Evaluating complications in a South African neurocritical care unit: A 1-year retrospective audit

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Background. The benefits of setting up a dedicated neurocritical care unit (NCCU) for critically ill neurological patients are well documented. These units are specifically designed to care for individuals with conditions affecting the brain and spine. However, complications particular to these units in low- and middle-income countries are not widely reported.
Objectives. To describe the complications observed in an NCCU at a tertiary-level academic hospital over the course of 1 year and examine their link with intensive care unit (ICU) length of stay (LOS) and mortality rates.
Methods. The study involved retrospective analysis of complications experienced by critically ill neurological patients admitted to the NCCU between 1 January and 31 December 2020, according to the NCCU patient data registry.
Results. A total of 850 patients, most of whom were male (61.2% in the high-care unit (HCU) and 68.1% in the ICU), were admitted to the NCCU, with a median age of 43 years and 41 years in the HCU and the ICU, respectively. The overall rate of complications was 38.2% (n=325/850 patients). Statistically significant complications (p<0.05) included metabolic and electrolyte imbalances, infections (including ventilator-associated pneumonia, surgical site infections and central line-associated bloodstream infections), and deep-vein thrombosis. The most common complication was metabolic disturbances (28.2%), particularly sodium homoeostasis abnormalities. The number of complications significantly affected NCCU LOS (p<0.001), but did not have a statistically significant impact on mortality (p=0.067).
Conclusion. Complications occurred in 38.2% of critically ill neurological patients in a specialised NCCU in a tertiary-level academic hospital in South Africa, primarily involving electrolyte disturbances and infections. These complications were linked to longer LOS in the ICU, but did not significantly increase the risk of mortality.

Keywords: Neurocritical care unit, South Africa, complications, ICU length of stay, mortality

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Contribution of the study
This study provides valuable insight into the burden and nature of complications encountered in a resource-constrained neurocritical care setting. By systematically identifying and quantifying clinical complications over a defined period, the article highlights critical areas for intervention and quality improvement. It contributes to the global body of neurocritical care literature by offering context-specific data from a low- to middle-income country, thereby addressing a significant gap in regional and global neurocritical care outcomes research. The findings support the development of targeted strategies to enhance patient safety, optimise resource use, and improve clinical outcomes in similar healthcare environments.

The creation of specialised neurocritical care units (NCCUs) has been systematically documented as beneficial for patients with severe neurological conditions. These units are designed specifically to address the needs of patients suffering from brain and spinal disorders. Research indicates that a dedicated NCCU enhances the quality of care for patients with cranial and spinal issues compared with management in a general intensive care unit (ICU).[1,2] Key advantages of a dedicated NCCU include shorter duration of hospital stay, lower overall mortality rates, decreased readmission rates, and improved neurological and functional outcomes.[1,2]

Mortality rates for patients in an NCCU are significantly lower compared with those for neurosurgical patients in general ICUs, with rates of 5.3% and 10.2%, respectively.[3] Additionally, NCCUs demonstrate better compliance with neurospecific guidelines and protocols, as well as improved chart documentation.[4,5] One study highlighted that the implementation of an NCCU resulted in the

development of management protocols and discharge criteria that directly contributed to reduced mortality rates and shorter hospital stays.[2,5] The establishment of a dedicated NCCU also leads to enhanced resource utilisation,[3] with these benefits being more pronounced when a neuro-intensivist is present.[2] Furthermore, NCCUs generate an environment that encourages learning and fosters research initiatives.[5]

