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ORIGINAL RESEARCH

The utilisation of the post-anaesthesia high-care unit at Tygerberg Hospital: a retrospective audit

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Background: The post-anaesthesia high-care unit (PAHCU) at Tygerberg Hospital is a short-stay high-care unit that provides continuous monitored care to patients identified preoperatively as having an elevated risk for postoperative complications. This study aims to describe the patient population, utilisation, and functionality of this unit and to investigate the correlation between patient comorbidities, surgery type, and risk of exceeding a 24-hour stay.

Methods: This is a retrospective, single-centre descriptive study of 1 020 patients' data admitted to the PAHCU from 1 January 2019 to 31 December 2020. All patients admitted were included. The primary outcome was the utilisation and functionality of the unit. Secondary outcomes were the indication for admission, modes of analgesia used, and length of stay.

Results: Of the 1 020 patients, 69 (6.76%) patients exceeded the 24-hour stay. In total, 889 (87.2%) were pre-planned admissions and 130 (12.8%) unplanned, one (0.09%) patient demised, and 11 (1.07%) patients were transferred to the ICU for further management. Bed occupancy during weekdays was 86.8% in 2019 and 58.13% in 2020. Patients with aortic stenosis had 4.36 (95% CI 1.23–15.41, $p = 0.022$) times the odds of exceeding a 24-hour PAHCU stay. Additional significant factors included ages < 40 ($p = 0.01$) and > 61 ($p = 0.006$), admission for epidural care ($p = 0.015$), haemodynamic monitoring ($p < 0.001$), and patients who were admitted from the general surgery department ($p = 0.014$).

Conclusion: PAHCU admissions are considered appropriate due to the low mortality rate, ICU transfer rate, and the number of patients exceeding a 24-hour stay. With a bed occupancy of 86.80% in 2019, the management of the unit can be considered effective.

Keywords: post-anaesthesia high-care unit, postoperative care

Introduction

The post-anaesthesia high-care unit (PAHCU) is a high-care unit linked to a theatre complex and is equipped to provide level 1 and 2 care, ideally for less than 24 hours. Care is provided by trained nursing staff and anaesthesiologists, with preferably a 1:2 nurse-to-patient ratio.[1,2] This care can include continuous cardiac and haemodynamic monitoring, non-invasive ventilation, inotropic or vasopressor support as needed, and optimising postoperative analgesia with intravenous opioids, analgesic infusions and epidural catheters. Additionally, this unit aids the implementation of enhanced recovery programmes.[3]

In the South African setting, critical care beds are in great demand due to the high burden of trauma and sepsis.[4] A descriptive study conducted in 2008 highlighted that the majority of critical care beds are in the private sector. In the Western Cape, only 18.8% of the total critical care bed count was in the public sector.[5] The South African Surgical Outcomes Study (SASOS) conducted in 2014 noted that even though patients admitted to the intensive care unit (ICU) (both planned and unplanned) postoperatively had high sequential organ failure assessment (SOFA) scores, the incidence of mechanical ventilation was low, suggesting patients were mainly admitted for continuous monitoring and cardiovascular support.[4] The incorporation of short-stay high-care units for elective patients that do not require invasive ventilation, multi-organ support, or are not anticipated to require admission for longer than 48 hours, may reduce the burden on critical care units in South Africa and specifically in the Western Cape.

The PAHCU at Tygerberg Hospital primarily admits patients after elective surgery but serves unplanned and emergency cases too. It was established to improve postoperative patient care and reduce the number of elective cases cancelled due to limited ICU bed availability. The PAHCU was originally designed as a two-bed unit but expanded to a four-bed unit in March 2020. These beds are equipped with continuous cardiac monitoring, plethysmography, invasive haemodynamic monitoring, and a ventilator should patients require non-invasive or invasive ventilation. Additionally, nasal high-flow oxygen is available if needed.

A doctor, namely the specialist anaesthesiologist on call, or the senior registrar anaesthesiologist on the floor is available 24 hours per day. The unit is staffed with one nurse trained in critical care, supported by a professional nurse and staff nurse to provide 1:2 nurse-to-patient care. Nurses are also trained in the management of epidural catheters. This allows the unit to implement modes of analgesia that may include continuous epidural analgesia, lignocaine analgesic infusions, and parenteral opioids. At Tygerberg Hospital, management of these modalities is not currently accepted in the general ward due to the lack of an acute pain service, high patient-to-nurse ratios, and a

lack of trained staff and equipment to monitor the potential complications associated with these modalities.

