# Undergraduate Anesthesia Skills for a Global Surgery Agenda: Students' Self-Reported Competence

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## Abstract

**BACKGROUND:** Safe anesthesia is imperative for the Global Surgery agenda and Sustainable Development Goal 3. Due to a shortage of specialists in South Africa (SA), anesthetic services are often provided by nonspecialist doctors, often newly qualified and frequently without immediate supervision. The burden of disease in the developing world demands fit-for-purpose, day-one medical graduates. Although undergraduate anesthesia training is mandatory for medical students in SA, no outcomes are specified, and these are decided autonomously at each medical school. This study describes the current self-perceived anesthetic competence of medical students in SA as a needs assessment directed at achieving the goals of Global Surgery in SA and other developing countries.

**METHODS:** In this cross-sectional observational study, 1689 students (89% participation rate), representing all medical schools in SA, rated their self-perceived competence at graduation in 54 anesthetic-related Likert scale items in 5 themes: patient evaluation, patient preparation for anesthesia, practical skills performance, administration of anesthesia, and the management of intraoperative complications. Medical schools were divided into clusters A (≥25 days of anesthetic training) and B (<25 days). Descriptive statistics, Fisher exact test, and a mixed-effects regression model were used in the statistical analysis.

**RESULTS:** Students felt more prepared for history-taking and patient examination than for managing emergencies and complications. The self-perceived competence of students at cluster A schools was higher across all 54 items and all 5 themes. The same was observed for general medical skills and skills relating to maternal mortality in SA.

**CONCLUSIONS:** Time-on-task, capacity for repetition, and student maturity might have impacted self-efficacy and should be considered in curriculum development. Students felt less prepared for emergencies. Focused training and assessment aimed at emergency management should be considered. Students did not feel competent in general medical areas, in which anesthetists are experts, including resuscitation, fluid management, and analgesia. Anesthetists should take ownership of this training at the undergraduate level. Cesarean delivery is the most performed surgical procedure in sub-Saharan Africa. The Essential Steps in Managing Obstetric Emergencies (ESMOE) program was designed for internship training but can be introduced at undergraduate level. This study suggests that curriculum reform is required. The achievement of an agreed-upon set of standardized national undergraduate anesthetic competencies may ensure fit-for-purpose practitioners. Undergraduate and internship training should align to form part of a continuum of basic anesthetics training in SA. The findings of this study might benefit curriculum development in other regions with similar contexts.

## GLOSSARY

ASA = American Society of Anesthesiologists
CICO = can't-intubate-can't-oxygenate
CLT = cognitive load theory
COSMO = community service medical officer
ESMOE = Essential Steps in Managing Obstetric Emergencies
HPCSA = Health Professions Council of South Africa
IRB = institutional review board
MO = medical officer
OSPE = objective structured practical examination
SA = South Africa
SDG3 = sustainable development goal 3
STROBE = Strengthening the Reporting of Observational Studies in Epidemiology

**KEY POINTS**

**Question**: What is the current self-perceived undergraduate anesthesiology competence at graduation in South Africa?

**Findings**: Students reported a lower self-efficacy to manage emergencies and complications, and this was more pronounced for medical schools with a shorter duration of anesthesiology training, possibly due to shorter time-on-task and lack of spiral curricula.

**Meaning**: A curriculum reform should define a national core set of anesthetic competencies to ensure fit-for-purpose, day-one practitioners in South Africa.

The burden of disease in the developing world demands that day-one medical graduates are fit for purpose. However, the anesthetic requirements for the "Bellwether" procedures referred to in the Lancet commission statement[1] have not been explored. The absence of clear guidelines for undergraduate training in anesthesia may be akin to "operating in the dark."

Safe anesthesia forms a vital part of achieving the Global Surgery agenda declared by the Lancet Global Surgery Commission of 2015. Safe surgery and anesthesia have also become essential to the realization of greater access to appropriate health care envisioned in Sustainable Development Goal 3 (SDG3).[1,2]

Maternal mortality is a surrogate marker of social disparity.[3] In South Africa (SA), 22% of maternal deaths are anesthetic related.[4] In the past decade, tragically, 94% of these were avoidable, and the majority occurred at regional and district hospitals.[5] Anesthetic services at regional and district levels, especially in rural areas, are mostly provided by nonspecialist medical officers (MOs), who are often newly qualified. This includes community service MOs (COSMOs) providing anesthetic services, often without direct supervision, in a compulsory year of service in underresourced areas, after internship. MO training consists of undergraduate training and a mandatory 2-month internship (mostly at non–university-affiliated hospitals), both of which are variable in terms of exposure. The provision of anesthetic services falls to MOs because there is a shortage of specialists with a total number of specialist surgeons, obstetricians, and anesthesiologists of 0.7/100,000 population in Africa.[6] A minimum of 5

specialist anesthesiologists per 100,000 population is recommended in lower- and middle-income countries.[7] In SA, an estimated 250 specialist anesthesiologists work in the public sector,[8] serving 82% of a total population of 60.6 million.[9,10] This translates to approximately 0.5 specialist anesthesiologists per 100,000 population in the public sector (where MOs work).

