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2021
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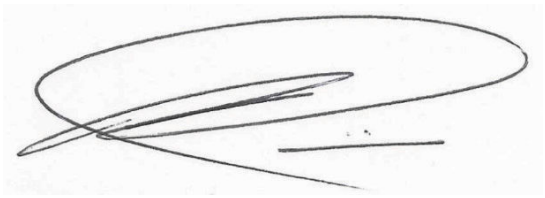
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A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg in partial fulfilment of the requirements for the degree of Master of Medicine in the branch of Anaesthesiology.

Johannesburg, 2021

Declaration

I, Laura Indiveri declare that this research report is my own unaided work. It is being submitted for the Degree of Master of Medicine in the branch of Anaesthesiology at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.



05 August 2021

Abstract

Background

Data pertaining to all subsets of neurosurgical patients admitted to South African hospitals is lacking. The aim of this study was to survey adult patients requiring neurosurgery at Charlotte Maxeke Johannesburg Academic Hospital (CMJAH).

Methods

A retrospective survey of the REDCap neuroanaesthesia database was conducted. Consecutive data were extracted for 2016 and 2017. Data described the pre-operative assessment, intra-operative anaesthetic management and post-operative status of patients undergoing elective and emergency neurosurgical procedures.

Results

The database entries of 873 patients were included in the study. Most of the patients, 622 (72.1%) were male, 558 (63.9%) received emergency surgery, and 337 (38.6%) patients had traumatic brain injury (TBI). The severe TBI incidence was 45.1%. The predominant anaesthetic technique was an intravenous propofol induction 629 (72.1%) and sevoflurane maintenance 539 (61.7%). Marked haemodynamic instability occurred in 208 (23.8%) patients, mandating either vasopressor 99 (47.6%) or inotropic 109 (52.4%) support. Seizure prophylaxis was only given to 39 (4.5%) patients. Steroids were administered to 134 (39.8%) TBI patients. Significantly more elective surgery patients, 224 (71.1%) were extubated immediately post-operatively ($p<0.0001$). However, the in-hospital mortality among patients did not differ significantly between those who had elective 30 (9.5%) or emergency surgery 47 (8.4%, $p=0.6697$). In-hospital mortality was higher for patients having cranial surgery 61 (9.0%) compared to spinal surgery 6 (6.4%), but this difference was not statistically significant ($p=0.3926$).

Conclusion

The frequent administration of steroids to TBI patients at CMJAH is concerning but highlights the importance of utilising databases for quality improvement purposes. The unexpected mortality finding in this study between elective and emergency cases may be explained by the higher ASA classification of elective patients. This study contributes to the understanding of neurosurgical patient peri-operative care.

Acknowledgements

I would like to take this opportunity to express immense gratitude for the unwavering support of my research supervisors, Helen Perrie, Juan Scribante and Alastair Moodley.

Helen and Juan were always kind, thorough and eager to assist, an end goal would not have been reached without my champions.

Alastair Moodley thank you so much for your direction, advice and clinical input. Your solid knowledge base and clinical experience aided tremendously in producing this research report. I am always grateful for our discussions.

To my family thank you so much for all your love, support and patience. I am truly humbled by the sacrifices made by my husband and by my mother to aid completion of this research report.

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Abbreviations

ASA	American Society of Anesthesiologists™
CMJAH	Charlotte Maxeke Johannesburg Academic Hospital
CNS	Central nervous system
ETT	Endotracheal tube
GCS	Glasgow Coma Scale
HIV	Human immunodeficiency virus
ICP	Intracranial pressure
ICU	Intensive care unit
LI	Laura Indiveri
NHLS	National Health Laboratory Services
PH	Permissive hypotension
SA	South Africa
SAH	Subarachnoid haemorrhage
SD	Standard deviation
TBI	Traumatic brain injury
TIVA	Total intravenous anaesthesia
USA	United States of America

Statement

The Research Report consists of a literature review, draft article, study proposal and appendices. The study proposal is included for background reference and is not for examination.

The formatting of this Research Report complies with the University of the Witwatersrand's Style Guide for Theses, Dissertations and Research Reports. The formatting of the draft article may differ from the author guidelines of the Southern African Journal of Anaesthesia and Analgesia, the journal to which it is intended to be submitted, in order to comply with the university's style guide.

Section 1: Review of the literature

1.1 Introduction

The Institute of Medicine (1) defines health care quality as “the degree to which health care services for individuals and populations increases the likelihood of desired health outcomes and are consistent with current professional knowledge …”. The field of neurosurgery is a speciality affiliated with high cost and expensive advanced technology (2). There is a need to establish a validated approach to measure the quality of neurosurgical care (3). There has been an increasing focus in the neurosurgical literature to explore suitable surrogate markers of the quality of care received by neurosurgical patients (4).

South Africa has a unique quadruple burden of disease profile. This encompasses human immunodeficiency virus and tuberculosis co-infection, other communicable diseases, non-communicable diseases, and trauma (5). There is limited literature evaluating the profile of neurosurgical patients in South Africa, however, a few examples exist. An outdated 1991, contextually relevant study reported an estimated incidence of traumatic brain injury (TBI) in Johannesburg of 316 per 100 000 person-years (6). The TBI characteristics of patients in a Pietermaritzburg study is a contemporary example (7). Regarding the paediatric population, the profile of patients at Red Cross War Memorial Children Hospital in Cape Town (8) and Inkosi Albert Luthuli Central Hospital in KwaZulu Natal have been described (9).

In South Africa, the move towards an increased emphasis on quality has been reflected in recent reforms. The National Development Plan identifies “quality health care for all” as a key priority (10). Stemming from this, the National Health Insurance plan intends on investing in quality improvement, cognisant that the quality of care provided in the public sector may be of concern (11). As such there is a direct imperative to strengthen quality measurement in South Africa (12). Databases are fundamental in validating the appropriateness of existing quality metrics as well as elucidating novel neurosurgical specific quality indicators (4).

Naidoo (12) noted in an editorial, “SA [South Africa] does not have a TBI databank, and contemporaneous studies on overall incidence and prevalence of TBI are lacking.” The author went on to comment, “SA needs improved and current TBI epidemiological data to develop protocols appropriate to our unique set of conditions …” (12). Data pertaining to all subsets of neurosurgical patients admitted to South African hospitals is lacking. Electronic databases have emerged as important mechanisms to define, measure, and promote health care quality (13-15).

The Charlotte Maxeke Johannesburg Academic Hospital REDCap neuroanaesthesia database was created with a view to record the anaesthetic details for all neurosurgical patients presenting to theatre at the hospital. The database includes data from 75 peri-operative variables. This literature review will address aspects of select database fields and will speak to the standard of neurosurgical care, and to relevant controversies within the neuroanaesthesia literature.

1.2 Demographics of neurosurgical patients

Neurosurgical patients are a heterogenous group with age, sex, and race predilection for a diverse array of neuropathologies (9, 16-24). Patient volumes differ by neurosurgical condition and global region (25). For descriptive purposes, neurosurgery can be broadly classified as either cranial or spinal surgery. Rock et al. (26), in a high-income setting, compared patients having cranial and spinal surgery and found significant differences in patient operative volume and demographic characteristics between the two groups. Spinal surgery (78.2%) accounted for a disproportionately larger patient volume compared to the number of cranial surgery (21.8%) patients. Spinal patients were more frequently male, >65 years old, white, overweight, and smokers (26).

In low-middle income countries, cranial surgery, performed either as an emergency or electively, is encountered more commonly (9, 18, 25, 27, 28). In Africa, ten conditions requiring operative management in order of clinical importance are TBI, hydrocephalus, intracranial infections, stroke, epilepsy,

traumatic spinal injury, brain tumours, intracranial vascular abnormalities, neural tube defects, and spinal tumours (25). Hydrocephalus (9, 21), congenital abnormalities (18, 27), and epilepsy (23, 24) affect the paediatric population most commonly and will not be discussed further.

TBI is a worldwide health concern (16, 20, 29, 30). TBI is estimated to affect 69 million people globally per annum (20). Cross-continental analysis of TBI studies, including patients of all ages, showed an estimated incidence ranging from 69.4 per 100 000 population in the United States of America (USA) to 1750.0 per 100 000 population in New Zealand (16). In Africa, the estimated annual incidence of TBI, and traumatic spinal cord injury is expected to be 127.8 and 11.4 per 100 000 population, respectively (25). A South African TBI incidence rate of 316.4 per 100 000 person-years was shown in Johannesburg (6). A meta-analysis estimates the annual incidence rate of TBI in adolescents and adults to be 618.5 per 100 000 person-years (16). TBI affects predominantly young adult males (6, 7, 16, 28, 31-36).

Certain central nervous system (CNS) infections require surgical intervention for effective source control (37). Internationally, the mean age of patients with CNS infections is 35.8 years, with a female predominance of 1:1.7 (22). The annual incidence of CNS infections requiring operation in Africa is estimated to be 24.4 per 100 000 population (25). Africa has the highest incidence of tuberculosis-related CNS disease compared to other global regions (22). In South Africa, the incidence of intracerebral abscess was estimated to be 15.5 per 100 000 population for 1993 – 2011 (38). A meta-analysis showed that this incidence level is higher than most countries, including the West Indies, Saudi Arabia, Taiwan, and the USA, reporting incidences of 2.4, 3.6, 10.5, and 0.8 per 100 000 population, respectively (22). In South Africa, a high HIV prevalence in the general population may account for this discrepancy (39).

An estimated incidence rate of intracranial aneurysm of 49.4 per 100 000 person-years has been reported in a Korean population (40). The estimated annual incidence rate of aneurysmal rupture leading to subarachnoid haemorrhage (SAH) in the USA is 7.2 – 9.0 per 100 000 population (17). SAH reportedly accounts for

5% - 10% of strokes in the USA. Aneurysmal SAH in this population is more common in females and black patients with a relative risk of 1.7, and 1.5 for sex, and race, respectively (17). The United Kingdom shows a lower incidence of SAH, although this reflects the findings of a single-centre study and excluding clinically worse grades of SAH. The incidence of World Federation of Neurosurgical Societies grades I and II SAH admissions was 3.0 per 100 000 population in the United Kingdom. The mean age of patients was 53 years. Similar to USA findings, the British population was predominantly female (65.2%). At an academic hospital in Bloemfontein, 161 patients with aneurysmal SAH detected by digital subtraction angiography were described over a six-year period. The mean age of these patients was 45 years, and they were predominantly female (63.4%) (41).

A combined age-adjusted incidence of brain and spine tumours of 22.6 per 100,000 population in the USA has been reported (42). The incidence of all CNS tumour types is highest in adults with a mean age at diagnosis of 59 years (42). Children who present with brain or spinal tumours will most commonly have a malignant subtype (19). Males and white patients will also more commonly present with malignant tumours, compared with females and black patients (19). In Africa, the estimated annual incidence of brain, and spine tumours of 7.9, and 0.1 per 100 000 population, respectively, are expected (25). Tumours accounted for 6.5% of patient admissions in a Nigerian audit of neurosurgical cases (27). The latter study did not stratify demographic data according to underlying diagnoses.

