A retrospective review of complications in a South African neurocritical care unit over one year

MMED (Neurosurgery)

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DECLARATION

I, Bakang Abiot Kgaodi, completed the work contained in this dissertation at the University of Cape Town between March 2021 and November 2022. It is original work except for where due reference has been made. It has not ,nor will it be, submitted for the award at any other University.

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Date: 13/06/2022

CERTIFICATION

The undersigned certify that they have read and thereby recommend for examination the dissertation titiled a retrospective review of complications in a south african dedicated neurocritical care unit over one year, in partial fulfilment of the requirements for the degree of Master of Medicine (Neurosurgery) of the University of Cape Town.

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Date 13/06/2022

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This work is a result of the dedication, patience, understanding and selfless guidance of my supervisors, Dr Christel Arnold-Day and Prof Patrick Semple. Special mention for Mr. Shaun Linde for his invaluable assistance with statistical analysis.

DEDICATION

I dedicate this work to my dearest wife, Boitshwarelo Rachaba-Kgaodi, without whose support and encouragement this work would not have come to completion. I appreciate my family, friends and colleagues for their support during the preparation of this work.

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LIST OF ABBREVIATIONS AND ACRONYMS

CCU	Critical Care Unit
CLABSI	Central Line Associated Bloodstream Infection
CSF	Cerebrospinal Fluid
CVA	Cerebrovascular Accident
CVC	Central Venous Catheter
DBI	Diffuse Brain Injury
DIND	Delayed Ischaemic Neurological Deficit
DVT	Deep Vein Thrombosis
EVD	External Ventricular Drain
GCS	Glasgow Coma Scale
GSH	Groote Schuur Hospital
HC	High care
ICU	Intensive Critical Unit
NCCU	NeuroCritical Care Unit
LMIC	Lower-and-Middle Income Country
LOS	Length of Stay
SD	Standard Deviation
SSI	Surgical Site infection
TBI	Traumatic Brain Injury
TICH	Traumatic Intracranial Haemorrhage
UTI	Urinary Tract Infection
VAP	Ventilator Associated Pneumonia
VP Shunt	Ventriculo-Peritoneal shunt

Chapter 1 Introduction

Context

The establishment of a Neurocritical Care Unit (NCCU) is well described in offering benefits to patients[1,2]. These units are optimised to care for patients with pathologies involving the brain and spine.

It is well recognised that a dedicated NCCU improves care for patients with cranial and spinal pathology compared to a general intensive care unit (ICU)[1,2]. These units are optimised to care for these patients. The proposed benefits of a dedicated NCCU include:

- decrease in length of hospital stay,
- decrease in all-cause mortality,
- decrease in readmission rates,
- improved neurological and functional outcomes.

The mortality rates for patients in a NCCU is lower in comparison to neurosurgical patients admitted to a general ICU; 5.3% and 10.2% respectively in one study[4]. Furthermore, better adherence to neuro-specific guidelines and protocols, and chart documentation has been demonstrated in NCCUs compared to a general ICU[3]. In one paper the introduction of a NCCU led to development of management protocols as well as discharge criteria that had a direct impact on reduction of mortality rate and decreased length of hospital stay[2]. The establishment of a dedicated NCCU is associated with improved resource utilization[4]. These benefits extend to a multitude of neurological pathologies including traumatic brain injury, subarachnoid haemorrhage, intracranial haemorrhage and ischaemic stroke[3]. These benefits are more pronounced in the presence of a dedicated neuro-intensivist[2]. Despite the literature that exists supporting the utilisation of dedicated NCCUs, there remains a paucity of literature on the complications peculiar to these specialised units globally. The dearth of literature is worse when focused on African settings where the availability of dedicated NCCUs is limited to large tertiary centres and are sparsely distributed across the continent. Complications in neurocritical care patients are often life threatening and, if not treated, may be fatal.

Ethical considerations

Ethical approval was obtained from the various research committees:

- Step 1: From the Department of Surgery Research Committee at Groote Schuur Hospital,
- Step 2: The University of Cape Town Human Research Ethics Committee
- Step 3: Permission from Groote Schuur Hospital's institutional review committee.

This is a retrospective observational study, therefore no risks were posed to study participants and no untoward effect on the quality of care they received.

Informed Consent process

All data was analysed retrospectively from an anonymised registered patient database (HREC: R012/2015); and therefore a waiver of consent was applied for and granted by the ethics committee. Confidentiality of patient information and data was strictly adhered to and maintained. No identifying personal patient information was required in data analysis or results interpretation.

Author guidelines of the Journal

Chosen journal: Southern African Journal of Critical Care

The Soutnern African Journal of Critical Care is a journal covering the categories related to Critical Care and Intensive Care Medicine (Q4). It is published by the South African Medical Association. Its is ranked 25561 with a SCImago Journal Rank (SJR) of 0.129 and an h-index of 7 and impact factor of 0.07. ISSN of this journal is/are 15628264.