Patients at high risk of complications, due to comorbidities and/or type of surgery planned, are identified at the preoperative visit with the assistance of risk stratification tools, such as the American Society of Anesthesiologists (ASA) physical status classification, Lee's revised cardiac risk index, frailty scores, STOP-Bang score, and the NSQIP risk calculator.[6] Patients that may need invasive ventilation or a prolonged stay due to comorbidities or the surgery planned are postoperatively referred to the ICU.

Bookings at the PAHCU are made preoperatively, stating a brief patient history and indication for admission. Patients can have more than one indication for admission noted on the admission form. Bookings may exceed the number of beds available on the day. The specialist anaesthesiologist on-call on the day of surgery allocates the four beds according to need. Admissions are mostly based on the patient's risk, as well as the need for analgesia not available in the general ward, such as intravenous analgesia or an epidural. The unit does not have a fixed set of admission criteria but rather depends on the anaesthesiologist's preoperative assessment. Exclusion criteria for the PAHCU include children under the age of five years, the expected need for ventilation postoperatively, and whether the expected stay would exceed 48 hours. Due to the high demand for postoperative care, patient stay is usually less than 24 hours.

This study aimed to describe the patient population, utilisation, and functionality of the PAHCU and to investigate the correlation between patient comorbidities, surgery type, and risk of exceeding a 24-hour stay. The indication for admission, modes of analgesia used, and the need for escalation of care to the ICU was also described.

Methods

A retrospective, single-centre descriptive study was conducted and the records of all 1 020 patients admitted to the PAHCU from 1 January 2019 to 31 December 2020 were reviewed. No patient records were excluded. The study was conducted at Tygerberg Hospital, a tertiary-level hospital located in the Cape Town Metropolitan area. It serves a population of 3.4 million and is a referral centre for several secondary hospitals. The hospital has 1 384 beds as well as 164 ICU and high-care beds.[7] The PAHCU is located within the theatre complex and is separate from the ICU of the hospital.

Paper record copies were reviewed and cross-referenced with the hospital's electronic recordkeeping database and electronic spreadsheets which recorded the duration of stay of each patient. This data was captured into an Excel spreadsheet on a password-protected computer. Each patient received a study number and data was reported anonymously. The data was used to assess the utilisation and efficiency of the unit, as well as the indication for admission to the PACHU, modes of analgesia used, and length of stay. A length of stay exceeding 24 hours was considered a complication.

Approval to conduct the research was obtained from the local institutional ethics committee, the Department of Anaesthesia and Tygerberg Hospital. A waiver of consent was granted by relevant ethics and hospital committees (HREC number X20/10/036).

Statistical analysis

Data was analysed using Stata 16 BE (Basic Edition). Descriptive statistics such as frequencies, percentages, means, and standard deviations (SDs) were used to summarise the data. Graphical displays such as histograms, boxplots, and locally weighted scatterplot smoothing (LOWESS) were used to represent the data. For categorical variables, the chi-square test was used to test for associations.

A binomial logistic regression model was developed to assess which specific factors contributed to the risk of exceeding a 24-hour stay in the PAHCU. The measure of risk estimated in the model was the odds ratio (OR) with 95% confidence intervals (CIs). Specific risk factors included age, ASA physical status classification, specific comorbidities (diabetes, ischaemic heart disease [IHD], and aortic stenosis), surgical department, and mode of analgesia.

Results

A total of 1 020 patients were admitted to the PAHCU during the study period. The average age at admission was 57.54 (SD 16.93). The youngest patient was six years old and the oldest was 100 years old. The most common comorbid conditions were hypertension (56.67%), followed by diabetes (20%), and IHD (18.72%) (Table I). Of the patients, 56 (5.63%) were classified as ASA I, which meant they had no known comorbidities. The majority of patients were classified as ASA II (43.4%) and III (46.52%) (Table II).

Table I: Patient comorbidities

Comorbidities	*n*	%
Hypertension	578	56.67
Diabetes	205	20
Ischaemic heart disease (IHD)	191	18.72
Smoker	136	13.33
Chronic obstructive pulmonary disease (COPD)	94	9.22
Obstructive sleep apnoea (OSA)	73	7.16
Pulmonary tuberculosis	46	4.51
Atrial fibrillation	43	4.21
Aortic stenosis	17	1.66

Table II: ASA classification distribution

ASA	*n*	%
I	56	5.63
II	431	43.4
III	462	46.52
IV	43	4.33
V	1	0.1

Approximately 30% of surgical procedures were orthopaedic, which included hip, knee, femur, and spinal surgery; 13.23% of procedures were gynaecological; and 7.84% were colorectal procedures (Table III). A total of four (0.4%) patients had no procedure documented on the admission form.

