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The following contributions will be accepted:

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EDITORIAL

Rethinking emergency theatre efficiency in South Africa

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Safe surgical care plays a critical role in advancing the 2030 Agenda for Sustainable Development which aspires to universal health and well-being.[1] Given that operating theatres constitute a major component of hospital costs, optimal theatre utilisation is essential to minimise wasteful expenditure.[2] The increasing burden of surgical disease in low- to middle-income countries is well documented, and with it, the rising imperative for more efficient surgical systems.[3,4]

In this context, the paper "*An investigation into the utilisation of available emergency theatre time at a tertiary academic hospital in South Africa*" by Venter et al.[5] in this edition of SAJAA, offers timely and crucial insights into a persistent but under-examined problem: the efficiency of emergency theatre utilisation (TU) in resource-constrained settings.

With a dataset spanning 1 663 emergency surgical cases over six months, the authors undertook an audit of theatre use at South Africa's second-largest tertiary hospital. Their findings revealed a sobering truth - less than 54% of available theatre time was actively used, with an average turnover time (TOT) of 2.51 hours, far exceeding international benchmarks.[6] This underutilisation equates to more than 2 300 hours of idle theatre time - resources lost in a setting where time is inextricably tied to patient outcomes, bed flow, staff fatigue, and institutional resilience.

Unlike elective theatres, emergency settings operate under non-linear conditions, with unpredictable caseloads and frequent reprioritisation. The authors acknowledge this complexity and rightly argue against using TU in isolation as a performance marker. Instead, they advocate for a composite approach that includes TU, TOT, and discipline-specific time metrics - an approach that could help identify actionable inefficiencies while respecting the fluid realities of emergency care. One could argue that additional theatre efficiency metrics such as first case on-time start and theatre cancellations could be added to such a composite approach.

To fully address the drivers of inefficiency, future research should consider anecdotal and evidence-based reasons for emergency theatre delays.[7] These include communication failures, such as between different surgical teams, surgeons and anaesthetists, and surgeons and nursing staff; human resource constraints compared to surgical demand such as insufficient theatre personnel (anaesthetists, surgeons, scrub nurses, anaesthetic nurses, recovery room nurses, porters, cleaners); and organisational issues like incomplete consent, outstanding special investigations, or inadequate preoperative preparation. Equipment shortages and infrastructure limitations, particularly intensive care unit and high care unit bed scarcity, further contribute significantly to ineffective emergency theatre flow.

These delays are not without consequence. They lead to clinical deterioration, infection, prolonged *nil per os* times with the risk of dehydration and further clinical deterioration. When emergency lists become too long, urgent cases are deferred to elective lists, resulting in elective case backlogs, extended hospital stays, and prolonged bed occupancy.

An important observation in the study by Venter et al.,[5] is the variability of theatre time usage across surgical disciplines, with gynaecological cases showing the least procedural time variability. This predictability forms the basis for the authors' recommendation to implement the Golden Patient Initiative (GPI) in emergency theatres - an evidence-informed practice shown to improve first case start times and reduce downstream delays.[8] Such a strategy could catalyse a broader operational shift within emergency theatre services in local contexts.

The study by Venter and colleagues is not without limitations. The retrospective design and reliance on manually recorded data raise valid concerns about documentation accuracy. More importantly, the study does not account for the causes of theatre delays which, if explored, could further refine interventions. These should be seen as opportunities for future research. As the authors suggest, delay forms, six-hourly data segmentations, and targeted GPI trials represent logical next steps for future investigations. In addition, other theatre efficiency metrics such as first case on-time start could be included in the exploration of emergency theatre utilisation.

In conclusion, this study is more than an audit. It is a call to action. In a country where surgical need outpaces capacity, inefficient use of existing resources is no longer just a logistical issue; it is an ethical one. By identifying theatre inefficiencies and offering implementable solutions, this research lays the groundwork for smarter emergency surgical care. Other institutions across South Africa should be encouraged to adopt similar audits. As we strive toward equitable, high-quality surgical care by 2030, let us respond to the Lancet Commission's call[3] for "available, accessible, safe, timely, and affordable surgical and anaesthesia care," also in our emergency theatres in South Africa.

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ORIGINAL RESEARCH

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

MM Venter, BJM Bornman, EM Geldenhuys, KG Louw, SJ Venter

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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

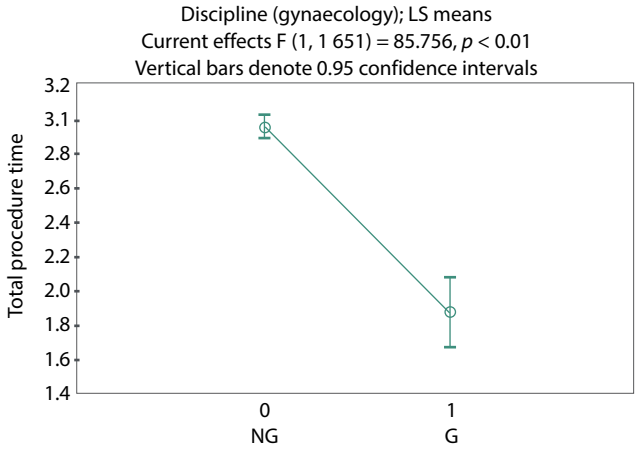

Figure 1: Total procedure time for gynaecological (G) surgical cases compared with non-gynaecological (NG) cases

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.

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Conflict of interest

The authors declare no conflict of interest.

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Ethical approval

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ORIGINAL RESEARCH

The prevalence of moderate-to-severe rebound pain after spinal caesarean section at Tygerberg Hospital following new analgesia guidelines implementation

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Background: A previous study at Tygerberg Hospital identified a 91.7% prevalence of moderate-to-severe rebound pain (Visual Analogue Scale [VAS] ≥ 4 mm) in patients undergoing spinal caesarean section (CS). Since implementing new analgesia guidelines that focus on using intrathecal morphine and administering systemic, multimodal analgesia before spinal offset and discharge to the ward, the prevalence has not been investigated again.

Methods: A retrospective, non-interventional study of 339 patients from the Tygerberg PAIN OUT South Africa (SA) database who underwent CS under spinal anaesthesia was conducted to determine the prevalence of moderate-to-severe rebound pain and allow comparison to the previous study. Patients completed a questionnaire, including a numeric rating scale (NRS), for the worst pain experienced since surgery on postoperative day one. Demographic and therapeutic data were also collected.

Results: The questionnaire was completed by 99% of the obstetric patients in the PAIN OUT SA database. The prevalence (95% confidence intervals [CI]) of moderate-to-severe pain was 83.2% (79.2% to 87.2%) compared to 91.7% (83.8% to 95.9%) in the previous study. For severe pain alone (NRS ≥ 7), the incidence was 46.6% (41.4% to 51.9%) compared to 65.5% (54.8% to 74.7%). The median (interquartile range [IQR]) intensity of the worst pain was 6 (4–8), compared to the median VAS of 85 (66–100) in the previous study. Therapeutic records revealed partial adherence to the new guidelines.

Conclusion: This study found a high prevalence of moderate-to-severe rebound pain after CS under spinal anaesthesia. Despite this, the prevalence of severe pain and the median intensity of pain have declined significantly after implementing new departmental guidelines. The analgesic options recommended by the guidelines were only partially utilised. Departmental guidelines should be visible, easy to follow, and convincingly advocated to have the optimal effect.

Keywords: acute postoperative pain, spinal anaesthesia, caesarean section, numeric rating scale, developing countries

Introduction

Although it may be routine to the anaesthetist, a caesarean section (CS). is a momentous event for the mother. The prevalence of moderate-to-severe pain in the early postoperative period is as high as 50% and is associated with the development of comorbidities in the postpartum period.[1] Litigation due to pain and discomfort from this procedure is currently the most frequent successful medicolegal claim against obstetric anaesthetists.[2] After spinal anaesthesia, rebound pain occurs due to the sudden unmasking of nociception when the neuraxial block resolves.[3] The anaesthetist should use their knowledge of the duration of spinal anaesthesia to anticipate rapid offset and administer adequate, pre-emptive multimodal analgesia timeously to prevent the occurrence of rebound pain.

A previous study of postoperative pain at Tygerberg Hospital by Murray & Retief found a prevalence of 87% of an episode of moderate-to-severe postoperative pain after CS (VAS ≥ 40 mm).[4] Isolating the spinal CS patients from this data gave a prevalence of 91.7% for moderate-to-severe pain, with a median VAS of 85 mm. This high prevalence is in keeping with other recent studies in developing countries.[5,6] At the time of the previous study, systemic analgesia after spinal anaesthesia was regularly entrusted to ward staff and initiated only after rebound pain had commenced, using intramuscular (IM) rather than intravenous (IV) titrated morphine. Intrathecal morphine and IV paracetamol were excluded from routine use due to financial constraints, and nonsteroidal anti-inflammatory drugs (NSAIDs) and dexamethasone were not routinely used intraoperatively for spinal CS patients.

To address the study's findings, the Department of Anaesthesiology and Critical Care at Tygerberg Hospital released new analgesia guidelines for CS in 2020.[4] The guidelines emphasised the establishment of multimodal analgesia before the patient's departure from the theatre recovery room. Analgesic adjuvants, including 50 µg intrathecal or 0.1 mg/kg IV morphine (up to a maximum of 10 mg), NSAIDs in the form of indomethacin 100 mg suppository or diclofenac 75 mg IM or IV, paracetamol 1 g IV, dexamethasone 8 mg IV, and regional blocks or local anaesthetic (LA) wound infiltration were to be administered in the theatre or recovery room to cover spinal

anaesthesia offset and manage the occurrence of rebound pain. Further, the guidelines advised regular paracetamol, NSAIDs, and tramadol in the ward, with morphine as needed. The addition of intraoperative multimodal analgesia after delivery follows recommendations of the Procedure-Specific Postoperative Pain Management (PROSPECT) guidelines for CS and also forms part of the Enhanced Recovery after Caesarean Delivery (ERAC) guidelines.[1,7,8]

The standard drugs for spinal anaesthesia at Tygerberg Hospital are 8–12 mg of bupivacaine 0.5% with dextrose combined with fentanyl 10–15 µg. Intrathecal low-dose morphine (50 µg) is a new addition to the guidelines as routine practice for spinal CS in patients without contraindications like morbid obesity, significant respiratory impairment, or severe preeclampsia requiring magnesium sulphate infusions. This is in keeping with consensus guidelines from the Society for Obstetric Anaesthesia and Perinatology (SOAP) and PROSPECT guidelines.[1,9] The range of mean times to first analgesia request after intrathecal morphine was 9.7–26.6 hours, according to a recent meta-analysis, and the risk of respiratory suppression was very low.[10,11] It is ideal in settings where staff shortages might contribute to delays in analgesia administration in the ward and is currently the standard of care for post-caesarean analgesia.[8]

The impact of the new analgesia guidelines has not been studied. This study aimed to determine the current prevalence of moderate-to-severe rebound pain after spinal CS and compare it to the results of the previous study as part of a quality improvement project. Secondary objectives were to determine and compare the intensity of rebound pain, describe the current utilisation of analgesic modalities, identify possible associations between rebound pain and individual analgesic strategies, and determine patient satisfaction with early postoperative analgesia.

Methods

Approval was obtained from the Human Research Ethics Committee (HREC) of Stellenbosch University (S22/06/109). All patients captured on the PAIN OUT SA database (HREC reference N19/10/140) who underwent elective or emergency spinal CS at Tygerberg Hospital between 1 October 2021 and 31 August 2022 were included in the study for retrospective analysis. No additional informed consent was required as no new data were collected, and consent for the PAIN OUT SA database includes data analysis and publication.

Inclusion criteria for PAIN OUT SA were patients 18 years and older who were postoperative day one and had been in the ward from surgery for at least six hours. Exclusion criteria were patients who received general anaesthesia, combined spinal-epidural, or epidural anaesthesia, and patients who did not correctly complete the pain scales on the outcome questionnaire. The database included the patients' demographic information, medical history, surgical procedure, anaesthetic technique, and all analgesics given in the theatre, recovery room, and ward up to the time the outcome questionnaire was completed.

The International Pain Outcomes questionnaire, assessing pain experience, was completed by patients on postoperative day one in English, Afrikaans, or isiXhosa. Patients rated their worst pain since surgery on a numeric rating scale (NRS). This would capture an episode of rebound pain following spinal anaesthesia if it occurred. These methods are similar to those used in the previous study by Murray & Retief at Tygerberg Hospital, where patients were asked to indicate the worst pain they experienced since surgery on a visual analogue pain scale.[4]

Pain scores on the NRS were categorised according to literature: no/mild pain (0–3), moderate pain (4–6), and severe pain (7–10).[12,13] The pain scores indicated on the NRS were compared to those documented on the previous audit's Visual Analogue Scale (VAS). A literature review revealed that NRS and VAS scores correspond excellently and that mean values on the two scales correlate closely with the efficacy of analgesic treatment.[14,15] Thus, comparing patients' NRS scores in the PAIN OUT SA database to the VAS scores in a previous audit is reasonable.