Journal Instructions to Authors for Original Papers (Appendix 4)

- Written in UK English in Microsoft word or RFT in 12 Times New Roman font with 1.5 line spacing.
- Abstract: 250-word limit
- Article word limit (excluding abstract,tables, figures and biblography): 3000 words
- Tables and figures allowed: 6
- References: limited to 30

- Authors of original papers are requested to provide the following information:
  - Full qualifications, affiliation and contact details of all authors

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Chapter 2 Publication-ready manuscript

A retrospective review of complications in a South African neurocritical care unit over one year

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3. Independent statistics consultant

Abstract

Background: The establishment of a Neurocritical Care Unit (NCCU) is well described in offering benefits to patients[1,2]. These units are optimised to care for patients with pathologies involving the brain and spine. Complications peculiar to such units in Low- and Middle-income countries (LMICs) are relatively undocumented.

Objectives: To determine the complications in a NCCU at Groote Schuur Hospital (GSH) over 1 year and their association with ICU length of stay (LOS) and mortality.

Methods: A retrospective review of complications of patients admitted to the NCCU at GSH from 01 January 2020 to 31 December 2020 as per NCCU patient data registry (HREC: R012/2015).

Results: 850 patients, predominantly males (61.2% for HC and 68.1% for ICU), were admitted to the NCCU with a median age of 43 years (HC) and 41 years (ICU). The overall complication incidence rate was 38.2%. The statistically significant complications (p-value <0.05) were metabolic and electrolyte abnormalities as well as infection (including VAPs, SSIs and CLABSIs) and DVTs. The most common complication was metabolic abnormalities (28.2%), specifically derangements in sodium homeostasis. LOS was shown to have a statistically significant association with number of complications. Mortality did not have a statistically significant association with number of complications.

Conclusion: Complications in a dedicated NCCU in South Africa are mostly electrolyte disturbances and infections. The complications are associated with increased LOS but not with increased risk of mortality.

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

Introduction

The establishment of a Neurocritical Care Unit (NCCU) is well described in offering benefits to patients[1,2]. These units are optimised to care for patients with pathologies involving the brain and spine. Multiple studies have shown the benefits of a dedicated NCCU[4,5,6.]

It is well established that a dedicated NCCU improves care for patients with cranial and spinal pathology compared to a general intensive care unit (ICU)[1,2]. These units are optimised to care for these patients. The benefits of a dedicated NCCU include:

- decrease in length of hospital stay,
- decrease in all-cause mortality,
- decrease in readmission rates,
- better neurological and functional outcomes.

The mortality rates for patients in a NCCU is lower in comparison to neurosurgical patients admitted to a general ICU; 5.3% and 10.2% respectively in one study[4]. Furthermore, better adherence to neuro-specific guidelines and protocols, and chart documentation has been demonstrated in NCCUs versus general ICUs[3,6]. In one paper the introduction of a NCCU led to development of management protocols as well as discharge criteria that had a direct impact on reduction of mortality rate and decreased length of hospital stay[2,6]. The establishment of a dedicated NCCU is associated with improved resource utilisation[4]. These benefits extend to a multitude of neurological pathologies including traumatic brain injury, subarachnoid haemorrhage, intracranial haemorrhage and ischaemic stroke[3]. These benefits are more pronounced in the presence of a dedicated neuro-intensivist[2]. NCCUs provide a conducive environment that fosters learning and promotes research[6].

Despite the literature that exists supporting the utilisation of dedicated NCCUs, there remains a paucity of literature on the complications peculiar to these specialised units globally. The dearth of literature is worse when focused on African settings where the availability of dedicated NCCUs is limited to large tertiary centres sparsely distributed across the continent. In an analysis of the PRINCE study, Rao et al revealed that 83% of the global access to dedicated NCCU is in North America.[12] Complications in neurocritical care patients are often life threatening and, if not treated, may be fatal. The presence of neurologic complications in an ICU patient almost doubles the mortality rate (55% vs 28% in those without) as well as

prolong the ICU and hospital length of stay and increases the tracheostomy rates[1,2]. Familiarity with these complications in the ICU can facilitate their timely recognition and treatment[2,3]. NCCUs have greater experience in identifying, preventing, and treating such complications[3].

Complications in a NCCU may be categorised into:

- General ICU complications including infections, electrolyte and metabolic derangements, ventilator-related and line-related complications.
- Post-operative complications including surgical site infections, post-operative meningitis, CSF leaks, neurological deficits and haemorrhage[5].

The common causes of mortality in a NCCU at a Saudi tertiary centre included ARDS 43%, brain herniation 30%, and sepsis and septic shock 27% [3]. In another study the main cause of mortality in the NCCU patients was sepsis and pulmonary embolism[2].