The large burden of disease related to trauma and violence leads to an expectation that newly graduated doctors are able to manage multiple emergencies without immediately available supervision.

The Health Professions Council of South Africa (HPCSA), the accrediting authority, mandates that all SA doctors undergo undergraduate anesthesia training. Outcomes are not specified by the HPCSA, and the length and content of such training are decided autonomously at each medical school. Internship outcomes are defined by the HPCSA,[11] but with no standardized national internship training program nor formal assessment, apart from a self-efficacy-based logbook. Exposure varies between intern training sites, with many interns in a recent survey having performed <3 obstetric general anesthetics during their internship.[12] There are calls for greater alignment between undergraduate training and internship.[13] Standardized undergraduate outcomes aligned to internship outcomes may enhance training in response to SA health needs.[13,14] Doctors will achieve outcomes that will better prepare them for their community service year.[15,16]

Outcomes-based transformative education delivers context-sensitive, fit-for-purpose graduates.[1,17] The challenge of providing safe anesthesia in rural areas is not unique to lesser-resourced countries.[18,19] However, the training needs for developing countries where junior doctors are expected to provide anesthetic services without further anesthetic qualifications are not known. The objective of this study was to describe the current self-perceived anesthetic competence of medical students in SA. The findings may further contribute to a needs assessment directed at achieving the goals of Global Surgery in other developing countries.

## METHODS

The study was approved by the appropriate institutional review board (IRB) at each of the 8 SA universities with medical schools (2017). The requirement for written informed consent was waived by the IRBs. The cover page of the questionnaire provided information about the study, including conditions relating to consent, and participation was regarded as informed consent.

This cross-sectional quantitative analytical study assessed the self-perceived competence of undergraduate medical students on completion of their anesthetic training. Self-efficacy theory states that students are more likely to be motivated and committed to tasks in which they feel competent.[20] We selected self-assessment as a proxy for actual ability as the methodology in our study. Although objective assessment does not necessarily equate to self-assessment,[21,22] an SA study showed that while undergraduate medical students were likely to overestimate their skills abilities, there was a good correlation between the rankings of self-assessment and objective scores.[21]

A questionnaire consisting of 54 items was developed by the authors, framed by the HPCSA internship anesthetic outcomes. A 4-point Likert scale was chosen to avoid the noncommittal middle option of a 5-point scale. Students were asked to decide on each item, as described in Table 1.

**Table 1.** - Description of Likert Scores

| Likert scale score | Meaning |
|---|---|
| 1 | No idea how to manage this |
| 2 | Vague idea; unable to manage independently |
| 3 | Able to manage with some supervision |
| 4 | Able to manage independently with confidence |

The items were grouped into 5 themes: patient evaluation, patient preparation for anesthesia, practical skills performance, administration of anesthesia, and the management of intraoperative complications. Two steps were taken at the home institution of the first author to validate the questionnaire. First, 5 specialist anesthesiologists with experience in the undergraduate curriculum reviewed the questionnaire. Second, the questionnaire was piloted on 54 final-year students. The pilot study achieved a Cronbach alpha score of 0.96, reflecting good internal consistency. The range of time taken to complete the questionnaire was 3 to 10 minutes, with a median of 7 minutes.

The scheduling of anesthetic training varied among medical schools, but all rotations took place in the senior (clinical) training phase. Some schools provided a single rotation, while others scheduled up to 3 rotations in consecutive years. Each medical school was visited once, and hard-copy questionnaires were distributed to all students at completion of their final anesthesiology rotation. No incentive was offered for participation. Students were briefed about the study before the questionnaires were distributed. There was no time restriction, but questionnaires had to be completed in the venue where they were briefed at the time of data collection. The cover page consisted of an information sheet not containing any data, therefore, upon submission, it was not possible for the investigator to see whether the questionnaire was completed. All questionnaires were returned, whether completed or not. Students were free to leave the venue at any time.

**Statistical Analysis**

Data were captured on an Excel spreadsheet, and statistical analysis was performed in Stata (Stata release 15.1, StataCorp). Questionnaires were allocated identifiers according to the institutions where they were completed (eg, 1-1 referred to the first questionnaire from institution 1). As per the study protocol, questionnaires were excluded if >5 questionnaire items were omitted (>10% of items).

The curriculum documentation at each medical school was analyzed. The median training duration was 25 working days or 5 weeks (range, 10–35 days), and the institutions were divided into 2 clusters based on whether their total duration of training was more or less than the median. This resulted in clusters A (≥25 training days) and B (<25 training days), consisting of 4 medical schools each.