Table III: Surgical department distribution

Type of surgery	*n*	%
Orthopaedic surgery	289	28.33
General surgery (including upper-abdominal surgery)	143	14.02
Gynaecology	136	13.23
Urology	107	10.49
Ear, nose and throat	104	10.2
Colorectal	80	7.84
Vascular surgery	59	5.78
Breast and endocrine	47	4.61
Hepatobiliary	17	1.67
Plastic surgery	16	1.57
Trauma surgery	10	0.98
Ophthalmology	5	0.49
Paediatric surgery	1	0.1
Maxillofacial	2	0.2
Procedures not documented	4	0.4

The most common indication for admission to the PAHCU was the need for analgesia not available in the general ward (Table IV).

Table IV: Admission indications

Indication	*n*	%
Analgesia	691	67.74
Haemodynamic monitoring	326	31.96
Cardiac monitoring	85	8.33
Airway monitoring	67	6.57
Flap care	54	5.29
CPAP	41	4.01
Neuro-observation	35	3.43
Calcium monitoring	4	0.39

The majority, 790 (77.45%) patients, received intravenous analgesia, while 385 (37.75%) patients had an epidural sited (Table V). Epidural/intrathecal morphine was given to 118 (11.56%) patients.

Table V: Modes of analgesia used in the PAHCU

Analgesia	*n*	%
Intravenous analgesia	790	77.45
Epidural	385	37.75
Intrathecal morphine	118	11.56
Lignocaine infusion	75	7.35
PCA	52	5.1

The bed occupancy rate was 86.8% during weekdays and 17.3% over weekends in 2019, compared to 58.13% during weekdays and 15.44% over weekends in 2020. There were 889 (87.2%) planned admissions and 130 (12.8%) unplanned admissions, either after emergency surgery or unanticipated complications during elective surgery. Of the unplanned admissions, 43 (33.08%) were in 2019 and 87 (66.92%) were in 2020.

The mean duration of stay in PAHCU was 17.85 hours with a maximum stay of 63 hours (SD 8.105). The 24-hour stay was exceeded by 69 (6.76%) patients. Invasive ventilation was required for nine patients (0.88%), however, four of these patients were successfully extubated in the PAHCU. When invasive ventilation is required for a patient in the PAHCU, the unit converts to a three-bed unit so one nurse may be dedicated to the patient's care. Escalation of care to the ICU was needed for 11 (1.07%) patients. During the study period adverse events were documented as follows: one (0.09%) patient demised, three (0.29%) had to return to theatre for emergency surgery, one (0.09%) patient was admitted preoperatively for heart rate control, and four (0.39%) patients were admitted for post-cardiac arrest care after they suffered a cardiac arrest intraoperatively.

Moderate to severe or symptomatic aortic stenosis was identified as the variable with the greatest OR for increased length of stay in the PAHCU (Table VI). There was a bimodal distribution found between age and increased length of stay, with more patients < 40 and > 61 requiring prolonged observation compared to the group aged 40–60. Patients admitted for haemodynamic monitoring and patients that had an epidural placed for analgesia also exhibited an increased length of stay. Lastly, those patients presenting for a general surgery procedure were more likely to exceed a 24-hour stay.

Table VI: Factors contributing to exceeding a 24-hour stay in the PAHCU

	Odds ratio* (95% CI)	*p*-value
Age		
< 40	3.08 (1.29–7.29)	0.01
> 61	2.68 (1.33–5.41)	0.006
ASA classification (II,III)	1.11 (0.74–1.66)	0.61
Patient comorbidities		
Diabetes	0.53 (0.24–1.12)	0.01
Ischaemic heart disease	1.48 (0.78–2.8)	0.23
Aortic stenosis	4.36 (1.23–15.41)	0.022
General surgery procedure	2.26 (1.18–4.31)	0.014
Indication for admission		
Haemodynamic monitoring	2.80 (1.64–4.79)	< 0.001
Epidural care	1.93 (1.136–3.28)	0.015

Discussion

The findings of this study confirm that the PAHCU at Tygerberg Hospital is being utilised effectively and that admissions are appropriate. The PAHCU fulfils its intended use as a short-stay high-care unit. This is evidenced by the occupancy rate, low

transfer rate to the ICU, and a shorter than 24-hour stay in the majority of cases.