Rationale

The establishment of dedicated NCCUs has not only been shown to improve the outcomes for critically ill neurological patients but is also associated with improved resource utilisation[4]. There is limited literature on the complications in such dedicated units and this study aims to help to understand their nature and possibly assist in the identification of mechanisms to decrease their occurrence and enhance the quality improvement programs, not only in the NCCU at GSH, but also in other NCCUs worldwide.

Objectives

Main objective

To describe the complications in a NCCU over a one year period in a South African tertiary care institution.

Specific objectives

Primary

To evaluate and characterise the complications in a NCCU over a one year period in a South African tertiary care institution.

Secondary

Determine the association of complications with LOS and mortality.

Methods

Study setting

GSH is an 893-bed tertiary level hospital in the Western Cape province of South Africa. It offers a comprehensive critical care service with dedicated Medical, Surgical, Acute Spinal Cord Injury, Cardiothoracic, Maternity and Neurocritical Care Units. The NCCU comprises of a 6-bed ICU and a 6-bed High Care Unit, with the main difference between the ICU and HCU being the capacity to ventilate patients.

Study design

A retrospective review of the complications of patients admitted to the NCCU at GSH over a a one year period, from 1 January 2020 to 31 December 2020 from the NCCU registered patient data registry (HREC: R012/2015).

Study population

All adult patients admitted to the NCCU at GSH between 1 January 2020 to 31 December 2020.

Inclusion criteria:

- Patients ≥ 18 years admitted to the NCCU at GSH from 1 January 2020 to 31 December 2020.

Exclusion criteria:

- All patients admitted to the other general ICUs (i.e. non-neurocritical care units).
- Children under the age of 18, for consent purposes.

Data analysis

Data from the NCCU data registry (HREC: R012/2015) will be anonymised, cleaned, coded and analysed using SPSS, Version 24. Percentages will be used to summarise categorical variables. Means and standard deviation (SD) or medians and interquartile range (IQR) will be used to summarise continuous variables.

Pearson's $\chi 2$ or Fisher's exact tests will be used to assess statistical differences for the categorical variables, while the Student's t-test or the Mann-Whitney U test will be used for the continuous variables. A 2-tailed p-value < 0.05 will be considered statistically significant.

Data management

Anonymised data collected from the password protected patient database was coded and analysed in a password protected computer software. Patient anonymity was of utmost importance and was maintained at all times. Only the research team had access to this data.

Ethical consideration

Ethical approval was obtained from the various research committees:

- Step 1: From the Department of Surgery Research Committee at Groote Schuur Hospital.
- Step 2: The University of Cape Town Human Research Ethics Committee.
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Informed Consent process

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maintained. No identifying personal patient information was required in data analysis or results interpretation.

Results

Table 1: Demographics of patients admitted to Neurocritical Care Unit at Groote Schuur Hospital from 01 January 2020 to 31 December 2020

	HC (N=502)	**ICU (N=348)**	**p-value**
Age (years)			
Mean (SD)	43.0 (16.0)	41.7 (16.6)	0.272
Median [Min, Max]	43.0 [14.0, 90.0]	40.0 [14.0, 91.0]	
Missing information	7 (1.4%)	0 (0%)	
Sex			
Male	307 (61.2%)	237 (68.1%)	0.0452
Female	195 (38.8%)	111 (31.9%)	
Referred from			
Neuro critical care unit	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 (0%)	4 (1.1%)	
Unknown	0 (0%)	3 (0.9%)	
Discharged to			
Neurocritical care unit	26 (5.2%)	112 (32.2%)	<0.001
Neurosurgery ward	431 (85.9%)	190 (54.6%)	
Other	41 (8.2%)	12 (3.4%)	
Missing	0 (0%)	3 (0.9%)	
Outcome			
Alive	496 (98.8%)	317 (91.1%)	<0.001
Dead	6 (1.2%)	31 (8.9%)	

Table 1 above describes the demographic and clinical characteristics of the study participants. A total of 850 patients were admitted into the NCCU over the 12 month study period with a median age of 43 years (HCU: range 14 to 90 years) and 41 years (ICU: range 14 to 91 years). 60% of the admissions were to the HCU of the NCCU. The majority (64%) of the participants were male. A large portion of the patients (27.4%) were admitted from the trauma ward. The majority (73.1%) of those admitted into the NCCU were discharged to the Neurosurgery ward. The overall mortality of the 850 patients was only 37 (4.4%). It is important to note that functional outcomes were not measured in this study.

