South Afr J Anaesth Analg. 2025;31(3):67-71
https://doi.org/10.36303/SAJAA.3181

South Afr J Anaesth Analg
ISSN 2220-1181 EISSN 2220-1173

ORIGINAL RESEARCH

An investigation into the utilisation of available emergency theatre time at a tertiary academy hospital in South Africa

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Background: The rising global health burden from non-communicable diseases and injuries requires effective surgical care. South Africa struggles with this due to resource limitations. Efficiently managed theatres provide financial benefits, improve operational efficiency, boost staff morale, and ensure high-quality healthcare. The lack of comprehensive South African literature on emergency theatre efficiency worsens the underutilisation issue in public theatres nationwide.

Methods: This study was conducted at Tygerberg Hospital (TBH), a tertiary hospital in Parow, Western Cape. It houses two general emergency theatres shared between all surgical disciplines, excluding orthopaedics and obstetrics. A retrospective audit of the emergency theatre registry was conducted for all surgical procedures performed over six months. Our analysis focused on start and end times for both anaesthesia and surgery to assess theatre utilisation (TU) and turnover times (TOT) between cases.

Results: A total of 1 663 surgical procedures were performed in two general emergency theatres over 181 days. The TU rate was 53.58%. The average TOT between consecutive cases was 2.51 hours. Total surgical time (TST) only accounted for 33.86% of the total theatre time utilised. Among the surgical specialities, neurosurgery emerged as the leading field, accounting for 23% of all cases performed.

Conclusion: This study explores the utilisation of emergency theatre time at a tertiary institution in South Africa. Our findings offer valuable insights into the distribution and demand patterns for emergency theatre time across various surgical disciplines, highlighting overall TU and TOT for emergency cases. The results reveal a significant gap in available theatre hours and actual usage, identifying a critical area of inefficiency with considerable potential for improvement.

Keywords: emergency theatre, operative theatre times, theatre performance parameters, theatre efficiency, utilisation

Introduction

The escalating global disease burden is driven by a surge in non-communicable diseases and injuries, necessitating surgical interventions.[1,2] Funk et al.[3] demonstrated a significant disparity in surgical activity between high- and low-income countries, attributing this divide to inadequate surgical resources and infrastructure. Like many other low- to middle-income countries, South Africa grapples with a mounting disease burden and multifaceted resource constraints.[4,5] To address this, there is an imperative need for a substantial increase in the public surgical service capacity in South Africa to align with the Global Surgical Goals for 2030.[6]

However, augmenting public healthcare resources by establishing new infrastructure and expanding staff may prove unfeasible in the South African context.[7] Given the expensive and limited nature of theatre time, optimising its efficiency becomes paramount, bearing significance for hospital management and enhanced patient care.[7,8] A well-functioning theatre complex in resource-limited settings significantly influences surgical service delivery, patient care, and staff satisfaction.[2] Unfortunately, despite these imperatives, many public operating theatres in South Africa remain underutilised.[9,10]

While acknowledging that TU alone lacks the comprehensive validity to serve as a single performance marker, it remains a crucial measure of resource usage.[11] When used in conjunction with other theatre parameters, it becomes a valuable indicator of theatre efficiency. Existing academic literature on operating TU in public hospitals in South Africa is scant. Recognising unused theatre time as a wasted resource, we sought to investigate the efficiency of a 24/7 general emergency theatre operating without scheduled breaks at South Africa's second-largest tertiary hospital over six months. This study seeks to contribute valuable insights into the intricate dynamics of the use of available emergency theatre time within a resource-constrained healthcare system.

Methods

We conducted a retrospective audit analysing data collected between January and June 2022 at Tygerberg Hospital (TBH). Data were sourced from the theatre registry and CLINICOM, the official patient administration system for the Western Cape. All emergency surgical cases performed in the two general emergency theatres during this period were included. Incomplete records, as well as obstetric and orthopaedic cases (due to their dedicated theatres) were excluded. Case triage was conducted by the booking surgeon using the timing in acute care surgery (TACS) classification, with cases of equal urgency managed on a first-come, first-served basis, and interdepartmental discussions were held when necessary for prioritisation. Emergency cases

were electronically booked using Medweb tools, an independent system accessible to all surgical disciplines and anaesthetists.

Collected data included patient demographics, surgical discipline, and specific theatre times. Key metrics recorded for each case were anaesthetic start (AS), procedure/surgery start time (PST), procedure/surgery finish (PF), and anaesthetic completion time (ACT).[12] Based on these times, theatre utilisation (TU) and turnover times (TOT) were calculated. Data processing was performed using a password-protected Microsoft Excel spreadsheet, and the anonymised data were subsequently analysed by the Centre for Statistical Consultation, Department of Statistics and Actuarial Sciences, Stellenbosch University.

