Original Research Article

Preparing the Health Workforce in Ethiopia: A Cross-sectional Study of Competence of Anesthesia Graduating Students

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ABSTRACT

Background: Efforts to address shortages of health workers in low-resource settings have focused on rapidly increasing the number of higher education programs for health workers. This study examines selected competencies achieved by graduating Bachelor of Science and nurse anesthetist students in Ethiopia, a country facing a critical shortage of anesthesia professionals. **Methods:** The study, conducted in June and July 2013, assessed skills and knowledge of 122 students graduating from anesthetist training programs at six public universities and colleges in Ethiopia; these students comprise 80% of graduates from these institutions in the 2013 academic year. Data was collected from direct observations of student performance, using an objective structured clinical examination approach, and from structured interviews regarding the adequacy of the learning environment. **Results:** Student performance varied, with mean percentage scores highest for spinal anesthesia (80%), neonatal resuscitation (74%), endotracheal intubation (73%), and laryngeal mask airway insertion check (71%). Average scores were lowest for routine anesthesia machine check (37%) and preoperative screening assessment (48%). Male graduates outscored female graduates (63.2% versus 56.9%, $P = 0.014$), and university graduates outscored regional health science college graduates (64.5% versus 55.5%, $P = 0.023$). Multivariate linear regression found that competence was associated with being male and attending a university training program. Less than 10% of the students believed that skills labs had adequate staff and resources, and only 57.4% had performed at least 200 endotracheal intubations at clinical practicum sites, as required by national standards. **Discussion:** Ethiopia has successfully expanded higher education for anesthetists, but a focus on quality of training and assessment of learners is required to ensure that graduates have mastered basic skills and are able to offer safe services.

Keywords: Anesthesia, ethiopia, higher education, objective structured clinical examination, student competency

Background

Despite significant advances in the provision of safe anesthesia in high-income countries,[1,2] anesthesia-related and perioperative mortality in low-resource settings remains high,[3,4] exacerbated by a critical shortage of anesthesia providers.[5] Estimates suggest that in Ethiopia only 19 anesthesiologists (medical specialists with 9+ years of university training), and 239 anesthetists (a mid-level cadre with 4 years of university training or nurses trained for 1 year) serve a country of approximately 80 million people.[6,7] Not only is the ratio of anesthesiologists to population in

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Ethiopia among the lowest in the world,[8] a survey[9] of nurse anesthetists in Ethiopia found that only 62% could provide safe anesthesia and only 11% could provide obstetric anesthesia (as determined by a tool developed by Hodges *et al.*[10] to help countries assess the state of anesthetic provision).

Many countries are training mid-level cadres in anesthesia to increase service coverage,[11-13] but their education and supervision are often under-resourced and their work environments can be challenging.[14,15] In Ethiopia, rapid expansion of training institutions to meet the great demand for health workers[7] has put added stress on anesthesia education, with faculty, equipment, and infrastructure in short supply.[16] This study examines competencies achieved by graduating anesthetist students in Ethiopia. It asks: (1) Are graduating students competent to practice safe anesthesia as defined in the national curriculum and guidelines? (2) What characteristics of students and training institutions are associated with achieving selected competencies in anesthesia? (3) What are students' perceptions of the adequacy of their learning environment?

Methods

Study design and sample

Findings come from baseline data collected as part of a study to evaluate the impact of interventions to improve the quality of education at anesthetist training programs in Ethiopia. All public higher education institutions that graduated students from anesthetist programs in 2013 were eligible for this study. Four universities and six regional health science colleges (RHSCs) met these criteria. (Universities offer a four-year anesthetist training program leading to a bachelor of science degree, while RHSCs offer a one-year diploma program in anesthesia for nurses who have at least two years of work experience). Students at four RHSCs had already graduated when data were collected. Therefore, the study sample is limited to four universities and two RHSCs, representing 6 of Ethiopia's 11 regions. All 153 anesthetist students who graduated from these institutions in 2013 were invited to participate in the study, but 31 had either returned home or did not wish to participate. Thus, the study includes 122 students, representing 80% of graduates.

Measures and instruments

Data come from direct observations of students' knowledge and skills in a simulated setting and structured interviews with students. Competencies to be assessed were selected based on national curricula and guidelines and international nurse anesthetist educational standards,[17] as well as logistic considerations.

