

Implementation of Brain Trauma Foundation guidelines in children with acute traumatic brain injury in tertiary-care hospital in Pakistan

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Abstract : Previous reports have shown that the implementation of Brain Trauma Foundation guidelines for management of traumatic brain injury in adults has been associated with significant reduction in mortality and neurological disability. To compare two-cohorts on the clinical outcome in the management of children with TBI in the tertiary-care pediatric intensive care unit before and after the implementation of BTF guidelines, 34 children (age from 1 month to 14 years) with acute traumatic brain injury admitted in Pediatric Intensive Care Unit of AKUH from January 2000 to December 2007 were identified from electronic database. Twenty patients (**Group I**) were treated with traditional treatment before the implementation of BTF guidelines and 14 patients (**Group II**) treated with BTF guidelines as multidisciplinary team approach with special emphasis on initial prompt resuscitation to avoid hypoxia, hypotension, and maximize the cerebral oxygenation by reducing intracranial pressure, and optimize cerebral perfusion. We compared the mortality, Glasgow Outcome Scale (GOS) and length of stay (LOS) between two cohorts. Patients in two groups were similar with respect to age, gender, mode of injury, Glasgow Coma Scale and neurosurgical procedure before admission in PICU. Implementation of BTF guidelines was associated with a marked reduction in mortality from 40 % to 0% (relative risk 2.6; 95% confidence interval 1.3 -5.2; $p < 0.007$) and decreased in the LOS (relative risk 2.2; 95% confidence interval 1.4-3.3; $p < 0.002$). The absolute risk reduction of mortality is 0.4 Adherence to BTF guidelines in management of children with acute TBI was very effective. It can be successfully implemented in other regional hospitals.

Keywords: child, traumatic brain injury, outcome

INTRODUCTION

Traumatic brain injury (TBI) is the leading cause of morbidity and mortality in the young all over the world¹. Exact incidence of TBI in Pakistan is unknown. Several reports have demonstrated positive impact of implementation of Brain Trauma Foundation (BTF) guidelines in adult with TBI²⁻⁵. The guidelines for the acute medical management of severe TBI in infants, children and adolescent were published in 2003⁶. The aim of this study is to determine the effect of the goal-directed BTF-guidelines on the clinical outcomes in the management of children with TBI admitted in PICU of a tertiary care hospital.

MATERIALS & METHODS

All children (age range from 1 month to 14 year) with acute TBI admitted in our PICU from January 2000 to

December 2007 were included in this retrospective study. Children with late presentation were excluded. A cohort of 34 patients was selected. The study period was divided into two periods: before (January 2000 to August 2006) and after (September 2006 to December 2007) implementation of BTF protocols.

Group I (Pre-BTF guidelines): Twenty patients with TBI admitted in PICU during first phase were managed by neurosurgeons in traditional ways with wide variation in practices.

Group II (Post-BTF Guidelines): Fourteen patients with TBI admitted in PICU during second phase were managed as multidisciplinary team (pediatric intensivist and neurosurgeon) with special emphasis on initial prompt and vigorous resuscitation according to Advance Trauma Life Support (ATLS) and BTF guidelines to maintain airway, breathing and circulation and special precaution to cervical spine. Mannitol was administered only if patient was having extensor posturing, unequal pupil or drop in level of consciousness with suspicion of herniation and fluid replacement was accomplished concurrently with diuresis to maintain euvolemia. CT scan was done after initial resuscitation and taken to

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operation room if needed. Central and arterial lines were placed in PICU to monitor hemodynamics. General supportive care included head-up 30° and in midline; temperature, systemic blood pressure, blood sugar, oxygen, PaCO₂ and serum sodium were maintained in expected range per protocol. Daily maintenance isotonic fluid was administered. Sedation and analgesia were provided and neuromuscular blocking drug was given if needed. Propofol was preferred because of ultra-short acting agent and multi-model neuroprotection⁷. All patients received early nutritional support. Anticonvulsant was given to selected patients. No external ventricular drainage was placed routinely for ICP monitoring because of high risk of nosocomial infection. Box 1 showed our protocol for the management of children with severe traumatic brain injury.