Descriptive statistics were compiled as means and standard deviations (SD) for continuous, normally distributed data, and as medians, IQRs, or frequencies and percentages for other data. Pain prevalences were reported with 95% CIs. The prevalence of moderate-to-severe pain and other pain categories were compared to the previous study using chi-square tests. As a secondary analysis, the median NRS scores and prevalences of moderate-to-severe pain were compared between groups of women who did or did not receive specific analgesics following the new guideline. Wilcoxon signed-rank tests were used to compare pain scores and chi-square tests for proportions.

Results

A total of 358 patients who underwent spinal CS between 1 October 2021 and 31 August 2022 were captured on the PAIN OUT SA database (Figure 1). There were 17 patients who were excluded because they indicated a higher NRS for the least pain

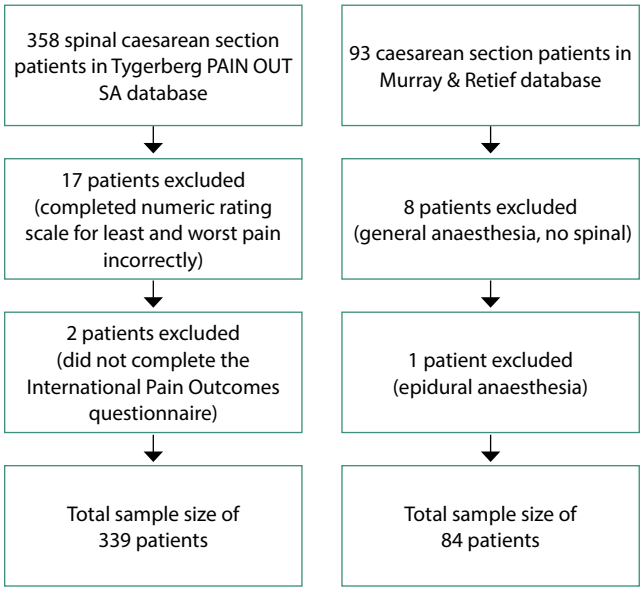

Figure 1: Patient flow diagram of the current study and the previous study by Murray & Retief [4]

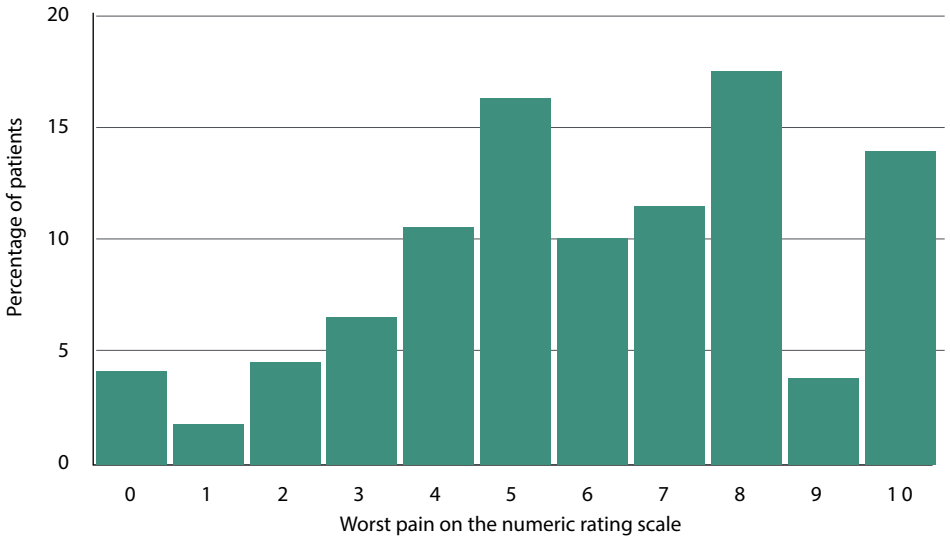

Figure 2: Percentage of patients versus intensity of worst pain on the numeric rating scale

they experienced than for the worst pain they experienced, according to the PAIN OUT guidelines for analysis. Two patients who did not complete the outcomes questionnaire were excluded. This gave a sample size of 339 patients.

Patient characteristics

The mean age was 33 years (SD 5.87), with a median body mass index (BMI) of 34 kg/m^2 (IQR 28–41). Non-South Africans comprised 4.23% of the participants. Most questionnaires were completed in English (247), with Afrikaans (45) and isiXhosa (44) following as the languages of choice. Comorbidities like hypertensive, cardiovascular, and gastrointestinal disorders, diabetes, and asthma, which could be contraindications to NSAIDs, were present in 30.9% of patients. A median period of 22.0 hours (IQR 17.6–24.5) elapsed between the time of surgery and the survey.

Prevalence and pain intensity

Regarding pain categories, 16.8% of patients reported no or mild pain (NRS 0–3), 36.6% moderate pain (NRS 4–6), and 46.6% severe pain (NRS 7–10). This gave an 83.2% prevalence of moderate-to-severe pain (95% CI 79.2% to 87.2%). The median intensity for worst pain was 6 (IQR 4–8). Figure 2 depicts the percentage of patients plotted against their respective worst pain scores.

Utilisation of pre-emptive intraoperative analgesia

Most patients received IV paracetamol (88%), 73% received systemic morphine (mean dose 7.7 mg, SD 2.4 mg), and 23% received intrathecal morphine (mean dose 0.05 mg). LA infiltration by the surgeon was given to 39% of patients, and 33% received NSAIDs (IV or suppository). Dexamethasone was administered to 6% of patients, and 2% received ketamine. The utilisation of the different analgesic modalities is presented in Figure 3.

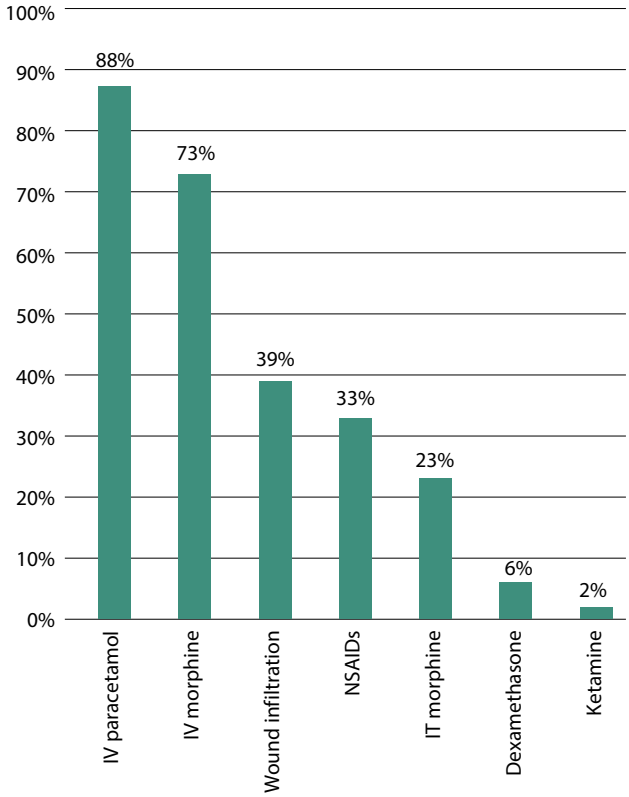

Figure 3: Percentage of patients receiving specific pre-emptive intraoperative analgesics
NSAIDs – nonsteroidal anti-inflammatory drugs, IT – intrathecal, IV – intravenous

Recovery room analgesics

A further 18.3% of patients received supplementary opioids in the recovery room in the form of IV or IM morphine or oral immediate-release tramadol. Thirteen per cent of patients received IV or IM morphine, and 8% received oral immediate-release tramadol.

Associations between pain and patient characteristics

No significant association was found between pain and age ($p = 0.47$) or BMI ($p = 0.73$). There were no significant differences

in pain scores between South Africans and foreigners ($p = 0.44$) or between patients completing the questionnaires in three languages ($p = 0.44$). Time from procedure to survey did not show any association with the worst pain recorded (r = -0.02).

Physical and emotional consequences associated with increased pain

A higher NRS for maximum pain was moderately associated with interference with activities in bed, such as changing position (r = 0.49; $p < 0.001$), as well as interfering with or preventing activities out of bed, such as standing or walking (r = 0.42; $p < 0.001$). Increased pain had a weak association with feelings of anxiety, helplessness, and insomnia (r = 0.34, 0.28, and 0.35, respectively; $p < 0.001$).

Patient satisfaction

The median satisfaction with pain treatment was 8/10 (IQR 6–10). The mean maximum pain score was 6.6 (95% CI 6.2 to 7.0) for patients who indicated they would have liked more pain treatment. In comparison, those who did not want more treatment had a mean pain score of 5.5 (95% CI 5.1 to 5.9; $p < 0.001$).

Correlation between maximum pain and specific intraoperative pre-emptive analgesics

We could not demonstrate any statistically significant association between maximum pain and using specific pre-emptive analgesic strategies. Patients who received intrathecal morphine had a mean NRS of 5.6 compared to 6.2 of those who did not receive it ($p = 0.07$). Those who received NSAIDs scored 5.7, while those who did not scored 6.2 ($p = 0.07$). Wound infiltration scored 5.9 versus 6.1 ($p = 0.45$), systemic morphine 6.1 versus 5.8 ($p = 0.29$), and dexamethasone 6.8 versus 6.0 ($p = 0.21$).

Comparison of results with the previous study

Patient characteristics and survey timing

The patients in this study had a mean age of 33 years compared to 29 in the previous study ($p < 0.001$). The median time from the procedure to the survey was 22.0 hours (IQR 17.7–24.5) compared to 23.0 (IQR 21.0–25.0) in the previous study.

Prevalence of moderate-to-severe pain

In the previous study, 77/84 (91.7%, 95% CI 83.8% to 95.9%) spinal CS patients reported moderate-to-severe pain, compared to 282/339 (83.2%, 95% CI 79.2% to 87.2%) patients in the current study ($p = 0.052$).

Comparison of the three different pain categories between the two studies

Considering the three categories of pain separately (Figure 4), the current prevalence of severe pain was 46.6% (95% CI 41.4% to 51.9%) compared to 65.5% (95% CI 54.83% to 74.7%) in the previous study ($p = 0.002$). There was an 18.9% reduction in severe pain, with an increase in moderate and no/mild pain of 10.4% and 8.5%, respectively.

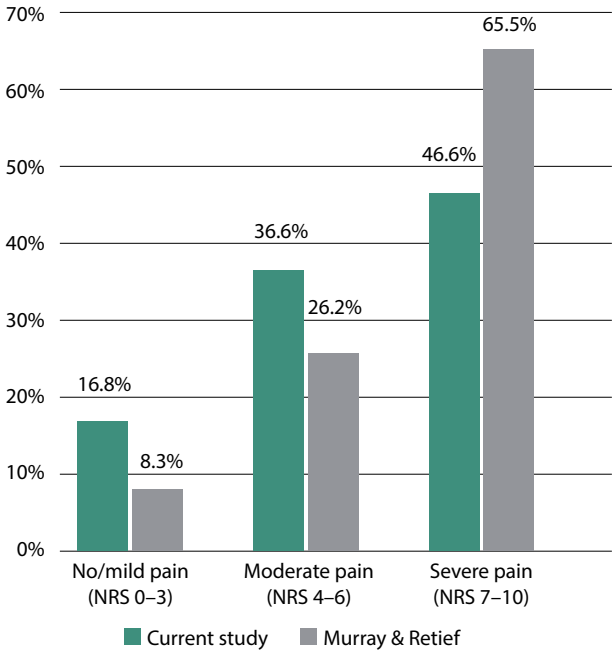

Figure 4: Comparison of the different pain categories between PAIN OUT SA data and the previous study by Murray & Retief [4]
NRS – numeric rating scale

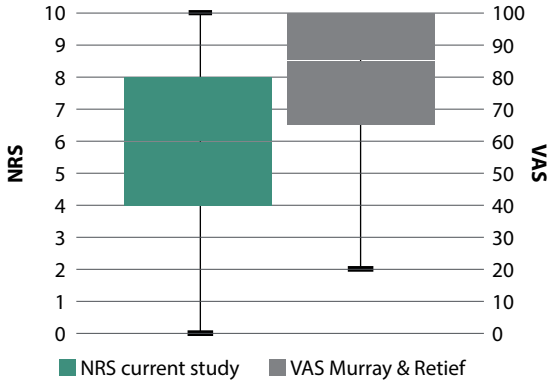

Figure 5: Comparison of median and IQR of pain intensity between PAIN OUT SA data and the previous study by Murray & Retief [4]
IQR – interquartile range, NRS – numeric rating scale, VAS – Visual Analogue Scale

Comparison of pain intensity

The median intensity of worst pain in our study was lower, with the NRS at 6.0 (IQR 4–8) compared to a median VAS of 85 (IQR 66–100) in the previous study ($p < 0.001$) (Figure 5).