The cost of an overnight admission to PAHCU is estimated at approximately R675–R5 450, depending on the patient's admission classification according to the hospital's financial department. In comparison, an overnight ICU admission can range from R1 065 to R11 546. Therefore it is reasonable to assume that the PAHCU can improve cost-effectiveness, if utilised correctly, by relieving the pressure of elective admissions to the ICU and opening ICU beds for patients that require the support of multiple organ systems.[8-10]

The bed occupancy in 2019 was 86.8% during weekdays. According to Van Tunen and colleagues, a bed occupancy rate of 85% was deemed to be cost-effective and efficient in their tertiary referral hospital.[11] As no elective surgery is performed over weekends, admissions are decreased. The bed occupancy decreased to 58.13% on weekdays in 2020. A possible explanation for this is the COVID-19 pandemic with the de-escalation of elective theatre services and redeployment of nursing staff during the first and second waves. Nursing staff availability most likely had a limiting effect on the number of admissions.

Unplanned admissions should ideally be kept below 5%.[12] A total of 889 (87.2%) patients were planned admissions after elective surgery and 130 (12.8%) unplanned, either due to complications during elective surgery or after emergency surgery. In 2019 there were 43 (33.08%) unplanned admissions, compared to 87 (66.92%) in 2020. Of these unplanned admissions, 31% were over weekends when staff was available. During the COVID-19 pandemic, the PAHCU also served non-COVID-19 surgical patients requiring high care or invasive ventilation when staff was available, due to the increased demand for ventilated beds for COVID-19-positive patients.

The majority of patients admitted to the PAHCU were over 50 years old, which correlates with the study Crosby and colleagues conducted in their high-care unit.[13] The patients under the age of 40 years that exceeded a 24-hour stay were documented to have significant trauma, the presence of an autoimmune disease like Crohn's disease, or cancer, which may explain the bimodal distribution of the risk of exceedance and age. Paediatric patients are preferably admitted to the paediatric surgical ward or paediatric ICU due to the availability of trained staff and equipment. Exceptions are made to accommodate children older than five years, so surgery is not delayed.

Approximately 46% of patients admitted to the PAHCU were classified as ASA III. Even though reported mortality varies widely (7.5–25.9%) for patients receiving this classification, it is well established that both elderly and ASA III patients are at a higher risk for postoperative complications, which makes admission of these patients appropriate.[14,15] Only 4.33% of patients admitted were classified as ASA IV, and 0.1% as ASA V. As this unit is aimed at transient care and these patients are likely to require the support of multiple organ systems and care for longer than 24 hours, ICU admission may be more appropriate. However, the number of these patients is low, therefore risk stratification and admissions to the PAHCU seem appropriate.

Analgesia was the main indication for admission (67.74%), followed by the need for invasive haemodynamic monitoring (31.96%).[10] Of the patients admitted, 385 (37.75%) had an epidural and 118 (11.56%) received neuraxial opioids. As 40.8% of patients admitted had major intra-abdominal surgery (which included gynaecological, upper-abdominal, colorectal, vascular, and urological surgery) the epidural rate seems appropriate. It is well established that inadequate postoperative pain control increases patient morbidity, duration of hospital stay, readmission rates, and healthcare costs.[16,17] Armstrong and colleagues reported higher levels of patient satisfaction and improved postoperative pain scores after opening a surgical high-care unit at their hospital.[18]

At Tygerberg Hospital, patients do not receive intravenous opioids, analgesic infusions or epidural care in the general surgical ward. This is due to a large patient-to-nurse ratio, and a lack of appropriately trained staff and equipment to monitor for complications associated with these modes of analgesia, such as local anaesthetic systemic toxicity and respiratory depression. As a result, this remains one of the main functions of the PAHCU.