For each of the 54 questionnaire items, the number and percentage of participants who chose each of the 4 Likert scale scores were determined. For simplicity and practical applicability, a dichotomous outcome (the student felt competent versus not competent) was created by combining Likert scale scores 1 and 2 to mean “not competent” and Likert scale scores 3 and 4 to mean “competent.”

Numbers and percentages were used to report competence, and an average percentage was calculated to establish the mean competence reported by students. Fisher exact test was used for statistical analysis of differences (categorical data). A mixed-effects regression model was used to assess the relationship between the response variables (overall mean self-perceived competence and mean self-perceived competence by theme) and the fixed-effect tuition cluster (≥ 25 days and <25 days). Medical schools were specified as the random-effects component with an intercept using an independent covariance structure. Testing was done at the 0.05 level of significance.

Competence in basic medical emergency management and the management of emergencies commonly linked to maternal mortality were also reported.

The study was reported in line with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline.[23]

# RESULTS

Data were collected between November 2017 and February 2019. The sample realization is presented in Figure 1.

A total of 1689 qualifying students were approached, of whom 1505 participated (participation rate, 89%) with participation at all 8 medical schools exceeding 83%. Nineteen questionnaires were excluded due to incomplete data (≥5 omitted Likert scale items), resulting in a total of 1486 analyzed questionnaires. The Cronbach alpha score for the questionnaire was 0.96.

### Individual Items and Themes

Table 2 summarizes the percentage of students across the 8 medical schools who felt competent (Likert scale 3 or 4) in each of the listed outcomes, as well as a range (percentage of students who felt competent at the medical school with the lowest self-perceived competence for that item compared to the percentage of students who felt competent at the medical school with the highest self-perceived competence for that item) and the competence differential (percentage difference of students who felt competent at cluster A compared to cluster B schools).