Statistical analysis

The statistics were presented depicting frequencies (accompanied by percentages) for categorical data and means with standard deviations (SD) for continuous data, particularly variables related to time elapsed. The average time elapsed was compared between different groupings using one-way analysis of variance (ANOVA). Normality was evaluated by examining normal probability plots, and in instances where deviations were observed, elapsed times underwent log transformation to enhance normal distribution. The homogeneity of variance was assessed using Levene's test.

Ethical considerations

Approval for the study was obtained from the Stellenbosch University Health Research Ethics Committee (HREC) (reference number: S23/01/001), and a waiver for consent was obtained due to the anonymised and de-identified data, thus preserving patient confidentiality. Additionally, the study was duly registered on the National Health Research Database under the identifier WC_202303_004, and institutional approval from TBH management (Project ID: 26984) followed. This study was conducted according to the South African Good Clinical Practice Guidelines, the Medical Research Council Ethical Guidelines for Research, and the Responsible Research Publication Position Statement 2010.

Results

A comprehensive dataset comprising 1 663 surgical cases was incorporated over six months. An analysis of patient demographics revealed a mean age of 32.8 ± 18.78 SD, aged 0 days to 93 years. The dataset exhibited a male predominance, constituting 61% of the cases (n = 1 021), while females accounted for 39% (n = 641). Gender data for one patient was incomplete.

Most patients (73.73%, n = 1 190) were transferred from the surgical wards. Comparatively, a smaller proportion of patients (26.27%, n = 424) was transferred from the intensive care unit (ICU) or high-care setting (Table I). A patient's preoperative location did not significantly impact the TOT (Table I). The average TOT (hours) between cases was 2.51 ± 3.30 SD. Of note, 49 surgical cases were excluded from the TOT calculation due to incomplete documented theatre times.

In examining the distribution of emergency theatre time across various surgical disciplines, all specialities utilising this resource were identified, with neurosurgery emerging as the predominant field, claiming 23% of all theatre cases (Table II). Surgical discipline information for two cases was incomplete.

Table I: Preoperative location of surgical cases transferred to theatre and the effect on turnover time

	Frequency (*n*)	Percentage (%)	TOT	*p*-value*
ICU/HC	424	26.27	2.65 ± 3.64	0.31
Ward/front room	1 190	73.73	2.46 ± 3.17	
Totals	1 614	100	2.51 ± 3.30	

HC – high care, ICU – intensive care unit, TOT – turnover time
*ANOVA

Table II: Emergency surgical cases

Surgical disciplines (n = 1 661)	*n* (%)
Neurosurgery	390 (23)
Trauma	352 (21)
Abdominal	302 (18)
Gynaecology	206 (12)
Urology	109 (7)
Paediatric surgery	107 (6)
Ear, nose and throat	65 (4)
Orthopaedic	42 (3)
Plastics	41 (2)
Vascular	39 (2)
Cardiothoracic	32 (2)
Ophthalmology	7 (0)
Interventional radiology	6 (0)
Organ transplant/harvesting	6 (0)
Maxillofacial	5 (0)
Paediatric pulmonology	4 (0)
Paediatric orthopaedic	1 (0)
Breast and endocrine	1 (0)
Adult pulmonology	1 (0)
Obstetric	1 (0)
Gastroenterology	1 (0)

Table III: Discipline-specific theatre times

	TPT		TST	
	n	Mean ± SD	*n*	Mean ± SD
All cases	1 654	2.81 ± 1.58	1 646	1.79 ± 1.32
Trauma surgery	352	3.45 ± 1.93	345	2.34 ± 1.54
Abdominal surgery	301	3.04 ± 1.54	301	1.85 ± 1.24
Neurosurgery	388	2.88 ± 1.38	386	1.88 ± 1.31
Gynaecology	205	1.88 ± 0.93	206	1.05 ± 0.76

SD – standard deviation, TPT – total procedure time, TST – total surgical time

Table IV: Available theatre time utilisation*

Theatre time available	
	***n* (%)**
	8 688 (100)
Theatre time used	
TPT	4 655 (53.58)
AT	1 713 (19.72)
TST	2 942 (33.86)
Non-operative time	
NOT	5 767 (66.38)
TOT	4 054 (46.66)
AT	1 713 (19.72)
Unused theatre time	
TOT	4 054 (46.66)

AT – anaesthetic time, NOT – non-operative time, TOT – turnover time, TPT – total procedure time, TST – total surgical time
* Time displayed in hours.