Outcome analysis: For the purpose of analysis, we divided the outcome in two groups: Favorable / Good Outcome included good recovery / moderate disability; and Unfavorable / Bad Outcome included death/persistent vegetative / severe disability based on Glasgow Outcome Scale upon hospital discharge⁸.

Fig1: Management of Children with Severe Traumatic Brain Injuries

ER :	Follow ABC's - Rapid resuscitation CT scan
OR :	If neurosurgical procedure is needed
PICU:	Place art line and CVC line Maintain normovolemia (One-fluid Maintenance -0.9NS) Vasopressor if needed (To maintain high SBP for age) Oxygenation- SpO ₂ >95% Ventilation – PaCO ₂ 35 Maintain head in neutral position Elevate HOB 30p Maintain Temp 34-36°C; treat fever aggressively Minimize stimulation Early enteral feed Keep euglycemic (Add dextrose if BG < 80mg %) Sedation – Propofol 1mg/kg/hr Analgesia – Fentanyl or Morphine drip Paralytic – Atracurium prn/infusion Magnesium Sulphate 25mg/kg q6hr Mannitol 0.5G/kg/dose q6hr (if needed / S. Osm < 320) 3% HTS 0.1ml/kg/hr (S.Na 145-155 meq) Omperezole 1mg/kg QD Lidocaine neb before suctioning Phenytoin 15mg/kg followed by maintenance (if needed) Correct Coagulopathies if abnormal Maintain Hb 10% Repeat Head CT in 12-24 hr/ (if neuroexam changes) Reassess patient and review therapy

We compared the two cohorts for outcomes and length of stay.

Data were included patients demographic, mode of injury, Glasgow Coma Scale (GCS) on admission, associated injuries, operation and outcome.

Data were expressed as means with range or percentage as appropriate. Statistical analysis was done on SPSS14. Analysis of variance (ANOVA) and Student's t-test or Chi-square analysis were used to compare the data as appropriate. A *p*-value of ≥ 0.05 was considered significant. The Ethical Review Committee of the hospital has approved the study.

RESULTS

Patients in two groups were matched for age, gender, mode of injury, GCS on admission, associated injuries, and neurosurgical interventions before admission to PICU (Table 1).

There were 20 in Group I, and 14 in Group II. The mean age of patients was 6±3.8 Yr. Male patients constituted 62% (21/34). The most common cause of TBI was fall in both groups followed by road traffic accident and then penetrating injury. The mean admission GCS score 6±3 for all patients. Group II had

Table 1: Patients Characteristics of two groups

Variables	Before intervention	After intervention
Age	0 – 5 yrs > 5 yrs	11 (55.0) 7 (50.0)
Gender	Male Female	14 (70.0) 9 (30.0)
Mode of injury	Fall RTA Penetrating	16 (80.0) 4 (20.0) 2 (14.3)
Surgical intervention done	Yes No	12 (60.0) 8 (40.0)
GSC*	Severe Non-severe	6.5 (0.5) 7.6 (0.9) 7(35.0) 8(57.1)
Isolated injuries	No Yes	3 (15.8) 16 (82.2)

* Mean (SE); GCS = Glasgow Coma Scale; MOI = Mode of injury; RTA = Road traffic accident; All (two sided) *p*-values >0.05

higher percentage of severe TBI. The initial cranial CT findings were abnormal in all. Combined brain pathologies were reported in most cases both groups (70% vs. 60%). The encountered pathologies were in order of decreasing skull fracture (14/20 vs. 12/14), diffuse brain edema (14/20 vs. 8/14) and hemorrhage (12/20 vs. 8/14). Only 20% in each group had extra-cranial injuries. The extra-cranial injuries including: long bone fractures (10%), pulmonary contusion (5%) and splenic laceration (5%) in group I and long bone fracture (14%), splenic laceration (7%) in group II. About 60% of patients from both group required neurosurgical interventions either evacuation of hematoma or decompressive craniotomy. Our neurosurgeon preferred decompressive craniotomy for persistent elevated intracranial pressure.