While there is existing literature supporting the use of dedicated NCCUs, there remains a significant gap in studies addressing the complications unique to these specialised units, on a global scale but particularly in low- and middle-income countries (LMICs). This lack of research is particularly prominent in African settings, where dedicated NCCUs are mainly found in a limited number of large tertiary centres scattered across the continent. According to an analysis of the PRINCE (Point PRevalence In Neurocritical CarE) study by Venkatasubba Rao *et al.*,[6] 83% of the global access to dedicated NCCUs is concentrated in North America. Complications that arise in critically ill neurological patients can often be life threatening, and may result in fatal outcomes if not quickly identified and managed. The presence of neurological complications in ICU patients nearly doubles the mortality rate (55% v. 28% for those without such complications), while also extending length of stay (LOS) in both the ICU and the hospital, as well as increasing tracheostomy rates.[1,2] Familiarity with these complications among ICU staff can enhance the prompt recognition and treatment of these critical issues. Dedicated NCCUs are well equipped to diagnose, prevent and treat complications that are specific to critically ill patients with neurological conditions.[4]

Complications in an NCCU can be broadly categorised into two main groups:[7] (*i*) general ICU stay-related complications, including infections, electrolyte and metabolic imbalances, and complications associated with ventilators, lines or other medical devices; and (*ii*) postoperative complications, encompassing surgical site infections (SSIs), postoperative meningitis, cerebrospinal fluid (CSF) leaks, neurological deficits (new or worsening), and haemorrhage.

The main objective of the present study was to describe the complications encountered over a 1-year period in an NCCU at a tertiary-level academic hospital in South Africa (SA). Secondary objectives were: (*i*) to evaluate and characterise the complications occurring in the NCCU during the 1-year study period; and (*ii*) to assess the association between these complications, LOS in the NCCU, and mortality rates.

Methods

Study setting

The study was conducted at Groote Schuur Hospital (GSH), an 893-bed tertiary-level academic hospital in Western Cape Province, SA. GSH provides a comprehensive critical care service, with dedicated units for medical, surgical, cardiothoracic and neurocritical care. The NCCU consists of a 6-bed ICU and a 6-bed high-care unit (HCU). The ICU and HCU are two separate units that operate independently of each other. The main distinction between the ICU and the HCU is the ICU's capability to ventilate patients and provide advanced organ support, including dialysis and inotrope infusions, whereas the HCU is more suited for patients requiring intense clinical neuromonitoring and invasive haemodynamic monitoring.

Study design

The study was a retrospective audit of complications experienced by critically ill neurological patients admitted to the NCCU at GSH over the 1-year period from 1 January to 31 December 2020. Data were sourced from the prospectively maintained NCCU patient data registry (HREC: R012/2015).

Study population

The study included all critically ill neurological patients aged ≥18 years who were admitted to the NCCU at GSH between 1 January and 31 December 2020. Exclusion criteria were patients aged <18 years and all critically ill neurological patients admitted to other general ICUs (i.e. non-neurocritical care units).

Data analysis

Data from the prospectively maintained NCCU data registry were anonymised, cleaned, coded, and analysed using SPSS Statistics, version 24, 2016 (IBM, USA). Categorical variables were summarised using percentages, while continuous variables were reported as means with standard deviations or medians with interquartile ranges (IQRs). Statistical differences for categorical variables were assessed using Pearson's χ^2 test or Fisher's exact test, whereas continuous variables were analysed using Student's *t*-test or the Mann-Whitney *U*-test. A two-tailed *p*-value <0.05 was considered statistically significant.

Ethical considerations and informed consent

Ethical approval for this study was obtained from the University of Cape Town's Human Research Ethics Committee (ref. no. HREC REF: 492/2021). As a retrospective observational study, it posed minimal risk to participants and did not adversely affect the quality of care they received. Data were analysed retrospectively from the anonymised registered patient data registry (HREC: R012/2015). A waiver of informed consent was therefore requested, and granted by the Ethics Committee.

Results

Table 1 presents the demographic and clinical characteristics of the study participants. A total of 850 patients were admitted to the NCCU over the 12-month study period, with a median (IQR) age of 43 (30 - 55) years for the HCU and 41 (29 - 53) years for the ICU. Nearly 60% (*n*=502/850) of the admissions were to the HCU. The majority of the participants (64.0%) were male, and a meaningful proportion (27.4%) were admitted from the trauma unit. Most patients (73.1%) admitted to the NCCU were discharged to the neurosurgery ward. The overall NCCU mortality rate among the 850 patients was 4.4% (*n*=37/850). It is important to note that neither functional outcomes nor long-term mortality were assessed in this study.

