Educating for Excellence: A Cohort Study on Assessing Student Nurse Anesthetist Non-Technical Skills in Clinical Practice

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Non-technical skills play an integral role in providing safe and excellent anesthesia. Currently there is little standardization in the assessment of non-technical skills in clinical practice, although various instruments exist. The aim of this study was to explore the use of the Nurse Anaesthetists' Non-Technical Skills-Norway (NANTS-no) structured assessment instrument in developing and assessing non-technical skills in clinical practice. This cohort study had a longitudinal design. Twenty student nurse anesthetists' non-technical skills were assessed by their mentors (N=31) and clinical supervisors (N=7) at three time-points over a 12-month period, after providing anesthesia to a patient. A 5-point rating scale was used for both the experts' assessments and students' self-assessments. Development of non-technical skills over time was estimated using linear mixed-effect models. The students demonstrated a significant overall development of non-technical skills (P<.001), achieving an expert assessment of 4.5 at the end of their education. The students significantly underestimated their clinical performance compared with the experts' assessments (P<.001). The structured behavioral assessment instrument appears to be reliable for assessing student nurse anesthetists' non-technical skills in clinical practice. This study may have implications for systematic assessment of non-technical skills in Norway and other countries.

Keywords: Anesthesiology, education, NANTS-no, non-technical skills, nurse anaesthetist/anesthetist, patient safety.

Non-technical skills are defined as "cognitive, social and personal resource skills."[1] Together with good theoretical knowledge and technical skills, they are generally acknowledged as playing an integral role in providing safe anesthesia.[2] In Norway, the organization and responsibility for providing anesthesia is regulated by the Norwegian Standard for the Safe Practice of Anesthesia.[3] Roles, competencies and tasks are clearly defined to ensure optimal patient safety when administering anesthesia both inside and outside the operating room. Central features are dialogue and teamwork between the anesthesiologist and Certified Registered Nurse Anesthetist (CRNA) based on a professional interdependency,[4] which contributes to reducing or ameliorating the incidence of adverse events.[5] While clinical responsibility lies with the anesthesiologist, a CRNA is qualified to independently administer general anesthesia to patients classified by the American Society of Anesthesiologists (ASA) as ASA I and II, and collaborate with an anesthesiologist when administering anesthesia to patients undergoing major surgical procedures (ASA III and IV).[3] This division of responsibility is similar to other Nordic countries and Switzerland; however, there are wide variations in the role nurses play globally in providing anesthesia.[6-10] Despite the importance of non-technical skills in clinical practice, there is currently no standardized assessment of these skills in Norway, nor in many other countries.[11,12]

Background

Excellence has become an aspirational goal in anesthesia in recent years. If this is to be achievable, excellence needs to be promoted at all levels and requires a high level of collaboration between educational and health care institutions.[13] The standards of practice advocated by the International Federation of Nurse Anesthetists (IFNA) provides a competency-based approach to ensuring high standards of quality and safety in nurse anesthesia education and practice.[7] These were recently also adopted by the Norwegian Association of Nurse Anesthetists in an attempt to further raise standards of professional competence. Since there is overwhelming evidence of the role of human factors in adverse events in anesthesia and other health-care fields, this move is in line with increased focus on improving individual resilience in professional practice by improving personal skills.[14]

Good teaching and supervision that enable learning in a complex and dynamic context, together with assessment that provides formative feedback based on mutual respect, are fundamental factors in education.[13] Integral to encouraging excellent practice is promoting an understanding of the role of non-technical skills, such as situation awareness, decision-making, task management and teamwork.[15] Situation awareness and decision-making are cognitive skills, involving the ability to identify and understand changes in the anesthetized patient while preventing and responding to unwanted complications and maintaining homeostasis.[16] Task management is also partially a cognitive skill, involving planning, prioritizing and coordination of available resources to ensure optimal patient safety.[17] Good teamwork depends on social and interpersonal skills; how individual team members communicate and co-operate and whether the team has a common understanding of what the situation requires.[5,16] A lack of these non-technical skills is often linked with poor and unsafe performance.[2,11]

Nurse anesthesia education in Norway is either a 2-year masters' program or an 18-months-long postgraduate specialist training in anesthesia, with clinical practice comprising 50% of the program. Pre-admission criteria for nurse anesthesia programs require candidates to be qualified registered nurses with a minimum of 2 years' relevant clinical experience (for example, critical care or emergency nursing).[18] However, these criteria for candidate selection do not guarantee a successful progression through the program. There are various possible reasons for attrition, such as academic failure, dismissal or withdrawal from the program, all representing a waste of individual and institutional resources.[12,19] A major concern in education is ensuring that student nurse anesthetists (SNAs) meet guideline expectations for clinical performance during the program.