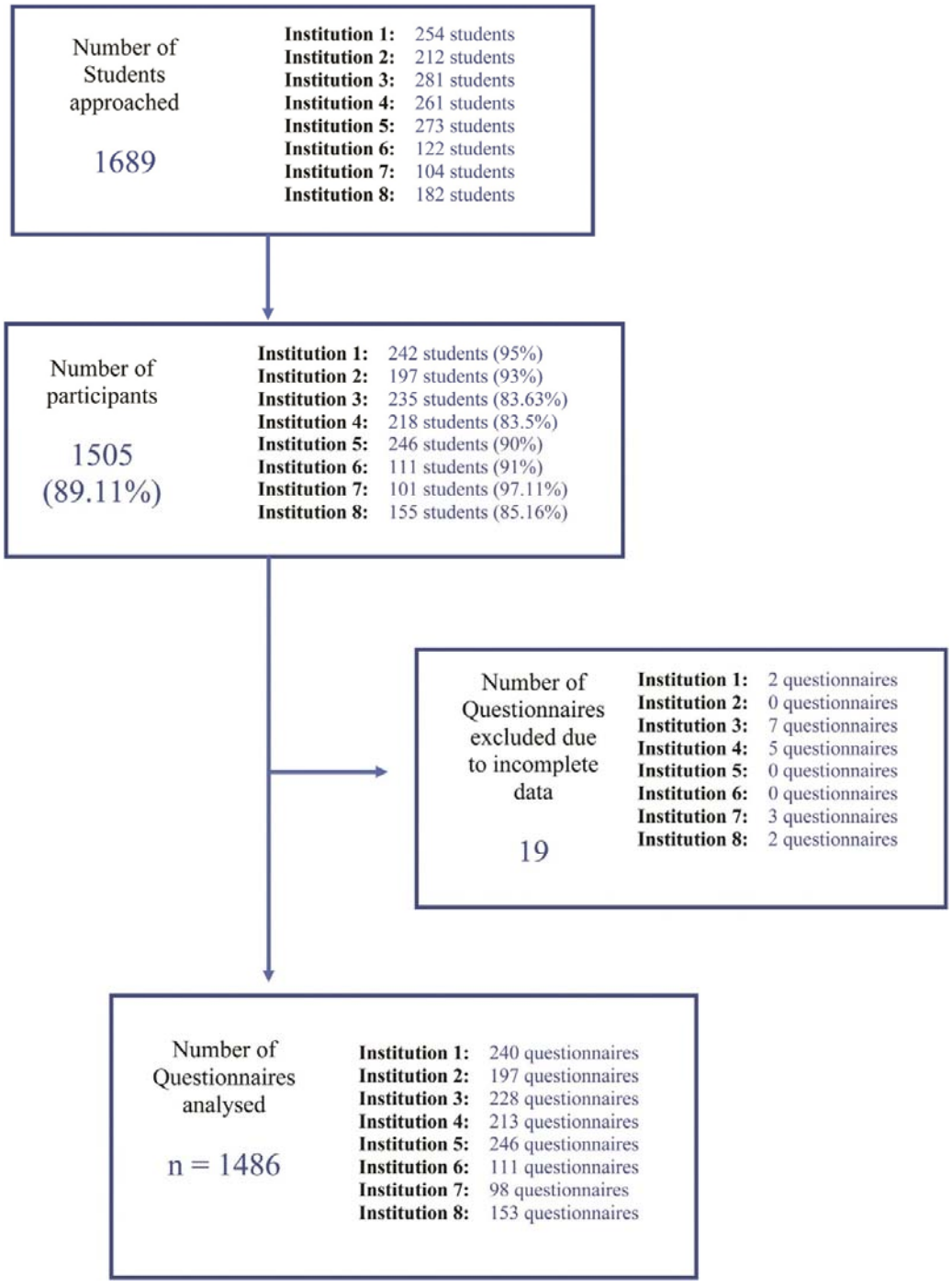



**Figure 1.:** Sample realization.

**Table 2**. - Self-Perceived Competence of Students at the 8 Medical Schools in South Africa

| Item number | Concept tested | Reported competence (% students over 8 institutions) | Range (% students reporting competence at institution with lowest versus highest competence for each item) | % Difference of reported competence between clusters A and B[a] |
|---|---|---|---|---|
| Theme 1: patient evaluation (history, examination, and special investigations) (Cronbach alpha = 0.76) | | | | |
| 1 | Take a history | 93.53 | 90.20–99.10 | 4.34 |
| 2 | Perform an examination | 90.70 | 85.62–97.30 | 7.04 |
| 3 | Perform an airway examination | 91.10 | 80.75–98.47 | 8.62 |
| 4 | Requesting special investigations | 77.37 | 54.61–86.67 | 14.60 |
| 5 | Diagnose and correct electrolyte disturbances | 67.32 | 25.49–85.45 | 14.03 |
| 22 | Evaluate the Mallampati score | 93.79 | 83.10–98.47 | 4.61 |
| 25 | Interpret an arterial blood gas analysis | 86.45 | 60.78–96.70 | 5.65 |
| Theme 2: preparing for an anesthetic (Cronbach alpha = 0.82) | | | | |
| 6 | Planning the sequence of an anesthetic | 72.14 | 61.79–89.17 | 18.12 |
| 7 | Prescribe anxiolytic premedication | 63.94 | 46.01–76.75 | 16.09 |
| 8 | Prescribe drugs to prevent aspiration | 69.08 | 39.44–91.56 | 26.77 |
| 9 | Choose general versus regional technique | 84.89 | 78.86–90.82 | 1.52 |
| 10 | Perform a rapid sequence induction | 85.89 | 73.71–95.82 | 8.41 |
| 11 | Obtain informed consent | 94.17 | 87.22–97.37 | -3.01[a] |
| 12 | Select endotracheal tube size | 83.69 | 62.44–95.82 | 11.99 |
| 13 | Classify a patient according to ASA | 91.50 | 83.57–97.96 | 1.84 |
| 54 | Design perioperative analgesic plan | 70.18 | 50.00–89.17 | 25.55 |
| Theme 3: practical skill performance (Cronbach alpha = 0.72) | | | | |
| 14 | Intubate a patient | 87.00 | 77.64–96.40 | 10.22 |
| 15 | Place a laryngeal mask | 93.45 | 89.54–98.20 | 4.47 |
| 16 | Insert an intravenous cannula | 97.50 | 94.04–100 | 2.00 |
| 17 | Perform a spinal block | 71.15 | 44.12–94.59 | 24.23 |
| 18 | Open airway and bag-mask ventilate a patient | 96.21 | 94.63–99.10 | 1.44 |
| 19 | Perform a needle cricothyroidotomy | 17.35 | 9.39–46.36 | -2.79[a] |
| 20 | Perform external cardiac massage | 31.12 | 17.11–71.82 | 7.82 |
| 21 | Use a defibrillator | 75.66 | 55.33–93.42 | 20.56 |