The American Society of Anesthesiologists™ (ASA) Physical Status Classification system serves as a surrogate indicator for patient pre-operative morbidity status. Comparing cranial and spinal surgery patients in the Rock et al. (26) cohort, cranial surgery patients were mostly classed ASA III (54.9%), and spinal surgery patients were mainly classed ASA II (48.8%). Moreover, significantly more cranial patients (13.6%) were classed ASA IV, compared to spinal patients (3.4%, $p<0.001$) (26). Specifically, hypertension, followed by chronic obstructive pulmonary disease, were the most common comorbid conditions in both patient groups. Overall, long-standing comorbidities were reported more frequently in spinal surgery patients. Cranial surgery patients more commonly had disseminated cancer, a bleeding diathesis, or were ventilator-dependent prior to

surgery. Evidence of sepsis was significantly more common in cranial surgery patients, with these patients having a six-fold increased risk of presenting to theatre with severe inflammatory response syndrome compared to spinal surgery patients. More cranial surgery (13.6%) was performed as an emergency procedure, compared to spinal surgery (2.7%).

The ASA status among glioblastoma patients undergoing cranial surgery in a German institution was 57.6% for ASA I and II and 42.4% for ASA III and IV combined (43). In a North American study, patients undergoing spinal fusion surgery were mostly classed ASA II (44.1%) and ASA III (50.4%) (44). The patients in the ASA class III group were more likely to be elderly, obese, diabetic, dyspnoeic, functionally dependent, use steroids, and have cardiac, respiratory, and renal comorbidities (44). Both the German (43) and North American (44) population groups did not include patients having emergency surgery. In a group of TBI patients for emergency cranial surgery, all enrolled patients were classed ASA I – II. A higher ASA class was not cited as an exclusion criterion for this study (45). The validity and reliability of utilising ASA classification in trauma patients have been questioned (46, 47).

1.3 The pre-operative neurological assessment

The Glasgow Coma Scale (GCS) is a ubiquitous clinical scoring system in the assessment of neurosurgical patients (48, 49). GCS is the most common clinical tool to classify TBI severity (50). TBI is classed as mild, moderate, and severe with corresponding GCS scores of 13 – 15, 9 – 12, and ≤8, respectively (50). Despite widespread use, there are certain caveats that need to be addressed. Firstly, a GCS-based TBI severity classification system is not universally adopted. Preceding the establishment of the Brain Trauma Foundation guidelines (51), earlier TBI studies would use non-standardised descriptive TBI classification systems based on mechanism of injury (28). This forms the greatest source of heterogeneity in meta-analyses of TBI studies (16). This is reflected by the large variation in TBI incidence within and across various global regions (16, 20).

Secondly, the use of alterations in GCS as a means to diagnose TBI impacts the ability to identify mild TBI as the GCS is often normal (16). This may be particularly important in settings where the potential for language barriers exist. Thirdly, confounders such as pain, intoxicants, and medications can cause alterations in brain function with or without brain injury, further complicating the interpretation of GCS assessments (16). Finally, an emerging concept expressed by contemporary TBI studies shows that TBI severity, as assessed by GCS is not predictive of outcomes (36, 52, 53). Suggested reasons for this observation include pre-hospital treatment obscuring admission GCS (28, 52, 54) and that the severity of TBI may fluctuate with time (53). International consensus regarding an alternative assessment tool is pending further enquiry (53).

1.4 The intra-operative anaesthetic management of neurosurgical patients

The use of total intravenous- and volatile-based anaesthetic techniques in neurosurgical patients

Deciding on which anaesthetic technique to employ is an important preliminary neuroanaesthetic consideration. There has been an ongoing debate regarding the superiority of total intravenous anaesthesia (TIVA) compared to a volatile-based anaesthetic technique in neurosurgical patients (55). The concerns surrounding this debate are three-fold. There is a need for rapid recovery following anaesthesia (56), stable haemodynamics with concurrent mitigation of raised intracranial pressure (ICP) (57), and finally, a theoretical concern that certain anaesthetic agents influence the dissemination of tumour cells during tumour resection (58).

Sixty-six adult patients having a craniotomy for brain tumour resection were randomised to maintenance of anaesthesia with either propofol-remifentanil (n=31) or sevoflurane-sufentanil (n=35) to compare the emergence characteristics between these two techniques (59). Intravenous or volatile anaesthetic doses were both guided by bispectral index monitoring. Opioid administration was titrated to heart rate and mean arterial pressure values. Post-operatively, patients in the sevoflurane-sufentanil group achieved maximum scores on consciousness targets, namely, GCS, Aldrete score, and Mini-Mental Status Examination score, more

rapidly compared to patients in the propofol-remifentanil group. However, between the two patient groups, there were no significant time differences between the end of anaesthesia and the ability to breathe spontaneously, follow simple commands, and be successfully extubated (59). Other studies, designed to optimise rapid emergence for neurological assessment, have failed to show a distinct benefit of TIVA compared with a volatile-based anaesthetic technique (55, 60, 61).

In an early prospective randomised trial (62), further clinical differences between patients receiving a propofol-fentanyl or isoflurane-nitrous oxide anaesthetic were assessed. No significant haemodynamic differences were found between the two groups. Additionally, no clinically important differences in the measured mean ICP were found. However, more patients in the volatile-based anaesthesia group had ICP measurements that exceeded 24 mmHg, compared to the TIVA group. Magni et al. (63) found that elective craniotomy patients receiving propofol experienced significantly more haemodynamic changes but no clinically significant differences in surgically assessed brain swelling. A similar study in emergency craniotomy patients showed no significant differences between propofol or sevoflurane groups for both episodes of hypotension and cerebral oedema (45). Of note, neither study measured ICP objectively.

Comparative studies on the ICP effects of anaesthetics show that all volatiles in a dose-dependent manner can increase ICP, but this effect is least for sevoflurane (57). On the contrary, propofol can reduce ICP (57), and some evidence exists that it may serve as a neuroprotectant (64). The importance of reducing ICP in TBI patients is reflected in the Brain Trauma Foundation guidelines (51). Furthermore, an association between the use of ICP monitoring in severe TBI patients, and a significantly reduced intensive care mortality, has been demonstrated (65). However, the findings of a prospective randomised controlled trial failed to show a significant outcome difference between severe TBI patients requiring emergency surgery receiving either a TIVA-based or volatile-based anaesthetic (45). This is in contrast to the findings of an earlier retrospective study which showed that TIVA was superior to volatile-based anaesthesia for TBI patients, although this benefit was greatest for the mild and moderate TBI groups (66).

Both TIVA and volatile-based anaesthesia are widely accepted for the anaesthetic management of supratentorial intracranial surgery (60, 61, 67, 68). The concern regarding the influence of anaesthetic technique on outcomes in brain tumour patients, specifically, stems from studies conducted in other cancer surgery patients, favouring the use of TIVA (69-71). A retrospective study (43) conducted at University Hospital Heidelberg, Germany, showed that the anaesthetic technique employed during the resection of glioblastoma did not impact patient survival. According to the authors, the chosen anaesthetic technique was based on the attending anaesthetist's preference, and the retrospective study design prevented deductions relating to the rationale for the given choice to be made. In the majority of patients (88.5%), the anaesthetist elected a volatile-based approach. Of all the TIVA cases, in 16 (30.8%) patients, TIVA was mandated by the use of intra-operative electrophysiological monitoring (43). In view of the available literature, judicious use of either anaesthetic technique is appropriate in neurosurgical patients.

Airway and ventilatory management of neurosurgical patients

General anaesthesia, regardless of whether TIVA or volatile-based, raises unique airway management concerns in neurosurgical patients. Patients with cervical spine instability, Cushingoid features, and acromegalic patients should be anticipated difficult airways and contingency airway management plans should be in place (72). Certain procedures require head fixation devices to be placed following the induction of anaesthesia. Stereotactic headframes pose a major limitation if there is a need for urgent or emergency airway management (73). Simulation studies have shown that the time to intubate or rescue the airway with a laryngeal mask airway is longer once head fixation devices are in place compared to standard airway management conditions (74). The advent of awake craniotomies has heralded a variety of airway management strategies. These include the use of nasal cannulae (75), simple facemasks (76), laryngeal mask airways (77, 78), endotracheal tubes (77, 78), and the novel application of bilateral nasopharyngeal airways (76).

Most commonly, general anaesthesia will necessitate intubation and ventilation. Compared with the general surgical population, patients who undergo craniotomy procedures are at increased risk for post-operative respiratory complications (26, 45, 56, 67). A theoretical concern exists that adopting the lung-protective paradigm of application of high positive end-expired pressure would increase ICP and thus adversely affect cerebral perfusion (56). The effect of incremental positive end-expired pressure was studied in a randomised group of 40 adult patients undergoing brain tumour resection (79). No statistically significant differences in ICP measurements were noted between the standard and the lung-protective ventilated groups. No outcome benefit was demonstrated in a similar study in patients having spine surgery in the prone position (80).

Analgesic management of neurosurgical patients

Opioids are often the mainstay of analgesic management in neurosurgical patients (9, 56, 73, 81, 82). Uchida et al. (83) found that in patients undergoing brain tumour resection, the intraoperative use of remifentanil, when compared to the use of fentanyl, was associated with reduced in-hospital mortality. The same authors applied this observation to patients who underwent cerebral aneurysm clipping (84). Similarly, patients who received remifentanil experienced significantly lower mortality rates (4.2%) compared to those who received fentanyl alone (7.7%; $P<0.001$). The purported theory for these findings relates to remifentanil possibly suppressing the stress response to surgery, and therefore mitigating consequent hyperglycaemia and inflammation, more so than fentanyl (84).

The analgesic management of neurosurgical patients is further challenged in needing to balance adequate analgesia, while mitigating the concurrent sedating effects of opioids to allow for accurate post-operative neurological assessment. As such, various opioid-sparing techniques have emerged using drugs such as dexmedetomidine (85), paracetamol (86, 87), and ketamine (88, 89) in cranial and spinal surgery patients. Scalp infiltration with local anaesthetic decreases post-operative pain scores and morphine consumption, but only for the first two hours after cranial surgery (90). Of novel interest, while the use of ketamine in TBI patients was previously discouraged, it may be unjustified in light of new information supporting ketamine as a potential neuroprotectant agent (89, 91).

This may in part explain the findings of Grathwohl et al. (66), demonstrating superiority in a TIVA-based anaesthetic technique since TBI patients receiving ketamine-based anaesthesia were included in the final outcome analysis.

Haemodynamic management of neurosurgical patients

The principal risk of intra-operative hypotension is end-organ ischaemia due to reduced organ perfusing pressure (92, 93). The practice of permissive hypotension (PH) is largely advocated by surgeons with a view to optimise operative fields and minimise intra-operative blood loss (94-96). Soghomonyan et al. (96) sought to establish the practise patterns surrounding PH in contemporary neuroanaesthetic practice. In their survey, they found that 87.5% of respondents reported using PH for selective neurosurgical procedures. Of these respondents, 73.1% denied awareness of patient complications due to PH strategies. The survey showed large inter-practise variability in terms of selected target values, whether systolic or mean arterial blood pressure measurements guided technique, type of vasoactive substances utilised, and the level of haemodynamic monitoring employed. The authors concluded that the role of PH in modern neuroanaesthesia needs further studies to clarify safety and best practice guidelines (96).

