



# An audit of trauma-related admissions to a paediatric intensive care unit in central South Africa: 2017–2020

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**Background.** Paediatric trauma is a major cause of mortality and morbidity worldwide. Policy and public health interventions have yet to adequately address paediatric trauma as a health concern in South Africa. To date, no research has documented the burden of trauma in paediatric intensive care units (PICUs) in central South Africa.

**Objective.** To determine the prevalence and mechanism of trauma, outcomes and use of services in children admitted to a PICU in Bloemfontein, Free State, 2017–2020.

**Methods.** This was a retrospective, descriptive medical record audit of trauma-related admissions to a tertiary PICU. Data collected included demographic information, mechanism of injury and outcomes (length of PICU stay, ventilator days, requirement for surgery, and death prior to discharge).

**Results.** Trauma-related admissions accounted for 37.7% ( $N=131$ ) of available PICU bed days. Median (interquartile range) length of stay was 11 (4 - 19) days. Mechanical ventilation was required in 49 cases (37.4%), accounting for 317 ventilator days. Eight children (6.1%) died before hospital discharge. Children younger than 5 years made up 43.8% of the study sample; 65.6% were male. Road traffic accidents accounted for 51.1% of trauma cases requiring PICU admission and resulted in the highest number of surgeries, cumulative bed days and ventilator days.

**Conclusion.** Trauma is associated with high resource use in a tertiary PICU setting. Road traffic accidents were the main cause for admission in this study. The need to strengthen policy and infrastructure to prevent, monitor and manage childhood injuries remains an unaddressed public health concern.

**Keywords.** trauma; injuries; paediatric trauma; accidents.

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Trauma is recognised as an important contributor to mortality and morbidity in children. This is the case particularly in low- and middle-income countries.<sup>[1]</sup> In 2017, the all-injury mortality rate for children under 5 in South Africa (SA) was 40.1 per 100 000, decreasing to 19 per 100 000 in the 5 - 14-year group.<sup>[2]</sup> Although 6.1% of all non-natural deaths in SA occurred in the Free State,<sup>[2]</sup> the province recorded the highest proportion (37.6%) of transport-associated deaths.

While trauma as a cause of childhood mortality is well described in the literature,<sup>[3,4]</sup> Prinsloo *et al.*<sup>[5]</sup> drew attention to the burden of non-fatal injuries. They reported 132 387 cases of children younger than 13 years presenting to the Red Cross War Memorial Children's Hospital, SA, between 1997 and 2016, which included 25 248 trauma unit consultations and 9 831 ward or paediatric intensive care unit (PICU) admissions; <0.2% of cases resulted in death. These findings support prior calls for improved programmes to prevent and address childhood injuries in SA,<sup>[6,7]</sup> especially as non-fatal trauma contributes to a significant burden of disability in the country.<sup>[8]</sup>

In paediatric critical care, the burden of trauma must be viewed in relation to the constraints within which these services function and the associated competition for resources, arising mainly

from a high burden of life-threatening communicable disease.<sup>[9-13]</sup> Patel *et al.*<sup>[14]</sup> reported that 185 PICU admissions at Chris Hani Baragwanath Academic Hospital in Johannesburg were related to trauma (excluding burns), from a total number of admissions of 919 over three years (2011–2013). The mortality rate was found to be 9%. Injured children in that study required significant support, with a median length of stay of 5 days (range: 1 - 33 days) and a mean of 4.5 days of mechanical ventilation in survivors. At the same hospital, Mashavave *et al.*<sup>[15]</sup> reported 428 admissions to a paediatric burns ICU over a five-year period, with 109 (25%) mortalities and a median length of stay of 14 days.

The PICU at Pelonomi Tertiary Hospital in Bloemfontein in the Free State provides a province-wide service to all patients referred to the Trauma Resuscitation Unit. Although this site is the main referral point for paediatric trauma services in the province, many patients follow complex referral pathways and receive care at more than one facility in smaller towns prior to PICU disposition. This is in keeping with what Hodkinson *et al.*<sup>[16]</sup> found in the Western Cape. In these settings, patients are managed by medical officers with or without oversight from general surgeons and paediatricians.