Continuous clinical evaluation is carried out by mentors and clinical supervisors. Mentors have the daily responsibility for guiding individual SNAs and providing formative assessment on areas that need addressing to improve performance. Clinical supervisors are responsible for organizing clinical practice for all the SNAs in a hospital, as well as teaching and carrying out summative assessments together with the mentors at the end of each period of clinical practice.

Assessment plays an essential role in stimulating learning, defining expectations and ensuring acquisition of necessary skills, while also demonstrating accountability to stake-holders.[13] Miller[20] highlighted some of the issues related to assessment of clinical competence 30 years ago, and many of his comments remain relevant. Identifying which students may be at risk and where the problem lies is often challenging, since assessments are at risk of subjectivity and bias.[21,22] Much of the literature has focused on formative rather than summative assessment. Thus, issues such as inconsistencies in the assessment process, a reliance on written papers rather than patient encounters, or the use of unsuitable or unnecessarily complicated evaluation forms remain a challenge.[20,22] Clinical evaluation instruments for anesthesia assess a wide range of competencies including technical and non-technical skills, theoretical knowledge, professional behavior and personal attributes.[6,12,21,23] Some instruments are used for assessing trainees, while others are used for workplace-based supervision and peer assessment.[24,25] However, few instruments assessing non-technical skills appear to have been extensively tested.[26] The objective structured clinical examination (OSCE) is also widely used in medical and nursing education, but while providing a framework for assessing various aspects of clinical competence it does not include the practitioner's attitudes or behavior.[27]

It is paramount that instruments used for high-stakes summative assessments of clinical progress that potentially result in dismissal, should be both standardized and validated.[12,13] Although there is growing evidence of the reliability of behavioral assessment instruments in simulation settings, few have attempted to test them in clinical settings.[26,28] The Nurse Anaesthetists' Non-Technical Skills-Norway (NANTS-no) is a structured behavioral assessment instrument for assessing non-technical skills in Norwegian CRNAs. The instrument is adapted from Anaesthetists' Non-Technical Skills (ANTS),[23] and provides a common taxonomy for addressing behavior that threatens patient safety and excellence in anesthesia care. NANTS-no has a hierarchical structure with four categories of key non-technical skills essential for providing safe anesthesia: situation awareness, decision making, task management and team working (Figure 1). Each category has a varying number of skill elements, and for each element there are behavioral markers exemplifying good and poor anesthesia practice.

NANTS-no has been tested in a simulation setting,[29] but has not previously been used to assess non-technical skills in clinical practice. To our knowledge, this is the first study to test a structured assessment instrument for non-technical skills in anesthesia over time in a clinical setting.

• ***Aim of the Study.*** The primary aim of this study was to explore how NANTS-no enables a systematic development and assessment of non-technical skills in clinical practice.

Materials and Methods

• ***Design.*** This cohort study had a longitudinal design. A cohort of SNAs was prospectively followed over a 12-month period during the cohort's anesthesia education, and assessed at 3 timepoints, at the end of each period of clinical practice. A clinical practice week is 30 hours, to allow time for study, and the practice periods vary in duration. Thus the first assessment of non-technical

Categories	Elements
Situation awareness	▪ Gathering information ▪ Recognizing and understanding ▪ Anticipating and thinking ahead
Decision making	▪ Identifying possible options ▪ Assessing risks and selecting options ▪ Re-evaluating
Task management	▪ Planning and preparing ▪ Prioritizing ▪ Identifying and utilizing resources ▪ Maintaining standards and levels of quality
Team working	▪ Exchanging information ▪ Assessing roles and capabilities ▪ Co-ordinating activities ▪ Displaying authority and assertiveness ▪ Supporting other team members

Figure 1. The NANTS-no Structured Behavioral Assessment Instrument

skills took place after 9 weeks (T1), the second after 20 weeks (T2) and the final assessment after 37 weeks (T3) in clinical practice. These assessments formed part of the normal evaluations which are routinely performed at the end of each semester's nurse anesthesia education.

• ***Participants.*** SNAs (N = 22) at a university in Norway in September 2017 volunteered to participate in the study. The participants were qualified nurses enrolled in a 2-year master's program in nurse anesthesia. Two SNAs quit the program (1 during the first period of clinical practice and the second during the subsequent period) and were not included in the study. In addition, the SNAs' mentors and clinical supervisors were invited to provide the expert assessments in the study.