The overall mortality rate fall dramatically from 40% (8/20) in group I to 0% in group II after implementation of protocol (RR 2.6 ; 95%CI 1.3 – 5.2; p<0.002) and decreased in length of stay (RR 2.2;95%CI 1.4-3.3; p <0.002) The absolute risk reduction of mortality is 0.4. Favorable outcome (GOS4&5) was improved significantly from 50 % (Group I) to 100% (Group II) (p<0.006). The mean length of PICU stay was reduced from over a week to less than a week. (p<0.002, RR 2.2, 95%CI 1.3-5.2) (Table 2).

DISCUSSION

In intensive care practices, implementation of protocols and monitoring in the management of critically ill patients have been improving the outcomes and reducing the variations that may result in suboptimal care and increased cost⁹⁻¹¹. We found that implementation of BTF guidelines in children with TBI significantly improves the outcomes.

Table 2 : Outcome variables of two groups

Variables	Before intervention	After intervention	p-value
Length of stay			
Week or less	6 (30.0)	12 (85.7)	0.002
Over a week	14 (70.0)	2 (14.3)	
Glasgow outcome scale			
Bad outcome	10 (50.0)	0 (0.0)	0.006
Good outcome	10 (50.0)	44 (100.0)	
Status at discharge			
Dead	8 (40.0)	0 (0.0)	0.007
Alive	12 (60.0)	14 (100.0)	

We developed our protocol and standard orders based on the evidence of BTF guidelines and our local institutional setup (Box 1). All children with TBI received multi-specialty care in our PICU in Group II where PICU team primarily provided nonoperative critical care management of TBI including ER management and coordinating with neurosurgeons and other specialty services involved in the care of child. Neurosurgical teams were readily available. Patients who survived from primary brain injury, secondary brain injuries are the physiological insults that occur after the initial injury and are important determinant of outcome^{12,13}. Among them, episodes of hypoxia tension are two most important causes of secondary brain injuries that worsen the outcome¹⁴. BTF guidelines algorithm was established to systemize the control of these parameters & thereby prevent & treat secondary injuries associated with TBI promptly⁶.

Improvement in survival with favorable outcome can be attributed to several factors. First, organized teamwork between neurosurgeon and PICU-team was most important. Second, the implementation of more goal-directed therapy algorithm lead to more intensive medical and surgical therapies. All children in Group II received neuro-protective strategies, including head-midline up 30°, low normal body temperature, maintain euvolemia, mechanical ventilation for normal oxygenation and ventilation, early enteral feeding, minimal stimulation, and prevent /treat seizure.. Additional steps include use of hypertonic saline infusion, propofol infusion, and infusion of magnesium sulphate. Four of our children required early decompressive craniotomy for diffuse cerebral edema and intractable elevated intracranial pressure. Several reports favor the use of early decompressive craniotomy in children with TBI for elevated intracranial pressure^{15,16}.

Recent publications suggest that such interventions can improve the outcome in selected patients. Patel et al has reported introduction of intensive care and implementation of protocol driven therapy improve the outcome of patients with TBI⁵. Palmer et al reported a threefold increase in odds of good outcome after implementation of BTF guidelines¹⁷. Hesdorffer et al reported that good adherence to evidence-based guidelines for severe TBI dramatically improved the outcome since 1991³. Fakhry et al reported that adherence to BTF guidelines substantially reduces financial cost and decrease the utilization of resources along with improvement in outcome⁵.

However, this study has few limitations including retrospective in nature, single center and small sample size.

To the best of my knowledge, this is the first pediatric report assessing the effect of implementation of BTF guidelines in children with TBI admitted in PICU with historical controls. The most prominent improvement in outcome was a significant decrease in mortality from 40% to 0% with good functional outcome and shortens the length of stay in PICU.

CONCLUSION

We found that the implementation of BTF guidelines in children with severe TBI is practical and very effective. It can be easily implemented to other institution.

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