Once patients are referred to the Trauma Resuscitation Unit, they are managed by the trauma team and referred for specialist surgery, anaesthesiology and paediatric critical care as required. Burns and a spectrum of mechanical injuries are managed at this unit and children requiring critical care services because of trauma are managed by a paediatric intensivist and relevant surgical teams in a PICU rather than in an adult ICU, as reported by Naidoo and Muckart.<sup>[17]</sup>

No reports of trauma requiring paediatric intensive care in the Free State currently exist in the literature. An evaluation such as this retrospective report of children admitted to the PICU of a regional, tertiary hospital provides important insights into the demand for services, patterns of critical trauma and outcomes of patients in this setting.

## Methods

### Study design

A retrospective descriptive audit was undertaken based on records of patients admitted to the PICU at the Pelonomi Tertiary Hospital in Bloemfontein, Free State, between 1 January 2017 and 31 December 2020.

### Study sample

Records of all children (up to the age of 13) who were admitted to the PICU for trauma-related injuries between 1 January 2017 and 31 December 2020 ( $N=135$ ) were considered for the study. Patients who presented with iatrogenic injuries or adverse drug reactions to medications or who were admitted to the PICU more than 7 days after their initial injury were excluded from the study ( $n=4$ ). The reason was to exclude children with critical illness related to the failure of adequate healthcare or other factors. The final study sample comprised 131 records (Fig. 1).

### Study site

The study site is a tertiary-level PICU and the designated unit for trauma admissions. From 2017 to 2019, the unit consisted of four beds in an adult ICU setting. In 2020, the paediatric service was separated from the adult unit, with a total of 13 beds; however, owing to staffing constraints only five are operational.

The Trauma Resuscitation Unit at this facility receives all paediatric patients with serious trauma referred from district and regional facilities. The unit includes a dedicated area for paediatric resuscitation, from where patients can be referred to intensive care. Services are also provided by the paediatric critical care team, and staff specialising in paediatric surgery, neurosurgery, orthopaedic surgery and anaesthesiology.

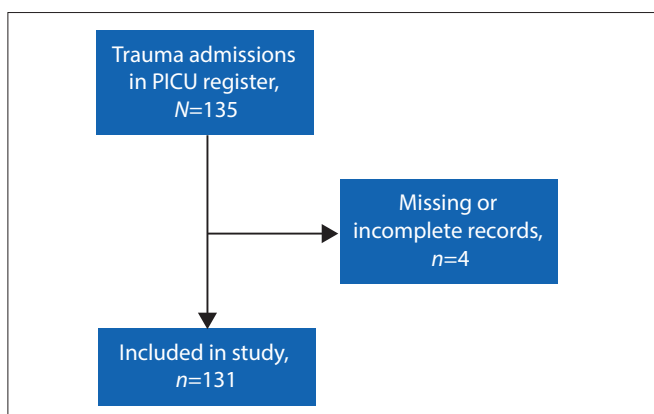


Fig. 1. Selection of study sample.

This PICU is one of only two in public facilities in the Free State (both with five beds) to provide dedicated critical care services in a province of 1 035 000 children.<sup>[18]</sup> Indications for admission to paediatric intensive care include provision of life-supporting therapies, invasive or non-invasive multimodal monitoring, or therapy that cannot be provided in a general ward setting. Regional centres in the province do not provide trauma-related paediatric critical care services.

### Data collection

Cases were identified from the ward register. Data were extracted from the electronic and paper-based health records of each patient and captured on a sheet designed by the authors. Details included: demographic particulars; mechanism of injury; outcome of trauma (discharged or deceased); length of PICU stay; number of days on a ventilator (if applicable); and surgery requirement (if applicable). All information was collated in a secure, password-protected spreadsheet; paper-based notes used during data capture were subsequently destroyed.

### Pilot study

A pilot study based on 20 patient files was conducted to evaluate the completeness of the records and to determine whether the research protocol had to be adapted. The majority of records contained relevant demographic details, the mechanism of injury and outcome data. A review of the data, including by a biostatistician, concluded that the nature of the data was adequate to achieve the study objectives.

### Data analysis

Statistical analysis was performed using the SAS software package (version 9.4). Continuous variables were summarised as medians, minimums, maximums and interquartile ranges (IQRs). Categorical variables were summarised as frequencies and percentages.

### Ethical considerations

The study was approved by the Health Sciences Research Ethics Committee of the Faculty of Health Sciences, University of the Free State (ref. no. HSD2021/0411/2707). Permission to conduct the study was obtained from the Free State Department of Health. All data were anonymised.

