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Early Antibiotic Exposure in Severe Pediatric Traumatic Brain Injury

To the Editor—Children with severe traumatic brain injury (TBI) require hospitalization in the intensive care setting, and are often administered antibiotic therapy as they are at risk for both infectious complications related to their initial injuries and nosocomial infections [1]. These infections have been associated with worse clinical outcomes [1–5]. To understand more about the patterns of antibiotic use in children with severe TBI, we performed a retrospective cohort study to describe and quantify the indication, duration, and spectrum of antibiotics used in 109 children with severe TBI admitted to a single-center pediatric intensive care unit (PICU) over an 11-year period. We collected age, sex, mechanism of injury, post-resuscitation GCS (Glasgow coma score), pediatric index of mortality, version 2 (PIM-2), pediatric risk of mortality, version 3 (PRISM3), presence of intracranial pressure (ICP) monitoring, length of mechanical ventilation, length of PICU stay (PICU LOS), and Glasgow Outcome Scale-Extended (GOS-E) at hospital discharge (Table 1). We performed additional chart review for microbial culture data results, antibiotic exposure, and indication for antibiotic administration for each patient. To quantify the intensity of antibiotic exposure during the hospitalization, we used the antibiotic spectrum index (ASI) [6]. To permit review of antibiotic course, we excluded all patients who died or were discharged from the PICU within the first 48 hours.

Table 1. Characteristics of Study Cohort

Patient Characteristics	Any Positive Culture During PICU Stay	All Cultures Negative During PICU Stay	Cultures Not Sent
Patients, n	59	28	22
Age in months, median (IQR)	130 (75, 192)	119 (44, 188)	76 (15, 157)
Male, n (%)	32 (54.2)	20 (71.4)	18 (81.8)
Injury mechanism, n (%)			
Motor vehicle crash	38 (64.4)	15 (53.6)	4 (18.2)
Pedestrian struck	10 (16.9)	7 (25)	3 (13.6)
Fall	4 (6.8)	0	4 (18.2)
Other	7 (11.9)	6 (21.4)	11 (50)
ICP monitoring, n (%)	53 (89.8)	23 (79.3)	13 (59.0)
Post-resuscitation GCS, median (IQR)	5 (3, 6)	3 (3, 5)	5.5 (3, 6.3)
PRISM3, median (IQR)	7 (3,10)	9.5 (5.3, 13.5)	5 (1.8, 8)
Duration of mechanical ventilation, median days (IQR)	12.8 (7.6, 17.6)	7.5 (3.8, 13.2)	2.2 (1.5, 4.9)
PICU length of stay, median days (IQR)	17.6 (11.9, 21.8)	10.4 (5.8, 16.8)	4.2 (3.0, 5.6)
GOS-E at hospital discharge, median (IQR)	3 (3, 4)	3 (3, 4)	4 (2.5, 6)
Mortality, n (%)	5 (8.5)	4 (14.3)	5 (22.7)
Received antibiotics, n (%)	59 (100)	27 (96.4)	15 (68.2)
Primary indication for antibiotics, n (%)			
ICP monitor prophylaxis	1 (1.7)	3 (11.1)	5 (33.3)
Open fracture prophylaxis	1 (1.7)	12 (44.4)	3 (20)
Pneumonia	19 (32.2)	6 (22.2)	3 (20)
Tracheitis	36 (61.0)	1 (3.7)	0
Sepsis	0	0	0
Other	2 (3.4)	5 (18.5)	4 (26.7)
Antibiotic duration, mean (SD)	14.3 (5.6)	10.1 (6.0)	5.0 (3.2)
Mean ASI in first week of PICU admission	6.7	6.7	3.4
Mean ASI over entire PICU admission	6.8	6.6	5.1
Mean ASI/total antibiotic days	7.9 (2.3)	7.6 (3.6)	5.4 (6.7)

Abbreviations: ASI, antibiotic spectrum index; GCS, Glasgow coma score; GOS-E, Glasgow outcome scale extended; ICP, intracranial pressure; IQR, interquartile range; PICU, pediatric intensive care unit.

Overall, 93% of severe TBI patients received antibiotics during their PICU stay, with a mean antibiotic duration of 11.8 + 6.4 days. The majority of patients (78%, n = 87) had at least one culture obtained to investigate for bacterial infection. Blood cultures were routinely sent (74% of patients), while cerebrospinal fluid (CSF) cultures were uncommon (19% of patients). Of the 87 patients with at least one culture specimen, 55 patients (63%) had at least one positive respiratory culture, 1 patient (1%) had a positive urine culture, and 3 patients (3%) had both positive respiratory and urine cultures. No patient had a positive blood or CSF culture. Respiratory tract infections were the most common indication for treatment (60%) and the most common source of infection (92%). In all, only 58% of children who received antibiotics had a microbe identified by culture. These patients had a longer duration of antibiotic therapy, but no difference in ASI compared with children with negative cultures (Table 1). Although ICP monitoring was rarely stated as the primary indication for antibiotic therapy, it was included as a secondary rationale in over 70% of patients with monitors who received antibiotics for other stated purposes.

Children with severe TBI are commonly exposed to broad-spectrum antibiotics for prolonged durations, many for the majority of their PICU stay. Less than 60% of these patients had positive cultures, and the children with negative cultures were often exposed to antibiotics with the same spectrum of activity as children with culture-proven infections. There are possible negative consequences associated with unnecessary antibiotic use, including the development of antibiotic-resistant bacteria and gut microbial dysbiosis. This creates an outstanding opportunity for collaboration

between neurocritical care, surgery, and antibiotic stewardship teams. Important future studies are needed to determine if broad-spectrum antibiotic exposure in the PICU impacts TBI outcomes.

Notes

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