| | | | | |
|---|---|---|---|---|
| 29 | Use ultrasound | 12.03 | 8.45–25.00 | 1.84 |
| Theme 4: administer anesthesia (cognitive decision-taking) (Cronbach alpha = 0.90) | | | | |
| 23 | Choose correct ventilator settings | 55.64 | 13.62–89.58 | 36.24 |
| 24 | Use an anesthetic machine (circuit and flows) | 46.43 | 14.08–82.92 | 34.50 |
| 26 | Interpret a capnogram | 76.34 | 52.94–99.10 | 14.34 |
| 27 | Interpret neuromuscular monitoring | 50.07 | 12.70–89.58 | 51.38 |
| 28 | Blunt the intubation response | 55.41 | 25.49–92.50 | 40.72 |
| 45 | Knowledge of anesthetic agents | 77.64 | 57.75–88.78 | 4.99 |
| 46 | Select appropriate anesthetic agents | 81.29 | 55.87–92.08 | 12.72 |
| 47 | Reversal of muscle relaxants | 83.56 | 53.30–94.90 | 17.18 |
| 48 | Select appropriate opioids | 72.06 | 58.49–85.00 | 15.82 |
| 49 | Use of local anesthetic agents | 80.39 | 58.17–88.60 | 15.06 |
| 50 | Manage intravenous fluid requirements | 73.67 | 53.95–93.69 | 11.42 |
| 51 | Manage blood product requirements | 59.66 | 38.67–81.98 | 1.36 |
| 52 | Use inotropes and vasopressors | 66.49 | 39.15–85.45 | 18.30 |
| 53 | Perform general anesthesia for cesarean delivery | 56.77 | 34.74–75.42 | 15.52 |
| Theme 5: management of intraoperative complications (Cronbach alpha = 0.92) | | | | |
| 30 | Manage intraoperative hypotension | 71.23 | 43.66–89.08 | 24.50 |
| 31 | Manage cardiac arrest | 61.08 | 36.60–85.59 | 18.63 |
| 32 | Manage a high spinal block | 41.41 | 18.40–67.57 | 19.33 |
| 33 | Manage anaphylaxis | 61.87 | 29.33–79.28 | 29.86 |
| 34 | Manage a hypertensive crisis | 44.53 | 34.21–62.16 | 3.75 |
| 35 | Manage dysrhythmias (extrasystoles, bradycardia, VT, and VF) | 31.22 | 11.27–50.45 | 13.40 |
| 36 | Manage “can’t intubate, can’t ventilate”[b] | 45.41 | 15.02–83.67 | 18.99 |
| 37 | Diagnose and treat the causes of hypoxia | 59.54 | 38.50–77.48 | 18.42 |
| 38 | Diagnose and treat the causes of hypercarbia | 50.34 | 29.58–81.08 | 20.26 |
| 39 | Diagnose and treat the pharmacogenetic diseases (porphyria, malignant hyperthermia, and suxamethonium apnea) | 42.85 | 14.55–72.50 | 6.43 |

| | | | | |
|---|---|---|---|---|
| 40 | Manage an opioid overdose | 60.34 | 32.68–83.47 | 6.28 |
| 41 | Manage a benzodiazepine overdose | 57.65 | 33.55–81.67 | 3.95 |
| 42 | Manage local anesthetic toxicity | 58.54 | 26.14–80.61 | 20.16 |
| 43 | Manage laryngospasm | 58.10 | 23.53–90.76 | 41.08 |
| 44 | Manage bronchospasm | 59.64 | 26.80–88.33 | 38.84 |

Abbreviations: ASA, American Society of Anesthesiologists; VF, ventricular fibrillation; VT, ventricular tachycardia.

[a]Positive values: cluster A recorded higher self-perceived competence; negative values: cluster B recorded higher self-perceived competence.

[b]Also called "can't intubate, can't oxygenate" (CICO).

Students reported a lack of competence (Likert scale <3) in 9 items, mainly relating to the management of complications or emergencies (needle cricothyroidotomy, external cardiac massage, ultrasound and anesthetic machine use, managing high spinal blocks, hypertensive crises, dysrhythmias, can't-intubate-can't-oxygenate [CICO] scenarios, and pharmacogenetic diseases). The highest self-perceived competence related to airway examination, Mallampati scoring, informed consent, American Society of Anesthesiologists (ASA) classification, laryngeal mask placement, inserting intravenous cannulae, and bag-mask ventilation.

