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Sensitivity of a preanaesthesia screening and triage tool in identifying high-risk patients attending the preanaesthesia assessment clinic in a tertiary referral hospital in Sub-Saharan Africa: a diagnostic accuracy study

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ABSTRACT

Objectives The use of preoperative triage questionnaires is an innovative way to mitigate the shortage of anaesthesiologists and to identify and refer high-risk patients early for evaluation. This study evaluates the diagnostic accuracy of one such questionnaire in identifying high-risk patients in a Sub-Saharan population.
Design Diagnostic accuracy study
Setting The study was conducted in a preanaesthesia assessment clinic in a tertiary referral hospital in Sub-Saharan Africa.
Participants The study had a sample size of 128, including all patients above the age of 18 scheduled for elective surgery under any modality of anaesthesia other than local anaesthesia presenting to the preanaesthesia clinic. Patients scheduled for cardiac and major non-cardiac surgery and those non-literate in English were excluded.
Outcome measures The sensitivity of the preanaesthesia risk assessment tool (PRAT) was the primary outcome measure. Other outcome measures were specificity, positive predictive value and negative predictive value.
Results Majority of patients were young and women with a mean age of 36 referred for obstetric and gynaecological procedures. The sensitivity of the PRAT in identifying high-risk patients was at 90.6% with 95% CI (76.9 to 98.2) in this current study while the specificity, negative predictive value (NPV) and positive predictive value (PPV) were 37.5% with 95% CI (24.0 to 43.7), 92.3% with 95% CI (77.7 to 97.0) and 32.6% with 95% CI (29.6 to 37.3) respectively.
Conclusion The PRAT has a high sensitivity and may be used as a screening tool in identifying high risk patients to refer to the anaesthesiologist early before surgery. Adjusting the high risk criteria to fit the anaesthesiologists' assessments may improve the specificity of the tool.

INTRODUCTION

A preoperative anaesthetic assessment is considered a basic component of anaesthesia care, and is a prerequisite for good postoperative outcomes.[1 2] The American Society of Anaesthesiologists (ASA) considers this the responsibility of the physician anaesthesiologist.[1] In as much as this is desirable, it may not be possible in low and middle-income countries plagued with a shortage of physician anaesthesiologists, particularly in Sub Sahara Africa.[3] This has necessitated preoperative reviews by other cadres of staff,[4] which has been associated with increased cancellations on the day of surgery (DOS) and increased cost of care due to unnecessary investigations.[5] To mitigate this stark shortage, innovative ways are required to conduct sound preoperative evaluations while preserving good perioperative outcomes and preventing DOS cancellations.

The timing of preanaesthesia assessment has not been established; however, ASA recommends that high-risk patients or those undergoing high-risk procedures be evaluated early before the DOS.[1] Inadequate preoperative preparation has been associated with increased rate of avoidable postoperative events or complications.[2] Early reviews such as in the preanaesthesia assessment clinics have been shown to alleviate patient anxiety,[6] reduce the length of in-hospital stay and the rate of DOS cancellations.[7]

The different strategies employed to address the shortage of physician anaesthesiologists and rationalise the preoperative assessment are centred on triage of patients to guide referral to the physician anaesthesiologist.[8] These include use of mail-in, online or physical questionnaires to triage patients into high and low-risk categories or the use of other cadres of staff such as nurse-trained anaesthetists to triage patients and determine need for referral to physician anaesthesiologists.[9–13]

While preoperative evaluation questionnaires are now in widespread use, few have been validated particularly in Western populations. Significantly, there is a paucity of data on preoperative evaluation and optimisation in Sub Sahara Africa and little information exists on use of triage questionnaires or systems in the preoperative assessments.[14] One such self-administered questionnaire was shown to have a sensitivity of 95% in identifying high-risk patients in a Western population as part of a triage system that involved a nurse-trained anaesthetist.[9] While this may be adopted in our setting, the differences in language, health literacy and health-seeking behaviour may mean that the results may not be translated to our population. The present study aimed to determine the sensitivity of this preanaesthesia risk assessment tool (PRAT) in identifying high-risk patients with the physician anaesthesiologists' assessment used as the reference standard in our population.

Objectives
The primary objective was to determine the sensitivity of a PRAT in identifying high-risk patients. The secondary objectives were to identify the specificity, negative predictive value and positive predictive value of the PRAT. Other secondary objectives were to determine the rate of cancellation, delays and rescheduling due to medical reasons and correlate this with the risk stratification by the anaesthesiologist and by the PRAT.

METHODS
Study design
This was a prospective observational diagnostic accuracy study.

Study population
The study was conducted in the surgical outpatient and preanaesthesia assessment clinics at Aga Khan University Hospital Nairobi between September 2020 and February 2021.