## Results

During the study period, 940 children were admitted to the PICU, 131 (13.9%) of whose admissions were due to trauma. The majority of trauma patients were male ( $n=86$ ; 65.6%). The biggest proportion of patients (57/131; 43.5%) were in the age range 0 - 4 years, followed by 38.5% (50/131) between 5 and 9 years old, and 17.6% (23/131) between 10 and 13 years old.

Road traffic accidents (pedestrian and passenger) accounted for most cases requiring critical care (51.1%), followed by burns (22.1%) and blunt, non-accidental injuries (13.0%). Injuries categorised as 'other' (13.7%) included drownings, penetrating trauma and bite wounds. No trauma associated with sexual assault was recorded.

Road traffic accidents were the most common cause of injury in all age and gender groups (Table 1), except for boys 0 - 4 years; in this group burns were the most common cause. The analysis reflects a preponderance towards younger patients and male sex.

During PICU stay, surgical intervention was required in 75 cases (57.3%), which involved transfer to an operating theatre where a procedure was performed under general or regional anaesthesia. Neurosurgery (18.3%) and orthopaedic surgery (14.5%) were the

most common surgical interventions. Of the road traffic accident cases, 67.2% required surgery (Table 2).

In this study sample, eight children (6.1%) died before discharge from the hospital. Three children under the age of 5 (3/57; 5.3%) died of their injuries. Of the 67 cases related to road accidents, five (7.5%) resulted in death. Two deaths were due to burns (2/29; 6.9%).

Admissions for trauma accounted for 2 062 PICU bed days during the study period, accounting for 37.7% of available bed days (Table 3). The median (IQR) length of PICU stay was 11 (4 - 19) days. Mechanical ventilation was required in 49 cases (37.4%), resulting in 317 ventilator days. The median (IQR) duration of mechanical ventilation in these patients was 6 (2 - 9) days. The greatest cumulative contribution to both bed and ventilator days was from road traffic accidents. Burns patients contributed disproportionately to total PICU bed days despite a similar median length of stay (average 23.6 days). This was a result of several patients with prolonged PICU stays (seven children were admitted for more than a calendar month, of which the maximum was 141 days). Treatment was provided for 33 nosocomial infections (25.2%).

**Discussion**

Although the mortality rate for trauma among the study sample was fairly low, and somewhat lower than reported by Patel *et al.*,<sup>[14]</sup> our findings show that children needing critical care after trauma experienced considerable morbidity, which required considerable PICU resources (e.g. prolonged stays and bed occupancy, and life-supporting mechanical ventilation). Surgical intervention was required in many cases. Road traffic accidents contributed to the greatest number of bed days and need for mechanical ventilation or surgical intervention in this study. This is in line with the findings of Patel *et al.*,<sup>[14]</sup> who found that most PICU admissions (66%) were due to road traffic injuries. Prinsloo *et al.*<sup>[5]</sup> also reported transport-related injuries as a major cause of injuries (19 603/132 387 cases). Burn injuries resulted, on average, in longer PICU stays than other mechanisms of injury and contributed disproportionately to bed days (maximum stay was 141 days). However, the median length of stay was similar to that of the rest of the study sample, and also similar to what was reported by Mashavave *et al.*<sup>[15]</sup> The finding that injuries related to road traffic accidents and burns account for most

**Table 1. Mechanism of injury, disaggregated by age group and gender**

Mechanism of injury	Age and gender categories						Total, (N=131), n (%)
	0 - 4 (N=57), n (%)		5 - 9 (N=50), n (%)		10 - 13 (N=23), n (%)		
	Male	Female	Male	Female	Male	Female	
Road traffic accident	9 (29.0)	12 (46.2)	22 (59.5)	9 (69.2)	10 (58.8)	5 (83.3)	67/131 (51.1)
Burns	11 (35.5)	10 (38.5)	4 (10.8)	2 (15.4)	0	1 (16.7)	29/131 (22.1)
Blunt, non-accidental	5 (16.1)	1 (3.8)	7 (18.9)	1 (7.7)	3 (17.7)	0	17/131 (13.0)
Other	6 (19.4)	3 (11.5)	4 (10.8)	1 (7.7)	4 (23.5)	0	18/131 (13.7)
Total (N=131), n (%)	31 (23.7)	26 (19.8)	37 (28.2)	13 (9.9)	17 (13.0)	6 (4.6)	