Discussion

This study reveals a high prevalence of 83.2% (95% CI 79.2% to 87.2%) of moderate-to-severe pain (NRS ≥ 4) after spinal CS and does not confirm a significant decrease from the 91.7% (95% CI 83.8% to 95.9%) found in the previous study before implementing new CS analgesia guidelines ($p = 0.052$). While the prevalence of moderate-to-severe pain remains unacceptably high, the percentage of patients experiencing severe pain decreased significantly by 18.9% ($p = 0.002$) from 65.5% (95% CI 54.83% to 74.7%) to 46.6% (95% CI 41.4% to 51.9%). Also, the median pain intensity declined from a VAS of 85/100 to a NRS of 6/10 ($p < 0.001$). Therefore, it may be concluded that implementing the new guidelines successfully prevented severe

pain in many patients but not moderate pain. This postoperative pain reduction after introducing protocolised care for CS patients is also evidenced by a meta-analysis.[16]

It may be asked if the decrease in pain intensity between the two studies makes a difference from the patient's point of view. In the acute postoperative pain setting, the minimal clinically important difference (MCID) is 10 mm on the VAS, meaning that analgesic efforts that result in a reduction of more than 10 mm, or 1/10 on the NRS, are meaningful for patients.[17] Thus, the decrease in pain intensity noted between the two studies indicates a clinically significant improvement.

Giving analgesia to eliminate all postoperative pain would be an unrealistic target and lead to increased complications from analgesic drugs, such as sedation, nausea, pruritus, and respiratory depression. The Patient Acceptable Symptom State is a more reasonable goal, with a VAS of 33/100 or NRS of 3/10 in the acute pain setting.[13,17] Therefore, scores of ≤ 33 on the VAS and ≤ 3 on the NRS signify acceptable pain control after surgery. Compared to the literature, our population seemed satisfied at a higher NRS. Patients who wanted more pain treatment in our setting had a mean NRS of 6.6, compared to the 5.5 of those who did not. The NRS difference between these patient groups is 1.1 (95% CI 0.5 to 1.7 units), including but not confirming a MCID. The median NRS of 6 in this study revealed that most patients need more analgesia than what is currently provided to reach a Patient Acceptable Symptom State.

Compliance with departmental guidelines

Healthcare workers are trusted to follow clinical guidelines when implemented. In practice, though, guidelines are sometimes not well disseminated or completely followed in the busy clinical routine.[18,19] In our analysis of intraoperative analgesics administered, we noted that full compliance with the guidelines was lacking. Only 23% of patients received intrathecal morphine, which is the gold standard in the absence of contraindications. Most, but not all, patients received IV paracetamol. About 68% of patients did not receive NSAIDs, while only 30.9% of patients had comorbidities that could have contraindicated its use. This leaves a potential 37% of patients that might have benefited from these drugs, provided haemorrhage from the CS was not a concern. The guidelines advocate that LA wound infiltration benefits patients who did not receive neuraxial morphine. Wound infiltration was given to 38% of patients, out of a potential of 77% who had not received neuraxial morphine.

A mere 6% of patients received dexamethasone. Reasons for this might include the association of dexamethasone with nausea prophylaxis rather than with analgesia or fear of immune suppression with perioperative sepsis. The omission of dexamethasone is significant. A meta-analysis looking at the effect of IV dexamethasone on postoperative pain after spinal anaesthesia found that its use was associated with a significant reduction in morphine consumption in the first 24 hours after surgery.[20] The authors reported high-level evidence that it improves postoperative analgesia after spinal anaesthesia. Furthermore, intraoperative IV dexamethasone after delivery is a grade A recommendation of the PROSPECT guidelines.

Most patients received some of the interventions recommended in the guidelines; 96% received at least IV or intrathecal opioids, and 88% received IV paracetamol. This partial compliance with the guidelines may explain why it was sufficient to decrease the prevalence of severe but not moderate pain.

Guidelines must be clear, simple to follow, and advertised like a product, as physicians cannot adhere to guidelines of which they are unaware. At Tygerberg Hospital, the guidelines were printed on A4 paper and inserted in a plastic sleeve on the theatre wall. A bigger poster might improve visibility. An academic presentation on the evidence for the guidelines and continued education to keep new staff informed may contribute to adherence.

Study limitations

Despite implementing new analgesia guidelines, the study revealed partial adherence to these guidelines, which may have impacted the results and effectiveness of the pain management strategies. In addition, the study was conducted at a single institution, possibly limiting the generalisability of the findings to other settings or populations.

We compared NRS scores to the VAS scores of a previous study. A literature review done in 2011 compared the Verbal Rating Scale, NRS, and VAS as tools to measure acute postoperative pain.[14] The review included 54 papers, with several using both the NRS and VAS to assess acute pain in each study participant. Overall, NRS and VAS scores corresponded excellently, and the mean values on the two scales correlated with the efficacy of analgesic treatment. Another study, looking at the correlation levels between the VAS, NRS, and Faces Pain Scale – Revised in acute postoperative pain, although not specific to the obstetric population, found that the intraclass correlation coefficient (ICC) between the VAS and NRS was the highest.[15] The ICC between the VAS and NRS at two separate time points were 0.917 and 0.945, respectively, indicating excellent agreement. Thus, it is reasonable to compare patients' NRS scores in the PAIN OUT SA database to the VAS scores used in a previous audit, as NRS and VAS scores correspond in the setting of acute postoperative pain and in measuring analgesic response.

Recruitment for the PAIN OUT SA database was done before surgery, whereas the previous audit recruited patients after their surgery. Our sample did not include consecutive CS patients during the data collection period since not all patients were included in the PAIN OUT SA database. Emergency and elective CS were included in both studies. We are not aware of any reason for bias in inclusion. Data collection for the PAIN OUT SA database was done by junior doctors from the anaesthesia department who were not involved in the cases, compared to a single study nurse in the previous audit. However, in both cases, the patients completed the pain scores without any interference from the data collector.

The age difference between the two studies is likely due to a difference in inclusion criteria, since the study by Murray & Retief included patients from the age of 12 years compared to 18 years in the PAIN OUT SA database. Because the comparison was done retrospectively, other population characteristics from the previous audit were unavailable for comparison.

No associations between pain and specific analgesic modalities were detected with sufficient statistical significance. While intrathecal morphine can last up to 30 hours, this is dose-dependent. A dose of 50 µg has a shorter duration and would likely have worn off by the time of assessment. The low dose may explain the small difference between those who received and those who did not receive intrathecal morphine. However, these were secondary outcomes for which the study was not powered and should only be considered hypothesis-generating at best.

Conclusion

We conclude that the prevalence of moderate-to-severe rebound pain after spinal CS at Tygerberg Hospital remains unacceptably high. Nonetheless, a statistically and clinically significant decrease in the prevalence of severe rebound pain and median pain intensity is evident after implementing the 2020 guidelines. The limited effect on moderate pain may be because the analgesic options recommended in the guidelines were only partially utilised. Staff should be educated that compliance with analgesia guidelines is critical for making a difference in patients' outcomes. Departmental guidelines should be visible, easy to follow, and convincingly advocated to have the optimal effect, a subject for future research at Tygerberg Hospital and elsewhere.

Conflict of interest

The authors declare no conflict of interest.

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Ethical approval

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ORIGINAL RESEARCH

Anaesthesiology registrars' knowledge of anatomy and assessment of two integrated anatomy teaching modalities: a comparative interventional study at a South African university

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Background: Knowledge of applied anatomy is essential for safe clinical practice in anaesthesiology. Despite the diverse use of applied anatomy and the negative consequences associated with inadequate knowledge, no formal postgraduate training course in applied anatomy exists for anaesthesiologists at any university in South Africa. To our knowledge, no prior study has been undertaken to assess knowledge or evaluate teaching modalities for applied anatomy among anaesthesiology registrars in African countries. This study aimed to assess applied anatomy knowledge and compare the effectiveness of two teaching modalities in anaesthesiology registrars at a central South African university.

Methods: A comparative interventional study was conducted. Data were collected using a questionnaire consisting of anatomy questions. Two randomised registrar groups wrote a pre-test and received different training modes: group A through a theoretical lecture and group B through an interactive anatomy museum cadaver and live model ultrasound demonstration. Their knowledge was re-evaluated immediately thereafter and one month after the training.

Results: There were 14 registrars who graduated from undergraduate medical school between 2010 and 2017 and participated in the study, divided into seven participants per group. The pre-test results indicated that the registrars' knowledge was below average (median score 44.6%, range 23.4–66.7%). No statistical difference was found between the two teaching modalities used in the study. Furthermore, no specific teaching modality was preferred, but simulation and lectures were more popular.

Conclusion: Most registrars' knowledge was inadequate for safe clinical practice. Intervention is required to keep anaesthesiology practitioners' knowledge at an acceptable level for patients' safety. Of the two teaching modalities, neither appeared superior. We highly recommend introducing a formal, structured postgraduate anatomy teaching programme encompassing diverse instructional strategies.

Keywords: applied anatomy, anatomy knowledge, health professions education, specialist training, training techniques

Introduction

Applied anatomy forms an integral part of anaesthesiologists' daily clinical practice. Limited anatomy knowledge is associated with various adverse events encountered by medical doctors, including morbidity and litigation due to damage to underlying structures.[1] Several studies have ascertained that limited knowledge among doctors and limited anatomy teaching compromise patient safety.[1-3]

Despite these associations, many new registrars are not adequately prepared in anatomy when starting their specialisation.[4,5] While some countries, such as Brazil, incorporate anatomy as part of their postgraduate anaesthesiology training programme, no literature was found on teaching applied anatomy to anaesthesiology registrars in African countries.[6] No formal scheduled postgraduate applied anatomy programme for anaesthesiologists is offered at the South African university where the study was conducted or at any other South African university.

Teaching postgraduate anatomy at this university in South Africa mainly involves informal discussions between the anaesthesiology registrars and consultants during clinical work and, less frequently, during departmental academic discussions of relevant cases. Senior registrars are taken to the anatomy museum for applied instructions on scheduled occasions. This differs from the university's undergraduate anatomy training, which involves a combination of mainly formal anatomy lectures, anatomical dissection of cadavers, tutorials, anatomy museum visits, and emergency case simulations for demonstrating anatomy to students. Despite this unstructured teaching, registrars are expected to be competent in anatomy on completion of their training. This has been described as having the relevant anatomy knowledge and being able to apply it in a clinical context.[7]

Several studies assessed anatomy knowledge in non-anaesthesiology doctors.[8-10] However, to our knowledge, no study has been conducted to assess such knowledge in anaesthesiology registrars at South African universities. Recent studies assessing knowledge in South African anaesthesiology registrars have concentrated on other aspects, such as the law, point-of-care viscoelastic testing, and neuromuscular monitoring.[11-13] In a recent study, obstetrics and gynaecology

registrars felt their applied anatomy knowledge was inadequate when they started their postgraduate training programme.[10] Conversely, a study among junior doctors comprising interns, medical officers, and registrars demonstrated that the doctors' knowledge was adequate for safe clinical practice. In this study, seniority and clinical experience had a positive association with being more knowledgeable.[8] Other doctors have also felt they had adequate anatomy knowledge for clinical practice.[14]

There has been extensive debate regarding effective methods of teaching anatomy. Globally, teaching in undergraduate programmes has revolved around the dissection of cadavers and lectures. Medical students indicated that they preferred dissection or exposure to cadavers for teaching anatomy.[15,16] In Saudi Arabia, efforts to teach clinical anatomy in an integrated way at one university included establishing an Anatomy Resource Centre that hosts, among others, an Anatomage, a clinical simulation centre, an ultrasound room, dissection, and various specimen rooms.[17]

Anaesthesiology registrars and consultants value anatomy teaching, although registrars mostly prefer integrated, learning-centred teaching.[6,18] A study in India described anaesthesiology registrars' satisfaction with vertical integration of anatomy in their postgraduate teaching programme.[19] Of the participating residents, 97.2% expressed overall satisfaction with the course, 94.5% indicated that the classes would be helpful in clinical practice, and 83.3% felt that the course covered mostly all the topics required for anaesthesiology practice.[19] The teaching modes preferred by South African registrars are unknown. This study aimed to establish the level of knowledge and the effective and preferred teaching modalities by anaesthesiology registrars and assess whether certain variables were associated with the level of knowledge.

Methods

Design

A comparative, interventional study was conducted using questionnaires, two teaching modalities, and pre- and post-tests.

Study population

The study population comprised postgraduate students registered as registrars in the Department of Anaesthesiology at the School of Clinical Medicine at a university in South Africa. The inclusion and exclusion criteria below were applied.

Inclusion criteria:

- Anaesthesiology registrars who were present on the days of data collection.
- Anaesthesiology registrars who gave consent to participate in the study.

Exclusion criteria:

- Anaesthesiology registrars who were not present on the day of data collection due to leave or clinical responsibilities such as working in emergency theatres, being on call that day, or the day before data collection.
- Anaesthesiology registrars who did not consent to participate in the study.