On the contrary, induced hypertension may have a protective role in select neurosurgical patients (97). Delayed cerebral ischaemia contributes to downstream morbidity and mortality in aneurysmal SAH survivors (98). There is a dichotomy in professional opinion regarding the best therapeutic approach in these patients (97). Haegens et al. (97) retrospectively investigated the role of induced hypertension in patients with symptomatic delayed cerebral ischaemia. They found a significantly reduced incidence of subsequent cerebral infarction in patients treated with induced hypertension. Additionally, significantly fewer patients treated with induced hypertension had a modified Rankin score >3, indicating a lower rate of poorer outcomes among these patients, compared with patients who were not treated with induced hypertension. In patients that were treated with induced hypertension, noradrenaline was the vasopressor of choice (97). In South African, noradrenaline use is subject to Section 21 authorisation for access to unregistered medication (99), and thus widespread availability is limited.

Phenylephrine and ephedrine are readily available vasopressors and are commonly administered to neurosurgical patients to manage intra-operative hypotension (100). However, phenylephrine may not be the ideal agent since several studies in non-neurosurgical patients suggest a reduction in cerebral oxygen saturation with its use, compared to ephedrine (101-103). It would be expected that this observed perturbation associated with phenylephrine use may be even more pronounced in patients with intracranial pathology. Koch et al. (104) studied the cerebral physiological effects of vasopressor administration in brain tumour patients in a double-blinded randomised clinical trial. The study showed that there were no significant differences in oxygen metabolic rate of peri-tumour and normal contralateral areas between the two vasopressors. However, in keeping with earlier studies (101-103), assessment of the normal hemisphere showed that ephedrine administration resulted in increased cerebral oxygenation compared to phenylephrine (104).

Blood transfusion practices in neurosurgical patients

Both cranial and spinal surgery have the potential for blood loss mandating the transfusion of red packed cells (105, 106). Physiological assessments guided by neurophysiological monitoring devices have shown improved cerebral oxygenation in neurosurgical patients following blood transfusion (107). However, these improvements in oxygen delivery have not consistently translated into clinical benefit. Moreover, ideal transfusion triggers in neurosurgical patients remain undefined (108) and may also differ depending on the underlying neuropathology (109). In patients with severe TBI, maintaining haemoglobin levels >9g/dL may have an association with improved neurological outcome (110, 111). Antagonistically, liberal transfusion practices have been associated with increased mortality rates. A retrospective study among severe TBI patients showed an in-hospital mortality of 41.0% in patients receiving a transfusion compared to 24.0% in those not transfused ($p<0.05$) (112). The study also showed that in their population transfusion was independently associated with increased risk for neurological complications [RR=3.4 (±95% CI 1.4, 8.6) $P<0.05$], as well as longer ICU, and hospital lengths of stay (112).

In other neurosurgical patients, the role of blood transfusion is equally contentious. Bell et al. (113) described intra-arterial vasospasm therapy practices in aneurysmal SAH patients and showed that a lower mean haemoglobin level was predictive of both the need for therapy and poor neurological outcome post-intervention. Antagonistically, the transfusion of red packed cells in aneurysmal SAH patients may be associated with an increased incidence of vasospasm (114), cerebral aneurysm rupture (115), and increased in-hospital mortality (116). On the contrary, English et al. (117) found that red packed cell transfusion did not correlate with mortality in their SAH cohort but restrictive transfusion practices were noted among the studied institutions. Brain tumour resection poses a risk for blood loss and the need for transfusion due to the vascular nature of certain tumours and the development of disseminated intravascular coagulopathy (109). In patients with tumours, the immunomodulatory effects of blood transfusion may cause cancer progression (118), further complicating risk-benefit analyses for intracranial and spinal tumour patients. Emphasis on individualised blood conservation strategies (108) may ameliorate the frequency of required blood transfusions in neurosurgical patients.

Adjuvant peri-operative medical management of neurosurgical patients

Steroids and anti-convulsant agents are commonly administered medications in neurosurgical patients (82). Steroids have an important role in managing cerebral oedema associated with brain tumours (119). The Brain Trauma Foundation states that steroid administration to TBI patients is harmful and is not recommended (51). Generalised seizures can cause marked derangements in cerebral blood flow, cerebral metabolic rate, and ICP (120). These extreme physiologic changes associated with seizure activity may have detrimental patient effects if not managed appropriately. The latter is evidenced by the risk of death produced by electroconvulsive therapy in patients harbouring unknown brain tumours (121). However, peri-operative administration of anti-convulsant medication is not routine in all neurosurgical patients. A systematic review showed a limited clinical benefit of prophylactic anti-convulsant administration in the prevention of post-craniotomy seizures (122). The Brain Trauma Foundation (51) recommends phenytoin to

decrease the incidence of early-onset post-traumatic seizures in light of level IIA evidence.

Hypertonic solutions are agents composed of a solute that cannot cross the blood-brain barrier and act to treat elevated ICP (73). Mannitol or sodium chloride are the commonly administered hypertonic solutions to treat intracranial hypertension. There is an ongoing debate as to which is the superior agent (123-125). In a study by Ali et al. (125), various clinical, physiological, and biochemical effects of mannitol and hypertonic saline were analysed. The study participants included 39 elective cranial surgery patients with brain tumours who had computed tomography evidence of raised ICP.

Baseline ICP measurements, which were similar between the two patient groups, were made via stereotactically placed probes at the tumour site following a burr hole and preceding hypertonic solution administration. Once standardised doses of respective hypertonic solutions were given, ICP was measured for 45 minutes, after which time the craniotomy was performed (125). Patients receiving hypertonic saline showed a significantly greater reduction in absolute and relative ICP when compared with ICP measurements in the mannitol patient group. Further differences between the two patient groups included a significant decrease in pulse pressure variation with hypertonic saline administration and a significant increase in serum lactate concentration with mannitol use (125).

1.5 The post-operative characteristics of neurosurgical patients

Institutional resources and scope of practice dictate the post-operative management plan for individual patients. Several case series in the literature describe ambulatory neurosurgical practices (126). Many patients are sent to the ward following their surgery (127). The type of neurosurgical procedure, along with certain patient characteristics and comorbidities, increases the risk of post-operative complications. This subset of patients may benefit from post-operative intensive care (127, 128). In addition to complication rates (26, 45, 67), other post-operative events are identified in neurosurgical patient populations to serve as crude indices of the quality of health care delivered. Commonly studied metrics include,

re-operation rates (129, 130), re-admission rates (131-133), length of hospital stay (134, 135), and mortality (7, 26, 33, 36, 43, 45). Mortality rate is a common outcome metric for its discriminatory nature (dead or alive), and routine incorporation into administrative databases.

The thirty-day complication rate in the Rock et al. (26) cohort was significantly higher in patients having cranial (22.0%) compared with spinal surgery (11.0%; $p<0.001$). The three most common complications in the cranial surgery group were the need for reoperation (6.8%), the need for blood transfusion (5.6%), and pneumonia (3.2%). The three strongest predictors for complications were ASA class V, pre-operative ventilator dependence, and pre-operative need for blood transfusion. Thirty-day mortality rates were significantly higher in the cranial (4.8%) compared with the spinal surgery group (0.5%; $p<0.001$). ASA class V, IV, and III were the three strongest predictors of mortality (26).

A retrospective survey of 583 TBI patients admitted to the National University Hospital of Iceland was done over 15 years (33). Craniotomies were performed most frequently in patients with moderate TBI (30.6%), whereas 26.4% and 24.3% of craniotomies were done for patients with severe and mild TBI, respectively. The mortality rate was significantly higher in the severe TBI group at 36.8%, compared to the mortality among moderate (9.0%) and mild (3.0%) TBI patients ($p<0.0001$). In the Austrian Severe Traumatic Brain Injury Study (31), severe TBI accounted for 13.0% of all TBI patients in this series and intensive care unit mortality was found to be 31.6% for severe TBI patients. A study from Lebanon reported specific mortality rates of 26.6% and 13.7% owing to infectious and non-infectious causes of post-TBI mortality, respectively (32).

Mulango National Referral Hospital in Uganda conducted a retrospective review of 120 severe TBI patients managed at the institution (32). An in-hospital mortality rate of 25.8% was observed. Mortality was greatest in the >45 age group at 40.0%. Patient age, gender, transfer time delays, length of hospital stay, pupillary reactivity, and the administration of mannitol were not significantly associated with outcome (32). A survey of 3 301 mixed adult and paediatric patient records extracted from the electronic systems of two hospitals in Pietermaritzburg found

that there was a statistically significant difference in the mean GCS of TBI survivors of 13.7 compared to a mean GCS score of 5.7 among patients who demised ($p<0.001$). The authors reported an overall mortality rate for severe TBI patients in the studied population at 33.4% (7).

The validity of available outcome quality indicators has been questioned (4). A study in Sri Lanka sought to assess the long-term neurological status of patients admitted with moderate and severe TBI to a tertiary neurocritical care unit (36). A telephonically administered questionnaire based on the Glasgow Outcome Scale Extended score was used to assess the functional outcome of patients at three and six months after injury. At three months following injury, only 38.0% of survivors were found to have good functional recovery. Such enquiries serve to better elucidate the impact of various management strategies on patient outcomes.

1.6 Summary

The provision of high-quality health care to neurosurgical patients is an ingrained tenet among all health care providers involved in their management. Databases are being ear-marked as instrumental tools to measure the quality of care delivered. This literature review has addressed aspects of the Charlotte Maxeke Johannesburg Academic Hospital REDCap neuroanaesthesia database. Neurosurgical patient demographics for several neurosurgical conditions have been described. The controversies surrounding the use of GCS in the pre-operative neurological assessment of TBI patients have been highlighted. Standard of neurosurgical care and neuroanaesthetic controversies in the intra-operative management of neurosurgical patients has been addressed. Particular emphasis has been placed on the anaesthetic technique, airway, ventilatory, analgesic, haemodynamic, blood transfusion, and peri-operative adjuvant medical management of neurosurgical patients by anaesthesiologists. Finally, a description of the post-operative characteristics of neurosurgical patients has been provided. Post-operative events are the metrics employed to benchmark the overall quality of the antecedent care provided.

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Section 2: Author's guidelines

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All articles must have a title page with the following information and in this particular order: Title of the article; surname, initials, qualifications and affiliation of each author; The name, postal address, e-mail address and telephonic contact details of the corresponding author and at least 5 keywords.

Abstract

All articles should include an abstract. The structured abstract for an Original Research article should be between 200 and 230 words and should consist of four paragraphs labeled Background, Methods, Results, and Conclusions. It should briefly describe the problem or issue being addressed in the study, how the study was performed, the major results, and what the authors conclude from these results. The abstracts for other types of articles should be no longer than 230 words and need not follow the structured abstract format.