Total procedure time (TPT), defined as the time (hours) from anaesthesia start to finish, showed a mean duration of 2.81 ± 1.58 SD. TU was calculated at 53.58% (*n* = 8 688). Anaesthesia time (AT) accounted for 19.72% of the total theatre time (Table IV), with general anaesthesia (GA) used exclusively in 95% of cases (*n* = 1 661). Only two cases were excluded due to incomplete data.

The mean total surgical time (TST) defined as the time (in hours) from surgical incision to closure across all disciplines, was 1.79 ± 1.32 hours (Table III). TST contributed 33.86% to the overall theatre time (Table IV). Only nine cases were excluded due to incomplete data.

Discussion

National standards for emergency TU, start times, and TOTs in South Africa are notably absent. This gap in standardisation was emphasised by Mazzei and Oh et al.,[14] who underscored the significance of establishing standard procedural times and institution-specific metrics.[13] Such metrics are essential in mitigating perceptual differences among various theatre team members, minimising inefficiencies, and enhancing theatre performance indicators. Using TU as a sole performance indicator has been questioned.[15] Nevertheless, it remains a crucial gauge of resource utilisation, offering valuable insights when considering other theatre metrics to gauge overall efficiency.[16]

In the South African context, there is a notable lack of academic literature addressing the utilisation of operating theatres in public teaching hospitals. Most local studies resort to international benchmarks, which vary significantly. The only consensus is that theatres cannot sustain 100% capacity, allowing no room for unforeseen delays.[17] All existing South African literature regarding TU in public hospitals has been exclusively based on scheduled lists. Asmal et al.[9] found a TU of 55% at a regional hospital, Ford et al.[18] reported a 59.8% utilisation rate in studies on a paediatric theatre complex, and Tsimanyane et al.[10] observed a TU of 62% at a tertiary eye hospital. Our study

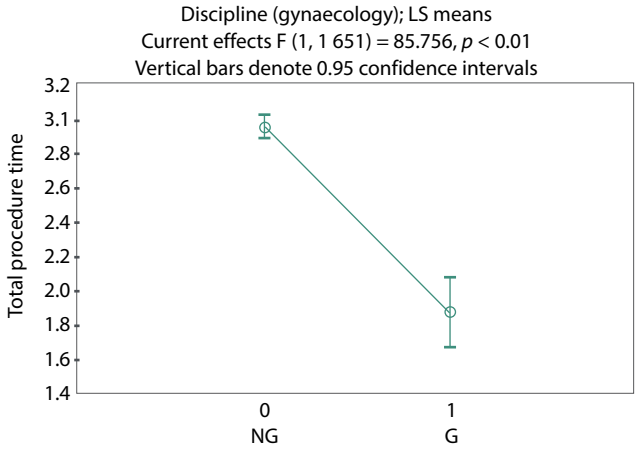

Figure 1: Total procedure time for gynaecological (G) surgical cases compared with non-gynaecological (NG) cases

revealed a TU rate of 53.58% for the emergency theatres at our institution. Due to a lack of comparative studies, it is difficult to contextualise this result.

The TOT, often synonymous with "empty theatre time", refers to the period when neither the anaesthetist nor the surgeon is in contact with a patient. It encompasses the intervals between scheduled patients, typically involving non-clinical activities, such as cleaning the theatre and preparing for the next case. Recognised as a component of non-operative time (NOT), TOT can contribute significantly to delays. In developed countries, the recommended optimal TOT is set at 30 minutes, with times exceeding 60 minutes signalling substantial delay and indicating theatre inefficiency.[9,19] It is essential to note that these benchmarks are primarily derived from elective theatre data. Notably, Naik et al.[20] presented relevant data suggesting that emergency theatres, with the added element of list rescheduling due to newly emerging emergency cases, significantly impact TOT.

Our institution's emergency theatre waiting list is consistently occupied, highlighting the relevance of TOT as a performance metric. The study revealed an average TOT of 2.51 hours, which is concerning. Notably, the 49 cases excluded from TOT calculations still occupied emergency theatre time for unspecified durations. This raises the possibility of a slight overestimation or underestimation of unused theatre time, which should be considered.

A comparison can be drawn with a local (unpublished) audit conducted at Groote Schuur Hospital in 2006 over 91 days.[21] In the audit, "fetch times" (the time between the anaesthetist's call for the next case and its arrival in the induction room) were recorded as a measure of time between cases. It is important to note that their "fetch time" does not directly correlate with the TOT used as the timeframe in our study, which measures the interval between a patient leaving the theatre and the next patient arriving in the theatre. The audit showed that most (73%) of their cases arrived in the induction room within 30 minutes of being sent for, and only 8% of cases took longer than 40 minutes.