Table 2 shows that the majority of the patients were admitted as emergencies, with a mean of 77.9% between the ICU and the HCU. The most prevalent diagnoses were trauma-related, accounting for ~40% of admissions, followed by aneurysmal subarachnoid haemorrhage (SAH) at 15.05%. The least common diagnosis was spinal trauma, which constituted only 0.4% of admissions. Brain oncological conditions represented the largest proportion of elective admissions at ~20%. Approximately 43.5% of total admissions had an initial Glasgow Coma Scale (GCS) score <12, with two-thirds of these patients improving to a GCS >13 by the time of discharge from the NCCU.

Craniotomy was the most frequently performed procedure, with no significant difference observed between trauma (18.5%) and non-trauma (19.5%) cases. Vascular interventions were the second most common procedure, comprising 18.7% of cases, the majority (97.5%) of which were endovascular in nature. The least common interventions were for spinal infections, accounting for 0.5% of admissions. Notably, ~58% of patients admitted to the ICU were intubated.

Table 1. Demographic characteristics of patients admitted to the NCCU at a tertiary-level academic hospital from 1 January to 31 December 2020 (*N*=850)

Characteristic	HCU (*n*=502), *n* (%)*	ICU (*n*=348), *n* (%)*	*p*-value
Age (years)			
Mean (SD)	43.0 (16.0)	41.7 (16.6)	0.272
Median (IQR)	43.0 (30 - 55)	40.0 (29 - 53)	
Missing information	7 (1.4)	0	
Sex			
Male	307 (61.2)	237 (68.1)	0.045
Female	195 (38.8)	111 (31.9)	
Referred from			
NCCU†	98 (19.5)	19 (5.5)	<0.001
Trauma	133 (26.5)	100 (28.7)	
Casualty (non-trauma)	132 (26.3)	41 (11.8)	
Neurosurgery ward	109 (21.7)	51 (14.7)	
Theatre	10 (2.0)	103 (29.6)	
Other ward	20 (4.0)	27 (7.8)	
Other hospital	0	4 (1.1)	
Unknown	0	3 (0.9)	
Discharged to			
NCCU‡	26 (5.2)	112 (32.2)	<0.001
Neurosurgery ward	431 (85.9)	190 (54.6)	
Other§	41 (8.2)	12 (3.4)	
Died	4 (0.8)	28 (8.1)	
Missing information	0	6 (1.7)	
Outcome			
Alive	496 (98.8)	317 (91.1)	<0.001
Dead	6 (1.2)	31 (8.9)	

NCCU = neurocritical care unit; HCU = high-care unit; ICU = intensive care unit.
*Except where otherwise indicated.
†Referred from the NCCU denotes a transfer between the HCU and ICU; at our instituition the HCU and the ICU are two separate 6-bed units.
‡Discharged to the NCCU denotes a transfer between the HCU and ICU; at our instituition the HCU and the ICU are two separate 6-bed units.
§'Other' includes other hospital ward, transfer back to referring hospital, or discharged home from the NCCU.

Table 3 presents an overall complication rate of 38.2%, with a higher incidence observed among patients admitted to the ICU (47.1%) compared with those in the HCU (32.1%). The most prevalent complications were metabolic, occurring in 28.2% of cases, predominantly involving abnormalities in sodium homoeostasis. The least frequent complications were aspiration (0.6%) and post-extubation stridor (0.7%). Statistically significant complications included infections (specifically ventilator-associated pneumonia (VAP), SSI and central line-associated bloodstream infection (CLABSI)) and metabolic disturbances (including sodium and other electrolyte abnormalities, as well as renal abnormalities). Notably, no cases of clinically important deep-vein thrombosis (DVT) were reported.