The majority of patients could be discharged in less than 24 hours. The reasons for delayed discharge were arterial hypotension requiring vasopressor support and fluid or blood administration, continued bleeding postoperatively that required monitoring, and new onset dysrhythmias needing further interventions. A total of eight patients that had epidurals stayed longer than 24 hours to receive maximal benefit from the epidural, when a bed and staff were available, in an attempt to implement ERAS principles in a resource-limited setting.[3,19]

Statistically significant associations with the risk of exceeding a 24-hour stay were observed in the population diagnosed with moderate to severe or symptomatic aortic stenosis, patients admitted for haemodynamic monitoring, and patients admitted for epidural analgesia. Patients aged over 60 had a higher association with a prolonged PAHCU stay. Kone and colleagues found that epidural analgesia increased the length of hospital stay by approximately half a day in patients that received open hepatic and pancreatic surgery.[20] Of the 68 patients that exceeded a 24-hour stay, 16 (23.52%) were admitted from the general surgery department. Of these 16, 14 patients had open abdominal procedures. Howes and colleagues showed that an average length of hospital stay ranged from 12 to 17 days after open abdominal surgery.[21] Dickinson and colleagues showed that for patients undergoing foregut and open procedures, the length of hospital stay was four days compared to two days for patients receiving laparoscopic surgery.[22] The fact that patients admitted from the general surgery department, which included upper-abdominal surgery, are more likely to have an open laparotomy could be a possible reason why these patients showed increased odds for a prolonged stay.

Elderly patients tend to have more comorbidities and frailty, consequently, the risk of perioperative complications can be higher.[15] Patients older than 61, those with moderate to severe or symptomatic aortic stenosis, and patients admitted for haemodynamic monitoring were identified to potentially have a higher risk for increased length of stay. Future careful review and optimisation of these patients, both preoperatively and in the PAHCU, will be prudent. Future studies are required to assess whether these patients would benefit from an extended stay in the PAHCU versus ICU admission, in which case the PAHCU may need more beds to accommodate patients that need to stay for longer than 24 hours.

Invasive ventilation was needed in nine (0.88%) patients due to complications intraoperatively or in the recovery room. Intubated patients were admitted to the PAHCU if ICU beds were unavailable, or if the patient did not meet the criteria for ICU admission at Tygerberg Hospital. As mentioned earlier, the PAHCU also served COVID-19-negative surgical patients requiring high care/ICU care during the pandemic due to the high demand for ICU beds. However, to accommodate an intubated patient, the unit has to de-escalate to a three-bed unit so one nurse may be dedicated to the patient's care. Keeping the number of patients requiring invasive ventilation low is important, as this limits the number of patients the unit can accommodate. ICU transfer for escalation of therapy was needed for 11 (1.07%) patients. During the study period, one (0.09%) patient demised, which is fewer than the 1.9% reported by Crosby and colleagues.[13]

Study limitations

As this is a retrospective study, the data was dependent on the integrity of the paper records. As all the records were kept in a single file, locked in a cabinet in the PAHCU, the chance of missing records was low. The collected data was cross-referenced with the hospital's electronic recordkeeping database to minimise possible missing data.

This was a single-centre study of a unit created to accommodate the specific hospital's needs. There are limited publications on the utilisation of a PAHCU both nationally and internationally, so extrapolation to other hospital settings may not be feasible.

The COVID-19 pandemic, which started in March 2020 and affected the performance of elective surgery during the first and second waves, may have had a confounding effect on the results. Another possible limitation on bed occupancy was the availability of nursing staff, which was not included in this study.

Despite these limitations, the study highlights the utilisation of the PAHCU at Tygerberg Hospital. Due to the low mortality rate, and the number of patients that required ICU transfer or a stay longer than 24 hours, the admissions to this unit were deemed appropriate.

Conclusion

In a resource-limited setting, a PAHCU that can provide monitoring, care, and multimodal analgesia to appropriately selected patients at high risk of complications can potentially be a cost-effective alternative to ICU admission. At Tygerberg Hospital, the PAHCU aids in the flow of elective cases and reduces the burden on the ICU. The utilisation appears appropriate as the mortality rate, ICU transfer rate, and number of patients exceeding a 24-hour stay were low. Efficiency and utilisation were affected in 2020 by the COVID-19 pandemic. However, the bed occupancy rate in 2019 confirms that the unit was utilised appropriately before the pandemic.

Conflict of interest

The authors declare no conflict of interest.

Funding source

No funding was required.

Ethical approval

The study was reviewed by the Human Ethical Research Committee (HREC) at Stellenbosch University (HREC Reference Number X20/10/036). The need for informed consent was waivered, as data was collected retrospectively. Approval for data capturing was obtained from the Institutional Research and Planning (Department of Anaesthesia) and Tygerberg Hospital management.

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