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Mid-term results in continuous intracranial pressure monitoring in severe traumatic brain injury in children - ERA-NET NEURON Grant

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Abstract: This article presents the mid-term results of the multi-center grant "Paediatric Brain Monitoring with Information Technology (KidsBrainIT). Using IT Innovations to Improve Childhood Traumatic Brain Injury Intensive Care Management, Outcome, and Patient Safety", acronym KidsBrainIT, of the Romanian team. Continuous real-time intracranial pressure monitoring is a standard in TBI intensive-care management and ICP-lowering therapy is recommended when ICP is elevated above 20 mmHg or more. Paediatric TBI patients requiring intensive care are recruited from more contributing centres in 4 different countries and the Romanian team includes doctors CA Apetrei, C Gheorghita and A Tascu as principal investigators. Children aged 2 to 16 years who require intensive care management after sustaining traumatic severe brain injury are included in this study in three neurosurgical hospital: "Prof. Dr. N. Oblu" Clinical Emergency Hospital Iasi, "Sf. Maria" Children Clinical Emergency Hospital Iasi and "Bagdasar-Arseni" Clinical Emergency Hospital Bucharest. Continuous ICP and mean arterial blood pressure (MAP) monitoring allow calculation of cerebral perfusion pressure (CPP) and establish of an optimal CPP. The aim of this study is to improve the treatments in severe traumatic brain injury in children.

Key words: cerebral perfusion pressure, children brain injury, intracranial pressure, paediatric brain monitoring

Introduction

Traumatic brain injuries in children represent an important cause of morbidity and the main cause of death in children older than one years of age. As it is presented in the scientific project proposal the "majority of children who survives a life threatening brain trauma have new disabilities that affect how they function throughout the rest of their lives. Currently the best option to improve survival and recovery of children with life threatening brain trauma is to improve their early hospital treatments including intensive care". Also "the current best therapeutic option to improve severe traumatic brain injury in children outcome is to optimise physiological support in the intensive-care to minimise secondary physiological insults which are proven to negatively affect outcome. We urgently need clinically relevant and readily translatable research that optimises paediatric brain trauma treatment".

Material and methods

Children aged 2 to 16 years who require intensive care management after sustaining accidental TBI are included in this study in three neurosurgical hospital: "Prof. Dr. N. Oblu" Clinical Emergency

Hospital Iasi, "Sf. Maria" Children Clinical Emergency Hospital Iasi and "Bagdasar-Arseni" Clinical Emergency Hospital Bucharest.

This neurosurgical units have same treatment protocols, which include: defined raised ICP treatment guidelines using osmo-diuretics as a first line medical treatment; sedation and muscle relaxant protocol; mechanical ventilation to control PaCO2 to low normal values; using intravenous infusions of vasopressive drugs to drive mean arterial blood pressure to achieve a target CPP; actively controlling core body temperature to normothermia.

Patients' anonymised clinical data are collected with the cause and nature of injury, age, Glasgow Coma Score (GCS) on admission and after acute non-surgical resuscitation, pupillary responses, initial radiological and computerized tomography (CT), operative and other treatment details. As planned in the scientific project CPPopt calculation and ICP dose-response visualisation analyses are performed and determine if TBI patients with favourable outcome have longer periods of measured CPP within the calculated CPPopt ranges and an enhanced tolerance of raised ICP. Figures 1, 2 and 3 show a case of a 2 years old children with severe TBI and contiuous intracranial pressure monitoring intensive care unit.

Figure 1 - Case of 2 years old children with severe TBI and contiuous intracranial pressure monitoring

Figure 2 - The same case of a children with severe TBI and contiuous intracranial pressure monitoring

Figure 3 - Medical devices used for contiuous intracranial pressure monitoring

Results

There were a total of 624 children with traumatic brain injury during 8 months in these three neurosurgical departments and 20 patients needed intensive care and 6 children have been ICP and blood pressure monitored, but onky three patients were included in this scientific project. In two cases the values of ICP were high and very high and cerebral decompression was performed; unfortunately, the initial clinical condition was extremely severe and evolution was not favorable in these two cases. The third patient monitored showed elevated ICP values up to 28-30 mm Hg, which were medically treated and had a favorable evolution.