**Table 2. Surgical interventions organised according to mechanism of injury\***

Mechanism of injury	Surgery required, n (%)	Type of intervention					
		General/ abdominal surgery, n (%)	Burns-related surgery, n (%)	Neurosurgery, n (%)	Orthopaedic surgery, n (%)	Maxillofacial surgery, n (%)	Other, n (%)
Road traffic accident (N=67)	41 (61.2)	5 (7.5)	-	13 (19.4)	13 (19.4)	4 (6.0)	6 (9.0)
Burns (N=29)	12 (41.4)	-	12 (41.4)	-	-	-	-
Blunt non-accidental (N=17)	11 (64.7)	2 (11.8)	-	6 (35.3)	2 (11.8)	-	1 (5.9)
Other (N=18)	11 (61.1)	1 (5.6)	-	5 (27.8)	4 (22.2)	-	1 (5.6)
Total (N=131)	75 (57.3)	8 (6.1)	12 (9.2)	24 (18.3)	19 (14.5)	4 (3.1)	8 (6.1)

\*A patient could have a combination of interventions.

**Table 3. Ventilator days and length of PICU stay organised by mechanism of injury**

Mechanism	Patients ventilated, n (%)	Total ventilator days	Median ventilator days (IQR)	Total bed days	Median length of stay (IQR)
Road traffic accident (N=67)	36 (53.7)	239	4.5 (2 - 9)	995	11 (6 - 19)
Burns (N=29)	6 (20.6)	46	8 (6 - 11)	685	12 (4 - 31)
Blunt non-accidental (N=17)	4 (23.5)	18	5 (3 - 6)	209	12 (3 - 16)
Other (N=18)	3 (16.7)	14	6 (4 - 6)	173	4.5 (1 - 15)
Total (N=131)	49 (37.4)	317	6 (2 - 9)	2062	11 (4 - 19)

IQR = interquartile range.

of the PICU resource use suggests that these two mechanisms can be identified as important targets for preventive strategies.

The preponderance towards younger and male children is also similar to the findings of Prinsloo *et al.*<sup>[5]</sup> and Patel *et al.*<sup>[14]</sup> and points to these groups being relevant populations for public health interventions aimed at reducing the burden of trauma.

All the admissions described in this study are, at least to some extent, preventable. Given the direct consequences for patients (both survivors and non-survivors) and the demonstrable strain on PICU resources, our findings further support calls for the strengthening of legislative, infrastructural and public health frameworks to prevent injuries in children.<sup>[4-6]</sup> Despite initiatives from non-governmental organisations (e.g. Child Safe South Africa and Surgeons for Little Lives) in this regard, efforts remain localised to areas where these organisations are active and have yet to translate to strong national and local policy or societal and infrastructural change.<sup>[6,19]</sup> To date, there are no formal structures or policy in the Free State for reducing injuries in children.

### Study limitations

This research focused only on injured children in the PICU setting. Knowledge gaps remain regarding the sequence of events leading up to injuries, prehospital care and the pathway to care as experienced in the cases reviewed. Some bias or missing data are expected in retrospective studies such as this one.

### Conclusion

Potentially preventable trauma led to morbidity and mortality in children admitted to the PICU in this study. Such admissions required extensive use of constrained PICU resources. Road traffic injuries were the largest contributor to deaths, surgical intervention, cumulative bed days and cumulative ventilator days. Services to manage severe trauma, including effective resuscitation, transport, surgery and long-term follow-up and care, are needed. It is essential that policy and legislation, societal change and infrastructural development are put in place to prevent injuries in children and reduce the burden of severe trauma.

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**Author contributions.** GC, JvR, JJ, LJ, KM, KN, J-PS and JU wrote the protocol, conducted the research and compiled the draft manuscript. CvR provided methodological input, and contributed to statistical analysis and writing of the manuscript. As study leader, MAP was involved with conceptualisation of the study, assisted with preparing the research proposal, and contributed to finalisation of the manuscript. All authors read and approved the final manuscript.

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**Conflicts of interest.** None.