Table 4 demonstrates the independence of LOS between the HCU and ICU settings. Analysis of the contingency table suggests that LOS in the HC is generally shorter when categorised into the following groups: 0 - 7 days, 8 - 14 days, and >14 days.

Utilising a linear regression model, we observed a significant relationship between the number of complications and LOS. The statistical analysis revealed: (*i*) a slope of 4.41, indicating that each additional complication is associated with an estimated increase in LOS of 4.41 days; (*ii*) an r^2 value of 0.59, suggesting that ~60% of the variance in LOS can be explained by the number of complications; and (*iii*) a *p*-value <0.05, allowing us to reject the null hypothesis and confirm a statistically significant relationship between LOS and complications.

Table 5 presents the results of a multivariate analysis examining the relationship between number of complications and mortality. The analysis indicates no significant overall relationship between the total number of complications and mortality, with a *p*-value of 0.0677.

Discussion

This study represents the first comprehensive investigation into complications occurring in a dedicated NCCU in an LMIC, specifically in sub-Saharan Africa. Such specialised units are scarce, and critically ill neurological patients in this region are typically managed in combined surgical, trauma or general ICUs, often without the oversight of neuro-intensivists.

The findings of this study indicate a complication rate of 38.2% in the NCCU, with an expected higher incidence observed among patients admitted to the ICU (47.1%) compared with those in the HCU (32.1%). Statistically significant complications identified in this study were infections (including VAP, SSIs and CLABSIs) and metabolic abnormalities (including sodium and other electrolyte disturbances, as well as renal complications).

Notably, no patients developed clinically important DVT, a finding that was also statistically significant. All the patients in the NCCU routinely have thromboembolic prevention stockings or calf compressor devices as mechanical prophylaxis, as chemical prophylaxis is often contraindicated in the acute setting in the NCCU. It is important to note that this NCCU does not include routine screening for DVTs by ultrasound. Instead, clinical examination is performed twice daily, and patients are only referred for ultrasound evaluation if there is a clinical suspicion of DVT based on these examinations. As a result, the absence of reported DVT

Table 2. Characteristics of patients admitted to the NCCU at a tertiary-level academic hospital from 1 January to 31 December 2020 (*N*=850)

Characteristic	HCU (*n*=502), *n* (%)*	ICU (*n*=348), *n* (%)*	*p*-value
Diagnosis†			
Trauma			
DBI	181 (36.1)	160 (46.0)	0.005
EDH	22 (4.4)	24 (6.9)	0.15
SDH	57 (11.4)	54 (15.5)	0.095
TICH	97 (19.3)	63 (18.1)	0.72
Fracture	129 (25.7)	133 (38.2)	<0.001
Hydrocephalus	52 (10.4)	41 (11.8)	0.588
SAH	97 (19.3)	31 (8.9)	<0.001
Missing information	0	2 (0.6)	
Brain oncology	89 (17.7)	81 (23.3)	0.05
Spine trauma	3 (0.6)	0	0.392
Missing information	1 (0.2)	1 (0.3)	
Spine oncology	14 (2.8)	3 (0.9)	0.084
Missing information	1 (0.2)	0	
Spine degenerative disease	26 (5.2)	5 (1.4)	0.007
Missing information	2 (0.4)	0	
CVA	18 (3.6)	8 (2.3)	0.382
Vascular other	16 (3.2)	10 (2.9)	0.953
Infection	30 (6.0)	44 (12.6)	0.001
Missing information	1 (0.2)	1 (0.3)	
Admission type			
Elective	106 (21.1)	82 (23.6)	0.446
Emergency	396 (78.9)	266 (76.4)	
Admission GCS			
13 - 15	355 (70.7)	114 (32.8)	<0.001
9 - 12	138 (27.5)	44 (12.6)	
<9	9 (1.8)	182 (52.3)	
Undefined	0	1 (0.3)	
Missing information	0	7 (2.0)	
Discharge GCS			
13 - 15	383 (76.3)	180 (51.7)	<0.001
9 - 12	104 (20.7)	92 (26.4)	
<9	15 (3.0)	63 (18.1)	
Missing information	0	13 (3.7)	
Interventions‡			
Non-trauma craniotomy	76 (15.1)	88 (25.3)	<0.001
Trauma craniotomy	62 (12.4)	95 (27.3)	<0.001
ICP monitoring	16 (3.2)	89 (25.6)	<0.001
Wash-out and debridement	20 (4.0)	41 (11.8)	<0.001
Burr hole drainage	30 (6.0)	18 (5.2)	0.753
Brain oncology	65 (12.9)	72 (20.7)	0.003
Endoscopy	11 (2.2)	0	-
EVD	31 (6.2)	38 (10.9)	0.018
VP shunt	34 (6.8)	15 (4.3)	0.172
Vascular	118 (23.5)	41 (11.8)	<0.001
Endovascular/thrombectomy	114 (22.7)	41 (11.8)	<0.001
Open vascular	4 (0.8)	3 (0.9)	1
Degenerative spine	26 (5.2)	6 (1.7)	0.0156
Spine infection	3 (0.6)	1 (0.3)	0.888
Spine oncology	13 (2.6)	3 (0.9)	0.117
Other	7 (1.4)	0	0.068
Missing information	0	3 (0.9)	
ICU care			
Ventilated	0	202 (58.0)	-
Tracheostomy	0	31 (8.9)	