Table 2: Characteristics of patients admitted to Neurocritical Care Unit at Groote Schuur Hospital from 01 January 2020 to 31 December 2020

	HC (N=502)	**ICU (N=348)**	**p-value**
Diagnosis			
Trauma			
DBI	181 (36.1%)	160 (46.0%)	0.00464
EDH	22 (4.4%)	24 (6.9%)	0.15
SDH	57 (11.4%)	54 (15.5%)	0.0954
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	0 (0%)	2 (0.6%)	
Brain Oncology	89 (17.7%)	81 (23.3%)	0.05
Spine Trauma	3 (0.6%)	0 (0%)	0.392
Missing	1 (0.2%)	1 (0.3%)	
Spine Oncology	14 (2.8%)	3 (0.9%)	0.084
Missing	1 (0.2%)	0 (0%)	
Spine degenerative disease	26 (5.2%)	5 (1.4%)	0.00722
Missing	2 (0.4%)	0 (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%)	0.00107
Missing	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			
GCS 13-15	355 (70.7%)	114 (32.8%)	<0.001
GCS 9-12	138 (27.5%)	44 (12.6%)	
GCS<9	9 (1.8%)	182 (52.3%)	
Undefined	0 (0%)	1 (0.3%)	
Missing	0 (0%)	7 (2.0%)	
Discharge GCS			
GCS 13-15	383 (76.3%)	180 (51.7%)	<0.001
GCS 9-12	104 (20.7%)	92 (26.4%)	
GCS<9	15 (3.0%)	63 (18.1%)	
Missing	0 (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%)	0.00325
Endoscopy	11 (2.2%)	0 (0%)	
EVD	31 (6.2%)	38 (10.9%)	0.0181
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%)	0.0678
Missing	0 (0%)	3 (0.9%)	
ICU Care			
Ventilated	0 (0%)	201 (57.8%)	
CVC	124 (35.6%)	201 (23.6%)	

Table 2 above shows that the majority of the patients were admitted as emergencies (mean 77.9%). The most common diagnosis was related to trauma (40%), followed by aneurysmal SAH (15.05%) and the least common was spinal trauma at 0.4%. Brain oncologic conditions made up the largest share of the elective admissions (20%) and spine oncology only around 2%. About 43.5% of the total admissions had an admission GCS $\leq$ 12 and two-thirds had improved to a GCS $\geq$ 13 at the time of discharge from the NCCU. Craniotomy was the most common intervention with no significant difference for trauma vs non-trauma craniotomy, 18.5% and 19.5% respectively. Vascular interventions were the second most common procedure at 18.7%, majority (97.5%) of which where endovascular in nature. The least common interventions were for spine infections (0.5%). Fifty-eight percent of the patients admitted in ICU were intubated.

Table 3.1: Description of overall complications of patients admitted to the NCCU at GSH from 01 January 2020 to 31 December 2020.

	HC (N=502)	**ICU (N=348)**	**p-value**
Total	161 (32.1%)	164 (47.1%)	<0.001
Infection	15 (3.0%)	45 (12.9%)	<0.001
VAP	0 (0%)	17 (4.9%)	<0.001
SSI	3 (0.6%)	9 (2.6%)	0.0343
EVD/Shunt sepsis	4 (0.8%)	7 (2.0%)	0.218
CLABSI	0 (0%)	6 (1.7%)	0.0114
UTI	0 (0%)	1 (0.3%)	0.855
Other	10 (2.0%)	7 (2.0%)	1
Missing	3 (0.6%)	0 (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	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	2 (0.4%)	0 (0%)	

Table 3.1 above shows the overall complication rate of 38.2%, the majority of which were for patients admitted to ICU (47.1%) compared to 32.1% of those admitted to High Care. The most common complication was metabolic complications at 28.2%, the majority being abnormalities of sodium homeostasis. The least common complications were aspiration (0.6%) and post extubation stridor (0.7%). The complications that showed statistical significance were infections (sub-categories VAP, SSI and CLABSI), metabolic (sub-categories sodium abnormalities, other electrolyte abnormalities and renal abnormalities). There were no patients that developed a DVT and this was shown to be statistically significant.

Table 3.2 Length of Stay Comparison of patients admitted to NCCU at GSH from 01 January 2020 to 31 December 2020.

