Original Article

# Development and Validation of a Self-Assessment Tool to Measure Non-Technical Skills in ICU Residents

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## Abstract

Objective: The aim of the study is to develop a self-assessment tool to measure non-technical skill in ICU residents and to validate a self-assessment tool to measure non-technical skill in ICU residents

Methodology: In Pakistan's acute care centers within six months after Riphah International University's accreditation (ICUs). This mixed-method study was conducted in two stages. Phase 1 of the ICU-NTS questionnaire's development involved qualitative literature analysis. Phase2 involved development of questionnaire's validity and reliability**.** SPSS vs 26 is used for analysis. Reliability and Exploratory factor analysis are performed.

Results: After doing a literature study, we created an 18-item questionnaire and distributed it to ten subject-matter experts for expert content validation. The scale validity index as a whole is 93. The resulting ICU-NTS was corrected for response process validity after cognitive validity. The final version of the 18-item ICU-NTS was reduced to 16 items after exploratory factor analysis. A Cronbach's alpha of .96 was discovered for the ICU-NTS questionnaire.

Conclusion: In this work, a self-assessment tool for intensive care residents' non-technical abilities using the ICU-NTS taxonomy was established. It can be utilized at the postgraduate level in training program to enhance the delivery of healthcare and avoid adverse events.

Keywords: Non-technical skills, NTS taxonomy, ICU residents, behavioral marker system.

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## Introduction

Every hospital relies on its intensive care units. There is no denying the significance of well-established intensive care facilities, especially in light of the growing needs for intensive care during the past decade, particularly in the case of Covid pandemic. Both technical and non-technical skills must be developed in ICUs in order to improve patient care outcomes.

Intensive care units are the backbone of every hospital and well-equipped intensive care units with well trained staff are very less in numbers in developing countries of the world. Pakistan, a developing country, has roughly 151 hospitals with intensive care units that are recognized for ICU training.[1] For the better outcomes in ICU in terms of patient care, it is mandatory to develop technical skills and non-technical skills. It has been documented worldwide that non-technical skills are essential for preventing adverse events and drastic improvement in patient outcomes.[2] That is why ACGME has implemented non-technical skills like communication skills, decision making, problem based learning, self-awareness, interpersonal non-technical skills as key components of their curriculum.[3]

The diversity in the availability of these non-technical tools reflects that every specialty has different domains/categories of non-technical skills related to them, but little research has been done on self-assessment tools of the non-technical skills required for safe working within the ICU. Literature research found that various NTS scales which are rater-based assessment tools, can be used to develop a tool to self-measure non-technical skills in intensive care settings. The need of developing non-technical skills like inter-

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professional communication and leadership skills in residents is well-accepted but formal tools to self-assess these skills are deficient in intensive care settings furthermore, research conducted on graduating urology residents established that self-assessment of their own non-technical skills like leadership skills did not differ largely from assessment by their PDs or consultants.[4] In this study we developed and validated a self-assessment tool for measuring non-technical skills in Intensive care residents.

## Methodology

A mixed-method study conducted at intensive care units (ICU's) in Pakistan within 6 months after approval by Riphah International University. This study is conducted in two phases.

Phase 1: development of ICU-NTS questionnaire qualitative literature review done.

Phase 2: Validation and reliability of the ICU-NTS questionnaire

For content validity (quantitative): Purposive non-probability sampling was used to select 10 consultants with at least three years of experience in intensive care.

For response process validity: Purposive sampling was used to select three ICU residents.

Pilot testing for construct validity and reliability: 300 ICU residents

Data was collected through Google forms and distribution of hard copies for all items in the questionnaire among different Post Graduate Trainees of different Hospitals. The valid data was collected from 300 respondents (n=300). There were 16 incomplete forms, which were sent again for completion. Among the items, none of the item was in reverse coded. All the Data was entered in SPSS 26.0 as continuous variables, as all were on the same Likert scale i.e Never, Occasionally (1-2 times/month), Regularly (1-3 times/week) and Frequently (daily) from 1 to 4 respectively.

