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Age-Related Differences in Injury Patterns and Early Care in Pediatric Polytrauma: A 13-Year Level I Trauma Center Study

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Abstract

Pediatric polytrauma constitutes an intricate clinical entity characterized by distinctive attributes and demands during the initial phase of care. The present investigation was designed to evaluate injury characteristics, immediate clinical management, and clinical endpoints among pediatric polytrauma cases treated at a Level I trauma facility. Particular attention was directed toward comparisons across developmental stages and the determination of whether specific injury types serve as prognostic modifiers. Employing a prospective cohort framework, pediatric polytrauma subjects (ISS ≥ 16) were followed over a span of 13 years and stratified according to developmental phase (Group A: 0–5 years; Group B: 6–10 years; Group C: 11–15 years; and Group D: 16–18 years). Intergroup analyses were undertaken to detect disparities in acute care delivery, causative mechanisms, anatomical involvement patterns (applying AIS and ISS parameters), and fatality attributable to trauma. Supplementary evaluation of mortality-associated variables was performed. Subjects had a median age of 16 years, with males constituting the majority (64.7%). ISS values fluctuated across groups but did not reach statistical significance. The death rate within 30 days reached 19.0%, demonstrating no meaningful divergence tied to patient age. Causative mechanisms varied across age strata; vehicular collisions predominated in all categories except the youngest cohort (0–5 years), where falls were the leading mechanism. Assessment of injury distribution via AIS anatomical categories revealed cranial trauma as a powerful determinant of fatal outcome (Hazard Ratio 2.894, $P < 0.001$). In contrast, injuries to the thorax, abdomen, and limbs lacked a statistically meaningful correlation with death. Multivariable regression identified ISS and prehospital GCS as reliable predictors of mortality ($P < 0.001$ and $P = 0.006$, respectively). Despite modest age-associated disparities in trauma magnitude and therapeutic measures, cranial injury proved to be the foremost factor influencing survival. Prompt identification and intervention for traumatic brain injury are indispensable for optimizing results. Likewise, ISS and prehospital GCS were validated as reliable prognostic tools, underscoring the need for prompt assessment and stabilization. An individualized therapeutic strategy attuned to both developmental stage and injury configuration may confer survival gains within this susceptible demographic.

Keywords: Severely injured, Children, Pediatric trauma, Polytrauma, Injury patterns, Mortality

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Introduction

The occurrence of polytrauma among pediatric individuals remains a comparatively uncommon phenomenon, constituting a mere 7.4% within the German Trauma Registry between 1997 and 2010 [1]. This figure corresponds to approximately 270 pediatric polytrauma presentations per year in Germany. Those aged under 15

years account for a much smaller fraction, roughly 3% [2]. Despite this relative rarity, traumatic injury during childhood persists as the foremost reason for inpatient admission. It represents the principal source of mortality in children who have surpassed their first year of life [3-5].

Managing polytraumatic injuries sustained by children and teenagers poses a singular challenge to healthcare teams. The S2k guideline "Polytrauma Management in Childhood" advocates harmonizing resuscitation bay protocols with the adult-oriented "Advanced Trauma Life Support" framework to ensure a validated, streamlined workflow [5]. Swift detection of life-threatening derangements and timely corrective actions are paramount when confronting these scenarios to secure favorable clinical trajectories. Delivering efficacious treatment necessitates an appreciation for injury configurations while accommodating the anatomical and developmental specificities inherent to younger populations. The diagnostic pathway, along with decisions favoring operative versus conservative strategies, is contingent on the character and distribution of the damage. Whereas adult-focused investigations into therapeutic missteps among critically injured individuals have been relatively abundant [6-8], analogous explorations centered on pediatric and adolescent populations remain conspicuously sparse. As a general principle, pediatric polytrauma victims ought to be directed increasingly toward regionalized trauma facilities [1], given that dedicated centers correlate with diminished death rates, superior survival following severe traumatic brain injury, and reduced visceral injury in instances of blunt abdominal injury [9-11].

Through the execution of this study, we endeavor to extract novel perspectives regarding the multidisciplinary handling of polytraumatized youngsters and adolescents within a German Level I trauma institution. The research is oriented toward two salient questions, each to be addressed through the prospective examination of critically injured individuals:

- Do noteworthy discrepancies exist across developmental age brackets within the pediatric polytrauma population with respect to injury patterns, immediate clinical interventions, and therapeutic endpoints?
- Which anatomical regions, when injured, demonstrate an association with elevated lethality among critically hurt pediatric patients (ISS > 16)?

Through the systematic exploration of these queries, we aspire to enrich the body of knowledge concerning pediatric polytrauma and, in turn, elevate the standard of care and subsequent outcomes for this particularly fragile patient subset.