1. Peden M, World Health Organization. World report on child injury prevention. Geneva: WHO, 2008. <https://iris.who.int/handle/10665/43851> (accessed 30 April 2024).
2. Prinsloo M, Mhlongo S, Dekel B, et al. The 2nd injury mortality survey: A national study of injury mortality levels and causes in South Africa in 2017. Cape Town: South African Medical Research Council, 2021.
3. Matzopoulos R, Prinsloo M, Pillay-Van Wyk V, et al. Injury-related mortality in South Africa: A retrospective descriptive study of postmortem investigations. *Bull World Health Organ* 2015;93(5):303-313. <https://doi.org/10.2471/BLT.14.145771>
4. Mathews S, Martin LJ, Coetzee D, et al. The South African child death review pilot: A multiagency approach to strengthen healthcare and protection for children. *S Afr Med J* 2016;106(9):895-899. <https://doi.org/10.7196/SAMJ.2016.v106i9.11234>
5. Prinsloo M, Hunter K, Matzopoulos R, et al. Non-fatal injuries among boys and girls presenting to Red Cross War Memorial Children's Hospital, Cape Town, South Africa. *S Afr Med J* 2022;112(7):465-471. <https://doi.org/10.7196/SAMJ.2022.v112i7.16303>
6. Van As AB, Millar AJ. From the pursuit of excellence to the quest for significance: Promotion of a Childsafe South Africa. *S Afr Med J* 2012;102(6):427-428. <https://doi.org/10.7196/samj.5602>
7. Herbert HK, Van As AB, Bachani AM, et al. Patterns of pediatric injury in South Africa: An analysis of hospital data between 1997 and 2006. *J Trauma Acute Care Surg* 2012;73(1):168-174. <https://doi.org/10.1097/TA.0b013e31824d67c3>
8. Van Niekerk A, Matthews S. Violence, injury and child safety: The new challenge for child health. In: Children's Institute: South African Child Gauge 2019. Cape Town: University of Cape Town, 2019:114-130.
9. Bhagwanjee S, Scribante J. National audit of critical care resources in South Africa – unit and bed distribution. *S Afr Med J* 2007;97(12 Pt 3):1311-1314.
10. Scribante J, Bhagwanjee S. National audit of critical care resources in South Africa – nursing profile. *S Afr Med J* 2007;97(12 Pt 3):1315-1318.
11. Argent AC, Ahrens J, Morrow BM, et al. Pediatric intensive care in South Africa: An account of making optimum use of limited resources at the Red Cross War Memorial Children's Hospital. *Pediatr Crit Care Med* 2014;15(1):7-14. <https://doi.org/10.1097/PCC.0000000000000029>
12. Clarence E, Jeena PM. The unmet need for critical care at a quaternary paediatric intensive care unit in South Africa. *S Afr Med J* 2022;112(11):871-878. <https://doi.org/10.7196/SAMJ.2022.v112i11.16452>
13. Msemburi W, Pillay-Van Wyk V, Dorrington R, et al. Second national burden of disease study for South Africa: Cause-of-death profile for South Africa, 1997-2012. Cape Town: South African Medical Research Council, 2016. <https://www.samrc.ac.za/sites/default/files/attachments/2022-08/SouthAfrica2012.pdf> (accessed 30 April 2024).
14. Patel N, Khofi-Phiri I, Mathiva LR, Grieve A, Loveland J, Nethathe GD. Trauma related admissions to the PICU at Chris Hani Baragwanath Academic Hospital, Johannesburg. *Pediatr Surg Int* 2017;33(9):1013-1018. <https://doi.org/10.1007/s00383-017-4125-0>
15. Mashavave NZ, Withers A, Doedens L, Jugmohan B, Loveland J. A retrospective study analysing mortality and outcomes in the paediatric burns intensive care unit at the Chris Hani Baragwanath Academic Hospital, Johannesburg. *S Afr J Child Health* 2020;14(4):212-216. <https://doi.org/10.7196/SAJCH.2020.v14i4.1724>
16. Hodkinson P, Argent A, Wallis L, et al. Pathways to care for critically ill or injured children: A cohort study from first presentation to healthcare services through to admission to intensive care or death. *PLoS One* 2016;11(1):e0145473. <https://doi.org/10.1371/journal.pone.0145473>
17. Naidoo N, Muckart DJJ. The wrong and wounding road: Paediatric polytrauma admitted to a level 1 trauma intensive care unit over a 5-year period. *S Afr Med J* 2015;105(10):823-826. <https://doi.org/10.7196/SAMJnew.8090>
18. Hall K. Demography of South Africa's children. In: Children's Institute, South African Child Gauge 2024. Cape Town: University of Cape Town, 2024:198-202.
19. Mahlaule R, Meghraj N, Tshuta L, et al. Burnt out: A retrospective review of paediatric burns admissions at Chris Hani Baragwanath Academic Hospital 2015-2020. *Burns Open* 2024;8(2):160-163. <https://doi.org/10.1016/j.burnso.2024.03.007>

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