• ***Data Collection.*** Data were collected using the structured assessment instrument NANTS-no to assess the SNAs' non-technical skills in clinical practice between January 2018 and January 2019. NANTS-no has a 5-point numerical rating scale (1-5), where behavior that places the patient's life at risk is rated as 1, marginal behavior as 2, acceptable behavior as 3, good behavior as 4, and excellent behavior as 5. Non-technical skills should be rated according to what is expected of a qualified CRNA. The instrument's psychometric properties were tested in an earlier study and demonstrated high reliability (ICC = 0.8, Cronbach's $\alpha > 0.9$) and dependability (G coefficient = 0.83).[30]

The SNAs were assigned to clinical placements at 5 different hospitals with 1 or 2 mentors responsible for guiding each SNA. As part of the educational program, SNAs attended lectures on the role of non-technical skills in providing safe anesthesia, as well as training in the use of NANTS-no in clinical practice. This included rating non-technical skills in simulated video-recorded scenarios. SNAs were encouraged to use NANTS-no on a regular basis to critically reflect upon their progress and discuss issues that needed addressing with their mentors as well as assessing themselves. Particular attention was given to explaining the NANTS-no 5-point rating scale and the use of "N" for "not observed" behavior. Calibration training and discussions on how to use NANTS-no were also undertaken several times during the study period. The majority of mentors and clinical supervisors at the hospitals also attended a workshop on non-technical skills as described in an earlier study.[30] The workshop included rater training and the use of NANTS-no.

The assessments were based on the non-technical skills displayed by an SNA while providing anesthesia to a patient. Both the SNA's mentor and a clinical supervisor were present in the operating room to aid the SNA as necessary, while simultaneously observing the SNA's skills. Once the anesthesia was safely completed, the SNA, mentor, and clinical supervisor each assessed the SNA's non-technical skills using the 5-point rating scale, without comparing notes. Participants were asked to rate all 15 NANTS-no elements and provide a global score. The completed assessment forms comprise the data for this study. Owing to unforeseen circumstances, the same mentor or clinical supervisor did not always rate the SNAs at all 3 time points.

• ***Ethical Considerations.*** The first author is responsible for the Master of Nurse Anesthesia program at the University. She also acts as one of the clinical supervisors in the study, therefore, the SNAs were recruited by the second author. Ethical principles regarding informed consent, voluntary participation and the right to withdraw without penalty were carefully explained to the participants. Requirements regarding confidentiality, data anonymity and secure handling of data were also explained. After an appropriate time for consideration, written consent was obtained from all participants.

The study was approved by the university and hospitals where it was carried out, and the Norwegian Centre for Research Data was notified (project number 56310). Approval from the Regional Ethics Committee was not required.

• ***Data Analysis.*** Descriptive statistics were presented for the SNAs. NANTS-no category scores were calculated as the mean score with standard deviation (SD) of the elements in each category. Any NANTS-no ratings that were written as 2 scores, for example "2-3," were entered as the mean of both scores, while "N" for "not observed" was treated as missing. A missing data analysis was carried out.

Linear mixed-effect models were used to estimate the development of non-technical skills over time. A mixed model allows for an unbalanced design (not all the remaining students were assessed 3 times), as well as estimates the variation between and within observations by estimating random effects. The mixed models

	n	%	Min.	Max.	Mean (SD)
Gender:					
Male	8	40			
Female	12	60			
Age in years	20		26	53	31.5 (6.7)
Clinical placement:					
Hospital 1	5	25			
Hospital 2	8	40			
Hospital 3	4	20			
Hospital 4	2	10			
Hospital 5	1	5			

Table 1. Characteristics of the Student Nurse Anesthetists (n = 20)
Abbreviation: SD, Standard deviation.

included fixed effects for time (T1, T2, and T3), rater (SNA, mentor, and clinical supervisor), gender and age. Random effects were included to take into account dependencies in the data, that is, each student was rated at 3 time points by 3 raters. The models also allowed for different variance by raters. Statistical significance was considered when P-value <.05.

ANOVA was used to calculate the amount of variance explained by the model. All students were not assessed 3 times, therefore the given adjusted R^2 could be considered as a minimum estimate.

All the analyses were calculated using IBM SPSS Statistics, version 26 or Stata Statistical Software, Release 15.