Materials and Methods

Study design and inclusion criteria

A prospective observational cohort methodology was adopted to probe clinically relevant divergences among developmental stages regarding traumatic injury profiles, acute care delivery, and variables linked to mortality within the pediatric polytrauma collective. Subjects presenting via the emergency pathway at our institution (a Level 1 trauma facility) during the interval spanning 2007 through 2019 were consecutively enrolled. Eligibility was defined by an Injury Severity Score (ISS) threshold of ≥ 16 coupled with an admission age not exceeding 18 years. Those who failed to meet the stipulated criteria were omitted. Additionally, records characterized by insufficient data fidelity were excluded from analysis. No patient was barred based on gender. Data acquisition was undertaken by designated research personnel operating on a continuous, 24/7 schedule.

Enrolled subjects were allocated into four comparative strata. Stratification was governed by chronological age (Group A: 0–5 years; Group B: 6–10 years; Group C: 11–15 years; Group D: 16–18 years). Variables captured included age, sex, Injury Severity Score (ISS) according to the framework established by Baker *et al*. [12], prehospital therapeutic measures, in-hospital procedures, duration of inpatient stay, injury morphology, mechanisms of trauma, and the 30-day case fatality proportion. The aggregate magnitude of injury was quantified via the Abbreviated Injury Score (AIS), whose scale extends from 1 (minor insult) to 6 (maximal, presently irremediable). Gradations further encompass 2 (moderate), 3 (significant, non-lethal), 4 (marked, survival-threatening), 5 (grave, prognosis equivocal), and 6 (maximal, beyond current therapeutic reach). Group-level comparisons were executed with reference to ISS values allocated to distinct anatomical territories, namely the cranium, thorax, abdomen/pelvis, and appendicular skeleton. The prioritization of ISS over competing instruments was informed by its exceptional utility and broad acceptance in injury quantification, reinforced by its entrenched role in nationwide trauma databases. This consideration will be further elaborated in the Discussion section that follows. Computed by summing the squares of the Abbreviated Injury Scale (AIS) values assigned to the three most severely affected anatomical domains, the ISS furnishes an integrative gauge of traumatic burden. To illustrate, should a patient manifest a cranial AIS of 3, a thoracic AIS of 4, and an abdominal AIS of 2, the resulting ISS calculation would proceed as follows: $(4^2) + (3^2) + (2^2) = 16 + 9 + 4$, yielding a total of 29.

$$ISS = (x^2) + (x^2) + (x^2)$$

Ethics statement and anonymity

The institutional ethical review board sanctioned this research in alignment with the Declaration of Helsinki (14-101-0004). Protection of patient identity was maintained.

When documentation commenced, each case was assigned a multi-digit identification number.

Statistical analysis

For variables measured on a nominal scale, descriptive statistics were applied, with reporting utilizing absolute counts (n) alongside percentage distributions (%). Assessment of normality among metric variables relied on histogram inspections, QQ plots, and the Kolmogorov–Smirnov test. Since the assumption of normality was largely violated within subgroupings, metric variables were uniformly reported as median values with 25th and 75th percentile boundaries (MD (25th; 75th percentile)).

Variation across age categories in nominal variables was explored using cross-tabulations and Chi-square tests. When anticipated cell counts were ≤ 5, Fisher's exact test served as the fallback method. The strength of association was denoted using Phi for two-by-two tables and Cramer's V for larger configurations. Benchmarks for interpretation were as follows: Phi/V = 0.1 indicated a weak effect, 0.3 a moderate effect, and 0.5 a strong effect. For metric variables that lack normality and for ordinal variables, intergroup comparisons across age strata used the Kruskal–Wallis test. When a significant result emerged from this global test, pairwise Mann–Whitney U assessments were incorporated within a post-hoc framework. Effect magnitude was expressed as r, with 0.1 equating to a small effect, 0.3 to a medium effect, and 0.5 to a large effect. Relationships among nominal attributes were probed through the symmetrical measure Phi for two-by-two tables and through Cramer's V, where more than two categories were involved.

To determine which factors independently forecast 30-day mortality, Cox proportional hazards modeling was undertaken. Single-predictor (univariate) Cox regressions were first fitted for each candidate variable separately, yielding a Hazard Ratio (HR) and its corresponding 95% confidence band [95% CI]. To mitigate concerns about potential collinearity among explanatory variables, a multivariable Cox regression was conducted, with all predictors attaining univariate significance included. A backward stepwise elimination procedure was employed, retaining variables with P-values < 0.07. In the finalized regression model, HR and its 95% CI were reported for each retained predictor.

Execution of all statistical procedures (alpha level set at P < 0.05) was performed using SPSS, version 29 (SPSS Inc., Chicago, IL, USA).