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Acknowledgements

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Cite references in numerical order in the text, in superscript format (Format> Font> Click superscript). Please do not use brackets or do not use the foot note function of MS Word.

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List all authors when there are six or fewer; when there are seven or more, list the first three, then “;et al.”; When citing URLs to web documents, place in the reference list, and use the following format: Authors of document (if available). Title of document (if available). URL. (Accessed [date]).

The following are sample references:

1. Jun BC, Song SW, Park CS, Lee DH, Cho KJ, Cho JH. The analysis of maxillary sinus aeration according to aging process: volume assessment by 3-

dimensional reconstruction by high-resolutional CT scanning. Otolaryngol Head Neck Surg. 2005 Mar;132(3):429-34.

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Tables should be self-explanatory, clearly organised, and supplemental to the text of the manuscript. Each table should include a clear descriptive title on top and numbered in Roman numerals (I, II, etc) in order of its appearance as called out in text. Tables must me inserted in the correct position in the text. Authors should place explanatory matter in footnotes, not in the heading. Explain in footnotes all non-standard abbreviations.

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4. All author details (Full names, Qualifications and affiliation) must be provided.
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8. It must be clear where every figure and table should be placed in the text. If possible, tables and figures must be placed in the text where appropriate. If too large or impractical, they may be featured at the end of the manuscript or uploaded as separate supplementary files.
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10. All numbers below ten, without percentages or units, must be written in words.
11. Figure numbers: Arabic, table numbers: Roman

Section 3: Draft article

A survey of adult patients requiring neurosurgery at a central hospital

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Key words: neuroanaesthesia database, neurosurgery, peri-operative care.

Abstract

Background

Data pertaining to all subsets of neurosurgical patients admitted to South African hospitals is lacking. The aim of this study was to survey adult patients requiring neurosurgery at Charlotte Maxeke Johannesburg Academic Hospital (CMJAH).

Methods

A retrospective survey of the REDCap neuroanaesthesia database was conducted. Consecutive data were extracted for 2016 and 2017. Data described the pre-operative assessment, intra-operative anaesthetic management and post-operative status of patients undergoing elective and emergency neurosurgical procedures.

Results

The database entries of 873 patients were included in the study. Most of the patients, 622 (72.1%) were male, 558 (63.9%) received emergency surgery, and 337 (38.6%) patients had traumatic brain injury (TBI). The severe TBI incidence was 45.1%. The predominant anaesthetic technique was an intravenous propofol induction 629 (72.1%) and sevoflurane maintenance 539 (61.7%). Marked haemodynamic instability occurred in 208 (23.8%) patients, mandating either vasopressor 99 (47.6%) or inotropic 109 (52.4%) support. Seizure prophylaxis was only given to 39 (4.5%) patients. Steroids were administered to 134 (39.8%) TBI patients. Significantly more elective surgery patients, 224 (71.1%) were extubated immediately post-operatively ($p<0.0001$). However, the in-hospital mortality among patients did not differ significantly between those who had elective 30 (9.5%) or emergency surgery 47 (8.4%, $p=0.6697$). In-hospital mortality was higher for patients having cranial surgery 61 (9.0%) compared to spinal surgery 6 (6.4%), but this difference was not statistically significant ($p=0.3926$).

Conclusion

The frequent administration of steroids to TBI patients at CMJAH is concerning but highlights the importance of utilising databases for quality improvement purposes. The unexpected mortality finding in this study between elective and emergency cases may be explained by the higher ASA classification of elective patients. This study contributes to the understanding of neurosurgical patient peri-operative care.

Introduction

The Institute of Medicine (1), defines health care quality as “the degree to which health care services for individuals and populations increases the likelihood of desired health outcomes and are consistent with current professional knowledge …”. The field of neurosurgery is a speciality affiliated with high cost and expensive advanced technology (2). There is a need to establish a validated approach to measure the quality of neurosurgical care (3). There has been an increasing focus in the neurosurgical literature to explore suitable surrogate markers of the quality of care received by neurosurgical patients (4).

South Africa has a unique quadruple burden of disease profile. This encompasses Human Immunodeficiency Virus (HIV) and tuberculosis, other communicable diseases, non-communicable diseases, and trauma (5). There is limited literature evaluating the profile of neurosurgical patients in South Africa, however, a few examples exist. An outdated 1991, contextually relevant study reported an estimated incidence of traumatic brain injury (TBI) in Johannesburg of 316 per 100 000 (6). The TBI characteristics of patients in a Pietermaritzburg study is a contemporary example (7). Regarding the paediatric population, the profile of patients at Red Cross War Memorial Children Hospital in Cape Town and Inkosi Albert Luthuli Central Hospital in KwaZulu Natal have been described (8, 9).

In South Africa, the move towards an increased emphasis on quality has been reflected in recent reforms. The National Development Plan identifies “quality health care for all” as a key priority (10). Stemming from this, the National Health Insurance plan intends on investing in quality improvement, cognisant that the quality of care provided in the public sector may be of concern (11). As such there is a direct imperative to strengthen quality measurement in South Africa (12). Databases are fundamental in validating the appropriateness of existing quality metrics as well as elucidating novel neurosurgical specific quality indicators (4).

Naidoo (12) noted in an editorial, “SA [South Africa] does not have a TBI databank, and contemporaneous studies on overall incidence and prevalence of TBI are lacking.” The author went on to comment, “SA needs improved and current TBI epidemiological data to develop protocols appropriate to our unique

set of conditions …" (12). Data pertaining to all subsets of neurosurgical patients admitted to South African hospitals is demonstrably lacking. Electronic databases have emerged as important mechanisms to define, measure and promote health care quality (13-15). The aim of this study was to survey adult patients requiring neurosurgery at Charlotte Maxeke Johannesburg Academic Hospital (CMJAH).

Methods

A retrospective, contextual, descriptive survey of the REDCap neuroanaesthesia Database was conducted at CMJAH. Approval to conduct the study was obtained from the Human Research Ethics Committee (Medical) (M180130), and other relevant authorities.

All patients 16 years and older captured on the database from 1 January 2016 to 31 December 2017 were included in the study. For patients having undergone multiple procedures throughout their hospital course, only the index data entry for such patients was included.

The data were extracted from the database in a consecutive manner. Data for incomplete entries were retrieved from source documents, including admission books, anaesthetic records, and laboratory records. The data captured on the database included: patient demographics, pre-operative neurological assessment, intra-operative anaesthetic management, and post-operative status. An entry was deemed inadequately completed if it failed to capture any of the following: date of surgery, patient age, gender, procedure undergone, and whether the procedure was performed electively or emergently. Inadequately completed entries were excluded from the final analysis. Data were collected by one author (L.I).

Data were analysed using Microsoft Exel® and Graftpad Instat™. Categorical variables are described using frequencies and percentages. Continuous variables are described using means, standard deviations, and ranges. Comparisons were made using Chi-square tests. A p-value of <0.05 was considered statistically significant.

Results

The database entries of 873 patients were included in the study. The derivation of the study sample is given in Figure 1, and patient characteristics are shown in Table 1. The mean (SD) age of patients was 43.2 (15.8), with a range of 16 – 88 years. Emergency procedures were performed in 558 (63.9%) patients, including 509 (91.2%) cranial surgeries, 8 (1.4%) spine surgeries, and 41 (7.6%) others. Trauma patients accounted for 340 (61.0%) of these emergency procedures, of which 314 (92.3%) were cranial surgeries. Comorbid conditions were documented in 355 (40.7%) patients, of which 116 (32.7%) had >1 comorbidity, ranging between 2 – 5 additional conditions. Cardiovascular comorbidities were reported in 202 (23.1%) patients, of which 154 (76.2%) were hypertensive.

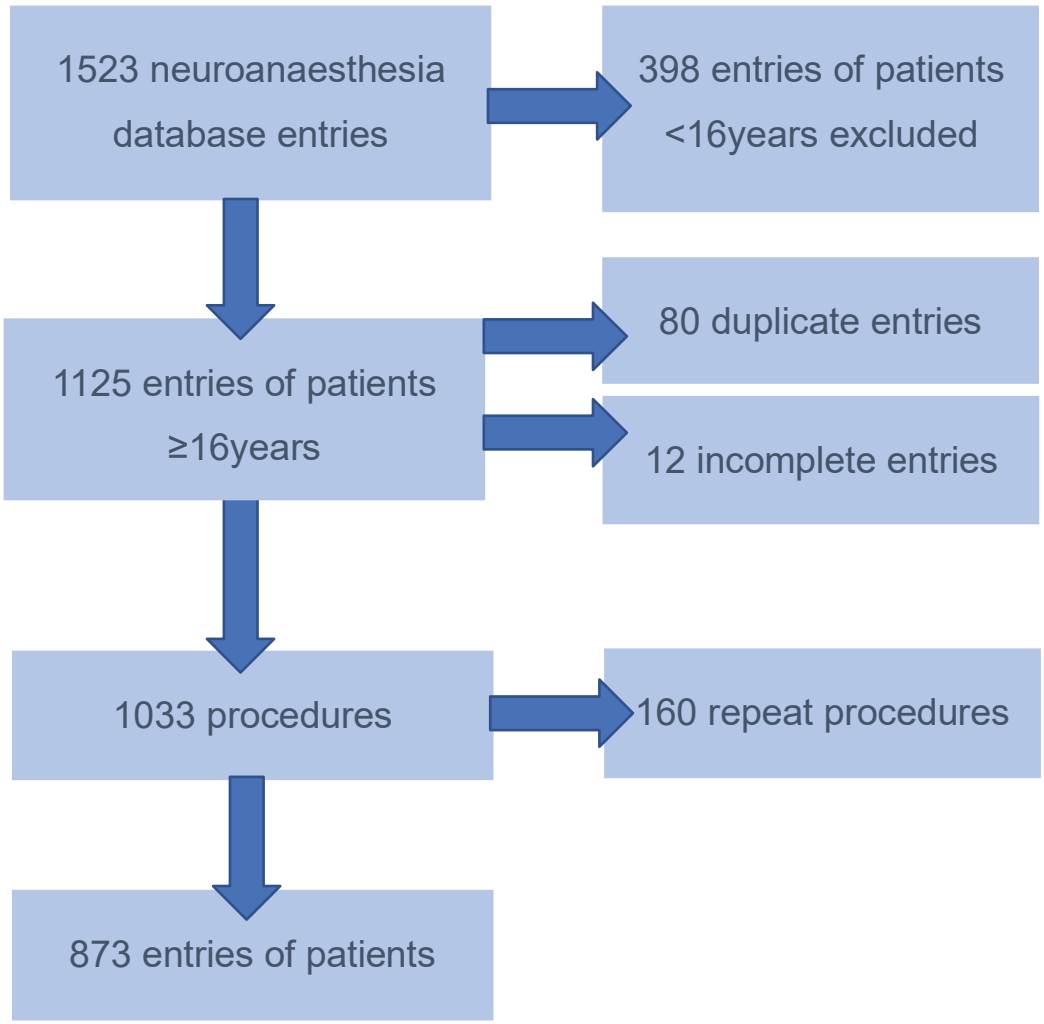


Figure 1: Derivation of study sample

Table 1: Characteristics of patients

Demographics	Number	Percentage
Gender		
• Male	622	71.2
• Female	251	28.8
ASA classification*		
• 1	132	15.1
• 2	229	26.2
• 3	389	44.6
• 4	114	13.1
• 5	9	1.0
Type of surgery		
• Elective	315	36.1
• Emergency	558	63.9
Neurosurgical procedure		
• Cranial	675	77.3
• Spinal	94	10.8
• Other	50	5.7
• Interventional neuroradiology	54	6.2
Neuropathology		
• Congenital	13	1.4
• Tumour	169	19.4
• Infective	78	8.9
• Vascular	131	15.0
• Trauma	383	43.9
• Iatrogenic	5	0.6
• Other	94	10.8
Comorbid conditions		
• Cardiovascular	202	23.1
• Respiratory	112	12.8
• Endocrine	65	7.4
• Renal	24	2.7
• Hepatic	6	0.7
• HIV positive status	109	12.5