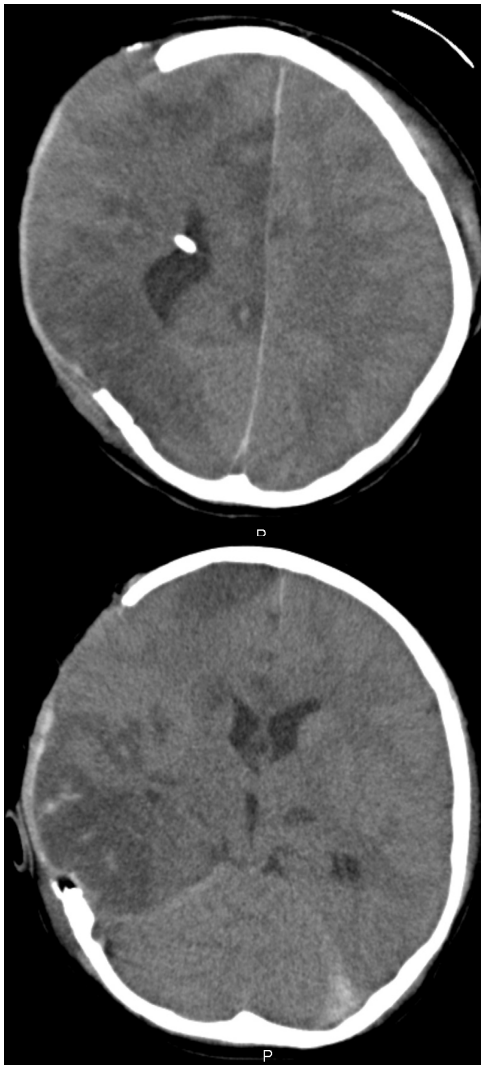

Figure 4 - a. Child with with severe TBI and contiuous intracranial pressure monitoring with intraventricular catheter and cerebral decompression; b. CT of the same case with efficient decompressive craniectomy

Discussion

The number of cases of pediatric TBI vary across clinical and epidemiological studies and our number of over 600 cases in 8 months should be interpreted by reference to only two neurosurgical centers : two hospitals in Iasi and one in Bucharest, so only for two areas from the country. The cases with ICP and CPP monitoring are few and a statistical analysis is not yet conclusive. With regard to cases that needed ICP monitoring, the gender distribution is predominantly male, and the most common cause was the road traffic accident.

Intracranial pressure monitoring is an invasive method but it assured an early detection of increased ICP in children with severe TBI. In our cases of monitored traumatic intracranial hypertension the performed maneuvers were decompressive craniectomy, drug therapy and CSF drainage in accordance with modern therapeutic guidelines.

The relationship between ICP elevation and CPP values is known in the adult, but in the pediatric TBI the studies are not conclusive; so "Chambers et al. proposed age-stratified critical levels of CPP: in the age groups 2–6, 7–10, and 11–16 years, CPP values of 43 mmHg, 54 mmHg and 58 mmHg, respectively, were associated with normal values of ICP and good outcomes".

Treatment used sedatives, analgesics; hyperosmolar therapy as intravenous mannitol and hypertonic saline to control intracranial hypertension; mild hyperventilation; barbiturates, temperature control and prophylactic anticonvulsants. The routine steroid treatment in children with severe TBI is not conclusive; it has to be individualized and rather it is not indicated because the potential harm from infectious complications. Decompressive craniectomy was performed for controlling intracranial hypertension and it was effective at ICP reduction. Our study will continue with the inclusion of patients and ICP and CPP monitoring with the hope of obtaining conclusive and beneficial results for setting standards in care of severe traumatic brain injury in children.

Conclusion

The best care of severe traumatic brain injury in children requires a multidisciplinary approach in each phase of management. The initial evaluation with prompt diagnosis and multimodal monitoring must be followed by the management of intracranial hypertension (ICP and CPP) to minimize the pathophysiological damage to the brain.

Intracranial pressure monitoring assured an early detection of increased ICP in children with severe TBI.

The findings from our study are directly transferable to a wider clinical audience because no special equipment is required, beyond that is currently used for the routine minute-by-minute physiological bedside monitoring.

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