Results and Discussion

Demographic data

A total of 184 individuals met the entry requirements; a summary of their demographic features is presented in **Table 1**. As patients advanced into higher age categories, a progressively greater share of males was noted (P = 0.049). Injury Severity Score (ISS) values differed somewhat across age-defined subsets but did not reach statistical significance. Prehospital Glasgow Coma Scale (GCS) ratings and the frequency of airway intubation did not diverge meaningfully across groups. Among the entire assembled cohort, intubation was performed in 76.6% of cases. Within the youngest subset, this rate climbed to 91.7%, whereas in the oldest subset, it stood at 71.6%. The application of chest tube drainage and the administration of cardiopulmonary resuscitation (CPR) did not display significant intergroup variation. Across the entire sample, 13.0% of individuals received resuscitative efforts before hospital arrival. Of those, 79.2% achieved only temporary restoration of circulation, lasting only until entry into the trauma resuscitation area. In the 0–5-year age bracket, 20.8% received CPR, and among these, 60.0% sustained successful resuscitation up to the point of trauma bay admission. Within the 16–18-year age group, 11.6% were resuscitated, with an 82.8% success rate. The overall 30-day mortality rate was 19.0%, with no statistically significant association with patient age. The length of inpatient stay likewise showed no significant heterogeneity across the age-defined groups.

Table 1. Demographic features of the patients under analysis.

Variable	16–18 years	11–15 years	6–10 years	0–5 years	Total
Number (n)	95	38	27	24	184
Age *	17 (16; 18)	14 (13; 15)	9 (6; 9)	3 (1; 4)	16 (9.25; 17)
Male (n/%)	70/73.7	23/60.5	14/51.9	12/50.0	119/64.7
ISS *	30 (22; 41)	29 (21; 38.75)	24 (21; 25)	29 (21.25; 40.25)	29 (22; 38)
Preclinical GCS *	10 (3; 14)	9 (4; 15)	9 (3; 14)	8 (4; 10)	9 (3; 14)
Intubation (n/%)	68/71.6	28/73.7	23/85.2	22/91.7	141/76.6
└ Preclinical intubation (n/%)	64/94.1	26/92.9	22/95.7	20/90.9	132/93.6
Thoracic drainage (n/%)	20/21.1	8/21.1	3/11.1	4/16.7	35/19.0
└ Bilateral drainage (n/%)	8/40.0	1/12.5	1/33.3	3/75.0	13/37.1
Preclinical CPR (n/%)	11/11.6	5/13.2	3/11.1	5/20.8	24/13.0

└ CPR successful until the emergency room (n/%)	9/82.8	5/100.0	2/66.7	3/60.0	19/79.2
30-day mortality (n/%)	15/15.8	9/23.7	4/14.8	7/29.2	35/19.0
Hospitalization time *	14 (9; 21)	11 (2; 19)	13 (7; 18)	13 (3; 23)	14 (6; 21)

median [25th; 75th percentile].

Mechanisms of injury

Considering the entire study population, automobile crashes were responsible for 34.2% of polytrauma presentations **(Table 2)**. A numerical trend suggested an increasing contribution of car-related trauma with ascending age group; nonetheless, this pattern was not statistically confirmed (P = 0.203). From the 6–10-year age stratum onward, motor vehicle collisions ranked as the predominant injury mechanism **(Figure 1)**. Motorcycle-related incidents constituted 22.8% of the aggregate cohort. Such events occurred substantially more frequently among adolescents aged 16–18 years than in the remaining age categories (P < 0.001). In this oldest group (16–18 years), motorcycle accidents ranked second among the leading causes. The data further brought to light that bicycle-related trauma was significantly overrepresented within the 6–10-year and 11–15-year brackets (P < 0.001) when contrasted against the two other cohorts. Across the entire sample, 7.6% of injuries were linked to bicycle accidents. Pedestrian-related trauma accounted for 9.8% of the total caseload, with a non-uniform spread detected across the age categories (P = 0.042); the peak proportion, 22.2%, was recorded among children aged 6–10 years. Descents from heights ≥ 3 meters accounted for 13.0% of all polytrauma cases in the dataset, without a meaningful difference across age strata (P = 0.218). A comparable pattern emerged for falls from lesser elevations (< 3 m), where intergroup variation was likewise absent (P = 0.176).