Ethical considerations

Approval to conduct the study was obtained in writing from the Health Sciences Research Ethics Committee (HSREC) of the University of the Free State (ethics approval number UFS-HSD2022/1875/2504). Approval was also obtained from the Department of Anaesthesiology, the Department of Basic Medical Sciences, and the university gatekeeper. Permission was obtained from Springer Nature and Wolters Kluwer to use copyrighted images in the learning content and tests. An information leaflet with the study information was given to participants. Voluntary completion of the questionnaire and the pre- and post-tests implied informed consent.

Measurements

Data were collected during academic time allocated by the department. The principal investigator designed a questionnaire that participants completed anonymously. It included information on participants' demographic characteristics, including age, gender, year of study, mode of anatomy teaching received in the undergraduate programme, previous anatomy exposure, and preferred mode of receiving anatomy teaching (Appendix 1).

Knowledge was assessed using a variety of applied anatomy questions. Only anatomy relevant to anaesthesiology practice was included in the questions. The principal investigator developed the questions and learning content according to Bloom's taxonomy[20] and in consultation with different stakeholders. These include a specialist anaesthesiologist and senior lecturer, a professor in health, and a lecturer and head of the anatomy division in the Department of Basic Medical Sciences.

For the pre-test, a total of 50 marks could be obtained. The first section consisted of 20 multiple choice questions (MCQ), the second consisted of two diagrams to annotate for 10 marks each, and the third section consisted of two short answer questions for five marks each. Each correct answer was scored one mark, and each incorrect answer was scored zero. No negative marking was applied. The total number of correct answers was summated for each participant and converted to a percentage. Knowledge was then graded according to the percentage scored as below average (< 50%), average (50–74%), and above average (≥ 75%).

The participants were randomly divided into two equal groups, A and B. Both groups wrote a similar pre-test. The post-test was different from the pre-test but the same for the two groups as a measure to reduce bias resulting from being assessed with the same set of questions immediately after being taught. Group A completed the pre-test and immediately received a formal lecture on anatomy before writing the post-test directly thereafter. Following the pre-test, group B received a

demonstrative lecture in the anatomy museum using cadaver specimens and ultrasound on a live model, then wrote the post-test directly after the session. The post-test results were used to compare the two teaching modalities and assess their efficacy in teaching applied anatomy.

One month later, both groups wrote another post-test to assess information retention. This test was the same for the two groups and similar to the pre-test. The two groups' performance was compared. For ethical considerations, group A received demonstrative training in the museum, and group B received a formal lecture to ensure exposure to both training modalities after the completion of data collection.

Pilot study

A pilot study involved five medical officers (not registered for postgraduate studies) in the Department of Anaesthesiology. Their data were not included in the final analysis as they were not part of the study population described. The pilot study aimed to identify potential deficiencies in the questionnaire and tests, and to make corrections before the main study. It also determined the time required to complete the questionnaire and tests and identify any mistakes or ambiguities in the documents. After the pilot study, one short-answer question was restructured, and the diagram questions were relabelled to the required total marks.

Methodological and measurement errors

Not all registrars could participate in the study, as some were on leave, off duty after working the night shift or covering emergency clinical duties. Questions might have been unclear to some participants, serving as a source of error. However, during data collection, the principal investigator and supervisor were present to clarify any unclear questions or other uncertainties.

Analysis

The data were analysed by the Department of Biostatistics at the university using the SAS program, version 9.4 (SAS Institute Inc., Cary, NC, USA). Anatomy knowledge was determined for each participant. One MCQ was excluded from test 2 due to all options being correct. The scores were categorised as below average (< 50%), average (50–74%), and above average (≥ 75%). Comparisons were made on anatomy knowledge between the two groups for each of the three tests. Numerical variables were summarised by medians, minimum and maximum. Categorical variables were summarised by frequencies and percentages. Differences between groups for categorical variables were evaluated using appropriate statistical tests (chi-square or Fisher's exact test) for unpaired data. Differences between groups for numerical variables were evaluated using the Wilcoxon two-sample test for unpaired data.

Results

In total, 14 of 24 registrars in the Department of Anaesthesiology participated in the study, representing a response rate of 58.3%. The participants' demographic, education, and clinical experience data are presented in Table I. Of the 14 participants, most were in the 30–34-years age group (n = 12, 85.7%) and were represented equally in both groups. Two participants were absent during the final part of data collection (test 3, written one month after the intervention), resulting in a total of 12 participants.

Regarding the sex distribution of the total group, most were male (n = 10, 71.4%), with a male-to-female ratio of 2.5:1. Group B comprised only male participants after randomisation. Participants had a median of 27 months (interquartile range [IQR] 18–36) experience in anaesthesiology before joining the registrar programme, and most (n = 10, 71.4%) had 6–10 years in practice since graduation from medical school. Two participants (28.6%) from each group had attended a prior applied anatomy course. Most participants were exposed to various teaching modalities as part of their undergraduate anatomy training.

Table I: Participants' demographic characteristics, experience, and education (n = 14)

Variable	*n* (%)
Sex	
Male	10 (71.4)
Female	4 (28.6)
Age (years)	
25–29	1 (7.1)
30–34	12 (85.7)
35–39	1 (7.1)
Years in practice	
6–10	10 (71.4)
> 10	4 (28.6)
Undergraduate anatomy teaching	
Dissection	13 (92.9)
Museum	12 (85.7)
Lectures	13 (92.9)
Tutorials	9 (64.3)
	Median (IQR)
Months in registrar programme	19.5 (15–21)
Months of experience in anaesthesiology before joining registrar programme	27 (18–36)

IQR – interquartile range

As shown in Table II, more than half of the participants scored below average in the pre-test (test 1) and immediate post-test (test 2). In both tests, the median scores were below 50%. Test 1's scores improved in the one-month post-test (test 3) by 22.9% and 8.3% for groups A and B, respectively. None scored above average in tests 1 and 2 in both groups, and only one participant in group A scored above average (79.2%) in test 3. Figure 1 illustrates the comparison of the two groups' performance throughout the tests in median percentage. No statistically significant difference occurred between the performance of the two groups on all three tests.

As part of the questionnaire, participants were asked to rate their anatomy knowledge. Their responses were compared with the actual scores obtained for the pre-test. Most participants rated

Table II: Comparison of the two groups' anatomy knowledge results for tests 1, 2, and 3

Group and test	Median score (%)	Below average	Average	Above average
		(< 50%) *n* (%)	(50–74%) *n* (%)	(≥ 75%) *n* (%)
Group A				
Test 1† (*n* = 7)	44.2	4 (57.1)	3 (42.9)	0 (0)
Test 2‡ (*n* = 7)	45.5	4 (57.1)	3 (42.9)	0 (0)
Test 3§ (*n* = 6)	67.1	1 (16.1)	4 (66.7)	1 (16.7)
Group B				
Test 1† (*n* = 7)	45.0	5 (71.4)	2 (28.6)	0 (0)
Test 2‡ (*n* = 7)	40.4	6 (85.7)	1 (14.3)	0 (0)
Test 3§ (*n* = 6)	53.3	3 (50.0)	3 (50.0)	0 (0)

Group A intervention – theoretical lecture, group B intervention – demonstrative lecture in the anatomy museum using a cadaver specimen and ultrasound on a live model
† pre-test
‡ post-test immediately after the intervention
§ post-test one month after the intervention

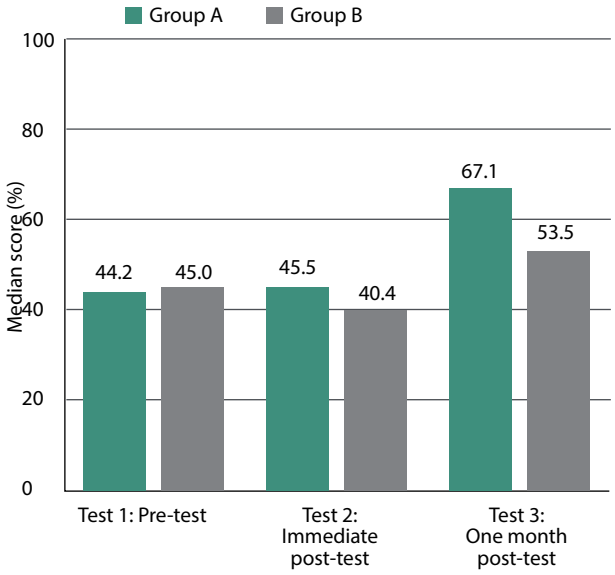

Figure 1: Comparison of test results in percentage (median) between groups A and B
Group A intervention – theoretical lecture, group B intervention – demonstrative lecture in the anatomy museum using a cadaver specimen and ultrasound on a live model

their anatomy knowledge as average, with a minority (14.3%) rating their perceived applied anatomy knowledge below average. However, 64.3% scored below average on the pre-test. The comparison between the perceived and actual anatomy knowledge is shown in Table III. One participant did not rate their anatomy knowledge; this participant scored below average on the pre-test.

Table III: Participants' perceived anatomy knowledge versus actual anatomy knowledge

Category	Perceived anatomy knowledge	Actual anatomy knowledge*
	n (%)	*n* (%)
Below average (< 50%)	2 (14.3)	9 (64.3)
Average (50–74%)	11 (78.6)	5 (35.7)
Above average (≥ 75%)	0 (0.0)	0 (0.0)
No response/rating	1 (7.1)	–

* Findings based on test 1 (pre-test) results.

When participants were asked to rate different teaching modalities as their preferred method of being taught anatomy during postgraduate studies, their responses were the simulation laboratory (*n* = 5, 35.7%), formal lectures (*n* = 4, 28.6%), tutorials (*n* = 3, 21.4%), and anatomy museum (*n* = 1, 7.1%). Two participants (14.3%) mentioned ultrasound as one of their preferred teaching methods, although it was the least preferred mode rated by most.

We compared performance according to anatomical regions and/or systems in the pre-test. Participants performed better in head and neck anatomy (median score 80.0%), followed by abdomen/pelvis/lower limb (median score 42.9%), central nervous system (median score 42.5%), cardiovascular system (median score 41.7%), and the respiratory system (median score 33.3%).

Discussion

Our participants' low levels of anatomy knowledge were in keeping with other studies involving doctors and registrars.[9,10,21] Throughout the study, there was no statistically significant difference in performance between the two groups, implying that neither of the teaching modalities was superior. The participants had been in the programme for at least 14 months and completed various rotations in the department. This pre-existing anatomy knowledge served as a confounding factor when assessing teaching modalities. Similar results were obtained in the pre-test for both groups (median 44.2% and 45.0%). Contrary to expectation, performance did not improve in the post-test taken immediately after the intervention (test 2). However, these results should be interpreted with caution as this test was different from the first one, so one cannot draw a reasonable conclusion regarding teaching modes and test 2 results.

In the test assessing information retention at one-month post-training (test 3, similar to the pre-test), participants' performance

improved compared with the pre-test. While there was no statistically significant difference between the two groups' performance in test 3, there was a 14% difference in the results (53.0% vs. 67.1%). Previous studies compared anatomy knowledge retention in undergraduate students at six months and postgraduate students at 18 months, finding no clinically significant improvement.[22,23] Prior studies failed to assess anatomy retention at one month.

The study participants were all junior registrars with similar years in practice since graduation. However, they had diverse anaesthesiology exposure before joining the registrar programme, which was equally represented between the two groups. Participants seemed to have had similar exposure to undergraduate teaching modes, mainly lectures, dissection, and museum cadaver specimens. Surprisingly, one participant did not indicate lectures as part of their undergraduate teaching. The association between anatomy knowledge and a participant's sex could not be assessed due to the asymmetrical distribution in the groups after randomisation, with all group B participants being male. However, one study found no association between sex and anatomy knowledge.[24]

Because of the small sample size, we could not establish a relationship between the level of anatomy knowledge and year of study, previous experience in anaesthesiology, or years of general clinical experience. An association between seniority and being more knowledgeable in anatomy has been reported by a single study, which was attributed to clinical experience and intense academic training.[8]

Of the 11 participants who perceived their anatomy knowledge as average, six (54.5%) obtained below-average scores in the pre-test. This was concerning because students who perceive themselves as having adequate knowledge are less likely to engage in activities that enhance their knowledge and are more likely to cause harm without realising it, referred to as the Dunning–Kruger effect.[25] Only two participants rated their anatomy knowledge below average and scored below average in the pre-test.

In our study, participants preferred various teaching modalities, with the simulation laboratory being the most popular and ultrasound the least. It has been reported in the literature that using simulation and dissection laboratories in addition to lectures yields favourable results in applied anatomy courses preparing doctors for different specialities.[26] Although surprisingly not popular in our study, ultrasound plays an invaluable role in an anaesthesiologist's clinical practice. Most of the anaesthesiologist's applied anatomy in clinical practice involves sonography and identifying sonoanatomy to perform procedures such as regional anaesthesia, vascular access, and cardiac assessment. While few studies investigated the role of simulation and ultrasound as teaching modalities in anaesthesiology registrars, they seem to elicit positive results in both registrars and undergraduate students.[27,28] Kathrada et al.[29] encouraged the incorporation of ultrasound in the training curriculum of anaesthesiologists in South Africa.