Patient and public involvement
There was no patient or public involvement in the design of this study.

Eligibility criteria
We included all patients above the age of 18 scheduled for elective surgery under any modality of anaesthesia other than local anaesthesia presenting to the PAC . Patients scheduled for cardiac surgery and major

non-cardiac surgery (Modified John's Hopkins Criteria Grade III) were excluded as these patients would ideally be required to be seen early by an anaesthesiologist for preoperative assessment and preparation regardless of their triage status.[15] Those unable to speak English (those accompanied by caregivers who understand English were included) were excluded.

Informed consent was obtained before enrolment into the study.

Sample size calculation
We calculated our sample size with an expected sensitivity of 95 %, expected prevalence of high risk (ASA 2, 3, 4) patients at 57.02% with reference to a study whose sample size was 11 382 in a referral hospital in Kenya.[16] We employed Buderer's formula[17] and powered the present study to detect a sensitivity of 95% with a precision of level of 5% and obtained a sample size of n=128.

Data collection and analysis
Patient demographics collected included age, level of education, comorbidities, ASA Physical Status (ASA PS) grading, type of surgery planned and this was presented as descriptive data on frequency tables. Normally distributed data were presented as means, data not normally distributed as median.

With appropriate permissions from and acknowledgements of the original author, a validated PRAT (online supplemental appendix 1) was used to stratify patients into two categories, high and low risk. Any 'yes' response to the questions, a body mass index (BMI) >30 (calculated by nursing staff receiving the questionnaire), and age >60 was considered 'high risk' meaning the patient was to be reviewed in the PAC early before their surgery by the anaesthesiologist.

A different form with a corresponding code was filled by a physician anaesthesiologist on completion of their preoperative reviews stratifying the patient as high or low risk. High-risk patients as per the anaesthesiologist assessment included the following groups:
► May proceed to surgery but requires special instructions such as medications to stop or withhold temporarily.
► May require further investigations to determine fitness for surgery or need referral to a subspecialty clinic for further evaluation or optimisation such as cardiology or pulmonology.
► May be unfit for surgery with no possibility of optimisation and, therefore, if the case is entirely elective, it may be deferred indefinitely.

These three groups essentially comprise patients who should have been referred to the physician anaesthesiologist early before their surgery. To standardise the anaesthesiologist's preoperative assessment for the purpose of the study, patients participating in the study were assessed by a consultant anaesthesiologist or by a supervised anaesthesiology resident and their assessment recorded in the anaesthesiologist's disposition form (ADF) (online

Table 1 2x2 table used to collect data on PRAT and Anaesthesiologists assessment to calculate measures of diagnostic accura

	Anaestheiologist: high risk	Anaesthesiologist: low risk
PRAT: high risk	a	b
PRAT: low risk	c	d

PRAT, preanaesthesia risk assessment tool.

Table 2 Baseline characteristics

Baseline characteristics	n	%
Gender		
Male	31	24.2
Female	97	75.8
Age		
<60	115	89.8
≥60	13	10.2
BMI		
<30	82	64.1
≥30	46	35.9
ASA PS		
I	63	49.2
II	58	45.3
III	7	5.5
IV	0	0
V	0	0
Level of education		
Secondary	7	5.5
Tertiary	121	94.5

ASA PS, American Society of Anaesthesiologists Physical Status; BMI, body mass index.

supplemental appendix 2). Each participant would then have a completed PRAT with a corresponding ADF with matching code.

Patient demographic data were presented as descriptive data.

The PRAT was self-administered and the corresponding form filled by an anaesthesiologist. The two data sets were then recorded in a 2×2 table shown in table 1 and sensitivity, specificity, negative predictive value (NPV) and positive predictive value (PPV) and positive and negative likelihood ratios calculated.

On the DOS, data on cancellations, delays or rescheduling due to medical reasons or inappropriate fasting were collected on these patients.

RESULTS

Of the 210 patients encountered in the preanaesthesia clinic, 128 were enrolled and evaluated both by the PRAT and the physician anaesthesiologist, with categorisation into high and low-risk groups as shown in flow diagram labelled in online supplemental figure 1.

The majority of participants were female and young at 75.8% with a median age of 36 (20 to 74) years. 10.2% of patients were 60 years or older. The mean BMI was 28.88±5.68 kg/m2 with 35.9% of patients obese. Majority of participants had an ASA PS Score of I at 49.2%, 45.3% with a score of II. 94.5% of the patients had attained a tertiary education. Table 2 summarises the baseline characteristics.