The objective structured clinical examination (OSCE) approach was used because it is a robust method for assessing clinical competence[18,19] and is used by Ethiopian training institutions. There were 10 OSCE stations. At six stations, students were observed performing a skill on a mannequin or standardized patient. These stations covered (1) endotracheal intubation; (2) preoperative screening assessment and determination of appropriate anesthesia for the client, including history taking and interpersonal communication; (3) chest examination; (4) neonatal resuscitation; (5) cardiopulmonary resuscitation; and (6) laryngeal mask airway insertion check. At four stations, students were asked to describe or write down the steps they would take to effectively complete a procedure. These stations covered (1) lumbar puncture for spinal anesthesia; (2) the anesthesia work station, including a routine check of an anesthesia machine that students had used during clinical practicums; (3) considerations before and during blood transfusion; and (4) interpretation and management of postoperative complications. For each item on the OSCE checklist, observers responded "yes" (indicating that the item was performed correctly) or "no" (indicating that the item was performed incorrectly or not performed).

Structured interview tools collected student socio-demographic information and posed 12 questions about their experience in the classroom, skills lab, and clinical practicum. Students could respond "yes," "partially," or "no." Students were also asked how many endotracheal intubations they had performed under supervision.

Data collection

Twelve university instructors were recruited to observe and interview the students; all were trained anesthetists with expertise in skills assessments. They attended five days of training, during which they pre-tested the tools and demonstrated their ability to perform OSCE assessments by completing role plays and knowledge tests. To minimize bias, data collectors were assigned to institutions where they were not currently serving as faculty.

Data were collected in June and July 2013, after students had completed their final examinations. The data collection team spent two days, on average, at each training institution. Two co-investigators supervised data collection, verifying that data collectors were recording data appropriately; they did not interfere with the assessment.

Students rotated through each OSCE station, read a case scenario, and then either performed the required skill or described how they would address the scenario. The stations assessed clinical decision-making, communication, and psychomotor skills. The data collector assigned to each station completed a 6- to 16-item checklist while observing each student. Two other data collectors interviewed students after they completed the OSCE. On average, it took 10 minutes for a student to complete each OSCE station and 15 minutes for the interview.

Data analysis

Double data entry and cleaning were conducted using CSPro 5.0. Statistical analysis was performed using STATA version 13.1 software. Assumptions regarding normal distributions and outliers were checked before applying statistical analysis. Composite scores were calculated for each OSCE station; they are the mean percentage of items performed correctly at that station. The overall mean skills score was calculated as the sum of all OSCE station scores divided by the number of stations; hence, each station contributes equally to the overall score. Bivariate and multivariable linear regressions were conducted to identify factors predicting student competence. The dependent variable was the overall mean skills score, and the potential predictor variables in the regression analysis were gender, age, type of training institution, and whether the number of endotracheal intubations performed by each student (self-reported) was at least 200. Student interview responses were divided into two categories ("yes" and "no") for analysis; responses of "partially adequate/sufficient" were recoded as "no" responses. Since data showed clustering at the level of the schools, bivariate and multivariable regression analyses were performed for independent variables of interest with adjustment for clustering due to study design. Clustering was accounted for by the use of Huber-White (also called Sandwich or robust) standard errors. In the null model, the variations accounted for between institutions was 38.2% (intraclass correlation coefficient = 0.382, with 95% CI = (0.055, 0.709)).

Ethical considerations

The study protocol was approved by the Johns Hopkins School of Public Health Institutional Review Board (IRB #5051). Informed oral consent was obtained from all participants after the aim of the study was explained, and steps were taken to preserve the confidentiality of the information gathered.

Results

Characteristics of study participants

Most study participants were male (72.1%), age 20–24 years (64.7%), and from an urban area (62.3%) [Table 1]. Few had prior job experience related to anesthesia (4.9%), and most attended from university programs (66.4%).

Student competence on selected skills

Higher education institutions in the country use 60% as the cut-off score for competency exams – we considered this as a threshold to judge student competence. The overall mean skills score across all OSCE stations was 61.5% [Figure 1]. Student competence varied across stations, with mean scores highest for spinal anesthesia (79.5%), followed by neonatal resuscitation (74.4%), endotracheal intubation (72.8%), and laryngeal mask airway insertion check (71.1%). Average scores were lowest for the routine anesthesia machine check (36.7%) and preoperative screening assessment (47.8%).