SPSS 26.0 was used to carried out descriptive analysis like frequency, Mean, Median, Mode, standard deviation etc. The Microsoft excel was used to calculate Content validity Index (CVI) and the index was of clarity is, 3 = very clear, 2 = item needs revision, and 1 = not at all clear.

The reliability analysis was carried out using SPSS 26.0, for the reliability of questionnaire and to find out the Cronbach's alpha coefficient.

SPSS 26.0 was used to carry to Exploratory Factor Analysis (EFA) to validate the scale of items, there were total 18 items in the questionnaire. Two factors emerged from the data against 16 items.

## Results

**PHASE 1- Development of ICU-NTS Questionnaire:** Following the methodology used to develop several other BMS, a systematic literature review related to intensive care residents' NTS was performed to facilitate comprehensive understanding of research to date5,6 and identify domains of NTS as can be experienced in intensive care. The priori categories of NTS from literature search included 9 categories i.e., Situational Awareness/Vigilance, decision making/problem solving and prioritization, Teamwork and cooperation, communication, leadership, Task management, Coping with Stress and Fatigue, accepting responsibility and awareness of roles and limitations. Keeping these categories in mind an ICU-NTS tool consisting of 18 items was made. The 18 items -based ICU-NTS was developed.

**PHASE 2- Establishment of Validation and Reliability of ICU-NTS:** In this study we recoded the experts' score 3 & 4 to "1" while 1 & 2 to "0". After this, we calculated the proportion relevance of each expert by taking the mean of all scores given by an expert against all items. we observed all the mean values but didn't find any value below than 0.7. After this average proportion of items judged as relevance across the 10 experts was calculated and the value is 0.93, which is acceptable.

In this study, for improving the clarity 3-point likert scale was used (i.e. Clarity (1-3): 3 = very clear, 2 = item needs revision, and 1 = not at all clear) to calculate the average content clarity. The data was collected from 10 experts against 18 items. The average clarity of each 18 items one by one by adding sum of all experts' score against an item divided by no. of experts. Each item found above 80% (i.e 2.4) and this was considered very clear.

**Response process validity of ICU-NTS through cognitive interviews:** 18 items were tested for response process validity. There was no gross change required only one participant needed elaboration of the term time pressured crisis

**Establishing the construct validity ICU-NTS:** The value of KMO (Kaiser-Meyer-Olkin) was calculated for sampling adequacy and Bartlett's test of sphericity are significant, while the value of KMO is 0.938 and P-value is significant (0.000 <0.05).

**Establishing the reliability of ICU-NTS**: The reliability test was run using SPSS 26.0 to calculate Cronbach's alpha coefficient for the reliability of questionnaire. The Cronbach's alpha values found high internal consistencies among items, each item Cronbach's alpha value also have score more than 0.85 and overall Cronbach's alpha value is 0.908.

**Exploratory Factor Analysis:** For exploratory factor analysis, there were 18 items for a questionnaire validation. There were total 300 ICU residents. The wording and the syntax were found explicit, easy, understandable and clear among all residents.

After conducting validity and reliability of questionnaire using SPSS with sample size of 300 and 18 questionnaire items, the exploratory factor analysis was conducted. The data was collected on 04-itmes Likert scale (i.e. Never =1, Occasionally (1-2 times/month) =2, Regularly (1-3 times/week) =3, Frequently (daily) =4). The total variance 53.275% was attained in the data. There were two factors emerged from the data against all 16 items.

| S. No. | Factors | Items | % Variance |
|---|---|---|---|
| 1. | Factor 1 | 06 | 42.615% |
| 2. | Factor 2 | 10 | 10.661% |

Out of 18 items, two were removed (i.e Q5 and Q18) due to less loading values, remaining 16 items values were considered for EFA to build Pattern matrix.

For the appropriation and suitability of data for factorization, the exploratory factor analysis was carried out using SPSS 26.0. The Principal Axis Factoring (PAF) was used for extraction and to find out the communalities of all 18 items, given in below table.