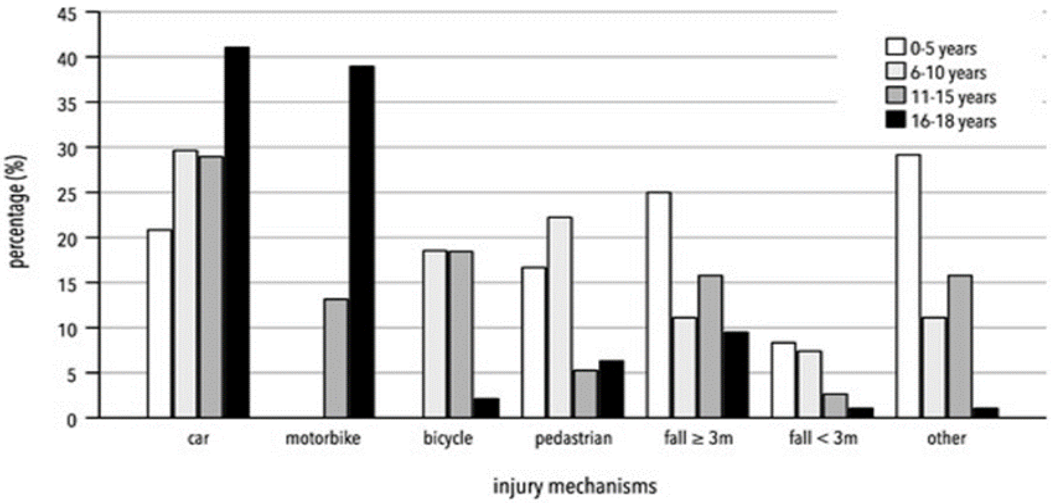

Figure 1. Relative frequencies of injury mechanisms are displayed across the four age categories. The category "Others" encompasses: suicide, physical assault, shaken baby syndrome, and injuries incurred during agricultural work.

Table 2. Distribution of traumatic mechanisms per age stratum.

	16–18 Years	11–15 Years	6–10 Years	0–5 Years	Total
Car (n/%)	39/41.1	11/28.9	8/29.6	5/20.8	63/34.2
Motorcycle (n/%)	37/38.9	5/13.2	0	0	42/22.8
Bicycle (n/%)	2/2.1	7/18.4	5/18.5	0	14/7.6
Pedestrians (n/%)	6/6.3	2/5.3	6/22.2	4/16.7	18/9.8
Fall ≥ 3 m (n/%)	9/9.5	6/15.8	3/11.1	6/25.0	24/13.0
Fall ≤ 3 m (n/%)	1/1.1	1/2.6	2/7.4	2/8.3	6/3.3
Others (n/%)	1/1.1	6/15.8	3/11.1	7/29.2	17/9.2

Among the youngest subset of patients (0–5 years), miscellaneous injury circumstances—exemplified by farming mishaps or being struck by an animal's hoof—predominated (29.2%; consult) **(Figure 1)**. A statistically significant heterogeneity in distribution was detected across the age bands (P < 0.001).

Injury pattern

Considering the collective dataset, traumatic lesions scoring AIS ≥ 2 were predominantly clustered within the cranial territory, a finding that held throughout all age brackets **(Table 3)**. Significantly, the head was the only bodily region in which the two youngest patient cohorts showed substantially higher frequencies of damage than the two older cohorts (P = 0.002) **(Table 4)**. Specifically, cranial involvement was recorded in 95.8% of subjects in the 0–5-year stratum and in 92.6% of those belonging to the 6–10-year stratum. Across all enrolled individuals, the midpoint AIS value attributed to head trauma was 4. Injuries to the thoracic cage were present in 70% of the sample, and no statistically discernible divergence was found upon comparing age-defined subsets (P = 0.700). By contrast, abdominal trauma constituted the least frequently encountered injury location among every age tier. A salient observation was the stepwise increase in the proportion of abdominal lesions with advancing patient age (P < 0.001). An analogous trajectory emerged regarding severe extremity trauma, with older subgroups manifesting comparatively higher rates (P = 0.004).

Table 3. Pattern of injury distribution disaggregated by ISS anatomical domain: head, chest, abdomen, and extremities.

	16–18 years	11–15 years	6–10 years	0–5 years	Total
AIS–Head trauma *	4 (1; 5)	3 (1; 4)	4 (3; 4)	4 (3.25; 5)	4 (2; 5)
AIS–Chest trauma *	3 (0; 3)	3 (0; 4)	2 (0; 3)	3 (0; 3.75)	3 (0; 3)
AIS–Abdominal trauma *	2 (0; 2)	0 (0; 3.25)	0	0	0 (0; 2)
AIS–Extremity trauma *	3 (0; 3)	2 (0; 3)	2 (0; 2)	0 (0; 2)	2 (0; 3)

median (25th; 75th percentile).

Table 4. Patterns of serious injury defined by AIS ≥ 2.