NCCU = neurocritical care unit; HCU = high-care unit; ICU = intensive care unit; DBI = diffuse brain injury; EDH = extradural haematoma; SDH = subdural haematoma; TICH = traumatic intracerebral haematoma; SAH = subarachnoid haematoma; CVA = cerebrovascular accident; GCS = Glasgow Coma Scale score; ICP = intracranial pressure; EVD = external ventricular drain; VP = ventriculoperitoneal.
*Except where otherwise indicated.
†Some patients presented with multiple diagnoses during a single admission, e.g. EDH, SDH and SAH.
‡Some patients had more than one intervention per admission, e.g. both craniotomy and placement of ICP monitors.

Table 3. Overall complications in patients admitted to the NCCU at a tertiary-level academic hospital from 1 January to 31 December 2020 (*N*=850)

Complication	HCU (*n*=502), *n* (%)	ICU (*n*=348), *n* (%)	*p*-value
Total patients with complications	161 (32.1)	164 (47.1)	<0.001
Infection	15 (3.0)	45 (12.9)	<0.001
VAP	0	17 (4.9)	<0.001
SSI	3 (0.6)	9 (2.6)	0.034
EVD/shunt sepsis	4 (0.8)	7 (2.0)	0.218
CLABSI	0	6 (1.7)	0.011
UTI	0	1 (0.3)	0.855
Other	10 (2.0)	7 (2.0)	1
Missing information	3 (0.6)	0	
Aspiration	2 (0.4)	3 (0.9)	0.679
Bleed	20 (4.0)	13 (3.7)	0.997
New infarct	11 (2.2)	6 (1.7)	0.819
New neurological deficit incl. DIND	19 (3.8)	7 (2.0)	0.203
Missing information	1 (0.2)	1 (0.3)	
DVT	0	0	<0.001
Metabolic (total)	106 (21.1)	134 (38.5)	<0.001
DI	8 (1.6)	6 (1.7)	1
Sodium abnormalities	76 (15.1)	88 (25.3)	<0.001
Other electrolyte abnormalities	27 (5.4)	45 (12.9)	<0.001
Renal abnormalities	39 (7.8)	68 (19.5)	<0.001
Hydrocephalus	12 (2.4)	7 (2.0)	0.895
Post-extubation stridor	2 (0.4)	4 (1.1)	0.386
CSF leak	4 (0.8)	1 (0.3)	0.616
Re-do surgery	24 (4.8)	21 (6.0)	0.518
Missing information	2 (0.4)	0	