Results

Twenty SNAs took part in the study. Seventeen SNAs' non-technical skills were rated at all 3 time points, while 3 SNAs' non-technical skills were rated at 2 of the time points. The demographics of the cohort are displayed in Table 1.

The SNAs' non-technical skills were rated at NANTS-no element level by the students themselves, their mentors (n = 31) and clinical supervisors (n = 7). The data was normally distributed and only 2% of the element ratings were missing. A detailed description of the missing ratings is presented in Table 2; however, since 27% of the global scores were missing these were not used in the analyses. The mean scores (SD) for each of the NANTS-no elements are presented by rater for the 3 time points in Table 3.

The observed average scores for all 4 NANTS-no categories are shown for the different time points in Figure 2. The students' average overall NANTS-no score at the end of the study was estimated as >4 by all 3 raters (SNA = 4.1, mentor = 4.5, clinical supervisor = 4.5).

The mixed-effect models showed a significant association of both time and rater with the overall NANTS-no scores (average of 4 categories). The SNAs demonstrated a significant overall improvement in non-technical skills from the first to second and first to third time point

NANTS elements	n	%
Gathering information	9	5
Recognizing and understanding	9	5
Anticipating and thinking ahead	9	5
Identifying possible options	9	5
Assessing risks and selecting options	15	8.3
Re-evaluating	11	6.1
Planning and preparing	10	5.6
Prioritizing	13	7.2
Identifying and utilizing resources	12	6.7
Maintaining standards and levels of quality	9	5
Exchanging information	9	5
Assessing roles and capabilities	13	7.2
Co-ordinating activities	3	7.2
Displaying authority and assertiveness	17	9.4
Supporting other team members	30	16.7
Total	188	

Table 2. Missing Ratings (not observed) Per NANTS-no Element

(*P*<.001). The students significantly underestimated their clinical performance compared with the experts' assessments (*P*<.001). Adjustment for age and gender did not influence the results (Table 4). To explore the importance of the random effect structure, different models were set up, all giving the same results as the estimated coefficients shown in Table 4 (data not shown). Adjusted R^2 = 0.7, indicating that 70% of the expected variation in the scores were explained by the progression of time (63%) and differences between the raters (7%). Thus, 30% of the variation was due to other unmeasured factors.

An improvement in the SNAs' non-technical skills was observed in all 4 NANTS-no categories (Figure 3A-D). The SNAs scored themselves significantly lower in all 4 categories (all P values ≤.005) compared to the expert groups. The variance among the SNAs and mentors

NANTS-no Elements	T1 (9 weeks)			T2 (20 weeks)			T3 (37 weeks)		
	SNA	M	CS	SNA	M	CS	SNA	M	CS
Gathering information	3.0 (0.7)	3.4 (0.5)	3.1 (0.6)	3.6 (0.5)	4.2 (0.7)	3.9 (0.5)	4.4 (0.5)	4.7 (0.5)	4.6 (0.5)
Recognizing and understanding	2.8 (0.6)	3.3 (0.6)	3.0 (0.5)	3.5 (0.6)	4.1 (0.5)	3.8 (0.6)	4.0 (0.6)	4.5 (0.5)	4.5 (0.6)
Anticipating and thinking ahead	2.6 (0.5)	3.0 (0.7)	2.7 (0.5)	3.3 (0.6)	3.8 (0.6)	3.8 (0.5)	3.8 (0.5)	4.3 (0.5)	4.4 (0.6)
Identifying possible options	2.8 (0.5)	3.1 (0.6)	2.8 (0.4)	3.4 (0.6)	4.0 (0.5)	3.7 (0.5)	4.1 (0.6)	4.5 (0.6)	4.5 (0.5)
Assessing risks and selecting options	2.6 (0.5)	3.1 (0.7)	2.6 (0.5)	3.4 (0.6)	3.9 (0.6)	3.7 (0.6)	4.1 (0.5)	4.4 (0.5)	4.4 (0.5)
Re-evaluating	2.7 (0.6)	3.1 (0.7)	2.7 (0.5)	3.2 (0.6)	4.2 (0.5)	3.5 (0.6)	4.0 (0.4)	4.5 (0.5)	4.5 (0.6)
Planning and preparing	2.8 (0.8)	3.4 (0.6)	3.2 (0.5)	3.6 (0.6)	3.9 (0.4)	3.8 (0.5)	4.3 (0.7)	4.5 (0.6)	4.7 (0.6)
Prioritizing	2.7 (0.7)	3.1 (0.8)	2.9 (0.3)	3.4 (0.5)	3.8 (0.7)	3.7 (0.4)	4.0 (0.5)	4.4 (0.7)	4.6 (0.5)
Identifying and utilizing resources	2.9 (0.7)	3.1 (0.7)	2.7 (0.7)	3.5 (0.5)	3.8 (0.7)	3.7 (0.5)	4.1 (0.5)	4.5 (0.5)	4.4 (0.5)
Maintaining standards and levels of quality	2.9 (0.6)	3.6 (0.7)	3.1 (0.5)	3.5 (0.6)	4.1 (0.6)	4.0 (0.3)	4.2 (0.6)	4.7 (0.5)	4.3 (0.5)
Exchanging information	3.0 (0.6)	3.2 (0.6)	3.0 (0.6)	3.6 (0.7)	4.1 (0.6)	4.1 (0.6)	4.3 (0.7)	4.7 (0.6)	4.7 (0.6)
Assessing roles and capabilities	2.9 (0.8)	3.3 (0.9)	3.1 (0.5)	3.7 (0.7)	4.0 (0.8)	4.0 (0.5)	4.3 (0.7)	4.5 (0.5)	4.7 (0.5)
Co-ordinating activities	2.7 (0.8)	3.1 (0.9)	2.8 (0.5)	3.3 (0.8)	3.9 (0.7)	3.7 (0.4)	4.0 (0.8)	4.4 (0.7)	4.3 (0.6)
Displaying authority and assertiveness	2.4 (0.8)	2.9 (0.7)	2.6 (0.5)	3.3 (0.7)	3.7 (0.8)	3.6 (0.6)	3.9 (0.6)	4.2 (0.7)	4.7 (0.5)
Supporting other team members	2.7 (0.8)	3.5 (0.6)	2.6 (0.5)	3.3 (0.8)	3.8 (0.8)	3.3 (0.6)	4.0 (0.9)	4.6 (0.5)	4.5 (0.6)