Most participants were scheduled for Obstetrics and Gynaecological procedures at 46.5% with Orthopaedic and General Surgical procedures as the second and third most common procedures at 21% and 18%, respectively. Most procedures were classified as Grade II based on Modified Johns Hopkins Surgical Severity at 56%. The rest of the cases were distributed as displayed in table 3.

There were 36 close-ended questions with a yes or no answer on the PRAT. The questionnaire addressed high-risk patient factors in a systemic order with responses displayed as frequencies.

Cardiovascular risk factors explored with positive responses included history of a heart attack, any heart trouble, heart failure, chest pain, angina or tightness, metabolic equivalent (as climbing one flight of stairs) and irregular heartbeat. 15.6% of patients had high blood pressure while chest pain and irregular heartbeat were

recorded in 4.7% of the participants each. The other risk factors were identified in one patient each.

Pulmonary risks identified by the PRAT included difficulty in breathing in 7.0%, asthma, bronchitis or emphysema 7.0%, frequent cough 7.0% and recent smoking 2.3%. Heartburn, indigestion or hiatus hernia was identified in 18.8% of patients, being a potential risk of aspiration.

Endocrine and metabolic abnormalities were also identified and included obesity 35.9%, diabetes mellitus at 5.3%, thyroid disorders in 3.9% and steroid use in 3.1%.

Organ dysfunction was explored as well with liver disorders and kidney problems identified in 1.6% each. Other important perioperative risks interrogated by the PRAT included haemoglobin and coagulation abnormalities, family history of anaesthetic complications, airway challenges such as jaw arthritis and loose dentures, medication allergies and neurologic disorders such as epilepsy and neuropathic pains.

The responses are presented in online supplemental table 1.

The sensitivity of the PRAT in identifying high-risk patients was at 90.6% with 95% CI (76.9 to 98.2) in this current study while the specificity, NPV and PPV were 37.5% with 95% CI (24.0 to 43.7), 92.3% with 95% CI (77.7 to 97.0) and 32.6% with 95% CI (29.6 to 37.3), respectively. Additional measures of diagnostic accuracy reported included a positive likelihood ratio of 1.37 with 95% CI (1.15 to 1.63) and a negative likelihood ratio of

Table 3 Case distribution into specialties and modified Johns Hopkins Classification of Surgical Severity

Specialty and modified Johns Hopkins criteria surgical severity grading	n	%
Obstetrics and gynaecology		
I	15	11.7
II	44	34.8
Orthopaedics		
I	11	8.5
II	16	12.5
General surgery		
I	14	11.0
II	9	7.0
Maxillofacial surgery		
I	8	6.3
II	0	0
ENT		
I	4	3.1
II	2	1.7
Plastic surgery		
I	2	1.7
II	0	0
Urology		
I	2	1.7
II	0	0

0.26 with 95% CI (0.08 to 0.79). There were no cancellations of scheduled surgeries in the PAC, nor were there DOS cancellations due to medical reasons.

DISCUSSION

The majority of patients presenting to our PAC were young and fit, 89.8% below the age of 60, ASA I and II patients being the majority at 94.2%. Our study population had comparable characteristics with that of Sileshi *et al,* which had 42.8% of patients categorised as ASA I with 57.8% between the age of 18 and 65.[16] Data from one Western series demonstrate a difference in demographics, with majority of the elective cases classified as ASA II or III (49.0% and 41.1%, respectively), which may be explained by a population with more advanced age.[18] The review was, however, done on general surgery cases while the present study looks at all elective surgical cases including obstetrics and gynaecology. The median age in the present study was 36, this might explain the high rates of ASA I patients in our study population.

A significant proportion of our patients was obese or greater at 35.9% based on BMI. Excluding pregnant participants in the analysis did not alter the proportion significantly in that 33.6% of patients who were not pregnant had a BMI >30. About 9.1% of Kenyan women are obese, one in three are overweight or obese, and more women in urban areas than their rural counterparts had a BMI more than 30.[19] The findings in our study may be explained by the patient profile presenting to our PAC being more commonly women who are from an urban setting.