The patients' pre-operative neurological assessment is shown in Table 2. Four hundred and five (46.4%) patients had a Glasgow Coma Scale (GCS) of 15. Of the 337 TBI patients, 137 (40.7%) were classed as mild, 48 (14.2%) moderate, and 152 (45.1%) severe, respectively. A positive history of neurological symptomatology was present in 571 (65.4%) patients, of which 97 (17.0%) patients experienced >1 symptom with a range of 2 – 3. Computed tomography brain scans were available for 813 (93.1%) patients and 436 (53.6%) patients had multiple radiological features documented with a range of 2 – 5 features per patient.

The patients' pre-operative mean (SD) haemoglobin was 12.8 (2.5) with a range of 1.8 – 20 mg/dL. One hundred and forty-seven (16.8%) patients presented to theatre with a haemoglobin <10 mg/dL. Trauma was the underlying aetiology for a haemoglobin <10 mg/dL in 48 (32.7%) of these patients. Transfusion of red packed cells was noted for 18 (37.5%) of these trauma patients. Fourteen (0.05%) trauma patients with an initial haemoglobin >10mg/dL received a blood transfusion during their index procedure.

Table 2: Pre-operative neurological assessment

Neurological parameter	Number	Percentage
GCS		
• ≤8	224	25.7
• 9 – 12	108	12.4
• 13 – 15	541	61.9
Pupils equal		
• Yes	399	45.7
• No	70	8.0
• Unable to assess/not done	404	46.3
Speech affected		
• Yes	61	7.0
• No	291	33.3
• Unable to assess/not done	521	59.7
Positive history of neurological symptoms		
• Loss of consciousness	427	48.9
• Headache	165	18.9
• Nausea and vomiting	44	5.0
• Seizure	59	6.8
Neurological deficit		
• Motor deficit present	199	22.8
• Motor deficit absent	424	48.6
• Unable to assess/not done	250	28.6
• Sensory deficit present	80	9.2
• Sensory deficit absent	484	55.4
• Unable to assess/not done	309	35.4
• Cranial nerve deficit present	42	4.8
• Cranial nerve deficit absent	530	60.7
• Unable to assess/not done	301	34.5

Intra-operative anaesthetic assessment and management are shown in Table 3. An intravenous induction was performed in 629 (72.1%) patients, and a sevoflurane maintenance technique was used most commonly in 539 (61.7%) patients. All patients had standard ASA monitoring applied, and arterial lines were placed for invasive blood pressure monitoring in 635 (72.7%) patients.

Multiple attempts to secure the airway occurred in 29 (4.5%) patients. A difficult airway was anticipated by pre-operative assessment in all 6 patients who had ≥ 3 intubation attempts. None of these patients were presenting for cervical spine

surgery. An introducer was employed in an attempt to secure the airway in all these patients. Variable use of other airway adjuncts was used in the form of a bougie (1), laryngeal mask airway (2), video laryngoscope (2), and other undefined airway adjuncts (1) to manage the airway of these patients. Of the 22 patients who had 2 intubation attempts, 7 (31.8%) had cervical spine pathology. Video laryngoscopy was used in 5 (71.4%) of these patients, and 1 (14.3%) patient was intubated with a fibreoptic bronchoscope.

Multiple pharmacological agents were administered for a given anaesthetic. Fentanyl was the opioid of choice given to 693 (79.4%) patients, followed by morphine and alfentanil in 353 (40.4%) and 207 (23.7%) patients respectively, in isolation or combination. Marked haemodynamic instability requiring vasopressor or inotropic support occurred in 208 (23.8%) patients. In these patients, phenylephrine infusions were started in 99 (47.6%) patients, and adrenaline infusions were started in 109 (52.4%) patients. Sixteen patients (7.7%) received both phenylephrine and adrenaline infusions intra-operatively. Patients requiring adrenaline infusions were presenting most frequently for emergency surgery 87 (79.8%), had cranial procedures 98 (89.9%), were ASA class ≥III 87 (79.8%), and had a GCS ≤8 60 (55.0%).

Anti-convulsant, anti-emetic and anti-hypertensive use was limited. The specific agents utilised most frequently per drug class were phenytoin in 42 of 47 (89.4%) patients, ondansetron in 38 of 42 (90.5%) patients, and labetalol in 4 of 5 (80.0%) patients. Anti-convulsants were administered for seizure prophylaxis in 39 (83.0%) of patients receiving this medication. The remaining 8 (17.0%) patients who received an anti- convulsant intra-operatively had a positive history of seizures preceding their surgery. Dexamethasone was administered to 409 (46.8%) patients. Of the 337 TBI patients, 134 (39.8%) were given a dexamethasone dose intra-operatively.

Table 3: Intra-operative anaesthetic assessment and management

Characteristic	Number	Percentage
Airway difficulty anticipated		
• No	572	65.5
• Yes	73	8.4
• ETT in situ	228	26.1
Mallampatti score		
• 1	212	32.9
• 2	316	49.0
• 3	67	10.4
• 4	13	2.0
• Unable to assess/not done	37	5.7
Intubation attempts		
• 1	610	94.5
• 2	23	3.6
• 3	5	0.8
• >3	1	0.2
• Not attempted	6	0.9
Anaesthetic induction technique		
• Intravenous induction	629	72.1
• Inhalational induction	223	25.5
• Co-induction	21	2.4
Pharmacological agents		
• Opioids	861	98.6
• Vasopressors	562	64.4
• Anti-convulsants	47	5.4
• Anti-emetics	42	4.8
• Anti-hypertensives	5	0.6
• Mannitol	121	14.0
• Dexamethasone	409	46.8

The post-operative characteristics of adult patients undergoing neurosurgical procedures are shown in Table 4. Fifteen (1.7%) patients developed new-onset neurology in the immediate post-operative period following extubation. More than half of these 9 (60.0%) patients were ASA class ≥III. Stratified by procedure and underlying neuropathology, 3 (20.0%) patients had undergone a neuro-interventional procedure for vascular pathology, 2 (13.3%) were thoracic spine surgeries for tumours, 2 (13.3%) had ventriculoperitoneal shunt insertions. The remaining 8 (53.4%) patients underwent supratentorial craniotomies, 2 had mild

TBI, 4 had tumours, 1 an abscess and 1 had an undefined surgical indication. Vasopressor or inotropic support was not administered to any of these patients.

Patients having received an intra-operative adrenaline infusion were less frequently extubated. Ten (9.2%) patients who required an intra-operative adrenaline infusion were extubated. The relationship between the number of patients extubated post-emergency versus elective surgery was significant, (X^2 [1] = 51.79, p<0.0001) with 224 (71.1%) patients having undergone elective procedures being extubated immediately post-operatively. The proportion of in-hospital mortality among patients did not differ significantly between those who had elective or emergency surgery (X^2 [1] = 0.182, p=0.6697). In-hospital mortality was higher for patients having cranial surgery 61 (9.0%) compared to spinal surgery 6 (6.4%), but this difference was not statistically significant (X^2 [1] = 0.7307, p=0.3926). The in-hospital mortality for TBI patients was (29) 8.6% and for severe TBI was (24) 15.8%. Severe TBI accounted for 82.3% of all TBI mortality.

Table 4: The post-operative characteristics

Characteristic	Elective (n=315) n (%)	Emergency (n=558) n (%)	Total cases (n=873) n (%)
Extubated post-operatively	224 (71.1)	256 (45.9)	480 (55.0)
Reason for non-extubation			
• Pre-operative GCS	22 (7.0)	151 (27.1)	173 (19.8)
• Intubated pre-operatively	33 (10.5)	129 (23.1)	162 (18.6)
New neurological deficit	9 (2.9)	6 (1.1)	15 (1.7)
Post-operative destination			
• Neurosurgery ward	42 (13.3)	60 (10.5)	102 (11.7)
• High care area	86 (27.3)	131 (23.5)	217 (24.9)
• Intensive care unit (ICU)	187 (59.4)	365 (65.6)	552 (63.2)
• General ward	0 (0.0)	2 (0.4)	2 (0.2)
In-hospital mortality	30 (9.5)	47 (8.4)	77 (8.8)
Discharge location			
• Referring hospital	41 (14.5)	230 (42.5)	271 (34.0)
• Home	210 (73.7)	208 (38.4)	418 (52.5)
• Other	5 (1.6)	1 (0.2)	6 (0.8)
• Unknown	29 (10.2)	72 (13.3)	101 (12.7)

Discussion

CMJAH is a central hospital offering a wide range of secondary, tertiary, and quaternary services. The 1 088-bed hospital serves as a referral hospital for a number of district and regional level hospitals, and for other African countries. The neurosurgical unit has a 20-bed capacity, 12 high care beds and 8 ventilator-equipped ICU beds. Four permanent neurosurgical consultants, a part-time intensivist, and 5 – 8 rotating neurosurgical registrars are based in the unit. One dedicated elective neurosurgical operating theatre functions four working days per week. Three emergency theatres are continuously operational and serve all surgical disciplines, barring obstetric and cardiac surgery.

A survey of the peri-operative care of neurosurgical patients, involving a spectrum of major neuropathology, was not identified in other settings. This limits the comparability of findings in this study with the existing national and international literature.

This study showed a predominance of male patients (71.2%). Of our TBI patients 92.9% were male, in keeping with the literature consistently reporting disproportionately more male TBI patients (7, 16 -18). This likely reflects high-risk behaviour patterns among young males (14, 19).

Emergency procedure rates (63.9%) in this study are similar to those described in the Neurosurgical National Audit Program in the United Kingdom and Ireland (20). For example, at John Radcliffe Hospital, a 61.7% adult emergency neurosurgery rate was reported for a 12-month period in 2018 – 2019 (20). A greater proportion of emergency procedures is expected in this study due to the high prevalence of trauma in South Africa (21). The implications of a higher caseload of emergency surgeries are numerous. Importantly, there is an inherent increased cost to all stakeholders (22), increased surgical and anaesthetic risk, and limited time for pre-operative patient optimisation (23).

