

Improving Surgical Safety and Nontechnical Skills in Variable-Resource Contexts: A Novel Educational Curriculum

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OBJECTIVE: A substantial proportion of adverse intra-operative events are attributed to failures in nontechnical skills. To strengthen these skills and improve surgical safety, the Non-Technical Skills for Surgeons (NOTSS) taxonomy was developed as a common framework. The NOTSS taxonomy was adapted for low- and middle-income countries, where variable resources pose a significant challenge to safe surgery. The NOTSS for variable-resource contexts (VRC) curriculum was developed and implemented in Rwanda, with the aim of enhancing knowledge and attitudes about nontechnical skills and promoting surgical safety.

DESIGN: The NOTSS-VRC curriculum was developed through a rigorous process of integrating contextually appropriate values. It was implemented as a 1-day training course for surgical and anesthesia postgraduate trainees. The curriculum comprises lectures, videos, and group discussions. A pretraining and posttraining questionnaire was administered to compare knowledge and attitudes regarding nontechnical skills, and their potential to improve surgical safety.

SETTING: The setting of this study was in the tertiary teaching hospital of Kigali, Rwanda.

PARTICIPANTS: Participants were residents of the University of Kigali. A total of 55 residents participated from general surgery (31.4%), obstetrics (25.5%), anesthesia (17.6%), and other surgical specialties (25.5%).

RESULTS: In a paired analysis, understanding of NOTSS improved significantly (55.6% precourse, 80.9% postcourse, $p < 0.01$). All residents reported that the course would improve their ability to provide safer patient care, and 97.4% believed developing nontechnical skills would improve patient outcomes.

CONCLUSIONS: Nontechnical skills must be highlighted in surgical training in low- and middle-income countries. The NOTSS-VRC curriculum can be implemented without additional technology or significant financial cost. Its deliberate design for resource-constrained settings allows it to be used both as an educational course and a quality improvement strategy. Our research demonstrates it is feasible to improve knowledge and attitudes about NOTSS through a 1-day course, and represents a novel approach to improving global surgical safety. (J Surg Ed ■■■■-■■■. ©2017 The Authors. Published by Elsevier Inc. on behalf of the Association of Program Directors in Surgery. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>)).

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COMPETENCIES: Interpersonal and Communication Skills, Professionalism, Patient Care

INTRODUCTION

Five billion people do not have access to safe, timely, and affordable surgical care.¹ This need is concentrated primarily in low- and middle-income countries (LMICs), where poor infrastructure, inadequate service delivery, and insufficient workforce are common challenges to providing high-quality surgical care.² Governments and ministries of health are therefore working to scale up surgical infrastructure, services, capacity, and workforce in many of these countries. However, it is critical to simultaneously prioritize the development of novel strategies for improving surgical education, performance, and safety. These efforts must emphasize contemporary challenges, one of which is how to optimize surgical teamwork and reduce adverse events attributed to nontechnical skills.

Previous research has shown that nearly one-half of all errors in the operating room are owing to surgeon behavior and intraoperative decision-making.³ A study by Way et al.⁴ reported that the primary cause of bile duct injury during laparoscopic cholecystectomy was errors in perception, rather than technical errors. Analysis of adverse events in surgery owing to communication breakdown discovered that nearly half of information exchanged in the perioperative period was not fully transmitted.⁵ These findings challenged the traditional paradigm of surgical education, which principally emphasized technical expertise and cognitive knowledge. Translating the learning from these findings into formal teaching is crucial. Nontechnical skills must be developed and taught as an explicit, integral part of a robust education curriculum to prepare surgeons for safety-focused practice and ultimately, to address reduce surgical errors and their affect attributable to nontechnical skills.

The Non-Technical Skills for Surgeons (NOTSS) system is a behavioral assessment tool that describes the main observable nontechnical skills associated with good surgical practice. It is intended to observe, rate, and improve surgeons' behavior in the operating room in a structured, transparent manner. The NOTSS system comprises only behaviors that are directly observable or can be inferred through communication.⁶ They encompass both cognitive and social skills, which can be organized into a 3-level hierarchy consisting of categories (highest level), elements, and behaviors. The 4 key categories include: (1) situation awareness, (2) decision-making, (3) communication and teamwork, and (4) leadership (Appendix). Within each category are 3 corresponding elements and exemplary

behaviors that are intended to be indicative rather than comprehensive. This skills taxonomy thus provides a common language and systematic method for surgeons to evaluate, monitor, and strengthen nontechnical skills.

The NOTSS framework is especially relevant and valuable in variable-resource contexts (VRC), which are common in LMICs, where skills for managing inconsistent technology, infrastructure, and workforce are essential to providing safe surgery.^{7,8} Given that NOTSS and associated curricula were developed, piloted, validated, and implemented exclusively in high-income countries, its utility may be limited by lacking context-specific validity. As such, a novel educational tool was adapted from the original NOTSS system with a specific focus on the surgical environment of VRC. Developing the NOTSS-VRC tool in Rwanda consisted of a systematic literature review and extensive provider interviews of local "experts" in surgical care delivery.⁹ These interviews led to the identification of context-specific challenges, as well as the behaviors necessary to overcome them. The need for a video curriculum that accurately represents the local setting was also identified,¹⁰ as were contextually valid education paradigms to teach surgical providers in variable-resource environments effectively.

In response to this need, the present study aims to assess the effect of introducing NOTSS-VRC into the surgical education curriculum at a university residency program in a low-income country. Our objectives were to improve residents' knowledge of nontechnical skills, and raise awareness of the importance of these skills as a method for avoiding surgical adverse events.

MATERIALS AND METHODS

Study Setting

This study involved faculty and residents from the University of Rwanda in Kigali. Rwanda is a low-income country in Sub-Saharan Africa, and is particularly well-suited for studying contextual challenges to providing safe surgical care in limited-resource settings that are common to most LMICs. At the time of study, there was a severe shortage of surgical providers in the country. An estimated 50 surgeons served a population of 11.5 million.¹¹ This ratio of 0.49 surgeons per 100,000 people contrasts with the minimum 20 surgeons per 100,000 people recommended by The Lancet Global Surgery Commission.¹ However, concerted efforts to strengthen and expand surgical training¹²⁻¹⁴ have led to an increase in the number of enrolled postgraduate surgical residents: from 15 in 2012, to 50 in 2016.¹⁵

Curriculum Design

The curriculum was based on original research identifying behaviors associated with nontechnical skills in VRC. Scott

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