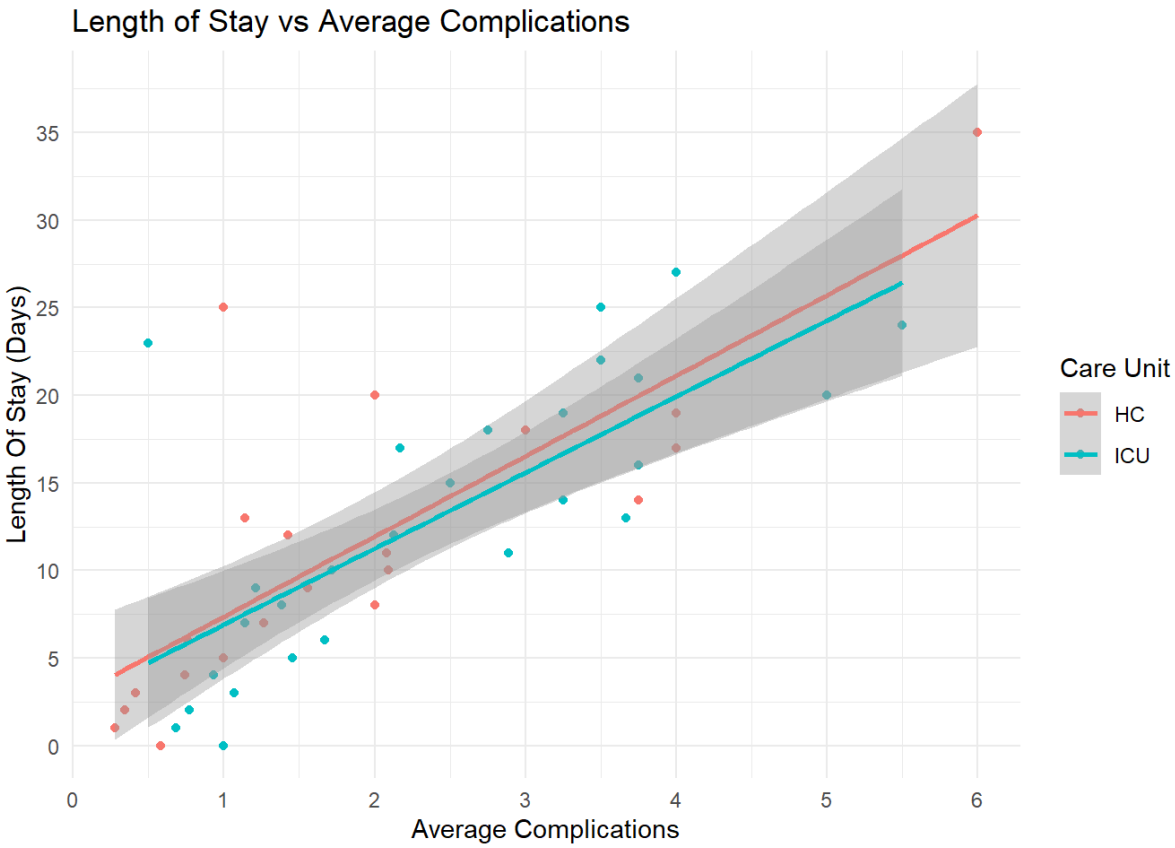
	HC (N=502)	**ICU (N=348)**	**p-value**
Length of stay (Days)			

Mean (SD)	4.04 (4.20)	6.10 (5.78)	<0.001
Median [Min, Max]	3.00 [0, 35.0]	4.00 [0, 27.0]	
Missing	3 (0.6%)	0 (0%)	
LOS Categories			
≤7 days	419 (83.5%)	247 (71.0%)	<0.001
8-14 days	72 (14.3%)	62 (17.8%)	
>14 days	8 (1.6%)	39 (11.2%)	
Missing	3 (0.6%)	0 (0%)	

Applying a Chi-Square test of independence with 2 degrees of freedom we obtain the following test statistic: x-squared = 39.964; df = 2; p-value = <0.05

Table 3.2 above therefore shows independence between HC and ICU in LOS. From the contingency table, we can make the assumption that HC LOS is of a shorter duration when categories are grouped: 0-7 days; 8-14 days and > 14 days.

Figure 1: Linear model of LOS vs Complications of patients admitted to NCCU at GSH from 01 January 2020 to 31 December 2020.



Applying a linear model we see that there exists a relationship between number of complications and length of stay.

Looking at the statistics:

- slope=4.41 (for every added complication we predict 4.41 days added to length of stay)
- R-squared:0.59 (~60% of residual variance can be explained by the complications)
- p-value= <0.05 (Reject null hypothesis that there is no relationship between length of stay and complications)

Table 3.3: Mortality vs Complications of patients admitted to NCCU at GSH from 01 January 2020 to 31 December 2020.

	HC (N=6)	**ICU (N=31)**	**p-value**
Number of Complications			
0	2 (33.3%)	3 (9.7%)	0.0677
1	0 (0%)	4 (12.9%)	
2	0 (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%)	

Table 3.3 above of multivariate analysis of the relationship of complications and mortality shows no overall relationship between the total number of complications and mortality.
- R-squared:0.00003 (~0.003% of residual variance can be explained by the complications
- p-value= 0.0647

Discussion

This is the first study interrogating the complications in a dedicated NCCU in an LMIC, more specifically Sub-Saharan Africa. Such dedicated units are sparcely located and by-and-large most neurocritical care patients in Sub-Saharan Africa are cared for in combined surgical or general ICU and often not led by a neuro-intensivists.