This study showed that cranial surgeries were more frequently performed as emergency procedures (75.4%) whereas spinal surgery was more frequently performed electively (91.5%). Similarly, hospitals included in the Neurosurgical National Audit Program mainly perform spinal surgeries as elective procedures (79.1%) (20). In the South African context, the pattern of traumatic injury may explain the findings in this study. Accurate contemporary incidence data is not available, but TBI and traumatic spinal cord injury crude incidence rates of 316 per 100 000 (6) and 75.6 per million (24), respectively, have been reported. The findings of this study support the presumption that proportionately lower emergency spinal surgery numbers reflect a relatively lower incidence of traumatic spinal cord injury compared to TBI at CMJAH.

In this study, cranial surgeries (77.3%) outnumbered spinal surgeries (10.8%). Rock et al. (25) used the American College of Surgeons National Surgical Quality Improvement Program database and reviewed cases performed by neurosurgeons over 10 years. They identified 21.8% were cranial surgeries and 78.2% were spinal surgeries. CMJAH has a dedicated orthopaedic spine unit, these patients do not have neurological involvement and are not captured on the database. However, these omitted surgeries do not account for the large variation in practice

observed. The discrepancy between spinal surgery numbers in this study and those identified by Rock et al. (25) may highlight that degenerative conditions, commonly the indication for spine surgery (26), are not a South African health priority (5).

TBI is an ongoing global health concern (16). In this study, 45.1% of TBI patients had severe TBI. This is similar to the severe TBI operative rates (40.0%) (7) in Pietermaritzburg and higher than the 26.4% reported in an Iceland study (18). The incidence of severe TBI is expected to be higher in low-middle income countries owing to a high occurrence of motor- and pedestrian-vehicle accidents (27), interpersonal violence (28), and war-related conflicts (17) spurred by low-level education (27), high unemployment rates, and cultural tensions (17, 28). Furthermore, TBI patients in low-middle income countries are suspected to have poorer outcomes due to competitive access to scarce pre-hospital, specialist in-hospital, and post-discharge injury care (7, 29, 30). In the South African context, the severe TBI rate shown in this study is concerning. TBI places a high demand on limited resources, including neurorehabilitation (31, 32).

In South Africa, HIV prevalence among the general population is 20.4% (33), however, a lower HIV prevalence of 12.5% was reported in this study. This low number of HIV positive patients in the study does not reflect ICU and high care admission discrimination. Not all neurosurgical patients at CMJAH are routinely tested for HIV. HIV status is either volunteered by the patient, or a test is performed if clinical indication exists. The true prevalence of HIV in this population is likely greater than that shown by the study.

There has been an ongoing debate regarding the superiority of total intravenous anaesthesia (TIVA) compared to a volatile-based anaesthetic technique in neurosurgical patients (34, 35, 36). At CMJAH the predominant technique was intravenous induction (72.1%) and volatile maintenance (61.7%). Possible explanations may be, the anaesthetists' familiarity with volatile-based anaesthesia, cost-containment concerns regarding the use of TIVA for prolonged surgeries, and inconsistent availability of disposables for depth of

anaesthesia monitors. The anaesthetic technique used at CMJAH is in alignment with international practice (34, 36 – 38).

Other areas of controversial practice relate to the use of hypertonic solutions and anti-epileptic drugs. The superiority of either hypertonic saline or mannitol for the treatment of raised intracranial pressure has been questioned (39). Mannitol was the hypertonic solution of choice at CMJAH. Historically mannitol is the available hypertonic agent at CMJAH and there is data to support its use (40, 41). A systematic review showed limited clinical benefit of prophylactic anti-convulsant administration in the prevention of post-craniotomy seizures (42). In TBI patients, there is evidence to support the use of phenytoin (43). In this study, an anti-convulsant, most commonly phenytoin, was administered for seizure prophylaxis in only 4.5% of patients.

Steroid administration is common in the peri-operative care of tumour patients with concurrent cerebral oedema (44). The Brain Trauma Foundation states that steroid administration to TBI patients is harmful and is not recommended (43). In this study, 39.8% of TBI patients were given dexamethasone intra-operatively. This may reflect post-operative nausea and vomiting prophylaxis practices. A randomised control trial has shown the detrimental hyperglycaemic effects of dexamethasone administration at prophylactic doses (45). It is recommended that the department investigates the nature of this practice and institute appropriate measures, including education, to address the problem.

Mortality rates are commonly employed outcome metrics to evaluate the quality of care (4). The in-hospital mortality rate in this study was 8.8%. Stratified by cranial or spinal surgery in this study, the mortality rates were 9.0% and 6.4%, respectively. In this study, the overall TBI mortality was 8.6%, and the mortality for severe TBI was 15.8%. These figures appeared to be lower than the reported mortality rates of 25.8% and 33.4% for Ugandan (19) and Pietermaritzburg (7) TBI studies, respectively. Unexpectedly, in this study, the proportion of in-hospital mortality among patients did not differ significantly between those who had elective or emergency surgery. A higher ASA class among patients presenting for elective neurosurgery may explain this finding.

Survival to discharge or transfer does not delineate which patients survived neurologically intact, with mild deficit or with profound neurological disability. Long term outcomes following discharge would be more elucidating and are recommended for future research. A further limitation was the retrospective acquisition of data and hence the concern of the accuracy of collated data. Additionally, the contextual nature of the sample limits the generalisation of findings.

Conclusion

Databases are being ear-marked as instrumental tools to measure the quality of care delivered to patients (3, 13). At CMJAH the frequent administration of steroids to TBI patients is concerning and a recommendation to further analyse the issue and institute corrective measures has been made. Comparability of mortality rates in this study with that of others is limited by inter-study methodological differences. However, the unexpected mortality finding in this study between elective and emergency cases may be explained by the higher ASA classification of elective patients. This study contributes to the understanding of neurosurgical patient peri-operative care.

Conflict of interest

The authors declare that we have no financial or personal relationships which may have inappropriately influenced us in writing this paper.

Acknowledgement

This research was done in partial fulfilment of a Master of Medicine degree.

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Section 4: Proposal

A survey of adult patients requiring neurosurgery at a central hospital

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4.1 Introduction and problem statement

The Institute of Medicine (1), defines health care quality as “the degree to which health care services for individuals and populations increases the likelihood of desired health outcomes and are consistent with current professional knowledge…”. The field of neurosurgery is a speciality affiliated with high cost and expensive advanced technology (2). There is a need to establish a validated approach to measure the quality of neurosurgical care (3). There has been an increasing focus in the neurosurgical literature to explore suitable surrogate markers of the quality of care received by neurosurgical patients (4).

Electronic databases have emerged as important mechanisms to define, measure and promote health care quality (5-7). Such databases are cost-effective and scalable tools that collect uniform data evaluating specified parameters for a designated population (5). Numerous authors highlight the Society of Thoracic Surgeons (STS) National Database and the National Neurosurgery Quality and Outcomes Database (N^2QOD) as examples of successful clinical registries (5, 6, 8, 9). Importance of collating these data speaks to informing quality improvement initiatives, service delivery restructuring, health service training and benchmarking purposes (10, 11).

By defining the population sub-served, institutions are able to advocate for restructuring of service delivery to meet population needs. St. George’s Hospital, conducted a retrospective audit which highlighted significant definitive treatment delay in up to 75% of good grade sub-arachnoid haemorrhage patients (12). The described finding translated into advocating for inter-neurosurgical unit collaboration between seven London hospitals to reduce treatment delay times (12). Evaluation of bed occupancy characteristics and theatre utilisation times have spurred efficiency improvements in other settings (13, 14).

Furthermore, the profile of neurosurgical patients dictates scope of practise. More than 50% of the patients treated at Shanghai HuaShan Hospital have brain or spinal tumours. This drives a well-developed neuro-oncology subspecialisation program at this institution (15). A preponderance for oncology in developed nations has been noted elsewhere (16). Moreover, a survival benefit is conferred

when surgeries are performed by subspecialists in dedicated institutions (17, 18). Tailored neurosurgical training to local circumstance is well documented (19-21).

Developing nations are privy to a unique pattern of neurosurgical pathologies. Lebanon has a high suspected incidence of traumatic brain injury (TBI) (22). In Africa, a commensurately high TBI incidence rate is expected (23, 24). The distribution of pathology in the paediatric population may be different. Adigun et al. (25) described endoscopic third venticulostomy as the most frequently performed procedure in their setting, followed by meningocoele repair. Paediatric TBI was reported as occurring in 10.5% of the study population (25). This rate is similar to that reported for other African countries (26).

South Africa has a unique quadruple burden of disease profile. This encompasses human immunodeficiency virus and tuberculosis co-infection, other communicable disease, non-communicable disease and trauma (27). Limited literature evaluates the profile of neurosurgical patients in South Africa. A few examples do exist. A pre-democratic 1991 South African study reported an estimated incidence of TBI in Johannesburg of 316 per 100 000 (28). A Red Cross Memorial audit showed a paediatric TBI mortality rate of 14.6% (29). A retrospective description of paediatric ventriculoperitoneal shunt insertions was performed in Kwa-Zulu Natal (30).

In South Africa, the move towards increased emphasis on quality has been reflected in recent reforms. The National Development Plan identifies “quality health care for all” as a key priority for the country (31). Stemming from this, the proposed National Health Insurance plan on universal health coverage acknowledges concerns about the quality of care provided in the public sector and makes clear the intention to invest in quality improvement (32). Directly related to the overarching policy context for quality improvement is the imperative to strengthen quality measurement in South Africa (33).

Providing quality health care is a mandatory pursuit in all settings (2). There is pressure to develop standardised approaches for measuring the quality of care delivered. Neurosurgery is a complex, high risk discipline. Furthermore, a paucity of neurosurgical specific quality indicators exists (4). Databases are fundamental

in validating the appropriateness of existing quality metrics as well as elucidating novel neurosurgical specific quality indicators (5).

Naidoo (33) noted in an editorial, “SA [South Africa] does not have a TBI [traumatic brain injury] databank, and contemporaneous studies on overall incidence and prevalence of TBI are lacking.” He then went on to comment, “SA [South Africa] needs improved and current TBI epidemiological data to develop protocols appropriate to our unique set of conditions…” (33). Data pertaining to all subsets of neurosurgical patients admitted to South African hospitals is demonstrably lacking.

The profile of neurosurgical patients and their theatre utilisation at Charlotte Maxeke Johannesburg Academic Hospital (CMJAH) is not known.

4.2 Aim and objectives

4.2.1 Aim

The aim of this study is to survey adult patients requiring neurosurgery at CMJAH.

4.2.2 Objectives

The objectives of this study are to describe**:**

- the demographics of neurosurgical patients
- the pre-operative neurological assessment
- the intra-operative anaesthetic management
- the post-operative status.

The secondary objective of this study is to compare the mortality and functionality of elective versus emergency patients.

4.3 Research assumptions

The following definitions will be used in this study.

Elective: scheduled procedure of non-urgent indication or not life-threatening nature in which pre-operative preparation is permissible.