NCCU = neurocritical care unit; HCU = high-care unit; ICU = intensive care unit; VAP = ventilator-associated pneumonia; SSI = surgical site infection; EVD = external ventricular drain; CLABSI = central line-associated bloodstream infection; UTI = urinary tract infection; DIND = delayed ischaemic neurological deficit; DVT = deep-vein thrombosis; DI = diabetes insipidus; CSF = cerebrospinal fluid.

Table 4. LOS comparison of patients admitted to the NCCU at a tertiary-level academic hospital from 1 January to 31 December 2020 (*N*=850)

	HCU (*n*=502), *n* (%)*	ICU (*n*=348), *n* (%)*	*p*-value
LOS (days)			
Mean (SD)	4.04 (4.20)	6.10 (5.78)	<0.001
Median (IQR)	3.00 (1 - 5)	4.00 (2 - 9)	
Missing information	3 (0.6)	0	
LOS categories (days)			
≤7	419 (83.5)	247 (71.0)	<0.001
8 - 14	72 (14.3)	62 (17.8)	
>14	8 (1.6)	39 (11.2)	
Missing information	3 (0.6)	0	

LOS = length of stay; NCCU = neurocritical care unit; HCU = high-care unit; ICU = intensive care unit.
*Except where otherwise indicated.

Table 5. Mortality v. complications of patients admitted to the NCCU at a tertiary-level academic hospital from 1 January to 31 December 2020

	HCU (*n*=6), *n* (%)	ICU (*n*=31), *n* (%)	*p*-value
Number of complications			
0	2 (33.3)	3 (9.7)	0.068
1	0	4 (12.9)	
2	0	8 (25.8)	
3	1 (16.7)	8 (25.8)	
4	2 (33.3)	1 (3.2)	
5	1 (16.7)	7 (22.6)	

NCCU = neurocritical care unit; HCU = high-care unit; ICU = intensive care unit.

cases in this study reflects that either no clinical signs were observed during these assessments, or special investigations such as ultrasound or computed tomography scans (when clinically indicated) excluded the presence of a DVT. We acknowledge that DVTs can develop without obvious clinical signs, and this limitation in our detection strategy may have implications for the interpretation of our findings.

The rate of complications observed in our study is somewhat higher than the rates reported in ICUs in higher-income countries, which range from 22.6% to 31.2%.[8] In a comparative study by Gounder *et al.*[9] examining complications in an SA trauma ICU, the overall complication rate was reported to be 33%, aligning more closely with our findings. Both the studies by Prin and Li[8] and Gounder *et al.*[9] used for comparison do not align with our study population, as both studies were done in a general ICU (rather than a specialised NCCU), the former in a high-income country and the latter in an LMIC. At the time this research was done and at the time of writing, there were no published studies focusing exclusively on NCCUs in SA. We therefore included the two above studies to provide some context for the findings of our study. Potential factors contributing to the differences in the reported complication rates may include variations in patient demographics, nutritional baseline, immune function, case severity, and institutional practices in diagnosing and reporting complication rates.

The most prevalent complication in our study was metabolic disturbances, which occurred in 28.2% of patients, particularly sodium abnormalities, followed by renal complications. Metabolic complications were more frequently observed in the ICU (38.5%) compared with the HCU (21.2%), with the difference potentially attributable to conditions such as syndrome of inappropriate antidiuretic hormone secretion or cerebral salt-wasting syndrome, which are commonly associated with central nervous system pathologies. Additionally, the work by Deveduthras *et al.*[10] highlights the prevalence of sodium abnormalities in patients with moderate to severe traumatic brain injury in a level 1 trauma unit in Durban, further emphasising the importance of monitoring metabolic disturbances in neurocritical care settings. Their findings underscore the need for vigilant management of electrolyte imbalances, particularly sodium, in this vulnerable patient population.

