Epidemiology of Traumatic Brain Injury and Central Nervous System Infection among Children in Four Resource Limited Settings

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Background

- Brain infection is a leading cause of death and disability in children worldwide but the epidemiology of traumatic brain injury in low and middle income countries (LMIC) is largely unknown
- We aimed to study and compare the epidemiology and outcomes of children with traumatic brain injury (TBI) and central nervous system (CNS) infections (infx) in order to develop programs that lead to improved outcomes in LMIC

Methods

- **Prospective, observational study over 4 consecutive weeks *(n=120 children*)**
- **Inclusion criteria**: Children aged 1 d – 17 yr presenting to hospital with TBI (except Ghana) or CNS infx
- **Study sites**: 4 centers in 4 countries (**Figure, Table 1**)
- **Data collection.** Hospital and patient demographics, disease details, monitoring and therapies, severity of injury, and outcomes
- **Primary outcome:** Frequency and survival of children with TBI or CNS infx (hospital discharge or 90 days, whichever longest)
- **Secondary outcomes:** Neurological morbidity using Pediatric Cerebral Performance Category (PCPC) score
- **Local IRB approvals and University of Pittsburgh IRB approval for Coordinating Center**

Table 1	Ethiopia N=52 (43%)	Kenya N=50 (41%)	Rwanda N=11 (9%)	Ghana N=7 (6%)
City	Addis Ababa	Nairobi	Kigali	Wenchi
Population	3.4 M	3.2 M	600 K	40 K
EMS available/cost	Yes	Yes/500 USD/yr	Yes/1 USD	Yes
University-affiliated	Yes	Yes	Yes	No
Public	Yes	Yes	Yes	Yes
Total/pediatric hospital beds	800/175	2,800/450	395/57	147/35
Pediatric ED admissions	3,000	600-800	2,400	900
Total/pediatric hospital admissions	28,500/3,000	6,580/4,250	15,520/1,230	9,908/3,578
Pediatric ICU beds	4	13	5	-
Pediatric ICU admissions	210	300	108	-
ICU nurse ratio	1:1	1:2	1:1	1:2
Neurosurgeon available	Yes	Yes	Yes	No

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Results

Table 2	Ethiopia N=52 (43%)	Kenya N=50 (41%)	Rwanda N=11 (9%)	Ghana N=7 (6%)
TBI	37 (71)	8 (15)	7 (14)	n/a
CNS Infx	15 (22)	42 (61)	4 (6)	7 (10)
Age	9 (0.04-17)	1.3 (0.03-14)	7 (0.17-13)	3 (0.03-12)
Male	35 (70)	26 (52)	6 (60)	5 (71)
MAUC	16 (12-19)	13 (9-17)	-	-
Health insurance				
Self	37 (74)	23 (47)	0 (0)	0 (0)
Government	10 (20)	19 (39)	0 (0)	0 (0)
Public	0 (0)	5 (10)	10 (91)	3 (43)
None	3 (6)	1 (2)	1 (9)	4 (57)
Private	0 (0)	1 (2)	0 (0)	0 (0)

Table 3	TBI n=52	Infx n=68	P-value
Age	10 (0.08-17)	1.7 (0.03-17)	**<0.001**
Male	39 (78)	33 (49)	**0.002**
Etiology Infx			
Meningitis		55 (79)	
Encephalitis	-	3 (4)	
Abscess		1 (1)	
Other		11 (16)	
Etiology TBI			
Blunt	48 (92)	-	
Penetrating	2 (4)		
Unknown	2 (4)		
Mechanism			
High energy fall	18 (35)		
Traffic MVA	11 (21)		
Blunt object	9 (17)		
Pedestrian	4 (8)	-	
Low energy fall	4 (8)		
Motorcycle	2 (4)		
Sharp object	2 (4)		
Other/unknown	2 (4)		
Intent			
Accident	43 (84)		
Assault	5 (10)	-	
Self-inflicted	1 (2)		
Other/unknown	2 (4)		
Palpable skull fracture	19 (40)	-	
Multiple trauma	22 (47)	-	
Altered mental status	37 (77)	48 (81)	
Altered mental status scale			
Agitation	9 (27)	16 (36)	
Somnolence	10 (29)	22 (50)	
Slow verbal resp	10 (29)	6 (14)	
Other	5 (15)	0 (0)	
Loss of consciousness (LOC)	38 (78)	29 (56)	
LOC duration			
0-60 sec	5 (14)	5 (21)	
1-5 min	6 (17)	3 (13)	
> 5 min	24 (69)	16 (67)	
Seizure	4 (9)	41 (71)	