Table 3. Mean Scores (SD) for NANTS-no Elements by Rater Over Three Semesters
Abbreviations: SNA, student nurse anesthetist; M, mentor; CS, clinical supervisor; SD, standard deviation.

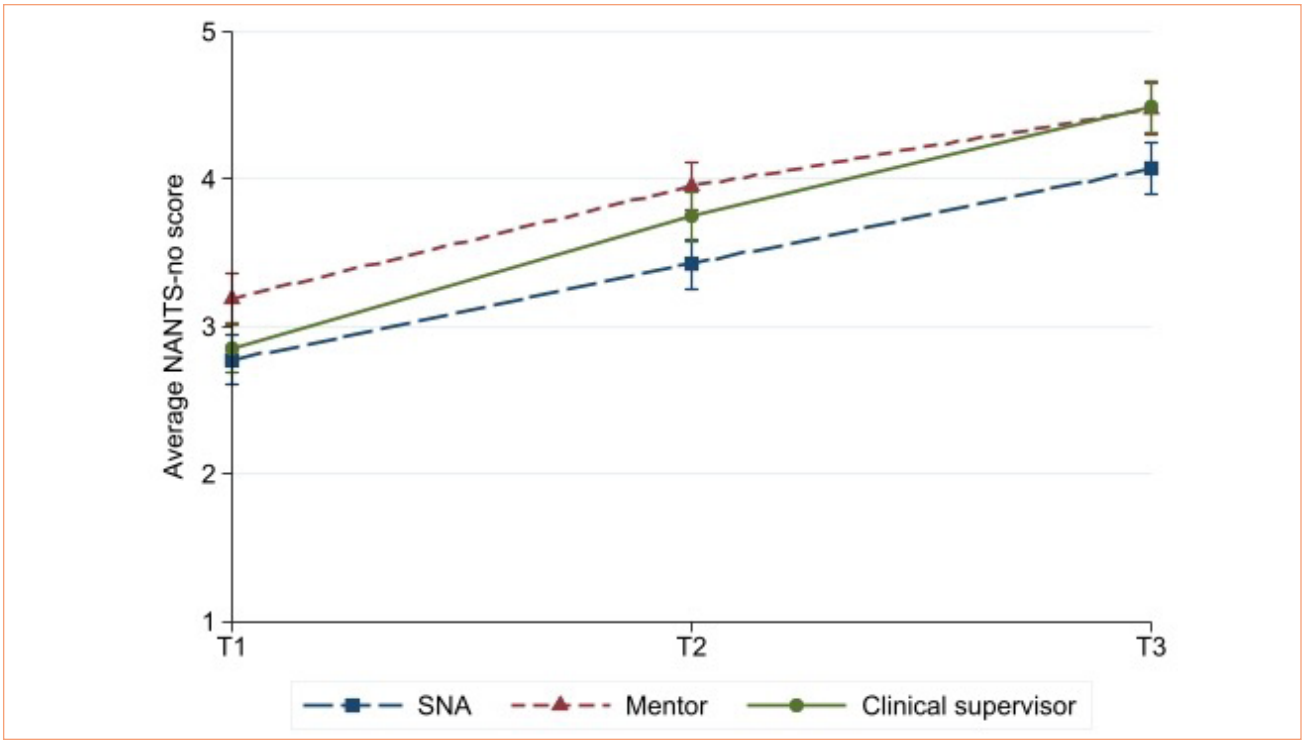

Figure 2. Development of Student Nurse Anesthetists' Non-technical Skills by Rater Over Three Semesters

was larger than the variance among the clinical supervisors for the categories *Task management* and *Team working*, while differences were not observed for categories *Situation awareness* or *Decision making*.

Discussion

The aim of this study was to explore how NANTS-no enabled a systematic development and assessment of non-technical skills in clinical practice. Two recent

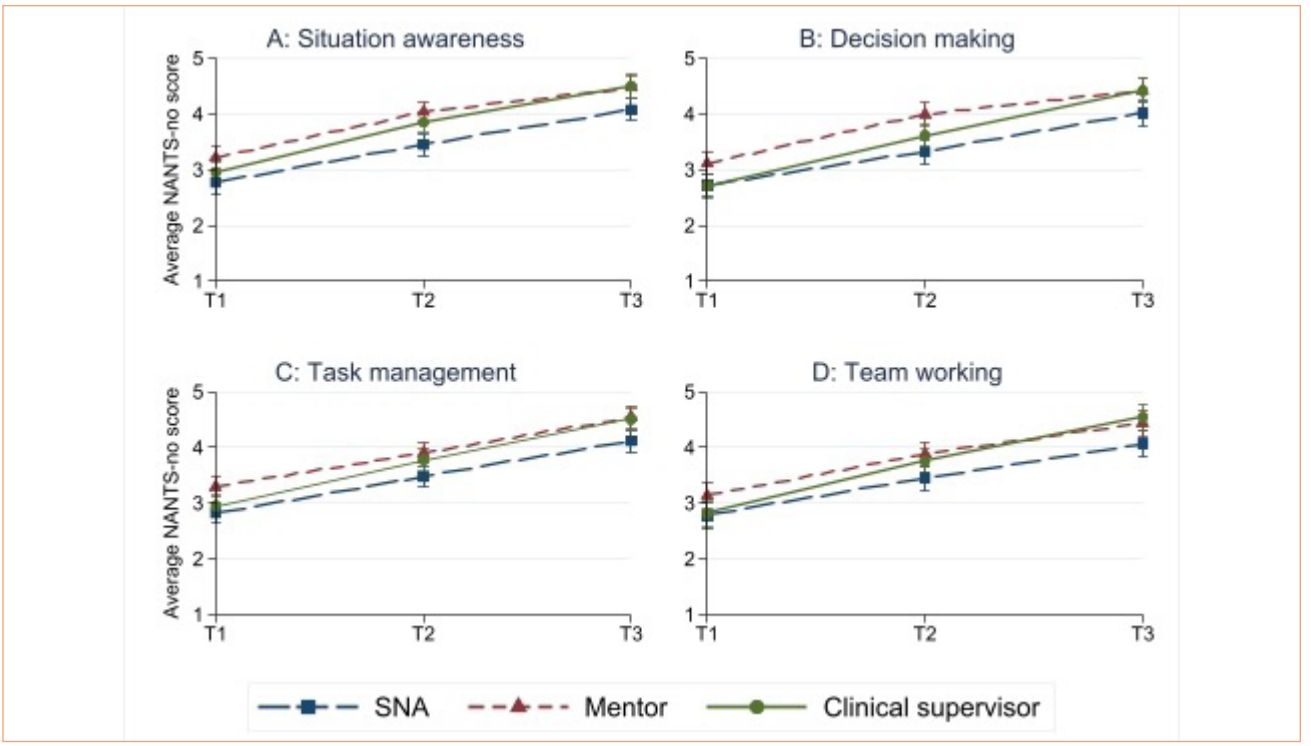

Figure 3A-D. Development of Non-technical Skills at Category Level by Rater Over Three Semesters