	16–18 years	11–15 years	6–10 years	0–5 years	Total
AIS–Head trauma (n/%)	69/72.6	23/60.5	25/92.6	23/95.8	140/76.1
AIS–Chest trauma (n/%)	70/73.7	26/68.4	17/63.0	16/66.7	129/70.1
AIS–Abdominal trauma (n/%)	50/52.6	18/47.4	6/22.2	4/16.7	78/42.4
AIS–Extremity trauma (n/%)	69/72.6	24/63.2	15/55.6	8/33.3	116/63.0

General influence of resuscitation on mortality

Resuscitative status exerted a powerful and statistically meaningful influence on the likelihood of death (P < 0.001), a relationship displayed graphically in **Figure 2**:

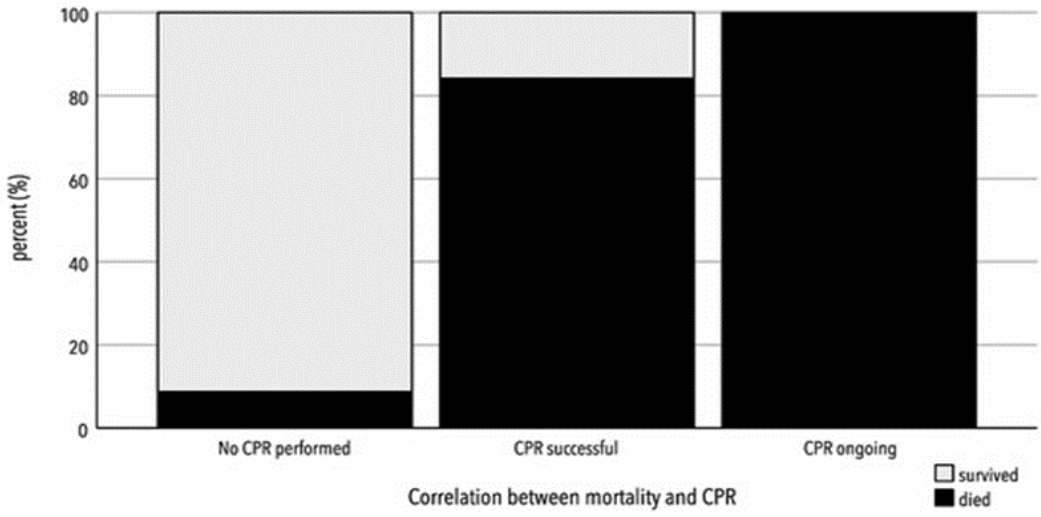

Figure 2. Association linking cardiopulmonary resuscitation with fatal outcome.

Subjects for whom prehospital resuscitation efforts led to a return of circulation and those who were brought in. In contrast, resuscitation that remained in progress was associated with dramatically worse survival odds

compared with patients who never required CPR (absent resuscitation: 8.8% (n = 14); vs. brief/effective resuscitation: 84.2% (n = 16)). The case fatality difference between individuals with sustained resuscitation success and those undergoing continued CPR at the moment of handover did not reach statistical significance.

Thirty-day survival/mortality rate

The survival plot **(Figure 3)** shows that the temporal window of greatest lethality within the study population was concentrated in the first 5 days post-injury.

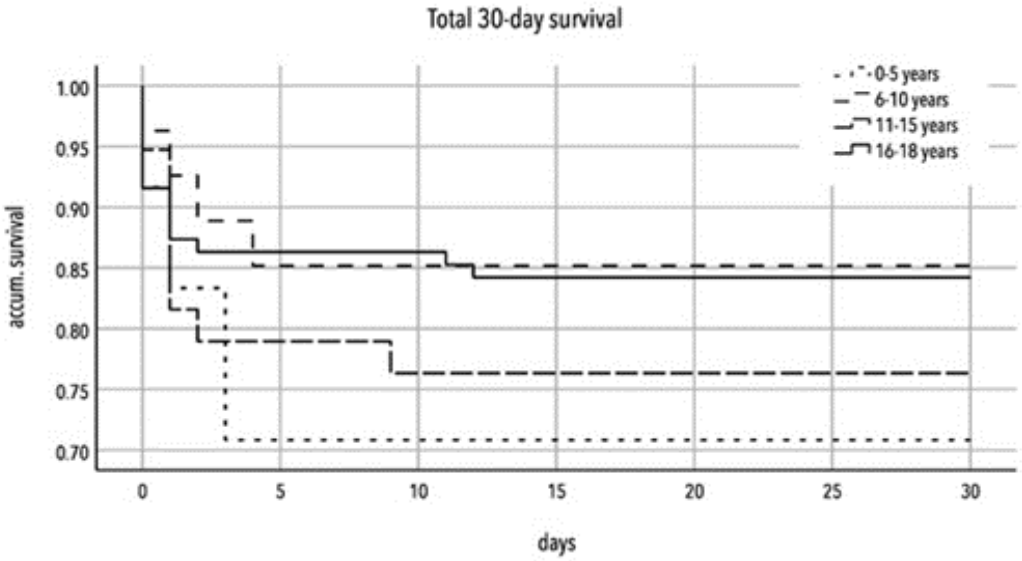

Figure 3. Kaplan–Meier estimates of 30-day survival among critically injured subjects (ISS ≥ 16), contrasting the age-defined subgroups: 0–5 years, 6–10 years, 11–15 years, and 16–18 years.