Radiology and prosection benefit students and anatomists, although not to the same extent as dissection.[16] On the contrary, undergraduate students in India rated a three-dimensional (3D) anatomy atlas as their preferred mode of teaching, followed by plastic models and, lastly, human cadavers. They also believed that imaging modalities, such as ultrasound, aided their understanding of the subject.[30] Our participants' choice of simulation as a preferred teaching mode could be attributed to the clinical nature of the applied anatomy employed in daily practice, as opposed to undergraduate medical students and anatomists who mostly learn gross anatomy and prefer dissection.

The findings of superior head and neck anatomy performance in the pre-test compared with other regions and/or systems could be attributed to anaesthesiology registrars being exposed to more general anaesthesia than regional anaesthesia during their daily clinical work. For general anaesthesia, registrars are more likely to revise head and neck anatomy as they secure the airway, obtain central venous access, or perform blocks involving the head and neck. The worst performance on the respiratory system could be because, by 19.5 months in the programme, most registrars have not rotated through the cardiothoracic block and hence would not easily answer most of the cardiorespiratory questions equally.

Regarding information retention, one study portrayed dissection and cadavers as effective means of teaching anatomy.[14] Limited research has been conducted concerning when and for how long anaesthesiology registrars should receive teaching in anatomy. In Waterston et al.'s[3] study, clinicians in all disciplines, anaesthesiologists included, believed that anatomy teaching should be continuous throughout medical school. Moreover, it has been proven that clinical integration, continuous education programmes, and problem-based education improve anatomy knowledge. Other doctors indicated that although their anatomy knowledge was adequate, they valued continuing anatomy education through refresher courses.[14]

These findings imply the need for a well-structured postgraduate training curriculum to address the lack of anatomy knowledge among anaesthesiology registrars. This curriculum would have to allow continuous education throughout the training period and include various teaching modalities identified by stakeholders at South African universities, emphasising methods to recurrently evaluate knowledge retention.

Study limitations

At the time of preparing the research protocol, there were 32 registrars at the Department of Anaesthesiology. However, at the time of data collection, some registrars had qualified and did not meet the inclusion criteria as registered registrars in the department. Only 24 registrars fulfilled the inclusion criteria, resulting in a small sample size. Consequently, a reliable conclusion could not be drawn between the level of anatomy knowledge and some variables of the study, and the findings are not generalisable.

Only junior registrars, defined as registrars in the first two years of their four-year training, were available on the day of data collection. It would have been meaningful to have data on the difference between results obtained by junior and senior registrars to give an overview of anatomy knowledge across the entire trainee group.

Despite obtaining expert input while formulating the assessment questions, our study ignored the fact that these were not standardised questions and, hence, could be ambiguous or misinterpreted by participants, leading to errors in the results.

Conclusion

A lack of adequate applied anatomy knowledge was evident among anaesthesiology registrars. We recommend a formal, structured programme aligned with the new Colleges of Medicine South Africa (CMSA) Part I Curriculum for anaesthesiology registrars.[31] We also encourage an integrated approach to teaching applied anatomy to anaesthesiology registrars. Although the sample size was a limitation, this study is a foundation for further studies of larger samples to validate our findings.

Conflict of interest

The authors declare no conflict of interest.

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Ethical approval

The authors declare that this submission follows the Responsible Research Publication Position Statements principles developed at the 2nd World Conference on Research Integrity in Singapore, 2010. Approval to conduct the study was obtained from the Health Sciences Research Ethics Committee (HSREC) of the University of the Free State (ethical clearance number UFS-HSD2022/1875/2504).

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ORIGINAL RESEARCH

Prevalence of vitamin D deficiency among anaesthesia providers at an academic hospital complex in South Africa

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Background: The primary source of vitamin D is skin exposure to sunlight. Vitamin D deficiency is common in people who have decreased sun exposure. Acute vitamin D deficiency symptoms are mild and non-specific, but the long-term sequelae of deficiency are extensive, severe, and easily preventable. Anaesthetists spend a large portion of their days working indoors and are at risk of developing vitamin D deficiency. This study aimed to determine the prevalence of vitamin D deficiency among anaesthetists at the Universitas Academic Hospital (UAH) complex, Bloemfontein, South Africa, and to correlate deficiency with known risk factors.

Methods: A descriptive cross-sectional study was conducted on doctors who provide anaesthesia daily at UAH. The study was explained during an academic meeting, and members were invited to participate. On the scheduled date, consent was obtained from participants. Blood was drawn for laboratory analysis. Participants completed a questionnaire regarding the risk factors. They received an informational poster and had access to their results if requested. Data were analysed, and the chi-square and Fischer's exact tests were used to determine if there was any significant association between vitamin D levels and categorical data.

Results: A total of 33 staff members from the Department of Anaesthesiology volunteered to participate in the study. An overall deficiency rate of 39.4% was found, with only one in five participants having sufficient vitamin D levels. The only factor that demonstrated a statistically significant correlation with deficiency was age ($p = 0.03$), but this study lacked sufficient power to make any conclusions.

Conclusion: Vitamin D deficiency is prevalent among anaesthetists at UAH. Awareness should be raised regarding deficiency in this group, and an increase in age is correlated with a higher risk for deficiency.

Keywords: vitamin D, deficiency, anaesthetists, sun exposure, risk factors

Introduction

Vitamin D, an essential nutrient, is a fat-soluble vitamin and hormone. It is mainly derived from exposure of the skin to sunlight. Its major role in the body is maintaining calcium homeostasis. However, every cell in the body contains receptors for vitamin D, so its effects are diverse.[1,2]

The primary source of vitamin D is sun exposure. Up to 90% of daily vitamin D production involves exposure to ultraviolet B sunrays.[3] This leads to the production of pro-vitamin D (cholecalciferol), which is converted by the liver and kidneys to its active form, 1,25-dihydroxyvitamin D.[1,2] Dietary sources of vitamin D include mushrooms, fatty fish, fish liver oils, eggs, and fortified dairy products.[4] It is absorbed from the gastrointestinal tract in the form of vitamin D_2 (ergocalciferol), which only has a third of the potency of cholecalciferol and accounts for 10–20% of daily vitamin D intake.[5]

The clinical effects of vitamin D deficiency are subtle but may be devastating in the long term, and multiple systems are affected. The acute symptoms of vitamin D deficiency are non-specific, and most patients do not seek medical attention. These symptoms include joint and muscle pain, weakness/tiredness, diarrhoea, headaches, depressed mood, recurrent infections, and delayed wound healing.[4,6] The long-term effects of vitamin D deficiency are multisystemic and can be severe. Systems where vitamin D plays a direct role in its development or affects the treatment of diseases include the skeletal, cardiovascular, and central nervous systems. It also plays a role in preventing malignancies and supporting immune function.[4,9,12-17]

The recommended daily vitamin D intake is approximately 600–800 international units (IU).[6] Certain populations may need higher levels, such as the elderly, children, and pregnant women.[2,7] The amount of sunlight needed to produce this level of vitamin D equates to one hour per day of direct exposure to sunlight on exposed limbs.[6] Dietary supplementations of vitamin D are available, but their use in South Africa is limited.[8]

The prevalence of vitamin D deficiency in the general population is estimated at around 24% in the United States of America (USA), 37% in Canada, and 40% in Europe.[9,10] In the South African population, a prevalence of 5–28% has been reported, with substantial variation in the prevalence depending on the province and population groups studied.[8] It has also been documented that indoor workers generally have lower vitamin D levels than those who work outdoors.[3]

Risk factors for the development of vitamin D deficiency include decreased exposure to sunlight (indoor work, sunblock use, darker skin tones), female gender, decreased dietary intake of vitamin D, obesity, age, smoking, pregnancy and breastfeeding, chronic liver and kidney disease, and certain medications (e.g.

glucocorticoids, antiepileptics, antifungals, and antiretroviral agents).[2,4,8,9,12]

In the medical field, medical residents and students are among the groups with the lowest vitamin D levels.[3] Only one study has demonstrated the extent of the disease in the field of anaesthesia. A single-centre study conducted in Chile showed a 12% deficiency rate among their study population during the summer months, which escalated to 67% during winter.[11]

Vitamin D deficiency commonly occurs in people with decreased sunlight exposure, such as indoor workers.[3] Anaesthetists spend most of their day working indoors, without even early morning or late afternoon sun exposure. Therefore, it is logical to assume that they would be at risk of developing a deficiency of this multisystemic vitamin. This study aimed to determine the prevalence of vitamin D deficiency in the anaesthetic workforce at the Universitas Academic Hospital (UAH) in Bloemfontein, South Africa.

Methods

Ethical considerations

A descriptive cross-sectional study was conducted, for which ethical approval was obtained from the Health Sciences Research Ethics Committee of the University of the Free State (reference number: UFS-HSD2021/1216/3011). Permission for the research was provided by the Head of the Department of Anaesthesiology, University of the Free State, for including registrars (registered students), and the Free State Department of Health for including staff members. All the participants provided written, informed consent for inclusion in the study. Participation was voluntary and anonymous, with the choice to withdraw at any stage without consequences.

Methods and information distribution

Blood specimens were collected to achieve the study's primary objective, determining the vitamin D levels of anaesthesia providers at UAH and ascertaining the prevalence of deficiency. To address the study's secondary objective, determining the presence of risk factors (as identified in the literature), a questionnaire was compiled to generate information to correlate these risk factors with the blood levels of vitamin D. The questionnaire was validated on a content-basis by the authors in line with published information.

The study details were presented and discussed during a weekly academic meeting. Staff members received an explanation of the planned research and how it would be conducted and had the opportunity to sign up for the study. Members who indicated that they would participate received an email with details regarding the dates of the phlebotomy, an electronic consent form, a questionnaire, and an informational vitamin D poster.[19] The first session to collect blood samples was scheduled one week after the initial presentation. Specimen collection was performed in February 2022 during the summer season.

Inclusion and exclusion criteria

All staff members in the Department of Anaesthesiology at the University of the Free State who were involved with daily anaesthesia provision in UAH at the time of the study were eligible to participate. Convenience sampling was applied as the population was readily available and volunteered upon request to participate in the study. The size of the population was unknown due to large variations in the department's size during the data collection. No sample size calculation was required.

The exclusion criteria were the following: any person with known renal or liver disease, being on leave two weeks before blood specimen collection, refusing to participate in the study, and being younger than 18 years.

Collection and processing of blood specimens

On the day of blood sample collection, a laboratory phlebotomist set up a phlebotomy station at the Department of Anaesthesiology. Participants were then called two at a time from the academic meeting for sample collection. A blood specimen was taken from each participant after written consent was obtained. Participants also had the opportunity to complete the questionnaire if it had not already been done online. The informational poster was also on display. Blood was drawn by the phlebotomist under the supervision of the principal investigator to ensure the correct technique was applied.[20]

Each specimen and questionnaire was marked with a corresponding number. The lead investigator noted each participant's unique specimen number on a separate page for confidential safekeeping. The laboratory had no identifying information other than the unique number. Participants were given their unique specimen number and information so they could contact the laboratory or principal researcher for their results.

The blood specimens were processed according to World Health Organization (WHO) procedures and recommendations.[18] The current classification of vitamin D deficiency proposed by the USA Endocrine Society, as shown in Table I, was used to identify deficiency.[2,6,18] The lead investigator entered the results into a Microsoft Excel (version 2016) spreadsheet along with the corresponding questionnaire answers for each specimen. The same process was repeated two weeks later to accommodate participants who could not attend the first specimen collection opportunity.