Emergency: surgical procedure is performed for an urgent or potentially neurologically devastating or life-threatening indication.

Adult: is a person identified or assumed as 16 years and older.

Database: in this study it refers to the password protected REDCap Neuroanaesthesia Database from which the data entries will be extracted. This database was created prior and independently to the study. Since it has not been created for the purpose of the study all database data collection sheet categories, nomenclature and fields are pre-stipulated and not subject to change. Missing data will be sought from source documents i.e. admission books, anaesthetic records and National Health Laboratory Services (NHLS) records.

Anaesthetic Management: In the study is limited to the description of the intra-operative medication administered including opioids, dexmedetomidine, dexamethasone, vasopressors, inotropes, anti-emetics, anti-epileptics and anti-hypertensives. Induction technique and volatile agent selected for anaesthetic maintenance is additionally noted.

Adequately completed database entries: describes the pre-requisite captured information. The mandatory fields to be completed are: patient pathology, date of neurosurgical intervention, type of procedure performed, whether the procedure was performed electively or as an emergency, pre-operative Glasgow Coma Scale (GCS) and post-operative intubation status.

4.4 Demarcation of study field

The study will be conducted at CMJAH, a 1200 bed central hospital, in the Department of Anaesthesiology affiliated with the University of the Witwatersrand. The hospital has 23 theatres of which one is a dedicated elective neurosurgical theatre and three are emergency theatres sub-serving all surgical, non-obstetric disciplines. On average 23 000 operations are done annually, and that includes approximately 150 neurosurgical cases.

4.5 Ethical considerations

Approval to conduct the study will be obtained from the Human Research Ethics Committee (Medical), the Graduate Studies Committee of the University of the Witwatersrand and the National Health Research Committee of Gauteng. Permission to review the REDCap Neuroanaesthesia Database was granted by the database administrator (Appendix 1). Permission to access source documents has been provided by the Head of Department of Anaesthesiology and Neurosurgical ICU (Appendix 1). Application will be made for an online password to access the REDCap Neuroanaesthesia Database once approval to commence data collection has been granted.

Confidentiality will be ensured as only the researcher and supervisors will have access to the raw data. Patient anonymity will be protected as a list of patient name, hospital number and study number will be generated and this will be filed separately. Only the study number will appear on the Excel spreadsheet to be analysed.

Data captured for cases performed for the period 1 January 2016 up to and including 31 December 2017 will be extracted and an Excel spreadsheet will be created. Date of surgery will be used solely for data extraction purposes and will not be recorded.

Data will be stored securely on a password protected Microsoft Excel spreadsheet for six years after completion of study.

The study will be conducted according to the principles of the Declaration of Helsinki (34) and the South African Guidelines for Good Clinical Practice (35).

4.6 Research methodology

4.6.1 Research design

A retrospective, contextual, descriptive research design will be followed in this study.

A retrospective study dictates a two-dimensional, temporal enquiry between variables, whereby the dependant variable is observed in the present and an attempt is made to link it to an independent variable or event that has already come to pass (36). This study is describing the profile of neurosurgical patients from January 2016 to December 2017.

In a contextual study, a specific study population or sample group of individuals is brought under scrutiny. Such is referred to as a “small-scale world” (37). This study is contextual as it is analysing a specific sub-group of patients presenting to CMJAH.

Descriptive design delineates that the variables under scrutiny are described as they appear. This extends to a description of intervariable relationships but excludes attempts to draw cause-and-effect inferences (38). This study will describe the profile of the neurosurgical cases requiring operative intervention at CMJAH.

4.6.2 Study population

The study population consists of data of patients presenting for neurosurgery at CMJAH operating theatres.

4.6.3 Study sample

Sample size

The sample size will be realised by REDCap Neuroanasthesia Database entries meeting study inclusion criterion. Approximately 150 neurosurgical interventions are performed at CMJAH annually.

Sampling method

In this study a consecutive convenient sampling method will be used. Consecutive sampling is a non-probability sampling method seeking to include all accessible participants as part of the derived sample (36). All REDCap Neuroanasthesia data meeting the inclusion criterion will be included in the study sample.

Inclusion and exclusion criteria

The inclusion criterion for this study is a REDCap Neuroanasthesia Database entry for patients presenting to theatre for neurosurgical intervention from January 2016 to December 2017.

The exclusion criterion for this study is inadequately captured database entries.

4.6.4 Data collection

The data will be extracted from the REDCap Neuroanaesthesia Database in a consecutive manner. Should the data be incomplete, data will be retrieved from source documents i.e. admission books, anaesthetic records and NHLS records. The data captured by the database (Appendix 2) includes:

- patient demographics
- pre-operative neurological assessment
- intra-operative anaesthetic management
- post-operative status.

4.6.5 Data analysis

Data will be captured onto Microsoft Excel spreadsheet. Descriptive and inferential statistics will be used to analyse the data. Categorical variables will be described using frequencies and percentages. Continuous variables will be described using means and standard deviations or medians and inter-quartile ranges, depending on the distribution of the data. Comparisons will be done using Chi-square or Fishers Exact tests. A p-value of <0.05 will be considered statistically significant.

4.7 Significance of the study

Provision of value-based quality health care is a current health imperative. Valid frameworks are needed to realise this end. Clinical registries, such as the REDCap Neuroanaesthesia Database, are being ear-marked as instrumental tools to elucidating, developing and validating key metrics to measure the quality of care delivered. Such data not only serves to drive local quality improvement imperatives but is also used for bench marking purposes.

CMJAH is a central hospital and a principal referral centre for large populous drainage areas. A better understanding of its patient population is mandatory for appropriate resource allocation and teaching purposes. On a national platform, the need for dedicated good quality clinical databases has been expressed (33).

4.8 Validity and reliability of the study

Validity broaches the subject of assurance that measured results are reflective of the true results. In tandem, results are deemed reliable if they are repeatable, consistent and dependable (39).

Steps taken to ensure the validity and reliability of this study include:

- using an appropriate study design
- a single researcher engaging with the data
- analysing data with the assistance of a biostatistician.

4.9 Potential limitations

Retrospective studies are limited by the reliance on the quality of information collected. Clinical registries are only as robust as they are adequately completed. There is an inherent risk of loss of data owing to poor data capturing. The contextual nature of the study limits extrapolation of findings to other settings.

4.10 Project outline

4.10.1 Time frame

Activity	Nov 2017	Dec 2017	Jan 2018	Feb 2018	Mar 2018	Apr 2018	May 2018	Jun 2018	Jul 2018	Aug 2018
Proposal										
Proposal submission										
Ethics & Post Grad approval										
National Health Research Committee										
Data collection										
Data analysis										
Draft article										
Submission										

4.10.2 Budget

The Department of Anaesthesiology will bear the cost of printing and paper.

Item	Number	Cost	Total
Printing	2000	R1/page	R2000
Binding	4	R200	R800
Grand Total			R2800

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4.11 Appendices

Appendix 1: Approvals

30 November 2017

Prof Peter Cleaton-Jones,

Chairman,

Wits Human Research Ethics Committee (Medical).

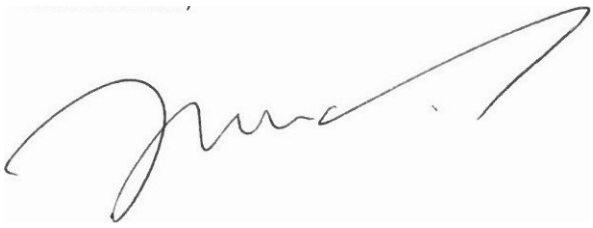
Dear Prof Cleaton-jones,

Re: Request for permission to access Neuroanaesthesia Redcap Database.

The purpose of this letter is to grant Dr Laura Indiveri permission to access the Neuroanaesthesia Redcap Database for the purpose of the research project titled: "A survey of adult patients requiring neurosurgery at a central hospital". This permission is valid for three years from the date of this letter and is subject to all the conditions set by the Wits Human Research Ethics Committee (Medical) and all the necessary approvals from the various authorities.

With kind regards

Yours sincerely



Dr Alastair W. Moodley

MBChB(Natal) DA(SA) FCA(SA)
Specialist Anaesthetist

Department of Anaesthesia
Charlotte Maxeke Johannesburg Academic Hospital/
University of the Witwatersrand
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DEPARTMENT OF ANAESTHESIA
Charlotte Maxeke Johannesburg Academic Hospital
University of the Witwatersrand
Tel: 011 488 4344
Fax: 011 488 4343

30 November 2017

Dr Laura Indiveri
Registrar: Department of Anaesthesiology
University of the Witwatersrand

Dear Dr Indiveri
RE: PERMISSION TO COLLECT DATA FOR MMED STUDY

Your request for permission to collect data for an M Med study refers.
Approval is granted to collect data for your study titled: “A survey of adult patients requiring neurosurgery at a central hospital”. This approval is subject to gaining the necessary clearances, e.g. ethical, etc.
I am looking forward to the results of your study.

Yours sincerely,



Prof EE Oosthuizen
Clinical Head: Department of Anaesthesia
Charlotte Maxeke Johannesburg Academic Hospital



CHARLOTTE MAXEKE JOHANNESBURG ACADEMIC HOSPITAL.
Department of Anaesthesia.

Section: Neurosurgical ICU and High Care Unit

To: Research Protocols Committee
University of the Witwatersrand

Dear Chair and Members of the Research Committee, Re: Research plans, Dr Laura Indiveri.

Dr Laura Indiveri has requested permission to review the clinical records of patients admitted to the Neurosurgical ICU and High Care Units.

Dr Indiveri's intention is to obtain information regarding patient demographics, admission diagnoses, clinical course, and outcome of care including that of morbidity and mortality for the purpose of research.

I have no objection to Dr Indiveri undertaking a review of the records of patients admitted to the Neurosurgical ICU and High Care Units for the purpose of the intended research.

Yours faithfully



Colin Clinton MBBCH, FFA(SA)(Critical Care)

Colin Clinton MBBCH,
Consultant Intensivist,
Neurosurgical ICU and Department of Anaesthesia
Charlotte Maxeke Johannesburg Academic Hospital

011 488 4343

Appendix 2: Neuroanasthesia database data collection sheet

Age	_____
Gender	◯ Female ◯ Male
ASA	◯ 1 ◯ 2 ◯ 3 ◯ 4 ◯ 5
Elective or emergency	◯ Elective ◯ Emergency
Is this a repeat procedure during this patient's current admission?	◯ Yes ◯ No
Type of neurosurgical procedure	◯ Cranial ◯ Spinal
Type of cranial procedure	◯ Supratentorial craniotomy ◯ Infratentorial craniotomy ◯ Cranioplasty ◯ Transphenoidal ◯ EVD ◯ VP Shunt ◯ Endoscopic 3rd Ventriculostomy
Type of Spinal procedure	◯ Cervical ◯ Thoracic ◯ Lumbar ◯ Myelo/meningocoele
Most likely pathology	◯ Congenital ◯ Tumour ◯ Infective ◯ Vascular ◯ Trauma
Neurosurgical consultant	_____
Neurosurgical registrar/ medical officer	_____
Anaesthesia consultant	_____
Anaesthesia registrar/ medical officer	_____
Surgery start time	_____
Surgery end time	_____
Anaesthetic start time	_____
Anaesthetic end time	_____

NEUROLOGICAL ASSESSMENT

Glasgow Coma Scale

◯ 1
◯ 2
◯ 3
◯ 4
◯ 5
◯ 6
◯ 7
◯ 8
◯ 9
◯ 10
◯ 11
◯ 12
◯ 13
◯ 14
◯ 15
(If patient intubated, what is the score out of 10?)