Influence of injury patterns on mortality

Univariate Cox proportional hazards modeling confirmed a highly significant detrimental effect of cranial injury severity. Each one-unit increment in the head AIS was accompanied by a near-tripling of the fatal hazard (HR = 2.894 [1.489–3.687], P < 0.001), a finding depicted in **Figure 4**. Trauma sustained in alternative anatomical compartments failed to register as a statistically significant driver of mortality, albeit patterns suggestive of elevated risk were observable for high-grade thoracic and abdominal damage (thorax: HR = 1.159 [0.935–1.434], P = 0.128; abdomen: HR = 1.123 [0.920–1.370], P = 0.254).

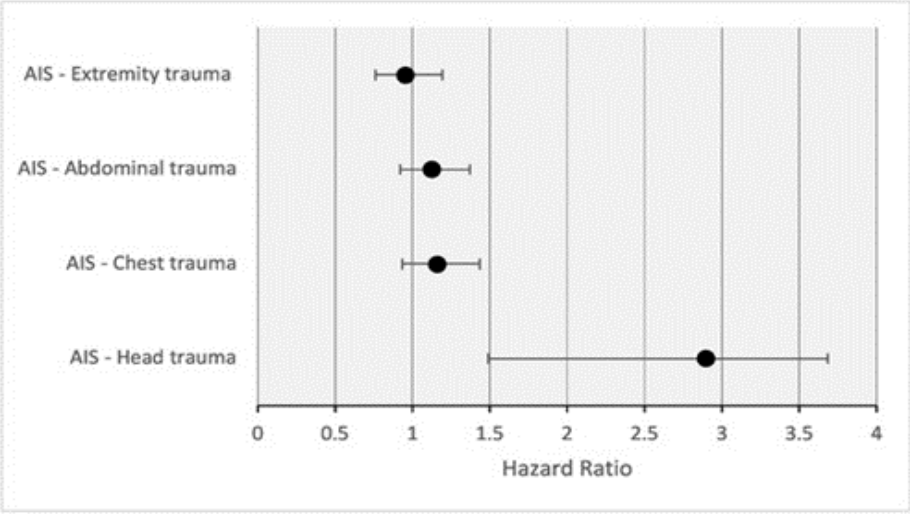

Figure 4. Relationship between injury distribution and mortality risk.

Once incorporated into a multiple Cox regression framework, the predictive validity of both the ISS (Injury Severity Score) and the prehospital GCS (Glasgow Coma Scale) was substantiated. Each incremental elevation in ISS was independently associated with a greater hazard of dying (HR = 1.053 [1.031–1.075], P < 0.001), as shown in **Figure 5**. In parallel fashion, a downward shift in GCS emerged as a significant independent correlate of

escalating mortality risk (HR = 0.828 [0.723–0.948], P = 0.006).

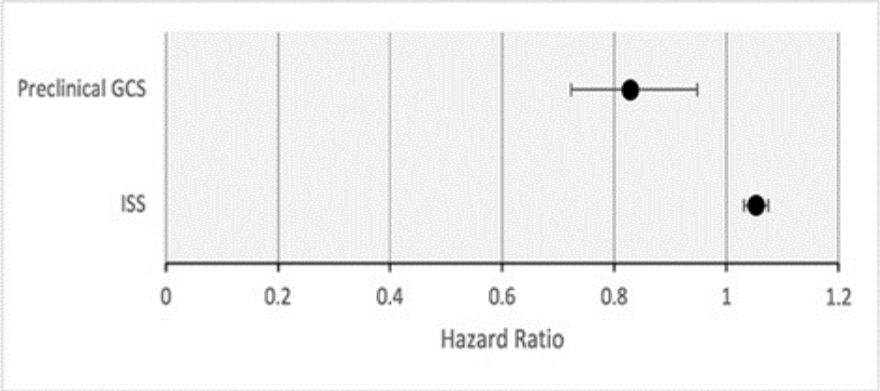

Figure 5. Output of multiple regression analysis: confirmed predictors of mortality.

This prospective cohort study evaluated injury profiles, initial clinical management, and endpoints in pediatric polytrauma cases. Two principal observations were drawn from the data: first, traumatic brain injury exerted the most pronounced effect on fatality within the pediatric sample, and second, both the Injury Severity Score (ISS) and the prehospital Glasgow Coma Scale (GCS) proved to be dependable prognostic indicators of death in our study population. Disparities tied to age regarding trauma magnitude and therapeutic measures were negligible.

Consistent with earlier reports, male children sustained injuries at a disproportionate rate relative to female children [13-15]. The fraction of male subjects climbed significantly with advancing age (P = 0.049). Nevertheless, among individuals younger than 10 years, the sex distribution approached parity in an investigation by Søreide *et al*. [16], which examined fatalities attributable to serious traumatic events among children and adolescents; a comparably balanced sex ratio was documented for those aged ≤ 13 years. These patterns imply that risk-taking conduct among males becomes more pronounced during the adolescent transition.