Table 1: Distribution of study participants by training institution (percentages)

Characteristic	Training institution			
	All students (*n*=122)	University (*n*=81, 66.4%)	RHSC (*n*=41, 33.6%)	*P**
Gender				0.584
Male	72.1	69.1	78.1	
Female	27.9	30.9	21.9	
Age in years				<0.001
20-24	64.7	88.9	17.1	
25-30	35.3	11.1	82.9	
Hometown				0.686
Urban	62.3	64.2	58.5	
Rural	37.7	35.8	41.5	
Previous job experience related to anesthesia				0.986
Yes	4.9	4.9	4.9	
No	95.1	95.1	95.1	

**P* values are based on Pearson Chi-square tests adjusted for clustering. RHSC=Regional health science college

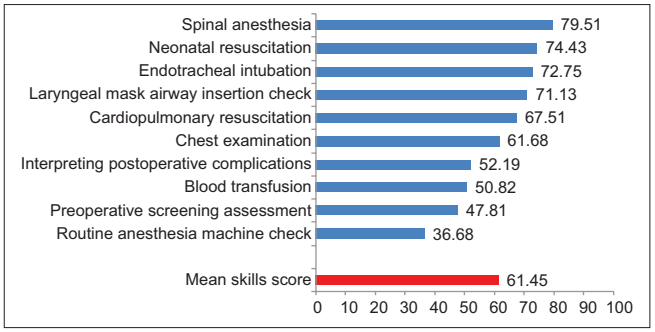

Figure 1: Mean percentage scores of anesthesia graduates, by OSCE station

University graduates significantly outscored RHSC graduates overall (64.5% versus 55.5%, $P = 0.023$) and on two skills: Blood transfusion and laryngeal mask airway insertion check [Table 2]. RHSC graduates did not score significantly higher than university graduates on any skill.

Male graduates significantly outscored female graduates overall (63.2% versus 56.9%, $P = 0.014$) and on two skills: Routine anesthesia machine check and interpretation of postoperative complications. There was no significant difference by gender on the remaining eight skills.

Student perceptions of the learning environment

Less than 10% of students believed that skills labs had adequate staff and resources [Table 3], but approximately half rated their instructors as effective (50.0%) and fair (48.4%). Students rated the clinical practicum highest, but only 55.7% thought they had received sufficient practical experience.

Table 2: Mean percentage scores on objective structured clinical examination stations, by student training institution and gender

OSCE station	Number of items	Training institution			Gender		
		University (*n*=81)	RHSC (*n*=41)	*P*	Male (*n*=88)	Female (*n*=34)	*P*
Spinal anesthesia	10	78.9	80.7	0.589	78.9	81.2	0.609
Neonatal resuscitation	10	75.3	78.7	0.761	75.5	71.8	0.439
Endotracheal intubation	16	71.0	76.2	0.532	74.9	67.3	0.325
Laryngeal mask airway insertion check	9	81.8	50.1	0.040	71.1	71.2	0.984
Cardiopulmonary resuscitation	11	66.3	69.8	0.621	70.6	59.6	0.070
Chest examination	12	65.2	54.7	0.205	65.8	51.0	0.063
Interpretation of postoperative complications	6	55.6	45.5	0.061	54.4	46.6	0.001
Blood transfusion	8	58.8	35.1	<0.001	52.0	47.8	0.395
Preoperative screening assessment	12	50.6	42.3	0.184	48.6	45.8	0.347
Routine anesthesia machine check	12	41.4	27.4	0.185	40.5	26.7	0.027
Mean skills score*		64.5	55.5	0.023	63.2	56.9	0.014

*The mean skills score is the sum of all OSCE stations divided by the number of stations; hence, each station contributes equally to the score. OSCE=Objective structured clinical examination, RHSC=Regional health science college

Table 3: Perceptions of the learning environment, by student training institution and gender (percentages)

