección Social República de Colombia. [Internet] 2012. [cited 2020 Apr 12]. Available from: <https://www.minsalud.gov.co/sites/rid/Lists/BibliotecaDigital/RIDE/VS/ED/PSP/Indicadores-basicos-en-salud-2012.pdf>
18. Del Toro S, Mastrapa C, Paredes L, Carralero E, Ávila C, Hernández D. *Correo Científico Médico de Holguín*. Vol. 12. 2008.
19. Raimondi C, Roca M, Lischinsky, A. Rehabilitación cognitiva en pacientes con TEC - Artículos - IntraMed. [Internet]. 2013. [cited 2020 Apr 14]. Available from: <https://www.intramed.net/contenidover.asp?contenidoID=79788>
20. Valdizón M. Complicaciones que repercuten en la morbimortalidad de niños con trauma craneoencefálico severo. [Internet]. 2018. [cited 2020 Apr 16]. Available from: [jesus/capitulos\\_espanyol\\_jesus/2005\\_motivacion para el aprendizaje Perspectiva alumnos.pdf%0Ahttps://www.researchgate.net/profile/Juan\\_Aparicio7/publication/253571379](https://www.researchgate.net/profile/Juan_Aparicio7/publication/253571379)