Motor Deficit

☐ Right Upper Limb
☐ Left Upper Limb
☐ Right Lower Limb
☐ Left Lower Limb
☐ None

Sensory Deficit

☐ Right Upper Limb
☐ Left Upper Limb
☐ Right Lower Limb
☐ Left Lower Limb
☐ None

Cranial Nerve Palsy

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐ 11 ☐ 12 ☐ None

Pupils equal ? ◯ Yes ◯ No

Speech deficit eg. aphasia, dysphasia

◯ Yes
◯ No

PRESENTING SYMPTOMS (even if they have resolved by the time of anaesthetic assessment)

Headache ◯ Yes ◯ No

Nausea/Vomiting ◯ Yes ◯ No

Seizures ◯ Yes ◯ No

CO-MORBIDITIES

CARDIOVASCULAR

☐ Hypertension
☐ Valvular heart disease
☐ Prev/current CCF
☐ Hypotension (systolic < 90 mmHg)
☐ Arrythmia (including Atrial Fibrillation)
☐ Coronary artery disease
☐ Other
☐ None

RESPIRATORY

- ☐ Asthma
- ☐ COPD
- ☐ Pneumonia
- ☐ Restrictive lung disease
- ☐ Smoker
- ☐ Other
- ☐ None

ENDOCRINE

- ☐ Diabetes mellitus
- ☐ HypERthyroidism
- ☐ Cushings Syndrome
- ☐ HypOthyroidism
- ☐ Adrenal insufficiency
- ☐ Acromegaly
- ☐ Diabetes INSIPDUS
- ☐ SIADH
- ☐ Other
- ☐ None

RENAL

- ☐ Acute kidney injury
- ☐ Chronic renal failure
- ☐ Other
- ☐ None

KNOWN LIVER DYSFUNCTION ◯ Yes ◯ No

HIV STATUS ◯ Positive ◯ Negative ◯ Unknown

INVESTIGATIONS

Haemoglobin g/dl _____

White cell count (___x10^9 cells/L) _____

Platelet count (___ x10^9 cells/L) _____

INR _____

Sodium _____

Potassium _____

Chloride _____

CO2 _____

Urea _____

Creatinine _____

Glucose _____

CT / MRI Scan

- ☐ Mass
- ☐ Hydrocephalus
- ☐ Cerebral oedema
- ☐ Midline shift
- ☐ Obliteration of basal cisterns
- ☐ Effacement of ventricles
- ☐ Subarachnoid haemorrhage
- ☐ Extradural haemorrhage
- ☐ Subdural haemorrhage
- ☐ Other
- ☐ Scan not seen

ECG	☐ Normal ECG ☐ AF ☐ Atrial ectopics ☐ Ventricular ectopics ☐ LVH ☐ LBBB ☐ RBBB ☐ T wave abnormal ☐ Tachy>100 ☐ Brady< 60 ☐ ST elevation 1mm or more ☐ ST depression 1mm or more ☐ Non-specific ST changes ☐ Prolonged QT > 410 ms/Shortened QT ☐ widened QRS > 100ms ☐ ECG not seen
Chest X-Ray	☐ no abnormalities ☐ hyperinflation ☐ mass ☐ opacities or infiltrates ☐ effusion ☐ pneumothorax ☐ cardiomegaly ☐ bone pathology ☐ CXR not seen

INTRAOPERATIVE

Monitors	☐ Standard ASA monitors (ECG, sats, NIBP, ETCO2) ☐ Asleep arterial line ☐ Awake arterial line ☐ CVP ☐ Ultrasound used ☐ Cardiac output monitor ☐ Evoked potentials ☐ Other

AIRWAY

Easy airway ?

- ◯ Yes
- ◯ No
- ◯ ETT already in situ

Mallampatti

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4

Number of attempts to intubate

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ >3

Airway adjuncts used :

- ☐ None
- ☐ Introducer
- ☐ Bougie
- ☐ LMA
- ☐ Fibreoptic bronchoscope
- ☐ Videolaryngoscope
- ☐ Other

ANAESTHETIC MANAGEMENT

Induction

◯ Intravenous
◯ Inhalational
◯ Combination

Maintenance

◯ Sevoflurane
◯ Isoflurane
◯ Desflurane
◯ Propofol + Volatile
◯ Propofol TIVA

Opioids

☐ Morphine ☐ Fentanyl ☐ Sufentanil ☐ Alfentanil (Rapifen) ☐ Remifentanil

Dexmedetomidine (Precedex) ◯ Yes ◯ No

Inotropes or vasopressors used :

☐ Phenylephrine infusion
☐ Adrenaline infusion
☐ Phenyl boluses as required
☐ Ephedrine boluses as required
☐ Adrenaline boluses as required
☐ Other
☐ None

Mannitol 20% (mls) _____

Dexamethasone ◯ Yes ◯ No

Anticonvulsants given intraoperatively :

☐ None
☐ Phenytoin (Epanutin)
☐ Valproate (Epilim)
☐ Other

Antiemetics

☐ None
☐ Metaclopromide
☐ 5 HT3 antagonists (ondansetron, granisetron)
☐ prochlorperazine (Stemetil)
☐ droperidol (Inapsin)

Antihypertensives used intra/postoperatively

☐ None
☐ Labetalol
☐ Brevibloc (esmolol)
☐ TNT
☐ Other

SURGICAL FACTORS

Brain relaxation score

◯ Completely relaxed
◯ Satisfactorily relaxed
◯ Firm
◯ Bulging
(Ask surgeon to assess upon opening)

Estimated blood loss (mls) _____

Number of units of Packed Red Cells _____

Number of units of FFP _____

Number of mega units platlets _____

Temperature at skin closure _____

Urine output (mls) _____

POSTOPERATIVE

Extubated in theatre ?
- ◯ Yes
- ◯ No

If not extubated, what was the reason for non-extubation ?
- ◯ 1. Preoperative altered consciousness
- ◯ 2. Hypertension (SBP >160 mmHg)
- ◯ 3. Large tumour resection with midline shift
- ◯ 4. Hypotension±hypovolemia
- ◯ 5. Long surgery (>6 h)
- ◯ 6. Haematocrit < 25%
- ◯ 7. Intraoperative brain swelling
- ◯ 8. Acidosis
- ◯ 9. Hypoxia or hypercapnia
- ◯ 10. Injury to cranial nerves (IX, X, XII)
- ◯ 11. Ineffective spontaneous ventilation
- ◯ 12. Convulsions during emergence
- ◯ 13. Hypoosmolality (5280 mOsmol/kg)
- ◯ 14. Disorders of coagulation
- ◯ 15. Residual neuromuscular blockade

Did the patient have any new neurological deficit or worsening of deficits ?
- ◯ Yes
- ◯ No

Post operatively the patient was sent to :
- ◯ ward
- ◯ high care
- ◯ ICU
- ◯ Other

Outcome
- ◯ Discharged
- ◯ Demised

If discharged, please indicate

Discharge disposition
- ◯ Home
- ◯ Rehabilitation centre
- ◯ Permanent Care Facility
- ◯ Other
- ◯ Unknown

Section 5: Annexures

5.1 Ethics approval

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

R14/49 Dr Laura Indiveri

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M180130

NAME: (Principal Investigator)	Dr Laura Indiveri
DEPARTMENT:	Anaesthesiology Charlotte Maxeke Johannesburg Academic Hospital
PROJECT TITLE:	A survey of adult patients requiring neurosurgery at a central hospital
DATE CONSIDERED:	26/01/2018
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Helen Perrie and Juan Scribante
APPROVED BY:	Prof C Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	02/07/2018

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary in Room 301, Third floor, Faculty of Health Sciences, Phillip Tobias Building, 29 Princess of Wales Terrace, Parktown, 2193, University of the Witwatersrand. I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report**. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. In this case, the study was initially reviewed in January and will therefore be due in the month of January each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature — Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

5.2 Graduate Studies Committee approval

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

Private Bag 3 Wits, 2050
Fax: 027117172119
Tel: 02711 7172076

Reference: Mrs Sandra Benn
E-mail: sandra.benn@wits.ac.za

26 April 2018
Person No: 0401539N
PAG

Dr L Indiveri
25 Leeds Road
Ferryvale
1491
South Africa

Dear Dr Indiveri

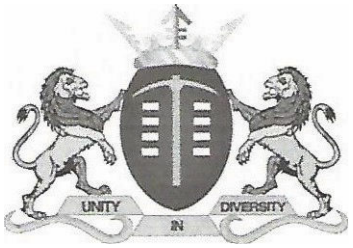
Master of Medicine: Approval of Title

We have pleasure in advising that your proposal entitled ***A survey of adult patients requiring neurosurgery at a central hospital*** has been approved. Please note that any amendments to this title have to be endorsed by the Faculty's higher degrees committee and formally approved.

Yours sincerely

Mrs Sandra Benn
Faculty Registrar
Faculty of Health Sciences

5.3 CEO approval



GAUTENG PROVINCE

HEALTH REPUBLIC OF SOUTH AFRICA

CHARLOTTE MAXEKE JOHANNESBURG ACADEMIC HOSPITAL

Enquiries:

Ms. N. Mzila

Office of the Clinical Director

Email:Nolwazi.Mzila@)gauteng.gov.za

Tell:)11): 488-4812

20 March
2018

Dear Dr. L. Indiveri

STUDY TITTLE: A Survey of Adult Patients Requiring Neurosurgery at a Central Hospital

Permission to conduct the above mentioned study is provisional approved. Your study can only commence once Ethics approval is obtained. Please forward a copy of your Ethics Clearance Certificate as soon as the study is approved by the Ethics Committee for the CEO's office to give you the final approval to conduct the study.

Supported ~~not supported~~

pp

Dr. M.I. Mofokeng
Clinical Director
DATE: 22/03/2018

5.4 Turnitin report

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG | FACULTY OF HEALTH SCIENCES

31st March, 2021

The Chairperson
Graduate Studies Committee
Faculty of Health Sciences
University of the Witwatersrand

Dear Madam,

Re: M Med: **A survey of adult patients requiring neurosurgery at a central hospital**

Dr Laura Indiveri, student number: 0401539N, has submitted her research report to Turnitin which revealed a similarity index of 15%. These similarities appear not to be plagiarism but mainly the use of common terminology and phrases specific to the topic of the research.

Yours sincerely,

Helen Perrie
Supervisor

1

0401539n:Research_report_v1.docx

ORIGINALITY REPORT

15%	10%	12%	2%
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