Our study shows a complication rate of 38.2% in a NCCU. In this study the complications that showed a statistical significance were infections (including subgroups VAPs, SSIs and CLABSIs) and metabolic abberrations (including subgroups sodium abnormalities, other electrolyte abnormalities and renal abnormalities). None of the patients developed DVT and this finding was also found to be statistically significant. The complication incidence rate in our study is comparable to those reported in ICUs in higher income countries which stands at 22.6-31.2% [19]. In a comparison study by Gounder et al reviewing complications in a South African trauma ICU the overall complication incidence rate was 33% which is also comparable to the complication rate in our study[18.] The most common complication in our study was metabolic disturbances (28.2%) more especially aberrations of sodium, followed by renal complications. Metabolic complications are more common in ICU (38.5%) than in HC(21.2%). This may be a result of SIADH or a cerebral salt wasting syndrome which are common with CNS pathologies. Gounder et al reported sepsis/infection related complications as the most prevalent at 60.2%[18.]while in our study infection accounted for 7.1% of the total complications. The majority of the total complications in our study were for patients admitted to ICU (47.1%) compared to 32.1% of those admitted to HC. This may point to the association of illness severity of ICU patients compared to patients admitte to the HCU. These patients are more likely to require intubation and mechanical ventilation (58%) and as such have a greater LOS.

Subgroup analysis shows that of the total infection complication rate, ICU had a higher total rate(12.9%) in comparison to HC (3.0%). This can be accounted for by the fact that VAP was the commonest cause of infection by subgroup (4.9%) and this most exclusively occurred in ICU where over fifty percent of the patients were ventilated at some point and none in HC. The VAP incidence rate in our study is similar to the one quoted by Papazian et al in their comprehensive review of VAP which was 5-40%.[14]. The VAP incidence at a quaternary South African trauma ICU was reported to be 38% significantly higher than in our study [18.] This differences may be accounted for by earlier tracheostomy timing, effect of instituted ICU VAP-care-bundle in the GSH NCCU and differences in the definition of VAP as well as quality of ICU care. The low CLABSI rate (1.7%) may be due in part to the ICU CLABSI-care-bundle instituted in the NCCU at GSH where peripheral and central venous lines are kept for a prescribed minimum number of days before removal or change as well as other measures to reduce infection rates in these types of infections. Other complications encountered but not statistically significant included new infarcts (3.9%), bleeding (0.6%), DIND (2.0%) , hydrocephalus (2.2%), post extubation stridor (0.7%), CSF leak (0.6%) and re-do surgery(5.3%).

The length of stay in NCCU not only has implications for patient outcomes especially physical functioning and quality of life months, and in some instances, years after discharge but is also a significant driver in hospital health care costs[15,16]. The average length of stay in HC is lower than for ICU with a median LOS of 3 and 4 days for each unit respectively. This finding is true across the categories 0-7 days and >14 days and is found to be statistically significant. It is expected given that by definition patients admitted to ICU at GSH NCCU are of a higher severity of disease and often require intubation and mechanical ventilation. The median stay in GSH NCCU ICU is lower than in a comparable study is a South African trauma ICU where the median LOS was 16 days[18]. Global median LOS as per the PRINCE study are also comparably higher than in our study, 7 days for US-based ICU and 8 days for the remainder of the world[12.] Multivariate analysis of LOS and number of complications (Figure 1) shows a linear relationship that is statistically significant. For every added complication a prediction of 4.41 days added to LOS. Jiang et al in his paper also found that there exists a linear relationship between LOS and higher rates of complications especially LOS greater than 8 days[17.]

The mortality incidence at GSH NCCU in this study stands at 4.4% and this result was found to be statistically significant. This incidence is significantly lower than quoted by Rao et al in

their analysis of the PRINCE study where median NCCU mortality was 12.4% and highest in LMIC[12]. The incidence of mortality in a South African trauma ICU was reported at 19.7% , significantly higher than in our study. Multivariate analysis of number of complications and mortality did not show a statistically significant overall relationship between the number of complications and mortality. This finding is also in keeping with a comparable study in a South African Trauma ICU were a statistically significant relationship between complication frequency and mortality was not established [18.]

Most of the admissions in our study presented as emergencies (77.9%) with the most common diagnosis being trauma-related, followed by aneurysmal SAH. World wide trauma is predicted to be the third largest contributor to the global burden of disease[11,13]. In their analysis of the PRINCE study, Rao et al found SAH as the most common diagnosis at presentation to the NCCU but more so in the North American/European setting where the prevalence of trauma is lower[12.]. It therefore follows that the most frequent procedures in the ICU will be for these two, and our study corroborates this expectation.

Conclusion

Patients admitted to GSH NCCU from 1 January 2020 to 31 December 2020 showed a complication incidence rate of 38.2 % which is comparable to prior studies both regionally and globally.