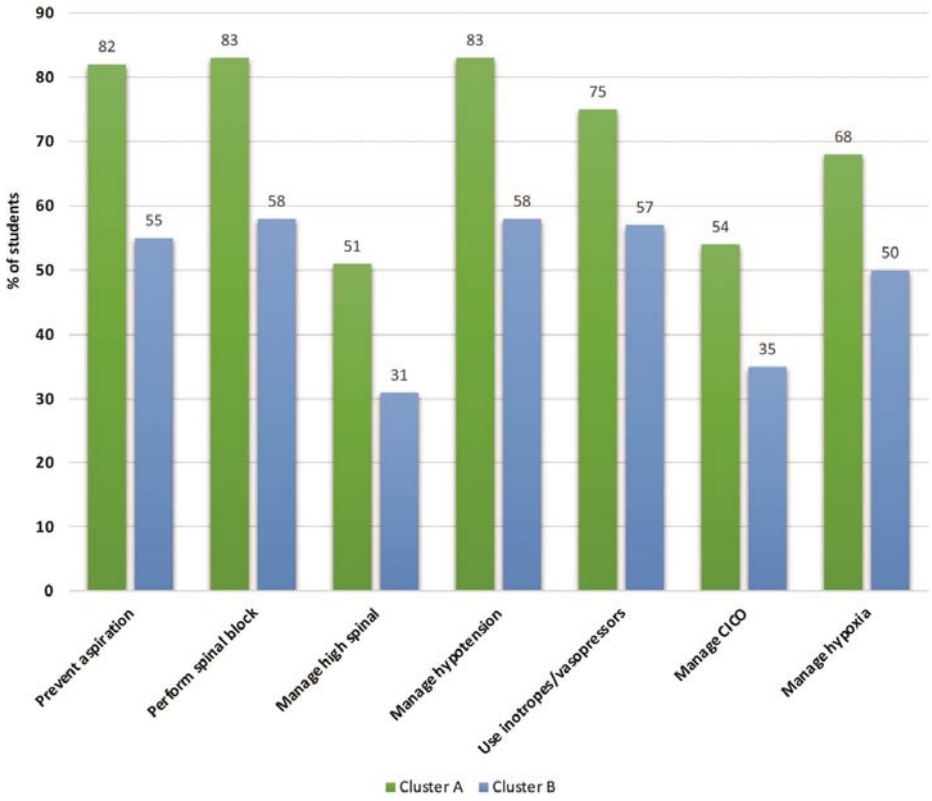
## Cluster Comparison

Cluster A (≥ 25 days of training) consisted of 4 medical schools and 776 individual responses, while cluster B (<25 days of training) consisted of 4 medical schools and 710 individual responses. All cluster B schools scheduled a single rotation in one of the senior study years, while all cluster A schools scheduled more than one rotation (either 2 or 3), in subsequent years (also in the final 3 study years), typically with an incremental increase in complexity of learning outcomes and teaching activities. The self-perceived competence of students at cluster A schools was statistically significantly higher ($P < .05$) than that of cluster B schools, for 4 of the 5 themes, as well as the overall competence across the 54 Likert scale items (Table 3). Table 3 also shows that students felt more competent in patient evaluation and preparation (mean Likert score >3 in clusters A and B) than in administering anesthesia and managing complications.

**Table 3**. - Mean Likert Score of Self-Perceived Competence of Students at Cluster A Versus Cluster B Medical Schools

| Theme | Cluster A predicted mean Likert score per theme (SE) n = 776 | Cluster B predicted mean Likert score per theme (SE) n = 710 | Difference between clusters A and B (% of Likert range) | *P* value of difference in mean Likert score between clusters | 95% CI of difference in mean Likert score between clusters |
|---|---|---|---|---|---|
| All 54 Likert scale items | 3.00 (0.06) | 2.74 (0.06) | 0.26 (8.67)[a] | .001[b] | 0.102 to 0.427 |
| Patient evaluation | 3.36 (0.04) | 3.16 (0.04) | 0.20 (6.67)[a] | .001[b] | 0.082 to 0.320 |
| Preparation for anesthesia | 3.22 (0.06) | 3.06 (0.06) | 0.16 (5.33)[a] | .054 | −0.003 to 0.331 |
| Skill performance | 2.94 (0.04) | 2.76 (0.04) | 0.18 (6.00)[a] | .002[b] | 0.068 to 0.293 |
| Administration of anesthesia | 3.00 (0.08) | 2.66 (0.08) | 0.35 (11.67)[a] | .003[b] | 0.114 to 0.579 |
| Managing complications | 2.93 (0.10) | 2.58 (0.10) | 0.35 (11.67)[a] | .012[b] | 0.078 to 0.626 |

Abbreviations: CI, confidence interval; SE, standard error.
[a]Difference/Likert range × 100; Likert range = 3 (4 – 1).
[b]Statistically significant (*P* < .05).