The sensitivity of the PRAT in identifying high-risk patients was 90.6%, while the specificity was 37.5%. As a screening tool, the high sensitivity of identifying high-risk patients is desirable, with an acceptable cost of low specificity. The tool used in our present study has been validated in a Western population with a sensitivity of 95% and a specificity of 79% although with a different methodology.[9] In that study, the questionnaire was part of a triage system that involved the use of a trained nurse anaesthetist using an elaborate predetermined referral algorithm with an anaesthesiologist evaluating the appropriateness of the preoperative assessment on the DOS. The present study used the PRAT in its entirety, had no nurse anaesthetist to review the form and the anaesthesiologist's evaluation was done prospectively. The negative and positive predictive value of the tool in the present study was 92.3% and 32.6%, respectively, comparable to that in a similar study by Mendes *et al* using a different tool (94.9% and 38.2%, respectively).[20] They reported the additional advantage of providing information not routinely collected in the clinical assessment. It should, however, be noted that the NPV and PPV may not be generalisable to populations with a different prevalence of high-risk preoperative patients; therefore, these measures should be interpreted with caution. Hilditch and colleagues employed a different approach to validation of their preanaesthesia assessment form by comparing patients' responses to the anaesthesiologists' confirmation of the response to the same question with the agreement measured by a Kappa coefficient.[11] They concluded from their study that information on general health, exercise tolerance and risk factors for anaesthesia could be obtained by their form and be used to determine who should be evaluated by an anaesthesiologist before surgery. Overall, the high sensitivity of the PRAT used in the present study, coupled with the ability to identify important preoperative risk factors such as pulmonary, cardiovascular and endocrinometabolic abnormalities increase its utility as a screening and triage tool.

The sensitivity of 90.6% meant that three patients who were considered low risk by the PRAT were subsequently classified as high risk by the anaesthesiologist. One patient had failed to disclose an alcohol use disorder, which was identified. Another patient denied having high blood pressure, but had hypertension currently being controlled by medical therapy. The third patient was found to have a difficult airway (Mallampati IV), which could only be determined by the anaesthesia examination.

Reviewing the high-risk criteria may improve the utility of the form making it more sensitive. History of a previous anaesthetic categorised 14 out of 128 patients as high risk. In and of itself, it may not be a risk factor;

however, a complication suffered in the last anaesthetic may inform the perioperative management plan. This information may not be obtained by a questionnaire but may be interrogated further by a trained nurse anaesthetist once flagged, and this used to decide on referral to an anaesthesiologist. In this effort, the specificity of the PRAT may improve, without compromising the sensitivity.

Another factor identified by the PRAT as high risk was pregnancy in 15/128 patients. There are several physiological changes associated with the pregnant state that may affect perioperative management plans.[21] These changes are normal and most often do not require special preoperative optimisation strategies. Non-obstetric surgery in the pregnant has been associated with increased risk of fetal loss, preterm delivery and low birth weight among other unfavourable outcomes; however, this risk is relatively low.[22] Standard antenatal screening by trained nurse anaesthetists in addition to triage by the PRAT may prove useful in identifying patients who require an anaesthesiologist's review.

From the PRAT, obese patients (BMI >30) were triaged as high risk; however, this was discordant with the anaesthesiologist's assessment in 13 cases. Obesity is associated with respiratory dysfunction, the metabolic syndrome and cardiovascular dysfunction among other pathological entities. Class III obesity in isolation is associated with increased postoperative morbidity and mortality, with longer operating time, postoperative recovery and return to mobility.[23 24] Class I and II obesity in association with the metabolic syndrome is associated with a twofold increase in perioperative morbidity.[23] Adjusting the high-risk criteria in the PRAT such that class III obesity in isolation or I and II with metabolic syndrome are considered high risk may improve its sensitivity.

The strengths of the present study are the prospective collection of data with comparison of the PRAT to real-time anaesthesiologist evaluation, the reference standard of preoperative evaluation. This prevents recall bias from the anaesthesiologist's evaluation. Our attempt to standardise the anaesthesiologist evaluation by limiting the assessments to the PAC and only by a consultant anaesthesiologist or a resident supervised by their consultant also adds to the merits of this study. An important aspect of our present study is that it was conducted across all surgical specialties including obstetrics and gynaecology, further improving its utility in triaging patients preoperatively.

The limitations in this study may include the use of multiple anaesthesiologists contributing to heterogeneous reviews. However, this is partially mitigated by the use of consultants or supervised residents. A more uniform assessment may have been achieved if done by a single reviewer.

Importantly, majority of our patients had received a tertiary education (94.2%) and, therefore, may have a higher level of health literacy than that in a less formally educated population. Another important limitation is the fact that patients not able to read and write in English were excluded from the study. This may mean that the results may not be generalisable to a different population with lower levels of education and/or health literacy or populations that speak Swahili or other languages primarily and that further research on utilisation of this tool in these populations may be necessary in that regard.

CONCLUSION

The form used in our present study is a good screening tool for determining high-risk patients in our population; however, the questions or triggers for referral to the PAC may need revision by the anaesthesiology team conducting the preoperative reviews to improve its specificity. The forms may be used better if reviewed by a trained nurse or staff anaesthetist as part of the triage system before referral to the PAC. Further studies may be needed to evaluate the utility of this form in populations with lower levels of literacy or non-English-speaking populations.

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