Conditions in facilities	All students (*n*=122)	Training institution			Gender		
		University (*n*=81)	RHSC (*n*=41)	*P*	Male (*n*=88)	Female (*n*=34)	*P*
Classroom instruction and resources							
Classroom resources are available and appropriate	26.2	27.2	24.4	0.851	25.0	29.4	0.712
Instructors are effective in facilitating learning	50.0	42.0	65.9	0.218	43.2	67.7	0.115
Instructors are fair in assessing learning	48.4	34.6	75.6	0.123	45.5	55.9	0.418
Skills lab							
Number of skills lab assistants is adequate	4.9	2.5	9.8	0.248	6.8	0.0	0.375
Skills lab resources are available and appropriate	9.0	8.6	9.8	0.881	10.2	5.9	0.504
Skills lab assistants are effective for learning	9.0	6.2	14.6	0.090	11.4	2.9	0.238
Clinical practicum							
Practicum sites are conducive to learning	38.5	37.0	41.5	0.887	34.1	50.0	0.498
Preceptors are available at practicum sites	72.1	63.0	90.2	0.011	68.2	82.4	0.193
Among students who said that preceptors were available at practicum sites	*n*=87	*n*=51	*n*=36		*n*=59	*n*=28	
Preceptors are adequate	35.6	31.4	41.7	0.528	35.6	35.7	0.989
Preceptors' support is adequate at the scheduled time	47.1	38.8	59.5	0.376	44.1	55.6	0.520
Practical experience is sufficient	55.7	58.0	51.2	0.515	53.4	61.8	0.382

RHSC=Regional health science college

RHSC students were significantly more likely than university students to believe that preceptors were available at practicum sites (90.2% versus 63.0%, $P = 0.011$).

Endotracheal intubation

The Ethiopian curriculum requires anesthesia students to perform a minimum of 200 endotracheal intubations at clinical practicum sites. Only 57.4% of graduates reported meeting that standard [Table 4]. University graduates were more likely than RHSC graduates to do so (76.5% versus 19.5%, $P = 0.018$).

Factors associated with student competency

Bivariate and multivariate linear regression models used predictors selected based on trends observed in the preliminary data analysis and discussions among the research team. The bivariate logistic regression found that the mean skills score was significantly associated with student's gender and type of training institution [Table 5]. These two factors remained significant in a multivariate linear regression: Competence was associated with being male and attending a university training program.

Discussion

Task-shifting of surgical care to mid-level providers may be a safe and sustainable way to address the surgical workforce shortage in low resource settings[20] and has been used in a number of countries.[21] Countries have focused on accelerating the production of mid-level cadres, including anesthetists. Training mid-level workers features prominently in national workforce plans in countries such as Zambia, Lesotho,

Table 4: Endotracheal intubations performed by students, by training institution and gender (percentages)

Number of procedures	Training institution				Gender		
	All students (*n*=122)	University (*n*=81)	RHSC (*n*=41)	*P*	Male (*n*=88)	Female (*n*=34)	*P*
<200	42.6	23.5	80.5	0.018	44.3	38.2	0.701
200	57.4	76.5	19.5		55.7	61.8	

RHSC=Regional health science college

Table 5: Association between mean skills score and predictors

Predictors (outcome=mean skills scores)	Bivariate linear regressions		Multivariate linear regression	
	Coefficients (95% CI)	*P*	Coefficients (95% CI)	*P*
Gender (ref: female)	-	-	-	-
Male	0.063 (0.019-0.107)	0.014	0.076 (0.007-0.145)	0.037
Age in years	0.010 (0.025-0.004)	0.117	0.003 (0.013-0.008)	0.555
Training institution (ref: RHSC)	-	-	-	-
University	0.090 (0.019-0.162)	0.023	0.096 (0.042-0.151)	0.006
Number of ETTIs performed (ref: <200)				
>200 procedures	0.037 (0.041-0.115)	0.281	0.014 (0.043-0.014)	0.256

RHSC=Regional health science college, CI=Confidence interval, ETTIs=Endotracheal intubations

and Ghana;[22] in Tanzania[23] and Mozambique,[24] mid-level professionals successfully provide major surgery.

The effort to rapidly increase the number of anesthetists in Ethiopia by expanding the number and size of training institutions is a tremendous achievement, but the mean score of 61.5% on the OSCE suggests that some graduates may not be fully prepared to safely provide services upon deployment. This raises questions about the adequacy of the training programs and their learner assessment methods, as study participants had already passed their institutional examinations. Although comparable studies of anesthesia training programs in other countries are not available, research on another mid-level cadre—nurses—suggests that this problem is not limited to Ethiopia. Studies in South Africa and the United Kingdom have identified deficits in the competence of newly qualified nurses.[25-27]

Student performance was not uniformly low across the skills assessed. The mean score of 79.5% for lumbar puncture for spinal anesthesia is important for Ethiopia, where three-quarters of the population resides in rural areas[28] with limited access to facilities providing general anesthesia. Similarly, the mean score for neonatal resuscitation (74.4%) suggests that students can effectively address challenges when they encounter birth asphyxia. It is also encouraging that the mean score for endotracheal intubation was 72.8%, even though only 57.4% of students had performed 200 or more endotracheal intubations.