reviews[26,28] highlighted the need for reliable and valid instruments for assessing non-technical skills in clinical settings. Although a number of these have been tested in simulation settings, there has been little research carried out in clinical practice. Standardization in the way non-technical skills are measured, instrument usability, and adequate rater training are central factors that also need researching.[11] In this study, NANTS-no demonstrated a significant improvement in SNAs' non-technical skills over a 1-year period. Similar improvements over time have been demonstrated in simulation-based studies also.[29,31,32] Although there was some variance in the results at category level, there was a significant improvement in all 4 NANTS-no categories.

The SNAs were chosen as the reference point for the analyses, as their scores were compared to the 2 expert groups. The aim of systematically focusing on non-technical skills in anesthesia education was to improve patient safety and promote quality and clinical excellence,[2,15] thus a final average score of 4.5 (1-5) from both expert assessors is positive. A NANTS-no score of 4 indicates good performance, while 5 indicates excellent performance, when compared with a qualified CRNA. The latter stages of clinical training focus on the student, demonstrating the ability to handle complex and dynamic situations with acute and critically ill patients. This requires highly-developed non-technical skills. The goal is excellence, therefore it would seem appropriate to suggest that a summative NANTS-no score of 4 should be a minimum requirement to determine adequate clinical competence.

High-stakes summative assessments require reliable, relevant and standardized criteria, qualified assessors, and appropriate assessment situations.[11,22] Rater-based assessments are fallible, with a range of psychometric weaknesses threatening dependability.[33] The importance of rater training has been argued to ensure clarity between assessors and increase reliability,[34] however recommendations are often difficult to follow owing to cost and staffing implications.[28] Rater training carried out before this study estimated that 2 raters could provide a dependable assessment when rating video-recorded simulated scenarios.[30] The expert assessments for each SNA were assigned to a mentor and a clinical supervisor. Although the mentors assessed the SNAs slightly higher than the clinical supervisors, at both the first and second time points, the expert assessments were aligned at the final time point.

At the end of the first period of clinical practice, the clinical supervisors estimated an average score of 2.9 compared to the mentors, who estimated an average score of 3.2. Cognitive NANTS-no elements, such as *Anticipating and thinking ahead* and *Assessing risks and selecting options* require experience to develop mental models,[1] so a low score is unsurprising after only 9 weeks of clinical practice. At the second time point, however, the clinical supervisors estimated an average score of 3.7, demonstrating acceptable non-technical skills, while the mentors estimated good non-technical skills (4.0). One of the participants was rated with lower scores and had to repeat the second practice period. Continual low per-

	Unadjusted analysis			Adjusted analysis		
	Coefficient	95% CI	*P* value	Coefficient	95% CI	*P* value
Time						
T1 (after 9 weeks)	**Ref**			**Ref**		
T2 (after 20 weeks)	0.8	0.7, 0.9	<0.001	0.8	0.7, 0.9	<0.001
T3 (after 37 weeks)	1.4	1.3, 1.6	<0.001	1.4	1.3, 1.6	<0.001
Rater						
SNA	**Ref**			**Ref**		
Mentor	0.4	0.3, 0.6	<0.001	0.4	0.3, 0.6	<0.001
Clinical supervisor	0.3	0.1, 0.4	<0.001	0.3	0.1, 0.4	<0.001
Age (per 10 years)				-0.05	-0.2, 0.1	0.5
Gender						
Female				**Ref**		
Male				0.1	-0.1, 0.3	0.4

Table 4. Results of the Linear Mixed-Effects Regression Analysis of Student Nurse Anesthetists' Non-technical Skills—Total Average Over Four Categories

formance in categories *Situation awareness* and *Decision making* and a lack of ability to translate knowledge into action led to dismissal from the program.

A tendency towards leniency and bias owing to close daily social interaction is not unusual.[21,22] This tendency was particularly noticeable in the scores for the first time-point when the mentors assessed the SNAs somewhat higher (3.2), compared to scores assessed by both clinical supervisors (2.9) and the SNAs themselves (2.8). It is plausible that the mentors based their assessments on impressions formed through regular observations of the SNAs' performance and their knowledge of the student.[22,33] It can be argued that because the clinical supervisors only assessed the SNAs' non-technical skills at certain points in time, their assessment would be less prone to rater leniency or bias.[35] The clinical supervisors were also responsible for assessing several SNAs, thus allowing competency comparisons between the SNAs; however, it has been argued that limited direct observations may provide an inadequate database for making objective assessments.[20] The variance in assessment ratings may stem also from an unconscious need to categorize people when observing their behavior, which may affect their judgment.[33] A negative Hawthorne effect, with SNAs performing less well in an assessment situation than normally may also explain the clinical supervisors' stringency.