Table 5	Overall N=120	TBI N=52	Infx N=68	P-value
Transport to hospital				**0.005**
Ground ambulance	52 (44)	33 (64)	19 (28)	
Public (taxi)	35 (29)	9 (17)	26 (39)	
Public (bus)	12 (10)	3 (6)	9 (13)	
Private motorized	8 (7)	3 (6)	5 (8)	
Private non-motorized	6 (5)	1 (2)	5 (8)	
Walk-in	4 (3)	2 (4)	2 (3)	
Other	2 (2)	1 (2)	1 (2)	
Inter-hospital transfer	72 (65)	40 (80)	32 (53)	**0.003**
Transport time to hospital (min)	60 (1-540)	80 (10-540)	60 (1-120)	**0.018**
Distance to hospital (km)	18 (1-521)	74 (1-521)	17 (1-375)	**0.036**
Level of prehospital care				0.342
None	53 (45)	21 (41)	32 (49)	
Basic life support	61 (52)	29 (57)	32 (49)	
Advanced life support	2 (2)	0 (0)	2 (3)	
Unknown	1 (1)	1 (2)	0 (0)	
No EMS				**0.021**
Not available	43 (73)	21 (88)	22 (63)	
Unaffordable	15 (25)	2 (8)	13 (37)	
Other	1 (2)	1 (4)	0 (0)	
	Overall N=120	**TBI N=52**	**Infx N=68**	**P-value**
Highest level of care				**<0.001**
ED	43 (40)	34 (69)	9 (16)	
Ward	46 (43)	3 (6)	43 (74)	
OR	9 (8)	7 (14)	2 (4)	
ICU	8 (8)	5 (10)	3 (5)	
Unknown	1 (1)	0 (0)	1 (2)	
Mechanical ventilation, d	N=7, 5 (1-16)	N=5, 7 (4-16)	N=2, 3 (1-4)	0.079
Hospital LOS, d	N=99, 7 (1-36)	N=37, 5 (1-36)	N=62, 7 (2-30)	**0.038**
ICU LOS, d	N=12, 4 (1-20)	N=9, 5 (1-20)	N=3, 4 (1-5)	0.572
Disposition				0.146
Home	82 (82)	34 (81)	48 (83)	
Ward	3 (3)	3 (7)	0 (0)	
ICU	1 (1)	0 (0)	1 (2)	
Rehabilitation	14 (14)	5 (12)	9 (16)	
Pre-PCPC 1-2 (no or mild disability)	93 (97)	39 (98)	54 (96)	0.114
Post-PCPC 1-2	73 (75)	29 (73)	44 (77)	0.294
Mortality HD	12 (11)	4 (8)	8 (13)	0.302

Conclusions/Future Directions

- The frequency of TBI was similar to that of CNS infection. Fall and meningitis were leading causes of TBI and CNS infection, respectively.
- Most children presented with altered mental status and 1 in 3 children had moderate or worse neurological disability for both diseases studied.
- Neurocritical care resources should be tailored by region, patient, and disease processes.
- Long term objectives of PANGEA-DC include development of Neurocritical Care curriculum and simulation programs; prospective quality improvement projects; research network building; and improving outcomes for children.

Level of undernutrition	MUAC (mm)
Moderate	< 185
Severe	< 160