Of concern are low mean scores for routine anesthesia machine check (36.9%) and preoperative screening assessment (44.8%), both of which are essential for patient safety.[29,30] Training institutions should consider curricula revisions, design of teaching materials, additional credit hours, more practice time in adequately staffed and equipped simulation labs, and increased caseloads and case mix during clinical practice rotations, all of which can strengthen student performance.[8,31,32]

Verification that students have mastered basic skills before deployment is important, as is ensuring that they receive ongoing support when employed. Strategies include establishment of a national licensing exam;[33] standardization, validation, and oversight of existing assessments; supportive supervision post-deployment; and in-service training. In Nepal, onsite coaching for anesthesia assistants has proven effective in strengthening their skills.[34]

Factors affecting student performance

Female graduates consistently performed more poorly on the OSCE than male counterparts. These results differ from previous studies of medical and physiotherapy students in the United Kingdom,[35,36] medical students in the United States,[37,38] nursing students in Pakistan,[39] and anesthesia students in Saudi Arabia,[40] all of which found that women tend to perform better than men on clinical skills assessments. Our findings call for targeted efforts to support female students during training,[41] including life skills training, safe campus environments, peer-to-peer coaching, and study support.

University graduates outperformed RHSC graduates on most competencies. Limited clinical practice opportunities and inadequate teaching staff at RHSCs likely play a role, highlighting the need for strengthened infrastructure and qualified instructors at RHSCs. Other options include twinning with nearby universities and RHSCs to mentor faculty and share best practices. RHSCs should also consider ways to increase student exposure to cases, such as weekend and night rotations or collaborating with nearby health facilities. It should be noted, however, that this study did not investigate other potentially important factors, such as program length (one year at RHSCs versus four years at universities) and the nature of the student body (high school graduates seeking a baccalaureate degree versus nurses seeking specialty training).

Student perceptions of adequacy of learning environment

Student perceptions of their learning environment are associated with learning outcomes and attitudes toward studying[42] and can help identify areas needing improvement.[43] It is clear that substantial investment is needed in skills labs, clinical practice sites, and the teaching skills of faculty and preceptors.

Strengths and limitations

This study provides insights into the quality of anesthesia higher education in a low-resource setting. The OSCE approach is a reasonably reliable, valid, objective, and practical method of assessing different competency domains (knowledge, skills, and attitudes) during a single assessment,[19,44-46] However, it is possible that there was an examination bias; we did not examine the gender breakdown of the examiners relative to the scores given to women. In addition, the structured interview tools were not pilot-tested and validated, although inconsistencies and errors were identified and corrected during data collectors' training. We were unable to include all eligible training institutions and students in the study, which may limit our ability to generalize the findings to the national level. However, the four RHSCs excluded from the study because of earlier than expected graduations are not materially different from the two RHSCs included in the sample. It is impossible to know whether the competency of the 31 students who did not participate differed from those observed.

Conclusions

Findings suggest that rapid expansion of higher education programs has not solved the problem of providing safe anesthesia services in Ethiopia, because of limited teaching and learning infrastructure and minimal opportunities for clinical practice. Literature on the link between rapid expansion of higher education institutions and competency of students is not available. However, this study suggests that the emphasis on increasing the number of anesthetists may come at the expense of their competency.

These findings have important implications for policymakers not just in Ethiopia, but across all countries that are struggling to rapidly expand their health workforce. As countries design and implement approaches to scale up higher education, they should prioritize measures that ensure graduates master required skills and can offer safe services. This requires a focus on the quality of training and assessment of learners.

Graduates entering the workforce should also be provided with targeted on-the-job mentoring, supportive supervision, and in-service training to improve and maintain their competence. Further research can help identify factors that are associated with the performance of anesthesia graduates in real world clinical settings, rather than a simulated test environment, and test interventions targeted to underperforming students and institutions.

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Conflicts of interest

There are no conflicts of interest.

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