Table I: USA Endocrine Society classification of vitamin D deficiency[2,6,18]

Classification	Serum vitamin D level (ng/ml)
Deficient	< 20
Insufficient	21–29
Sufficient	> 30
Toxic	> 150

ng/ml – nanogram per millilitre

Table II: Demographic information of participants and prevalence of vitamin D deficiency

Variable	Distribution of participants per variable (*n* = 33)	Participants per variable with vitamin D deficiency
	n (%)	*n* (%)
Age (years)		
< 25	1 (3.0)	1 (100)
25–30	7 (21.2)	4 (57.1)
31–40	18 (54.5)	7 (38.9)
41–50	4 (12.1)	0 (0)
> 50	3 (9.1)	1 (33.3)
Gender		
Male	18 (54.5)	7 (38.8)
Female	15 (45.5)	6 (40.0)
Race		
African	7 (21.2)	4 (57.1)
Coloured	2 (6.1)	1 (50.0)
Indian	3 (9.1)	2 (66.7)
White	21 (63.6)	6 (28.6)
BMI (kg/m²)		
18–24.9 (normal weight)	13 (39.4)	4 (30.5)
25–29.9 (overweight)	12 (36.4)	5 (41.7)
30–34.9 (obese class I)	5 (15.2)	4 (80.0)
35–40 (obese class II)	3 (9.1)	0 (0)
Rank		
Consultant	8 (24.2)	2 (25.0)
Senior registrar	13 (39.4)	4 (30.8)
Junior registrar	6 (18.2)	4 (66.7)
Medical officer	1 (3.0)	0 (0)
Intern	5 (15.2)	3 (60.0)
Experience as anaesthetist (years)		
< 1	4 (12.1)	2 (50.0)
1–5	9 (27.3)	3 (33.3)
5–10	13 (39.4)	6 (46.2)
> 10	7 (21.2)	2 (28.6)

BMI – body mass index, kg/m² – kilogram per metre squared

Table III: Questionnaire results on factors that may influence vitamin D levels

Variable	Distribution of participants per variable (*n* = 33)	Participants per variable with vitamin D deficiency
	n (%)	*n* (%)
Smoking		
Current	4 (12.1)	3 (75.0)
Ex-smoker	2 (6.1)	0 (0)
Non-smoker	27 (81.8)	10 (37.0)
Sun exposure		
< 1 hour per day	25 (75.8)	3 (12.0)
1–3 hours per day	8 (24.4)	
Daily sunscreen use		
Yes	9 (27.3)	5 (55.6)
No	24 (72.7)	8 (33.3)
Previously tested for vitamin D levels		
Yes	9 (27.3)	2 (22.2)
No	24 (72.2)	11 (45.8)
Previous results when tested		
Deficient	5 (15.2)	1 (20.0)
Insufficient	4 (12.1)	1 (25.0)
Not applicable	24 (72.2)	11 (45.8)
Supplementation use		
Multivitamin	8 (24.2)	3 (37.5)
Vitamin D	3 (9.1)	0 (0)
None	22 (66.7)	10 (45.5)
Vitamin D supplementation (IU/day)		
0–300	6 (18.1)	3 (50.0)
301–600	4 (12.1)	0 (0)
601–800	0 (0)	0 (0)
> 800	1 (3.0)	0 (0)
None	22 (66.7)	10 (45.5)
Previously wondered about vitamin D deficiency		
In the preceding year	11 (33.3)	2 (18.2)
When tested before	7 (21.2)	2 (28.6)
Never	15 (45.5)	9 (60.0)
Food consumed		
Fish	5 (15.2)	3 (60.0)
Cod liver oil	1 (3.0)	1 (100)
Eggs	19 (57.6)	8 (42.1)
Mushrooms	14 (24.4)	4 (28.6)
Dairy	16 (48.5)	6 (37.5)

IU/day – international units per day

Data collection and analysis

The data sheet with the final specimen results and corresponding questionnaire answers was processed and analysed by the Department of Biostatistics, University of the Free State. Descriptive statistics were determined. Blood levels of vitamin D and categorical data were expressed as frequencies and percentages. The vitamin D levels were then compared with responses to the questionnaire items to identify any associations between risk factors and vitamin D levels. The data were subjected to chi-square and Fischer's exact tests to analyse categorical data to determine whether any significant association occurred between vitamin D levels and categorical data. Significance was expressed as a *p*-value of less than 0.05. The Kolmogorov–Smirnov test was used to determine whether the data were normally distributed. The statistical software package used for analysis was SAS version 9.4 (SAS Institute, Cary, USA).

Results

A total of 33 out of a potential 42 staff members participated in the study, giving a response rate of 78%. Of the 33 participants,

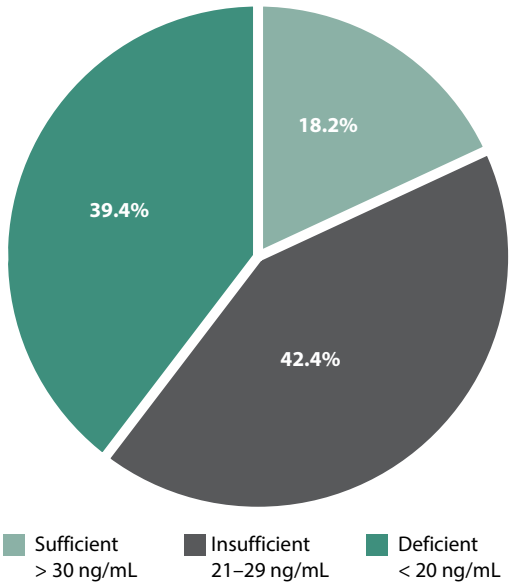

Figure 1: Distribution of participants (n = 33) according to vitamin D levels; toxic levels of vitamin D (> 150 ng/ml) were not observed in any of the participants

13 (39.4%) had deficient vitamin D levels (confidence interval 0.22 to 0.56). Only six (18.2%) participants had sufficient vitamin D levels. The mean vitamin D plasma level was 22.7 ng/ml, with a standard deviation of 7.7 ng/ml. The lowest recorded value was 10.5 ng/ml, and the highest was 41.9 ng/ml.

Figure 1 illustrates the distribution of participants according to the classification of vitamin D levels. Tables II and III summarise the participants' demographic information, the prevalence of vitamin D deficiency, and the questionnaire results. Table IV shows associations between risk factors and vitamin D deficiency.

Discussion

The prevalence of vitamin D deficiency in this study population was 39.4% (Figure 1), which was in keeping with findings reported for the general population (not necessarily high-risk groups) in the USA, Canada, and Europe (range 28–40%).[9,10] However, the prevalence was notably higher than recorded in previous South African studies, with ranges of 5–28.6%.[8] Our data were collected in the summer, during February. By implication, generally higher levels of vitamin D would be expected because of the potentially increased exposure to sunlight, a major factor in vitamin D synthesis. Therefore, it was concerning to find deficiency values similar to or lower than those in the other studies. These studies involved the general population and not necessarily high-risk groups, the medical community, or anaesthetists, which complicated the comparison and relating of the results.[8-10] There was also a variation in the units in which vitamin D levels were measured, leading to difficulty in comparison.

Compared to the Chilean study on anaesthetists reporting a deficiency rate of 12% during the summer months, we found a notably higher prevalence.[11] However, this comparison did not consider the difference in altitude between the two countries. As Chile has a higher altitude (1 871 m above sea level, consequently closer to the sun with less dense air), it might have played a role in the fact that they found a lower prevalence of vitamin D deficiency compared to Bloemfontein (1 395 m above sea level). This explanation is echoed by the systematic review of South African studies, reporting that coastal provinces (at lower altitudes) tended to have a higher prevalence of vitamin D deficiency than inland provinces (at higher altitudes).[8]

An increase of 55% in the deficiency rate to 67% was reported when studies were repeated in the winter months.[8] A South African study conducted during winter demonstrated a deficiency rate of 57.3%.[21] As this study used a different classification system for deficiencies, no direct comparison could be made with our results, although it is likely that a potentially increased prevalence would be observed in winter.[21] Consequently, it could be concluded that anaesthetists working in this hospital complex are at risk of developing vitamin D deficiency. Awareness should be raised to alert anaesthetists to the potential risk. It may also be true for other specialities working under similar conditions, i.e. starting work early in the morning and only leaving the building at night or late afternoon on working days, including some weekends.

Table II shows that 54.5% of the participants were male and in the 31–40 age group. In the group of participants with vitamin D deficiency, 53.8% were male. Age was statistically associated with vitamin D deficiency (p = 0.03). According to the literature, vitamin D deficiency is more prevalent among the elderly, although not many participants in our study were in this category.[2] Most participants were aged 18–29 years (n = 25, 75.8%), which could have led to some bias regarding the results. A steady increase in the number of deficient participants was observed with increasing age (Table II). The sudden drop in the prevalence of vitamin D deficiency after age 40 could mainly be attributed to the lack of data. Thus, it is prudent to repeat the study with more anaesthetists in advanced age groups and to raise awareness in this subgroup.

Most participants (63.6%) identified themselves as white (Table II), the skin colour that permits more sunlight to penetrate the skin and allows for increased vitamin D production.[6] Darker skin tones are more likely to have vitamin D deficiency.[2,4,6,8,9,12] However, the few participants from darker race groups and the lack of power in the data resulted in insufficient data, preventing corroboration of our findings with previously published findings. Furthermore, race as a surrogate for skin tone is not always accurate.

Most participants classified themselves as having a normal body mass index (BMI) of 18–24.9 kg/m^2. Obese individuals are at a higher risk of developing vitamin D deficiency.[2,4,8,9,12,14] The group with the highest percentage of vitamin D deficient participants was the 25–29.9 kg/m^2 BMI group. This study did not perform formal weight and height measurements to calculate participants' BMI; they were requested to select their BMI category on the questionnaire, which might have led to biased results.

Most participants were senior staff members (consultants and senior registrars) or had more than five years of experience in anaesthesia. Their prolonged indoor work could have contributed to developing chronic complications of vitamin D deficiency. However, as shown in Table II, more deficient levels occurred in the registrar group (both senior and junior) and participants with 5–10 years' experience in the field.

Of the 27 non-smokers in this study, 10 had vitamin D deficiency (Table IV). Although smoking increases the risk for vitamin D deficiency, no significant association was found in this group ($p = 0.39$).[14]

Three-quarters of participants indicated exposure to sunlight for less than one hour per day (Table III), the minimum amount of sun exposure needed to produce sufficient levels of vitamin D.[6] None of the participants indicated that they had more than three hours of direct sun exposure a day. An association was expected because sun exposure is the main contributor to vitamin D production. Participants might have been more exposed to sunlight than they noticed (driving to work or weekend outdoor activities). The questionnaire did not further probe sun exposure, and it was not objectively measured. The study was also conducted during the summer, with longer daylight time, increasing the potential of sun exposure. Most participants do not apply sunscreen daily (72.7%). Deficiency was higher in the group that did use sunscreen daily.

Only nine participants had previous vitamin D testing done, five of whom had previously been diagnosed with deficiency, while the remaining four had insufficient levels. Of the participants, 11 used dietary supplementation, eight took multivitamins, and three specifically used vitamin D supplements. Only five of these supplementations contained adequate amounts of vitamin D (> 600 IU/tablet/day, Table III). However, the deficiency prevalence increased as less supplemental vitamin D was taken, and a significant association might have been observed in a larger study population.

Nearly half of the participants (45.5%) had never considered their vitamin D status before the study, while a third started wondering in the preceding year (Table III). The questionnaire responses were limited and could have influenced the results.

Eggs were the most consumed vitamin D-containing food, followed by fortified dairy products and mushrooms. The least consumed food group was cod liver oil, with two participants indicating they did not know what it was. The lower intake of fish-based food could be attributed to the study population being from an inland province with limited access to fresh fish produce (Table III).

Study limitations

The study population was small, limiting the ability to significantly associate possible contributing factors with vitamin D deficiency. Age showed a significant association, but the lack of data among participants aged 40 years and older and the lack of powering of data restricted the interpretation. The study was conducted in summer with no comparative winter data. It is likely that a higher prevalence of deficiency will occur in winter.

The study population only consisted of doctors working in the public sector in Bloemfontein and did not include private sector practitioners or anaesthesia providers in other locations. Literature about the extent of deficiency is limited in this specific field of medicine. Furthermore, this study only focused on anaesthetists and did not include other medical specialities or axillary staff who may have similar deficiencies. Medication use, which could be a potential risk factor, was not considered.

The limited options provided on the questionnaire might have restricted it in an effort to increase compliance. Expansion of the questionnaire may yield improved responses and data distribution. Initially, the aim was to determine a correlation between vitamin D levels and risk factors as a secondary objective; however, this was not possible due to our small sample size and the inability to power the study due to variations in the size of the population during data collection.

Recommendations for future research

The study should be repeated during winter to assess the effect of seasons on this specific population. Other hospitals (including the private sector) in the province/country should be recruited to increase the study population and the data pool to determine associations between vitamin D deficiency and possible risks. Research can also be performed to investigate vitamin D deficiency symptoms in this population and its associated long-term complications.

Other branches of medicine can be approached to participate in a similar study to determine whether the entire medical community is at risk of developing deficiency, or if certain specialities are at higher or lesser risk (e.g. radiologists who exclusively work indoors and specialities working shorter hours indoors).

The questionnaire should be expanded to obtain more information regarding the risks of developing vitamin D deficiency. A follow-up study should be conducted to reassess the vitamin D status of department staff after they were exposed to an awareness campaign, such as the informational poster, to assess the effectiveness of this method in preventing vitamin D deficiency.

Conclusion

Anaesthetists in this academic hospital complex are at risk of developing vitamin D deficiency, with only one in five having sufficient vitamin D levels. The prevalence of deficiency was higher (39.4%) than previously reported in Chile (12%), the general population of the USA (24%), and South Africa (5–28%). The prevalence was in keeping with findings in European and Canadian studies. A potential association between vitamin D deficiency and an increase in age was observed, but adequately powered data are needed to make further conclusions. Thus, it is imperative to raise awareness regarding the signs, symptoms,

and prevention of vitamin D deficiency amongst anaesthetists to prevent the consequences of long-term deficiency and related subsequent medical conditions.

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REVIEW

A review of anti-obesity medications and anaesthesia

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The growing use of anti-obesity medications (AOM) in an expanding population of overweight and obese patients renders these drugs of importance to the anaesthesiologist. We review the current pharmacotherapy available in South Africa, the drugs' mechanism of action (MOA), and their potential interactions and implications with various anaesthetic agents during the perioperative period.