CICO: Can't-intubate-can't-oxygenate

**Figure 2.:** Student self-perceived competence in skills implicated in maternal mortality: cluster A versus cluster B.

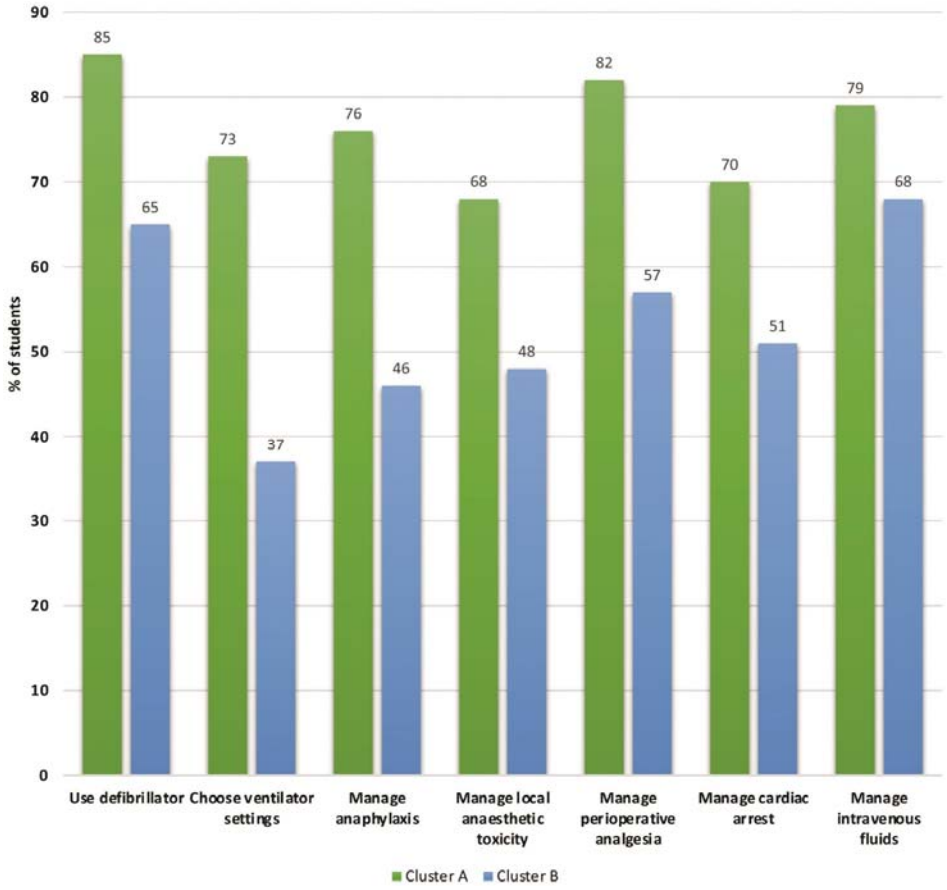



**Figure 3**.: Student self-perceived competence in general medical skills: cluster A versus cluster B.

For 52 of the 54 Likert scale items (96.29%), the lowest self-perceived competence was recorded at one of the cluster B institutions. Only obtaining informed consent and administering blood products were the lowest at cluster A institutions.

### Managing Anesthetic and General Emergencies

Seven of the questionnaire items covered the competence to manage complications implicated in anesthetic-related maternal mortality in SA (Figure 2).[5] The competence differential between cluster A and B medical schools for prescribing drugs for prevention of aspiration was 27%; performing a spinal block, 25%; managing a high spinal, 20%; managing hypotension, 25%; using inotropes/vasopressors, 18%; managing CICO, 19%; and managing hypoxia, 18%. The same trend was observed for general medical competencies that all doctors should be able to manage, but for which anesthetists are regarded as experts (Figure 3). The range for many of these competencies across the 8 medical schools (lowest to highest competence medical school) was often high, exceeding 40% in some instances (Table 2).

## DISCUSSION

Students reported variable self-efficacy across a range of anesthetic competencies related to the SA burden of disease. Previous research on outcomes has been limited to environments in which anesthesia is delivered by specialists.[24,25] The training of fit-for-purpose, day-one

practitioners is context sensitive,[26] and a clear statement of such outcomes may facilitate the achievement of the Global Surgery and SDG3 agendas. This statement of outcomes may ensure that the quality of the learning during the 2-month internship is enhanced. We determined the self-perceived competence of medical graduates in anesthetic practice to inform curriculum development.

Students who attended programs with longer anesthesia training (cluster A) reported statistically significant greater self-efficacy in 96% of items and themes of patient evaluation, skills performance, administration of anesthesia, and management of intraoperative complications. A similar trend was reported for general medical and anesthetic skills commonly implicated in SA maternal mortality. Cluster B schools with shorter training scheduled a single rotation before the final year of study, while all cluster A schools offered anesthesia over 2 or 3 years, all including the final study year. The reduced self-perceived competence at cluster B schools might have been a result of reduced time on task, fewer opportunities for learning through repetition, and the timing of the anesthetic rotation in the curriculum.

"Time on task" is the correlation between learning and time spent engaging with the subject material.[27] Equal time investment does not result in the same benefit across different tasks, and factors, including the nature and quality of activities and student engagement, influence learning.[28] However, the reduced self-perceived preparedness of cluster B students could be explained by the reduced rotation durations, resulting in reduced time on task.

The role of repetition in long-term knowledge and skill retention is well recognized, from Aristotle[29] to modern-day adult learning theories, including behaviorism, constructivism, and experiential learning.[30] Spaced repetition (reexposing students to information) may enhance knowledge retention.[31] Cluster A students were likely to have had repeated exposure to anesthesia and practical skills. Spiraling of learning in these schools might have further enhanced the students' feeling of preparedness due to reinforcement and increasing complexity of content and activities with eventual higher level objectives.[32] Spiraling also reduces cognitive load, as increasing complexity is introduced when basic concepts are better understood.[33]

Furthermore, cluster A students were likely to have benefited from the anesthetics scheduling in the final year, with enhanced maturity, knowledge of other disciplines, critical thinking, and metacognitive skills. Anesthetics in the final year also means that concepts are taught immediately preceding internship, which might aid retention.