Further, Exploratory factor analysis (EFA) was conducted through SPSS 26.0 to explore the common factors in the latent variables. The extraction method called principal axis factoring (PAF) was used while Direct Oblimin rotation method with Delta value "0" was selected, and suppressing coefficient value 0.40 was set to run EFA. After getting Pattern matrix on above said criteria, the factor loading less than 0.40 was observed for each factor, all the values above 0.80 and below 0.40 were removed against factor loading or cross loading.7

The process of execution EFA was continued until developing a simple structure of pattern matrix with maximized loading as per standardized criteria. There are only two factors having less loading value, those are Q5 (i.e I am aware of different treatment plans and can select the most relevant in both normal and in time-pressured crisis in ICU) and Q18 (i.e I display the necessary authoritative role in taking suitable decisions whenever required).

## Discussion

The aim of the research was the development of a valid and reliable questionnaire for self-assessment of NTS in intensive care residents for improving the provision of health care facilities for critical patients and decreasing the adverse events associated with non-technical skills. ICU-NTS is a 16-item questionnaire that is developed for ICU in our context and is the first self-assessment tool for NTS for ICU in the literature. It is intended for post graduate level who will be future consultants of intensive care units. Intensive care units are the backbone of every hospital where aggressive management and monitoring is provided. As the patients are critical and environment of ICU is stressful, both technical and non-technical skills are mandatory to acquire by whole ICU team for management of the patients.[6]

There are various tools available to measure NTS in different medical and non-medical fields that are validated and reliable like NOTSS, NOTECH, ANTS and many more in literature, but there is none for intensive care residents.[8] Moreover, one of the key components of principles of adult learning is self-assessment and there is little research done in self-assessment of NTS in field of intensive care. In our study we have developed a 16-item questionnaire which we have named ICU-NTS which will lead the residents to self-assess themselves for non-technical skills for their own awareness of strengths and weaknesses so that they can improve themselves before high stake assessments as well as to improve the safety and quality of health care they provide to patients.

As compared to the NTS framework given by Flin for developing NTS for other fields our ICU-NTS is specific to intensive care and is more comprehensive.[8] All tools provided in literature like ANTS, N-ANTS, SPLINTS, NOTSS and others are rater assessed while ICU-NTS is a self- assessment tool formed on the basis that by self-assessment of non-technical skills, the residents can take responsibility for their own learning as well as for patient safety. Knowles, M. S explained the importance

on self-assessment in his article and stressed the fact that residents should reflect on their performance and develop their skills before assessments are done by their seniors.

In comparison to a study conducted by Reader T et al, who explained that the ANTS framework has four categories (task management, teamwork, situation awareness, decision making) and they can be used as a background framework to assess NTS in intensive care units. Our 16 items questionnaire has various aspects of non-technical skills, which after EFA are grouped into factors 1 and 2.[9]

AMEE guideline 87 for tool development explains various steps of tool development in detail; we have followed these steps in our study.[10] Systematic review are done to identify various categories of non-technical skills in ICU because systematic review is always required for establishing a tool.[11] Regarding the number of subject experts for content validity it is said ten subject experts with minimal of 3 years of experience as choosing the subjects is very crucial as if not done so will lead to errors in instrumentation. [12]

After establishing the validity and reliability of ICU-NTS using SPSS 26 EFA was conducted. The total variance attained was 53.27% and two factors emerged. Factor 1 had 6 items and is related to "Vigilence" which is an important established category of non-technical skill in a study conducted on medical students in 2019.[13,14] Factor 2 in our study has 10 items and they are related to "task management in a team". It plays an important role because ICU is always a team effort, and patient outcomes are highly dependent on the performance of ICU staff as a team, as established in a study.[15]

Our study's main strength is that it is a self-assessment tool for non-technical skills, whereas the majority of tools in the literature are rated-assessed. Secondly, no such study related to measuring the status of NTS in our context is available. So this ICU-NTS framework can provide a starting point for future studies.

## Conclusion

The valid and reliable self-assessment tool for non-technical skills of intensive care residents with the taxonomy of ICU-NTS is developed in this study and it can be used at postgraduate levels in training programs for improvement in health care provision and reducing adverse events.

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