In contrast, Gounder *et al.*[9] reported sepsis and infection-related complications as the most common, accounting for 60.2% of cases, while in our study, infections constituted only 7.1% of total complications. The majority of complications in our cohort were observed in ICU patients (47.1%) as opposed to those in the HCU (32.1%), suggesting a correlation between illness severity and the higher complication rates in ICU patients, who are more likely to require intubation and mechanical ventilation (58.0%), which increases the risk of ICU-related infections (such as VAPs) and may contribute to an extended LOS.

Subgroup analysis revealed that the total infection complication rate was significantly higher in the ICU (12.9%) compared with the HCU (3.0%). This discrepancy may be attributed to the predominance of VAP, which accounted for 4.9% of infections and occurred only in the ICU, where over half of the patients were ventilated at some point, in contrast to none in the HCU. The VAP incidence rate in our study aligns with the range reported by Papazian *et al.*[11] (5 - 40%), although again it should be noted that this study looked at VAP incidence rates in the setting of a general ICU. In comparison, a quaternary SA trauma ICU reported a VAP incidence of 38%,[9] which is significantly higher than the rate observed in our study. This difference may be attributed to the more heterogeneous patient population in that ICU, as opposed to the more specialised, homogeneous cohort in our NCCU. Factors contributing to this discrepancy may include the timing of tracheostomies, implementation of a VAP care bundle in our NCCU, variations in the changes in definition of VAP over time, the quality of ICU care, including staffing ratios or constraints, and potential under-reporting or over-reporting of VAP cases across different institutions.

The low CLABSI rate of 1.7% in our study may indicate the effectiveness of the CLABSI care bundle implemented in the NCCU, which encompasses detailed protocols for managing both peripheral and central venous lines. However, this rate may also be subject to diagnostic challenges, including the potential for under- or over-reporting of CLABSIs, similar to the issues observed with VAP rates. Reported infection rates may be influenced by several factors. One possibility is under-reporting of infectious complications, which can occur as a result of limitations in data capture or documentation practices. Other reasons for low infection rates may be attributable to rigorous implementation of strict infection prevention and control (IPC) practices and adherence to best care and antibiotic stewardship (BCAB) bundles in the NCCU. The NCCU has prioritised comprehensive IPC protocols, including regular staff training, strict hand hygiene practices, and use of evidence-based guidelines for prevention of healthcare-associated infections. Additionally, the BCAB bundles have been instrumental in optimising antibiotic use and reducing the risk of infection.

Other complications encountered, although not statistically significant, included new infarcts (3.9%), bleeding (0.6%), delayed ischaemic neurological deficit (2.0%), hydrocephalus (2.2%), post-extubation stridor (0.7%), CSF leaks (0.6%) and re-do surgeries (5.3%).

LOS in the NCCU has significant implications for patient outcomes, particularly with regard to physical functioning and quality of life in the months and years following discharge, as well as being a major driver of healthcare costs.[12,13] Our analysis revealed that average LOS in the HCU was shorter than in the ICU, with median LOS of 3 days and 4 days, respectively. This finding was consistent across categories of 0 - 7 days and >14 days, and was statistically significant. This difference is expected, given that patients admitted to the ICU at the GSH NCCU typically present with high severity of illness and often require intubation and mechanical ventilation. The median LOS in our NCCU's ICU is lower than the median of 16 days reported for a comparable SA trauma ICU.[9] While we recognise the challenges in comparing different ICUs that cater to distinct patient populations and may follow varied management protocols, our aim in making this comparison is to provide context for our findings and to underscore potential differences in patient outcomes related to the nature of injuries and the level of care provided. By examining LOS across various ICU settings, we seek to offer valuable insights into resource utilisation and patient management strategies. We acknowledge the limitations inherent in such comparisons and emphasise the need for further research to better understand the factors influencing LOS across different ICU types.