Overall, students felt more competent in history-taking, examination, and diagnostic reasoning than in managing anesthetic and general medical complications and emergencies. Our findings concur with studies in which medical graduates felt well-equipped in a similar suite of skills.[21,34] It is likely that managing emergencies requires a higher metacognitive ability. It poses a higher intrinsic cognitive load through the number of required task elements, as well as high element interactivity, which is further complicated by the stressful and time-limited nature of such events.[35] Apart from the intrinsic load, cognitive load theory (CLT) defines a germane load that is incurred by the mental processes involved in learning (eg, automation and schemata formation).[33] Learning complex procedures, like emergency management, takes time. High-fidelity simulation, situational awareness training, and teacher engagement through feedback have been proposed to enhance germane load.[35] These interventions again require time on task, spaced repetition, and student seniority. Competence in emergency management

could potentially also be enhanced by increased assessment through, for example, objective structured practical examinations (OSPEs).

As reported previously,[36–38] students in our study did not feel competent in several general medical areas in which anesthetists are seen as experts, including resuscitation, fluid and blood product management, and analgesia. Several groups have advocated for anesthetists to play a bigger role in teaching these skills,[24,25] taking ownership through teaching in other rotations, and emphasizing these skills during anesthetic rotation(s).

Contextual differences in the availability of human and material resources impact undergraduate medical training. Students in our study, similar to those in other environments, felt competent in obtaining intravenous access.[24,25,37] They were comfortable with airway management, including intubation, which correlates with a previous study in which SA medical graduates rated their intubation competence at >70%.[21] In contrast, other African studies[37] showed that students did not feel competent in intubation, and trainers in the developed world regarded intubation as too advanced a skill for undergraduate students.[24,25] Endotracheal intubation is a lifesaving skill, and due to the often limited supervision of newly qualified doctors, it is often considered an essential skill for graduates in SA.[39] Our study participants likely felt competent, as intubation is typically taught in several disciplines, including anesthesia, emergency care, and trauma.

Cesarean delivery is the most commonly performed surgical procedure in sub-Saharan Africa[6] and is often performed by unsupervised junior doctors in SA,[15] with reports indicating that anesthetic-related maternal mortality was largely preventable.[17] The lack of self-perceived competence in aspects associated with maternal mortality, especially in cluster B schools in our study, is concerning. The Essential Steps in Managing Obstetric Emergencies (ESMOE)[40] program was designed for internship training, but we believe that introducing this at the undergraduate level and repeating it during internship would improve alignment of the 2 phases of learning, and could, through repetition, enhance knowledge retention and assist in preparing junior doctors for unsupervised, independent practice.

Students in our study were less confident in the administration of anesthesia, likely because it is taught only during the anesthetic rotation. Full anesthetic competence is unlikely at the undergraduate level, but the 2-month internship anesthetic rotation is meant to afford additional experience in anesthesia. Currently, there is a disconnection between undergraduate and internship training[13] (which does not have a formal training program or assessment of outcomes). Thus, we, like others,[14] believe that there is a need for national undergraduate anesthetic learning outcomes, including a core skill set, and that the undergraduate and internship training should align to form part of a continuum of basic anesthetics training in SA.

**Recommendations From This Study**

- The results of this study show that time on task, capacity for repetition, and maturity of students may impact the level of self-efficacy that is achieved. This has implications for curriculum development.
- Standardized, national core undergraduate anesthesiology outcomes should be defined (including a core skill set). These should align with the HPCSA internship outcomes and should include operational definitions for competence.

- Anesthesiologists should take ownership of undergraduate training in generic competencies relating to airway management, resuscitation, basic ventilation, and perioperative patient preparation and care.
- Greater emphasis should be placed on fully integrated curricula that emphasize skills competencies and emergency management.
- Assessment should align with this integration of the curriculum.
- Emergency management might be enhanced by courses such as ESMOE in undergraduate anesthetic teaching.

### Strengths

Students from the 8 (2017–2019) medical schools in SA participated in this study, providing a national perspective. The large sample size and participation rate further strengthen confidence in the results.

### Limitations

This study used self-reporting and not objectively assessed competence. The number of student exposures to skills was not recorded, and the study aims did not include correlations between experience and self-perceived competence.

### Future Research

Consensus around core undergraduate anesthesia outcomes should be obtained. The minimum number of attempts required for competence could be studied for each defined skill outcome. The study could be repeated at the end of the internship training phase.

## CONCLUSIONS

This study assessed the level of self-perceived undergraduate medical student competence in anesthesiology outcomes. Students reported a lower self-efficacy to manage emergencies and complications. These are important in the context of maternal mortality in SA as well as an increased trauma and violence burden. The low self-efficacy was more pronounced for medical schools with a shorter duration of anesthesiology training. This study suggests that curriculum reform is required. The achievement of an agreed-upon set of competencies is a necessary first step toward fit-for-purpose practitioners. This study is the first of its kind in a lower specialist-to-patient ratio environment. The findings might benefit curriculum development in other regions with similar contexts.

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## DISCLOSURES

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