Keywords: anti-obesity medications, anaesthesia

Introduction

Obesity is one of the fastest-growing healthcare problems of our time, with the global prevalence tripling since 1975.[1-3] In South Africa, 68% of women and 31% of men are overweight or obese.[4] These patients have a higher prevalence of cardiovascular, respiratory, endocrine (e.g. diabetes mellitus), musculoskeletal disorders and certain cancers.[5,6] AOMs, though currently under-prescribed, are increasingly utilised in this group to achieve weight loss and improve health.[7,8]

The increasing number of obese and overweight patients using AOMs and presenting for surgery means anaesthesiologists need a thorough understanding of the drugs and their effects. There has been much recent interest in the literature on the impact of glucagon-like peptide-1 (GLP-1) receptor agonists on anaesthesia, and there is older evidence regarding the impact of sympathomimetics perioperatively.[9-13] This review examines all current AOMs available in South Africa, their MOA, potential interaction with anaesthetic agents, and impact on safe anaesthesia practice.

Physiology of appetite

Weight regulation is a balance between energy expenditure and energy intake. Energy expenditure is a combination of resting basal metabolism and energy to metabolise food and perform activities.[14] Energy intake is food consumed. There is a balance between appetite and satiety, with nervous and endocrine systems integral to regulating expenditure and intake, and both central and peripheral mechanisms contribute.

The hypothalamus coordinates with the limbic, cortical, and autonomic centres centrally, and it receives peripheral inputs from the gastrointestinal tract (GIT), pancreas, liver, adipocytes, leptin, and vagus nerve.[2,5-7,16-18] The mesolimbic reward pathways interact with hypothalamic control. Increased sugar and fat intake disrupt homeostasis. Thus, emotional eating or food addiction is mitigated by neurochemistry. The chief neurotransmitter in this area is dopamine; however, opioids, gamma-aminobutyric acid (GABA), glutamate, orexin, and nicotinic cholinergic receptors have also been identified.[18] Serotonin is also a hedonistic input, and it is associated with appetite suppression and may explain why mood affects appetite.[16-19]

Peripheral inputs arise from the liver, pancreas, GIT, and adipocytes. Acute regulators are released in response to food intake, and longer-term hormones are produced in response to energy stores.[2,15,18] Communication between the central and peripheral components of the neuroendocrine system occurs via a combination of the vagus nerve, nucleus tractus solitarius, and the circulation transporting hormones.[18] Some of the peripheral inputs include (listed anatomically):

- Ghrelin, the "hunger hormone", secreted by the stomach and stimulates appetite.
- Cholecystokinin (CCK), secreted by the intestine, slows gastric emptying, stimulates gallbladder contraction, and leads to satiety.[2,15]
- Glucose-dependent insulinotropic polypeptide (GIP), released by the proximal duodenum and stimulates satiety.
- Pancreatic polypeptide, produced by the pancreas in response to intake, slows gastric emptying, and suppresses hunger.
- Fibroblast growth factor 21 (FGF21), secreted in response to fasting. It is implicated in the preference for sweet foods.[2,15]
- GLP-1, secreted in the distal bowel, acts on the hypothalamus to decrease appetite, slow gastric emptying, stimulate insulin release, and inhibit gluconeogenesis.
- Peptide YY (PYY), has similar effects to GLP-1.
- Oxyntomodulin (OXM), released by the GIT, activates GLP-1 and glucagon receptors.
- Cocaine- and amphetamine-regulated transcript (CART), released in the hypothalamus in response to nutrient absorption information and suppresses appetite.[19]

- Leptin, secreted by adipocytes, gastric mucosa, and enterocytes, and signals satiety. It also activates sympathetic outflow to increase energy expenditure.[15,16,18]
- Insulin, secreted in response to increased adipocytes, leads to reduced food intake via central mechanisms.[19]
- Amylin, secreted by the pancreas, regulates the mesolimbic dopaminergic response to food intake.[2,15,18]

In summary, energy balance is under a complex web of endocrine controls with multiple pathways coexisting.

Anti-obesity medications

Weight loss occurs when energy expenditure exceeds energy intake. AOMs reduce hunger and increase satiety, leading to a reduction in energy intake. They all work via central mechanisms, affecting the nervous system and neurochemistry, except for the lipase inhibitor, orlistat, which works exclusively in the GIT.[16]

AOMs are registered for use in obese patients with a body mass index (BMI) > 30 kg/m^2 or in overweight individuals with a BMI > 27 kg/m^2 with more than one comorbidity related to their weight, such as hypertension, diabetes, or non-alcoholic fatty liver disease.[19] Despite these United States Obesity Working Group recommendations, AOMs are utilised in only 3% of the applicable population.[18] This may be due to clinician ignorance, cost, or side effects.[18] This will likely change due to research and growing demand from an expanding patient population.[6]

A drug is an effective AOM if its use for one year results in at least a 6% reduction in total body weight (TBW). Most drugs need to be used in combination therapy to cause greater weight loss.[17-19] Many of these drugs have side effects related to their MOA, which, together with potential drug interactions, should be considered in the perioperative period. AOMs are discussed below, with a summary provided in Table I.

Peripherally acting agents

Lipase inhibitors

Orlistat (Xenical) is a pancreatic lipase inhibitor that acts on lipase released within the GIT, preventing lipid breakdown and fat uptake. Lipid is lost undigested in the stool. This drug is registered for long-term use and is affordable, but it may only be beneficial for those eating high-fat diets. As monotherapy, its effect is a modest 3% loss of TBW [2,7,18,20]

Orlistat has numerous GIT side effects: flatulence, faecal incontinence, abdominal cramps, and the decreased absorption of fat-soluble vitamins and medications. Therefore, it is contraindicated in patients who have undergone gastric bypass surgery.[2,7,18,20] Anaesthetic considerations are the reduction in vitamin K-dependent coagulation factors and, thus, increased blood loss during surgery.[20]

Centrally acting agents

Glucagon-like peptide-1 receptor agonists

Liraglutide (Saxenda, Victoza) and semaglutide (Ozempic, Wegovy) mimic hormones produced by the L-cells of the distal small intestine. They bind to receptors both centrally and in the gut, causing satiety and reducing gastric emptying.[2] By slowing stomach emptying and inhibiting postprandial acid secretion, they act as an ileal brake and further prolong gut transit times.[9] Liraglutide is the most efficacious drug of all the AOMs as monotherapy, with an average reduction of 8% in TBW. These drugs are the most expensive AOMs.[7]

Side effects commonly include fatigue, headaches, nausea, and abdominal cramps. Pancreatitis, thyroid C-cell cancers, tachycardia, and renal impairment can occur less frequently. This group is contraindicated in patients with a personal or family history of pancreatitis, thyroid malignancy, or multiple endocrine neoplasia (MEN) syndromes.[2,7]

Delayed gastric emptying from GLP-1 receptor agonists must be considered in the perioperative period.[9-11] Studies indicate solid gastric content within the stomach well beyond the current fasting guidelines of six hours. Aspiration of gastric contents during anaesthesia is a pertinent concern, but there are conflicting opinions at present.[9,21-23] Current American Society of Anesthesiologists (ASA) guidelines suggest stopping these drugs for seven days before elective surgery in agents employed weekly or for 24 hours in those administered daily.[23]

The Australian and New Zealand College of Anaesthetists (ANZCA) guidelines indicate insufficient evidence to support the cessation of GLP-1 receptor agonists before anaesthesia, as the duration of delayed gastric emptying is unknown and may be several weeks. They recommend that patients using daily injections omit these for 24 hours before anaesthesia but that all patients using these medications within four weeks preceding anaesthesia be managed per local protocols for the unfasted state. They further highlight that the absence of GIT symptoms as a side effect of GLP-1 receptor agonists does not preclude significant retention of gastric contents and aspiration risk in supposedly fasted patients.[25] They suggest a preoperative gastric ultrasound to quantify stomach contents may help the clinician to risk stratify patients. [24,25]

Preoperatively, it is also important to consider nutritional status. Patients actively losing weight are in a catabolic state and may have limited fat-soluble vitamins, iron, and protein, which may all impair wound healing and predispose them to sepsis.[20]

Opioid receptor antagonists and dopamine-noradrenaline reuptake inhibitors

Naltrexone/bupropion (Contrave) is a combination drug that contains an opioid receptor antagonist, naltrexone, and a dopamine-noradrenaline reuptake inhibitor (DNRI), bupropion. Naltrexone is commonly used to manage long-term opiate addiction. It is also thought to inhibit the reward centres involved

Table I: Current anti-obesity medications

Drug	Trade names	Mechanism of action	Contraindications	Side effects	Drug interactions	Cost ±	Dose	Formulation
Orlistat	Xenical	Lipase inhibitor	Short gut syndrome, post gastric bypass	Gastrointestinal tract side effects Vitamin A, D, E, and K deficiency	Anti-coagulants	R17.31 to R51.93 per day	Up to 120 mg three times daily	Oral
Naltrexone Buproprion	Contrave	Opioid antagonist and dopamine/noradrenaline reuptake inhibitor	Hypertension Seizures Drug or alcohol abuse	Hypertension Seizures Hepatoxicity Nausea and vomiting	Opioids Monoamine oxidase inhibitors	R11.90 per day	8 mg/90 mg daily	Oral
Liraglutide Semaglutide	Saxenda Victoza Ozempic	Glucagon-like peptide-1 agonists	Multiple endocrine neoplasia Thyroid malignancy Pancreatitis	Headache Nausea Vomiting Diarrhoea	Warfarin may affect absorption of other oral medications	R995.49 to R6 000 per week Some not available in South Africa	0.6–3 mg weekly 0.5–2 mg weekly 3–14 mg daily	Subcutaneous injection Oral
Phentermine	Duromine	Sympathomimetic amine	Ischaemic heart disease Hypertension	Hypertension Anxiety Dizziness Insomnia	Alcohol Monoamine oxidase inhibitors	R18.24 to R36.48 per day	15–30 mg daily	Oral
Lisdexamfetamine	Vyvanse	Amphetamine prodrug	Phaeochromocytoma Cardiovascular disease	Hypertension Tachycardia Insomnia Irritability Anxiety	Monoamine oxidase inhibitors Selective serotonin reuptake inhibitors	R36.47 per day	70 mg daily	Oral
Metformin	Glucophage	Biguanide	Renal impairment	Hypoglycaemia Nausea Vomiting	Alcohol Corticosteroids	R0.82 to R3.50 per day	500–2 000 mg daily	Oral
Dapagliflozin Empagliflozin	Forxiga Jardiance	Sodium-glucose linked_ transporter Alpha-inhibitors	Renal impairment	Hypovolaemia Urinary tract infections Hyperkalaemia Diabetic ketoacidosis	Rifampicin Ketoconazole	R50 to R100 per day	10 mg daily	Oral

in appetite and feeding. It has been employed in weight loss therapy in low doses and is particularly useful in combination with DNRIs as they seem to act synergistically. DNRIs, often used in depression, attention-deficit/hyperactivity disorder (ADHD), and Parkinson's disease, block dopamine and noradrenaline transporters in the synaptic cleft leading to increased concentrations of both with greater effect.[2,7]

Contrave use can achieve an average TBW loss of 3%. It is a cheaper option, at a quarter of the cost of the GLP-1 inhibitors, and approved for long-term use. It is the agent of choice in those patients with depression or who are quitting smoking.[2,7,15] Contrave's side effects are due to increased dopamine and noradrenaline and include elevated blood pressure, tachycardia, raised intraocular pressure, an increased propensity for seizures, dry mouth, headaches, nausea, and vomiting. Subsequently, this class of AOM is contraindicated in patients with hypertension, seizure disorders, glaucoma, alcohol misuse, or chronic opioid use.[2,7] There are also risks for drug interactions with other medications that lower the seizure threshold (neuroleptics, steroids, antidepressants, theophylline) and a risk of severe hypertensive reactions in patients taking monoamine oxidase inhibitors.

The most troublesome anaesthetic implication of this drug class is opioid tolerance due to naltrexone-induced opioid receptor antagonism. Patients on this medication may require higher doses of opioids, and it is advised that these patients be offered multimodal analgesia and opioid-sparing analgesic techniques. It is advised that patients stop naltrexone medications two hours before surgery.[26] In all cases, the risk of sedation and respiratory depression due to the up-regulation of central opioid receptors exists, and these patients should be

monitored in a high-care unit while on opioid therapy until safe dosing has been established.[27]

While naltrexone can be discontinued abruptly, the rapid discontinuation of bupropion may lead to withdrawal symptoms, hypertension, and delirium. Postoperatively, if treatment is restarted, the dose must be tapered upwards over four weeks.