Another potential reason for higher scores from the mentors may be due to a fear of discouraging the SNAs by rating their performance as poor or marginal. It was explained during rater training that lower scores would be appropriate for many NANTS-no elements at the first time-point, as the SNAs lacked the experience to administer anesthesia without help and would threaten patient safety. It would be fitting to assess performance as marginal for elements requiring experience, such as *Anticipating and thinking ahead, Re-evaluating, Prioritizing* and *Displaying authority and assertiveness*. The findings also showed a certain amount of variance among the mentors in the categories *Task management* and *Team working*. Surprisingly, this was not the case in the cognitive categories *Situation awareness* and *Decision making* that are generally regarded as more difficult to differentiate between and assess.[23]

NANTS-no is intended to be used regularly to aid SNAs to reflect critically upon their performance and identify areas that need addressing. Self-assessment, critical reflection, and receiving constructive feedback are motivational factors in affecting behavioral change.[13] Interestingly, the SNAs' self-assessments were significantly lower in all 4 categories at all three time points compared to the experts' assessments. Simulation-based studies have shown that inexperienced or poor performers tend to overestimate their performance, while high performers may underestimate theirs.[36-38] The SNAs' underestimation in this study may be a result of increased insight owing to a regular use of NANTS-no.

The acquisition and assessment of non-technical skills is acknowledged as essential to improving patient safety and promoting quality and clinical excellence.[2] Strategies for ensuring quality in education and patient safety should include a structured and consistent approach to incorporating non-technical skills at all levels, which would be endorsed by both educational and healthcare institutions. Effective implementation depends on having a common taxonomy, and standardized, reliable and feasible instruments, as well as adequate training for those involved in clinical supervision and assessment.[11,22] It may also be useful to incorporate self-assessment to raise self-awareness.[37] This study explored a strategy for developing and assessing SNAs' non-technical skills in clinical practice using a structured behavioral assessment instrument that appears to be reliable in a clinical setting. This kind of

systematic assessment of non-technical skills may also be useful in other countries and healthcare professions.

• ***Limitations.*** There are several limitations to the study. One limitation is the size and recruitment method of the cohort, where a convenience sample was used rather than a power calculation. Owing to the design, however, the number of individual measurements was large. A possible threat to the study's objectivity was due to the first author acting as one of the clinical supervisors; however, this does not appear to have affected the robustness of the data. It is possible that the study could have been improved by using a small number of mentors and clinical supervisors to assess the SNAs at all 3 time points; however, this proved impossible to transact. The study reflects the challenges facing clinical assessment in real-life, therefore, while simultaneously highlighting the instrument's reliability in clinical practice. In an observational study of behavior, the Hawthorne effect may be a confounding factor.

Conclusion

The structured assessment instrument NANTS-no demonstrated a significant improvement in non-technical skills during nurse anesthesia education, with the cohort approaching a level of excellence. There were significant differences between the SNAs' self-assessments and the expert assessments; however, the clinical significance of these differences is debatable as the final score was estimated as >4 by all raters. NANTS-no appears to provide a reliable framework for making summative assessments of SNAs' non-technical skills in clinical practice and ensures that students can demonstrate the level of professional excellence expected in a CRNA. NANTS-no may also have potential for use in work-based assessments of CRNAs and in promoting professional development. More research is needed, however, to ensure the generalizability of this method in high-stakes assessments. This study may have implications for systematic assessment of student nurse anesthetists in other countries as well as an assessment of other healthcare professionals' non-technical skills.

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Author's Corrections

In the October 2021 issue of the *AANA Journal* (vol 89, no 5) in the article "Mentoring Team Projects for the Doctor of Nursing Practice: Considerations for Nurse Anesthesia Faculty," an erroneous sentence was included that has now been removed from the online version. On page 436, under the heading Team Formation, the following sentence was deleted: "According to the COA and AACN, team projects for the DNP should include a maximum of 5 students.[4,7]" The authors' intent was to describe the maximum number of team members used at their institution of learning. The authors wish to clarify that neither the COA nor the AACN has a prescribed number of team members for these projects.