The most prevalent complications were of metabolic abnormalities. Infection (including subgroups VAP, SSI and CLABSI) and metabolic abnormalies (including sodium abnormalities, other electrolyte abnormalities and renal abnormalities) were found to have statistical significance in this population of patients. LOS has been shown to have a statistically significant linear association with the occurrence and frequency of complications in GSH NCCU. Complication frequency has however not been shown to have an association with mortality. This study shows lower infection and mortality rates in comparison to prior studies and may show the impact of having ICU bundles incorporated into the treatment protocols.

Strengths

The data is from a large NCCU in South Africa were a well maintained data base is kept.

Limitations

This is a retrospective review study and as such presented with challenges that are commonly associated with such databses such as missing information. There is also an inherent inclination for recall or misclassification bias in such studies. 2020 was also a year when health systems the world over were overwhelmed with COVID-19 infection and our study is to be interpreted in that context.

Author contributions

BAK and CAD coded and cleaned the data. CAD, BAK, PS and SL analysed data. All authors had access to the data set, assisted with data review and manuscript preparation, and approved the final manuscript.

Declaration of Conflicting Interests

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Appendices

Appendix 1: Ethical approval from the Department of Surgery at UCT

Appendix 2: Ethical approval from the Human Research Ethics Committee from the University of Cape Town

Appendix 3: Instituitional approval from Groote Schuur Hospital

Appendix 4: Southern African Journal of Critical Care Author guidelines

UNIVERSITY OF CAPE TOWN

Department of Surgery
Departmental Research Committee
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Observatory 7925
South Africa
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6 Jul 2021

Dr B Kgaodi

Department of Surgery
University of Cape Town

Dear Dr Kgaodi

RE: Project 2021/223

PROJECT TITLE: A Retrospective Review Of Complications In A South African Dedicated Neurocritical Care Unit Over One Year

The above protocol has been reviewed by the Department of Surgery Research Committee. I am pleased to inform you that the committee approved the scientific merit of the study, and endorse the protocol for submission to the relevant ethics committee.

Although this letter serves as confirmation that the above protocol has successfully passed through the surgical DRC, respective ethics committees still require DRC chair signature before submission.

Please use the above project number in all future correspondence,

Yours sincerely

A/PROF MARITZ LAUBSCHER
CHAIR SURGICAL DRC

UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Human Research Ethics Committee

Room G50- Old Main Building
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Website: www.health.uct.ac.za/fhs/research/humanethics/forms

04 August 2021

HREC REF: 492/2021

Prof P Semple
Division of Neurosurgery
D-13 NGSH
Email: Patrick.semple@uct.ac.za
Student: kgaodibk@gmail.com

Dear Prof Semple

PROJECT TITLE: A RETROSPECTIVE REVIEW OF COMPLICATIONS IN A SOUTH AFRICAN DEDICATED NEUROCRITICAL CARE UNIT OVER ONE YEAR-MASTERS CANDIDATE-DR BAKANG KGAODI

Thank you for submitting your study to the Faculty of Health Sciences Human Research Ethics Committee (HREC) for review.

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study.

This approval is subject to strict adherence to the HREC recommendations regarding research involving human participants during COVID -19, dated 17 March 2020; 06 July 2020 & 01 July 2021.

Approval is granted for one year until the 30 August 2022.

Please submit a progress form, using the standardised Annual Report Form if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.
(Forms can be found on our website: www.health.uct.ac.za/fhs/research/humanethics/forms)

The HREC acknowledge that the student: Dr Bakang Kgaodi will also be involved in this study.

Please quote the HREC REF 492/2021 in all your correspondence.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please note that for all studies approved by the HREC, the principal investigator **must** obtain appropriate institutional approval, where necessary, before the research may occur.

Yours sincerely

PROFESSOR M BLOCKMAN
CHAIRPERSON, FACULTY OF HEALTH SCIENCES HUMAN RESEARCH ETHICS COMMITTEE
Federal Wide Assurance Number: FWA00001637.
Institutional Review Board (IRB) number: IRB00001938
NHREC-registration number: REC-210208-007

This serves to confirm that the University of Cape Town Human Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRC-SA), Food and Drug Administration (FDA-USA), International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use: Good Clinical Practice (ICH GCP), South African Good Clinical Practice Guidelines (DoH 2006), based on the Association of the British Pharmaceutical Industry Guidelines (ABPI), and Declaration of Helsinki (2013) guidelines. The Human Research Ethics Committee granting this approval is in compliance with the ICH Harmonised Tripartite Guidelines E6: Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95) and FDA Code Federal Regulation Part 50, 56 and 312.

Western Cape Government
Health

GROOTE SCHUUR HOSPITAL
Enquiries: Dr Bernadette Eick
e-mail: GSHReserach.Request@westerncape.gov.za

Professor Patrick Semple
SURGERY - NEUROSURGERY

E-mail: Patrick.Semple@uct.ac.za / kgoadibk@gmail.com

Dear Professor Semple,

RESEARCH PROJECT: A Retrospective Review Of Complications In A South African Dedicated Neurocritical Care Unit over One-Year (Masters Candidate Dr Bakang Kgaodi)

Your recent letter to the hospital refers.