Sympathomimetic amines

Phentermine (MINEX, Duromine) has some pharmacodynamic similarity to its parent compound, amphetamine, releasing noradrenaline and, to a lesser extent, dopamine and serotonin at the synaptic cleft. This causes central stimulation of satiety and peripherally stimulating lipolysis and thermogenesis. It is the oldest AOM and affordable, but it contributes to only a 4% loss of TBW when used in isolation. It is only registered for short-term use for a maximum of 12 weeks, and tolerance may occur.[2,7,12]

Phentermine commonly causes cardiovascular side effects like palpitations, hypertension, and tachycardia, and it carries a small risk of angina and myocardial infarction. It may also cause anxiety, headaches, insomnia, and, rarely, psychosis. It frequently causes nausea, vomiting, abdominal pain, and a dry mouth. It is contraindicated in patients using recreational drugs, monoamine oxidase inhibitors, or in patients with hypertension, hyperthyroidism, or ischaemic heart disease.[12]

The primary anaesthetic concern is perioperative hypotension. The ASA advises this drug to be omitted for a minimum of four days before elective surgery.[12] In patients who have taken this drug up to the time of surgery, direct-acting vasopressors or inotropes should be used as first-line management of hypotension. Phentermine also carries the risk of serotonin syndrome when used with drugs such as tramadol or pethidine, and it may inhibit the effects of alpha-2 agonists.[12]

Sympathomimetic amine and GABA receptor modulators

Phentermine/topiramate (Qsymia) is a combination drug that incorporates the synergistic effects of phentermine and a GABA receptor modulator topiramate. Topiramate is an excellent antiepileptic and migraine therapy. Its MOA in weight loss is poorly understood. It is modestly effective in isolation, but it averages a 7% loss in TBW in combination with phentermine. Qsymia is registered for long-term use.[2,7,12,15]

Side effects are those of phentermine plus hypokalaemia, peripheral neuropathies in vulnerable patients, and seizures and delirium with rapid discontinuation. The anaesthetic implications are the same as those of phentermine.[2,7,15]

Amphetamine products

Lisdexamfetamine (Vyvanse) is a prodrug converted in the bloodstream by lysine to dextroamphetamine. It is used to treat ADHD in children but is also used for binge eating in adults. It acts centrally to stimulate satiety, like sympathomimetic amines, but has a sustained release and less potential for abuse as a stimulant.[2,7,15]

Side effects include insomnia, irritation, anxiety, hypertension, and tachycardia. It is contraindicated in cardiovascular disease. Perioperative use can lead to hypertension and tachycardia. It is costly, and there are worldwide shortages.

Biguanides

Metformin (Glucophage) reduces gluconeogenesis in the liver, thus reducing plasma glucose. It also increases insulin sensitivity and glucose uptake by the tissues. The proposed mechanism of weight loss is via hypothalamic modulation of appetite regulation centres, but this is currently not completely understood. It is by far the cheapest AOM on the market and the most frequently employed.

Side effects of diarrhoea, nausea, and vomiting occur commonly. Metformin is contraindicated in patients with chronic kidney disease. There is a theoretical low risk of perioperative lactic acidosis.[5-8,15,18]

Sodium-glucose transport protein 2 inhibitors

The gliflozins (dapagliflozin [Forxiga], empagliflozin [Jardiance], and canagliflozin [Invokana]) act on the nephron's semisynthetic glucagon-like peptide-2 (SGLP-2) receptors, inhibiting glucose reuptake, thereby lowering blood sugar. They are used in diabetics with concomitant cardiovascular disease. They may lead to modest weight loss but are better at treating hyperglycaemia. They are affordable and have the benefit of reducing the risk of major adverse cardiovascular events in at-risk patients. They are contraindicated in patients with chronic kidney disease.

Side effects include hyperkalaemia, hypovolaemia, and euglycemic diabetic ketoacidosis. To limit these potential side effects, the ASA recommends cessation of these agents three days before elective surgery.[5-8,15]

Amylin analogues

Pramlintide (Symlin) mimics endogenous secreted pancreatic hormones, stimulates satiety centres, and slows gastric emptying. Its major risk is aspiration under anaesthesia. This drug is a novel agent, and much research is ongoing on its efficiency and tolerability.[15,18]

Cannabinoid receptor-1 antagonists

Rimonabant (Serenade) has shown promise in weight loss in rodent studies. It targets central reward pathways involved in feeding. Human studies indicated a clinically significant increased risk of depression and suicidal ideation anxiety, and it was withdrawn from the market.[15,18]

Proopiomelanocortin activators

Lorcaserin (Belviq) is a selective serotonin 5-hydroxytryptamine receptor 2C (5-HT2C) receptor that acts centrally to induce satiety. Studies indicate an average weight loss of 3% from baseline. It held promise in obesity management in patients

with depression, but early trials showed an increased incidence of cancer, and the drug was withdrawn.[15,18]

Conclusion

AOMs are a diverse group of drugs that show immense promise in assisting with weight loss and management in overweight and obese patients. They have further independent benefits of limiting insulin resistance, lipid levels, and blood pressure. Though currently under-prescribed, growing knowledge of and access to these drugs means that the anaesthesiologist must be aware of the implications of their use in the perioperative setting and be able to advise the patient using them regarding appropriate cessation or particular risk.

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SAJAA CPD ANSWER FORM – May/June 2025

PLEASE SUBMIT ONLINE BEFORE 31 MARCH 2026

Please answer the following questions:

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

1. What is one of the primary reasons for the disparity in surgical activity between high- to low-income countries, as identified by Funk et al.?
a. Lack of skilled surgeons
b. High cost of surgical procedures
c. Inadequate surgical resources and infrastructure
d. Limited patient demand for surgery

2. What is the primary aim of the study conducted at South Africa's second-largest tertiary hospital?
a. To compare surgical outcomes between different hospitals
b. To evaluate the efficiency of a 24/7 emergency theatre without scheduled breaks
c. To assess the impact of new surgical techniques on patient outcomes
d. To determine the most common emergency surgeries performed

3. What was the calculated theatre utilisation (TU) rate for the emergency theatres in this study?
a. 62%
b. 53.58%
c. 59.8%
d. 55%

4. What is the key limitation of relying solely on TU as a performance indicator?
a. It does not consider patient outcomes
b. It is not a recognised metric in surgical efficiency studies
c. It only applies to elective theatres
d. It does not measure overall resource usage effectively without additional metrics

5. What is the primary objective of the Golden Patient Initiative (GPI) as introduced by Javed et al.?
a. To prioritise paediatric cases in emergency theatres
b. To reduce the First Case Start Time (FCST) by preselecting a surgical case for the following day
c. To allocate more theatre time to high-risk surgical cases
d. To standardise all emergency theatre scheduling

A review of anti-obesity medications and anaesthesia

6. South Africa is not immune to the global pandemic of obesity. What percentage of South African women are obese according to the 2021 WHO Health Statistics?
a. 26%
b. 45%
c. 68%
d. 73%

7. Emotional eating is mitigated by neurochemistry including serotonin. How has this hormone been implicated in appetite control?
a. Serotonin acts centrally and is associated with appetite suppression.
b. Serotonin acts centrally and is associated with appetite stimulation.
c. Serotonin acts chiefly on the peripheral nervous system in the GIT.
d. Serotonin plays no role in the neurochemistry associated with appetite.

8. Which anaesthetic implications must be borne in mind in a patient taking long term Lipase Inhibitors (Orlistat)?
a. Delayed gastric emptying.
b. Opioid tolerance
c. Depletion of Vitamin K dependent clotting factors
d. Serotonin syndrome risk

9. The ANZCA guidelines for patients taking GLP 1 receptor agonists suggest that which of the following investigations may assist with quantifying stomach contents to risk stratify patients?
a. Gastroscopy
b. Abdominal X-ray
c. Fasting glucose test
d. Gastric ultrasound

10. How does Naltrexone-bupropion (Contrave) effect analgesic management in users undergoing surgery?
a. Opioid tolerance due to opioid receptor antagonism.
b. Opioid tolerance due to MOA enzyme induction.
c. Opioid tolerance due to delayed gastric emptying.
d. No effect observed.

Prevalence of vitamin D deficiency among anaesthesia providers at an academic hospital complex in South Africa

11. Common sources of Vitamin D include the following, EXCEPT:
a. Leafy vegetables
b. Sunlight
c. Fatty Fish
d. Eggs

12. The recommended daily Vitamin D intake for an adult is:
a. 400–600 IU
b. 600–800 IU
c. 800–1000 IU
d. 1000–1200 IU

13. What is considered a deficient level of Vitamin D according to the USA Endocrine Society?
a. < 40 ng/ml
b. < 30 ng/ml
c. < 20 ng/ml
d. < 10 ng/ml

14. What was the prevalence of Vitamin D deficiency in this study population?
a. 28.6%
b. 39.4%
c. 18.2%
d. 42.4%

15. Which risk factor demonstrated a potential association with Vitamin D Deficiency in this study population
a. Gender
b. BMI
c. Smoking
d. Age

Anaesthesiology registrars' knowledge of anatomy and assessment of two integrated anatomy teaching modalities: a comparative interventional study at a South African university

16. Doctors rely on anatomy competency for successful outcomes when performing procedures. This anatomy competency may be compromised by
a. Limited anatomy teaching during doctors' training
b. Nurses not cleaning the procedure site effectively
c. Presence of distractive medical students in theatre
d. Non-anatomical lectures during doctors' years of training

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17. Non-anaesthesia registrars assessed their anatomy knowledge when starting the specialisation. They concluded that
a. Their knowledge was adequate for safe practice
b. Their knowledge was limited but adequate for safe practice
c. Their knowledge was inadequate for safe practice
d. Their knowledge was on par with international standards

18. In recent years, South African anaesthetists have undertaken and published a study on one of the following
a. Knowledge of applied anatomy in anaesthesia
b. Knowledge of perioperative viscoelastic testing
c. Preferred teaching methods in anaesthesia
d. Knowledge of intraoperative crisis management

19. Regarding registrars' satisfaction with teaching methods, one of the following statements is true
a. Indian registrars prefer vertical integration
b. South African registrars prefer vertical integration
c. South African registrars' preferences are widely known
d. Malaysian registrars prefer simulation as their primary teaching modality

20. Regarding retention of anatomy knowledge in postgraduate students a year after teaching, it has been found that
a. There is a clinically significant decline in knowledge
b. There is a clinically significant improvement in knowledge
c. There is no clinically significant improvement in knowledge
d. Retention of knowledge does not play a role in clinical performance

The prevalence of moderate-to-severe rebound pain after spinal caesarean section at Tygerberg Hospital following new analgesia guidelines implementation

21. Low dose intrathecal morphine in caesarean section patients
a. Holds risk for apnoea and therefore requires postoperative high care.
b. Has a limited duration of less than 8 hours.
c. Is indicated in combination with local would infiltration.
d. Is the gold standard for caesarean section patients without contraindications.

22. A Patient Acceptable Symptom State (PASS)
a. Is a state where side effects of analgesia are acceptable to a patient.
b. Is signified by a VAS of less than 4 according to current literature
c. Is pain intensity that is acceptable to patients.
d. Had been reached in most obstetric patients in the study by du Toit and colleagues.

23. Intraoperative IV dexamethasone
a. Should rather be omitted in spinal caesarean section due to the risk of postoperative sepsis.
b. Leads to decreased opioid consumption for 24 hours in spinal anaesthesia patients.
c. Is not recommended in the PROSPECT guidelines for obstetric anaesthesia due to lack of high-level evidence.
d. Is indicated for treatment of nausea and vomiting in spinal caesarean section patients.

24. Moderate-to-severe postoperative pain in caesarean section patients
a. Has a low prevalence in most developed countries.
b. Typically appears around 12 hours after spinal anaesthesia.
c. Is defined as a VAS of ≥ 4.
d. Is worse when opioids are used in the spinal.

25. Multimodal analgesia for spinal caesarean section patients:
a. Should be initiated as soon as the spinal begins to reverse.
b. Should always include opioids, either neuraxial or systemic.
c. Should always include regional techniques and systemic analgesia
d. Is recommended intraoperatively by the PROSPECT and ERAC guidelines.

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43RD EMGH MEETING 2025 ABSTRACTS

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The European Malignant Hyperthermia Group (EMHG) was formed in 1983 and comprises all MH investigation centres who follow the EMHG testing protocol. This includes centres from Europe, North America, Brazil, Australia, New Zealand and from South Africa. The EMHG annual meeting is usually hosted by one of these centres and the 43rd annual EMHG meeting took place in Cape Town, South Africa, on 24–25 April 2025, marking the first time this prestigious event was hosted in this country. Delegates from around the globe attended, contributing to a robust and diverse academic programme. The event featured both clinical and scientific presentations, which significantly contributed to its success. Three distinguished guest speakers—a paediatric neurologist, a veterinary surgeon, and an anaesthetist—delivered insightful talks, offering unique interdisciplinary perspectives. Abstracts from the meeting are published in this edition of the South African Journal of Anaesthesia and Analgesia (SAJAA).

Prof Thierry Girard
Chairman of EMHG, Basel, Switzerland

Dr Hannah Brand
Meeting organiser, MHCSA South Africa

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MEPA WORKSHOP
TRANSFORMATIVE HIGH-FIDELITY SIMULATION WORKSHOP | 08H30 - 16H00
Venue tbc

PTRC WORKSHOP
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