Regarding prehospital and acute-phase therapeutic measures, several noteworthy findings warrant attention. Within this study, airway intubation was performed in 76.6% of the cohort. In the subset aged 0–5 years, the rate was even more striking at 91.7%. This stands in marked contrast to figures reported elsewhere in the published literature [17]. In the study by Wyen *et al*. [17], the corresponding intubation rate for toddlers aged 2-5 years was only 50.9%. The inflated intubation rate in our series may be attributed to the greater overall injury burden.

Furthermore, a notably elevated frequency of cardiopulmonary resuscitation was documented, most conspicuously within the 0–5-year stratum. Wyen *et al*. [17] described analogous observations in their analysis and proposed two plausible explanations for these intergroup discrepancies. One interpretation relates to divergent injury morphologies, specifically a meaningfully higher representation of immediately life-threatening traumatic brain injuries among the youngest cohort. An alternative explanation centers on the considerable difficulty inherent in deciding to forgo or discontinue resuscitative attempts in the out-of-hospital setting, a predicament that is especially acute when young children are involved, given the heightened emotional strain affecting all treating personnel [18]. In these circumstances, paramedics and emergency physicians may postpone concluding CPR until after arrival at the Emergency Department (ED) when managing pediatric patients. Our own findings lend credence to both interpretations, as none of the patients transported to the ED while receiving ongoing resuscitation ultimately survived.

Additionally, vehicular road traffic incidents constituted the predominant source of polytrauma among children and teenagers within our sample. Parallel outcomes emerge when juxtaposing these data with the international body of research. Based on those analyses, collisions involving motor vehicles accounted for roughly 24%–41% of pediatric and adolescent polytrauma presentations [19, 20]. Debus *et al*. [1] articulated that the nature of road traffic mishaps shifted in accordance with developmental stage, spanning pedestrian-related events, bicycle crashes, motorcycle collisions, and automobile accidents, thereby reflecting developmentally appropriate modes of participation in traffic and suggesting that mechanisms of injury evolve alongside the expanding mobility radius of the child. This pattern is mirrored in the present investigation. Upon comparing the different age tiers, it becomes evident that among children below 5 years of age, a heterogeneous mix of alternative injury mechanisms, together with descents from elevated heights, accounted for the leading causes.

The configuration of traumatic injuries varies with patient age, a phenomenon supported by the data from this study.

When scrutinizing lesions classified as AIS ≥ 2, a discernible divergence in the anatomical distribution involving the head, abdomen, and extremities was noted. Children aged 0–5 years predominantly manifested cranial injuries. Among the 11–15-year-old subgroup, the occurrence of such injuries reached its nadir at 60.5%. Conversely, the probability of sustaining serious limb and intra-abdominal damage rose in tandem with increasing age group. This heightened susceptibility to trauma in these body areas can be explained by the disproportionately large cranium and relatively underdeveloped cervical musculature characteristic of young children [17]. Even under low-velocity conditions, the likelihood of head injury is substantial, a risk compounded by the unavailability of age-appropriate passenger restraint devices and by the child's positioning in the central seating location [21, 22]. Moreover, severe cranial trauma appears to function as the pivotal determinant of death in the context of pediatric injury [23-26]. This observation held true both for trauma confined to a single organ system and for injuries involving multiple organ systems concurrently [26]. Our investigation yielded congruent results, identifying the maximal head AIS as the most potent predictor of lethal outcome. In contrast to findings reported by other groups, injuries sustained in alternative body regions did not show a statistically significant association with mortality in our data. The published literature underscores thoracic trauma as a pertinent indicator of critical injury associated with heightened death rates and elevated complication risks [15, 27]. Although intrathoracic injuries appear to occur relatively infrequently, they are tied to considerable overall lethality [14]. Owing to the greater pliability of the pediatric ribcage, thoracic injuries in children may have grave consequences, potentially culminating in greater pulmonary and mediastinal damage [15]. The absence of a statistically significant effect of thoracic injury on mortality in our study, which diverges from prior research, could be rationalized by the dimensions of the cohort under analysis, particularly given the clear directional trend in the contribution of thoracic trauma to fatal outcomes.

The findings derived from our investigation affirm that the trauma grading instruments employed for the evaluation of polytraumatized children and adolescents constitute legitimate prognostic tools for mortality. Both the Glasgow Coma Scale (GCS) and the Injury Severity Score (ISS) prove adequate for discriminating critically unwell pediatric patients. A depressed prehospital GCS value demonstrated a statistically robust linkage to an amplified probability of death. Correspondingly, an escalating ISS bore a significant independent association with heightened lethal risk. To date, the ISS remains the most widely used trauma quantification system [28]. That said, its suitability for appraising injured pediatric subjects has been a matter of contention, owing to the physiological and anatomical divergences separating adults from children [26].