These times are considerably shorter than the TOT measured in our study, possibly suggesting room for improvement at our institution.

To better understand the empty theatre time in our study, we compared the observed TOT against the upper limit of 60 minutes, which is considered acceptable. For the 1 663 cases performed during the study period, 1 663 hours were allocated for TOT between cases. However, we found 2 391 hours of unaccounted-for empty theatre time. This substantial discrepancy between available and utilised hours highlights a significant inefficiency in TU.

Furthermore, the SD for TOT exceeds 100%, indicating a high variability and making it challenging to identify specific inefficiencies during the study period. A more granular analysis of TOT at different time intervals would offer clearer insights into periods of inefficiency. Unfortunately, our study did not address the underlying factors affecting TOT, leaving a gap for future research.

In 2013, Javed et al.[22] introduced the Golden Patient Initiative (GPI), an innovative approach where a preselected surgical case from the emergency list is scheduled as the first case the following day, given the absence of newly admitted life- or limb-threatening cases. The "golden patient" undergoes a meticulous preselection, investigation, and preparation process to alleviate unnecessary delays associated with patient readiness, required equipment, senior staff coverage, and postoperative bed availability. Notably, the GPI has shown the potential to reduce the First Case Start Time (FCST) by 20 to 60 minutes.[23] A comparison of the Least Squares (LS) Means confidence intervals for TPT across the top four surgical disciplines utilising the emergency theatre revealed that gynaecological cases exhibited the least variability in TPT ($p < 0.01$), as illustrated in Figure 1. In other words, gynaecological cases showed the highest level of TPT predictability, suggesting that they might be ideal GPI cases. This strategic approach may significantly contribute to the improvement of FCST.

The dynamic nature of emergency theatres underscores the need to avoid sole reliance on a single performance indicator when evaluating the efficient use of available theatre time. Unlike elective theatres, emergency theatres operate differently due to unscheduled patients and newly emerging life- or limb-threatening cases that lead to last-minute list changes. The insights gained from this study provide a foundation for a more in-depth analysis of theatre inefficiencies, emphasising the identified key performance area: TOT. Understanding all factors influencing these areas is vital to establishing institution-specific benchmarks for future quality improvement strategies. Enhancing the efficiency of emergency theatres benefits the institution by reducing patient waiting lists, enhancing bed occupancy, and boosting staff morale. Ultimately, this improvement ensures quality healthcare for all patients by decreasing morbidity and mortality through reduced waiting times.

This study has several noteworthy limitations. The retrospective design raises concerns about potential inaccuracies and missing data. Additionally, relying on nursing staff to record times introduces the possibility of bias. Another significant limitation is that the CLINICOM and theatre registry did not document the reason for delays, which is a crucial omission, as understanding these factors could provide valuable insights into perioperative delays. Lastly, the study was limited by not evaluating specific timeframes within the 24-hour period, which could have identified more precise intervals where inefficiencies occur.

Conclusion

This study examines emergency theatre time utilisation at a South African tertiary institution, revealing significant inefficiencies. The gap between available and actual theatre usage highlights a need for improvement in emergency theatre efficiency. We hypothesise that unused theatre time may result from scheduling inefficiencies, resource allocation issues, administrative delays, equipment problems, and emergency case prioritisation. Future interventions should focus on optimising emergency scheduling, improving resource allocation, streamlining administrative processes, enhancing triage systems, and upgrading technical infrastructure.

For future research, we propose the following:

- TOT analysis. If 60 minutes is deemed acceptable, exceeding this should prompt a delay form to investigate the prolonged TOT.
- TU. Analysing smaller time intervals, such as six-hour blocks within a 24-hour shift, allows a more granular examination of data to reveal specific trends and optimise TU. This approach is beneficial for identifying efficiency patterns around shift changes.
- GPI. Selecting a priority patient from the emergency list with whom to start the following day as the first case of the day in one of the two theatres. Our research indicates that gynaecological cases exhibit the highest level of TPT predictability, making them ideal candidates for GPI implementation. This strategy could contribute to enhancing FCST efficiency within a single theatre.

By addressing these areas, theatre time underutilisation can be reduced, improving efficiency and patient outcomes.

Acknowledgements

We express our gratitude to Prof. Kidd for undertaking the statistical analysis.

Conflict of interest

The authors declare no conflict of interest.

Funding source

No funding source to be declared.

Ethical approval

Ethical approval for the research was granted by the HREC of Stellenbosch University (reference number: S23/01/001).

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