Additionally, global median LOS figures from the PRINCE study indicate higher averages, with 7 days for USA-based ICUs and 8 days for the rest of the world.[6] Our multivariate analysis of LOS and number of complications demonstrates a statistically significant linear relationship, predicting an increase of 4.41 days in LOS for each additional complication. Jiang *et al.*[14] identified a similar linear relationship between LOS and increased rates of complications, particularly for stays exceeding 8 days.

The mortality rate in the NCCU was found to be 4.4%, a statistically significant finding. This figure is considerably lower than the 12.4% median mortality reported by Venkatasubba Rao *et al.*[6] in their analysis

of the PRINCE study, which highlighted higher mortality rates in LMICs. Additionally, the mortality incidence for traumatic brain injury patients in the SA trauma ICU[9] was reported at 19.7%, significantly exceeding our figure. However, our multivariate analysis did not reveal a statistically significant overall relationship between the number of complications and mortality, a result that aligns with findings from the comparable study in the trauma ICU.[9]

The majority of admissions in our study were emergency cases (77.9%), with trauma-related diagnoses being the most common, followed by aneurysmal SAH. Globally, trauma is the third largest contributor to the burden of disease.[15,16] In their analysis of the PRINCE study, Venkatasubba Rao *et al.*[6] identified SAH as the most prevalent diagnosis at NCCU presentation, particularly in North American and European settings where the prevalence of trauma is relatively low.[6] It follows that the most frequent procedures performed in the ICU would correspond to these diagnoses, a finding corroborated by our study.

Study limitations

This study was a retrospective review, which inherently presents challenges such as missing data and potential biases, including recall and misclassification bias. Unfortunately, owing to the high loss to follow-up rates in our province, we were unable to conduct comprehensive follow-up for all patients after discharge. This limitation is a significant challenge in our setting, where many patients are discharged to base hospitals for palliation or rehabilitation, and tracking their outcomes becomes difficult. While we recognise the importance of accounting for mortality that occurs after discharge, we were unable to capture data on patients who may have died in these facilities, or those who were declined admission owing to poor prognosis. As a result, our mortality figures reflect only those patients who died during their stay in the NCCU and do not include subsequent/long-term outcomes. We acknowledge that this limitation may affect the comparability of our findings to other local studies that may have more robust follow-up protocols. Additionally, the study period coincided with the global COVID-19 pandemic, which significantly strained healthcare systems worldwide. The findings should therefore be interpreted in the context of these extraordinary circumstances, which may have influenced patient admissions and staffing levels and structure, as well as the implementation of protocols in our NCCU, all of which may have impacted on patient management and outcomes during the study period.

Conclusion

The study revealed a complication rate of 38.2%, aligning with findings from previous studies both regionally and globally. Metabolic abnormalities such as sodium and other electrolyte imbalances emerged as the most prevalent complications, with the rate of infections, including VAP, SSIs and CLABSIs, also statistically significant. A statistically significant linear relationship was observed between LOS and the frequency of complications, although no significant association was found between complication frequency and mortality. Notably, this study reported lower infection and mortality rates compared with previous studies, potentially reflecting the positive impact of implementing ICU care bundles into treatment protocols.

Our study provides valuable insights into the complications and outcomes associated with neurocritical care in a sub-Saharan African context, highlighting the need for continued research and the establishment of dedicated NCCUs to improve patient management and outcomes in this region.

Data availability. The datasets generated and analysed during the present study are available from the corresponding author (PLS) on reasonable request. Any restrictions or additional information regarding data access can be discussed with the corresponding author.

Declaration. The research for this study was done in partial fulfilment of the requirements for BAK's MMed (Neurosurg) degree at the University of Cape Town.

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Author contributions. BAK and CA-D coded and cleaned the data. CA-D, BAK, PLS and SL analysed the data. All authors had access to the data set, assisted with data review and manuscript preparation, and approved the final manuscript.

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