Despite the availability of pediatric-specific scoring instruments, the ISS remains the benchmark for assessing injury burden in younger trauma victims [28, 29]. The decision to employ the Injury Severity Score (ISS) in the present study was motivated by its well-established use as a widely accepted parameter for quantifying trauma severity in pediatric cohorts. While contemporary scholarly discourse has examined alternative rating frameworks intended to offset the shortcomings encountered when evaluating polytraumatized children [30, 31], the ISS persists as the most prevalent instrument applied in trauma assessment, delivering a panoramic appraisal of injury extent [31]. It remains imperative, however, to regard these metrics as components of a holistic prognostic construct and to pursue additional investigations to clarify their clinical relevance and transferability to pediatric populations, thereby improving survival prospects for these patients. Within the scope of our research, potential disparities in trauma management warrant explicit recognition, particularly in tertiary institutions possessing dedicated pediatric treatment infrastructures, where access to subspecialty expertise and sophisticated medical capabilities may facilitate more refined and multifaceted strategies for pediatric trauma care. Given the shifting terrain of pediatric trauma management, our observations highlight the need for individualized therapeutic protocols in tertiary settings equipped with specialized pediatric resources. A recent contribution by Snyder *et al*. [32] provides an integrative framework for understanding resource deployment in pediatric trauma facilities, based on a Delphi expert panel methodology. Additionally, the work of Gatto *et al*. [33] underscores the value of a pediatric observation unit for overseeing children admitted via the emergency pathway, offering pragmatic perspectives that can shape initiatives to enhance the standard of pediatric trauma treatment. Synthesizing these insights within the wider context of tertiary care environments endowed with specialized resources enables a thorough discussion of refining management paradigms and elevating the caliber of care delivered to pediatric trauma patients.

The intended purpose was to furnish a synopsis concerning the consequences of injury, diagnostic imaging utilization, and patient survival. It is essential to recognize that the outcomes of this investigation are circumscribed by the inherent characteristics of the analysis, which confer a descriptive quality upon our conclusions. The observational framework limits our ability to infer causal relationships or to assess the effectiveness of specific interventions. In a similar vein, exhaustive scrutiny of radiographic records and the accurate diagnostic characterization of each patient proved unfeasible within the scope of our methodological design. For this study, the

previously delineated age strata were adopted. It must be noted, however, that the 0–5-year category in particular amalgamates disparate developmental phases, indicating that no highly granular age differentiation is undertaken. A salient limitation of our research concerns the pronounced imbalance in subgroup sizes across the age-defined divisions, largely attributable to the paucity of cases within the < 2-year segment. In recognition of this constraint, we opted to preserve broader age groupings to safeguard statistical integrity, while acknowledging that such disparities may affect the precision of certain subgroup-level analyses within the pediatric collective.

The comparatively elevated frequency of agricultural mishaps or livestock-associated incidents, classified within the miscellaneous injury mechanism category in this investigation, may be plausibly explained by the location of our facility. The institution serves an extensive and predominantly rural referral region, a contextual factor that must be acknowledged when interpreting the data.

Moreover, the design of this study was monocentric, thereby curtailing the generalizability of its conclusions. While the single-center design is acknowledged, the external generalizability of the findings may be influenced by the distinct trauma profiles and therapeutic practices at this institution. Subsequent investigations might productively examine potential heterogeneity in pediatric trauma care delivery across multiple sites, with specific attention to contrasts between rural and urban environments. The focused attention on the most severely injured patients constitutes an additional key restriction. This deliberate orientation, though yielding insights into a defined patient subset, may not wholly capture the complete spectrum of pediatric traumatic pathology. Future research endeavors could benefit from incorporating a broader range of injury severity. Even so, the outcomes of the present study lay a robust groundwork for subsequent exploration within this domain, including cross-institutional or nationwide collaborations. Despite its limitations, this investigation draws upon an ample regional dataset. It furnishes a substantiated perspective on the resuscitation bay management of polytraumatized children and adolescents at our Level 1 trauma facility. While this study provides instructive observational findings, additional randomized controlled trials are needed to delve more deeply into this topic.

Conclusion

Pediatric polytrauma recipients managed at this Level I trauma center present with heterogeneous injury configurations and clinical profiles. Although age-attributable differences in aggregate injury magnitude and therapeutic measures were circumscribed, cranial trauma surfaced as a decisive prognosticator of fatal outcome. The current study identified the Injury Severity Score (ISS) and the prehospital Glasgow Coma Scale (GCS) as markers of mortality risk, reinforcing the importance of prompt evaluation and resuscitative intervention. These findings argue for finely calibrated strategies in pediatric polytrauma management that integrate developmental stage and injury morphology to maximize favorable outcomes. Nevertheless, the observational nature of this investigation necessitates caution in making definitive assertions about interventional benefits, underscoring the need for additional research, potentially through controlled experimental designs, to sharpen clinical guidance for pediatric polytrauma populations.

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