You are granted permission to proceed with your research, which is valid until 30 August 2022.

Please note the following:

a) Your research may not interfere with normal patient care.
b) Hospital staff may not be asked to assist with the research.
c) Confidentiality must always be maintained.
d) No additional costs to the hospital should be incurred as indicated in your Annexure 2 i.e. Lab, consumables or stationery. **If access to TRACK Care/NHLS is required, kindly attach our letter of approval to the application form and approach Information Management to assist with data.**
e) **No patient folders may be removed from the premises or be inaccessible.**
f) Please provide the research assistant/field worker with a copy of this letter as verification of approval.
g) Should you at any time require photographs of your subjects, please obtain the necessary indemnity forms from our Public Relations Office (E45 OMB or ext. 2187/2188).
h) Should you require additional research time beyond the stipulated expiry date, please apply for an extension.
i) Please discuss the study with the HOD before commencing.
j) Please introduce yourself to the person in charge of an area before commencing.
k) On completion of your research, please forward any recommendations/findings that can be beneficial to use to take further action that may inform redevelopment of future policy / review guidelines.
l) Please contact Michelle Riley (Patient Fees) at ext. 2276 to ascertain if there will be charges for conducting the Research and to obtain a quote or to discuss charges
m) Kindly submit a copy of the publication or report to this office on completion of the research.
n) At no time should any posters encouraging patients to partake in research, be displayed within a clinical area.
o) Please adhere to ALL COVID-19 regulations and Groote Schuur Hospital policies.

I would like to wish you every success with the project.

Yours sincerely

DR BERNADETTE EICK
CHIEF OPERATIONAL OFFICER
Date: 30 September 2021

C.C. Mr. L. Naidoo / Dr B. Jacobs / Mr A. Mohamed / Professor G. Fieggen

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26 March 2015

REF NO: R012/2015

Prof P Semple
Neurology
H-53
OMB

Dear Prof Semple

PROJECT TITLE: DATABASE OF D13 ICU

Thank you for registering your database with the Faculty of Health Sciences Human Research Ethics Committee (HREC).

The HREC has **approved** the registration of your database.

The registration of this database is valid until 30 March 2018.

Please provide the HREC with an update if the registry continues beyond this period.
Please Note: All research, including that undertaken for a master's or doctoral degree, using registered databases, registries and repositories, requires submission as a new study. It requires an application form (FHS013) and a protocol which has undergone departmental review. The study will receive its own HREC REF number which will be linked to the main database or repository.

For all future studies, please submit a protocol to the HREC.

Please provide the HREC with an update if the database continues beyond this period.

Please quote the HREC REF in all your correspondence.

Yours sincerely

PROFESSOR M BLOCKMAN
CHAIRPERSON, HSF HUMAN ETHICS

UNIVERSITY OF CAPE TOWN

HUMAN RESEARCH ETHICS COMMITTEE
2 6 SEP 2018
HEALTH SCIENCES FACULTY
UNIVERSITY OF CAPE TOWN

FACULTY OF HEALTH SCIENCES
Human Research Ethics Committee

FHS017: Annual Progress Report / Renewal

Record Reviews/Audits/Collection of Biological Specimens/Repositories/Databases/Registries

HREC office use only (FWA00001637; IRB00001938)			
This serves as notification of annual approval, including any documentation described below.			
☑ Approved	Annual progress report	Approved until/next renewal date	30/09/2021
☐ Not approved	See attached comments		
Signature Chairperson of the HREC	pp CBurgess	Date Signed	26/09/2018

Principal Investigator to complete the following:

1. Protocol information

Date (when submitting this form)	26/9/2018		
HREC REF Number	R017/305	Current Ethics Approval was granted until	MARCH 2018
Protocol title	DATA BASE OF DBS ICM.		
Principal Investigator	PROF P.L. SEMPLE		
Department / Office Internal Mail Address	DIVISION OF NEUROSURGERY OH 53 OMB, GROOTE SCHUUR HOSPITAL		
1.1 Does this protocol receive US Federal funding?		☐ Yes	☑ No

2. Protocol status (tick ✓)

☑	Research-related activities are ongoing
☐	Data collection is complete, data analysis only

Please indicate (in the block below) the titles and HREC reference numbers of any projects currently making use of the Database/Registry/Repository

3. Protocol summary

Total number of records or specimens collected, reviewed or stored since the original approval		400 +100
Have any research related outputs (e.g. publications, abstracts, conference presentations) resulted from this research? If yes, please list and attach with this report	☐ Yes	☑ No

4. Signature

Signature of PI		Date	26/9/2018