ORIGINAL REPORT

Training Tools for Nontechnical Skills for Surgeons—A Systematic Review

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OBJECTIVE: Development of nontechnical skills for surgeons has been recognized as an important factor in surgical care. Training tools for this specific domain are being created and validated to maximize the surgeon's nontechnical ability. This systematic review aims to outline, address, and recommend these training tools.

DESIGN: A full and comprehensive literature search, using a systematic format, was performed on ScienceDirect and PubMed, with data extraction occurring in line with specified inclusion criteria.

SETTING: Systematic review was performed fully at King's College London.

RESULTS: A total of 84 heterogeneous articles were used in this review. Further, 23 training tools including scoring systems, training programs, and mixtures of the two for a range of specialities were identified in the literature. Most can be applied to surgery overall, although some tools target specific specialities (such as neurosurgery). Interrater reliability, construct, content, and face validation statuses were variable according to the specific tool in question.

CONCLUSIONS: Study results pertaining to nontechnical skill training tools have thus far been universally positive, but further studies are required for those more recently developed and less extensively used tools. Recommendations can be made for individual training tools based on their level of validation and for their target audience. Based on the number of studies performed and their status of validity, NOTSS and Oxford NOTECHS II can be considered the gold standard for individual- and team-based nontechnical skills training, respectively, especially when used in conjunction with a training program.

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KEY WORDS: training, tools, nontechnical, skills, surgery, surgeons

COMPETENCIES: Patient Care, Medical Knowledge, Practice-Based Learning and Improvement, Interpersonal and Communication Skills, Professionalism, Systems-Based Practie

INTRODUCTION

Modern surgery no longer depends entirely on a surgeon's technical prowess.[1] Alongside technical surgical ability, nontechnical skills are fast becoming recognized as major factors in surgical outcome.[2] A study from 2003 identified that 86% of adverse surgical events were due to "system errors" and were not related to technical skills.[3] Overall, 40% of intraoperative errors were found to relate to failures in communication alone.[3] Furthermore, important nontechnical skills identified include teamwork, leadership, situational awareness, and decision-making[4]; all of which have been shown to have a significant effect on surgical success.[3]

Situational awareness involves the surgeon's perception of surrounding events relating to the team and the operation itself. Decision-making involves the surgeon's ability to choose, implement, and communicate the most appropriate solution when faced with a potential problem.[4] Teamwork skills include being entrusted to implement instructions and engage in effective communication with colleagues to achieve a particular goal.[4,5] Leadership skills involve professionalism, motivation, and setting a suitable example.[5] Communication skills involve the transmission and receiving of information in a manner which can be understood.[5]

The safe and effective surgeon identifies nontechnical skills as an ability set that is not necessarily innate, but can be trained and improved throughout their career.[2] As modern surgeons face restrictions in working hours, experience alone can no

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longer be relied upon to allow these skills to reach their full potential.[6] Training tools allow modern surgeons to recognize, develop, and maximize their nontechnical abilities, without necessarily having to spend more time in the operating theater. The common aim of all current nontechnical skill training tools is to improve safety in the surgical setting, while maximizing the surgical benefits that patients receive.

Aims

The primary outcomes of this systematic review are as follows:

(1) Provide up-to-date details of the training tools currently available and comment on their status of validity.
(2) Offer a recommendation for the prominent training tools based on the average quality of studies performed.

METHODS

Definitions

Training tools were considered to be any object (such as an assessment checklist for training purposes), course, curriculum, program, or method of simulation aimed at quantifiably developing a surgeon's nontechnical ability. Frameworks and suggested practice methodologies were not considered to be indicative of a training tool.

Databases and Search Criteria

A comprehensive literature search was performed between October 29, 2015 and December 3, 2015. PubMed and ScienceDirect databases were searched using the following Medical Subject Headings (MeSH) and free-text terms in various combinations. No restrictions were placed on the search results.

- Nontechnical skills surgery
- Nontechnical skills training surgery
- Training tools nontechnical skills
- Nontechnical skills surgical training
- Nontechnical skills surgery
- NOTSS
- Surgical observation—teamwork assessment
- Training surgical leadership
- Training surgical teamwork
- Training and assessment surgical decision-making
- Surgical simulation nontechnical skills
- Surgery situational awareness
- Surgical cognitive skills training
- Intraoperative communication skills
- Intraoperative communication skills training

Inclusion and Exclusion Criteria

Only research articles were searched for and included. Articles meeting the inclusion criteria were those that reported the development or validation or both of identifiable nontechnical skills training tools specifically for the surgeon or the surgical team, where the surgeon remained the central focus of the tool. Articles where technical skills were examined alongside nontechnical skills were also included.

For search terms relating to a specific behavioral domain, such as "leadership" or "cognitive skills," articles meeting the inclusion criteria were required to mention that specific skill domain, and refer to a method of training it.

Exclusion criteria involved articles not in the English language, those relating to technical skills, articles that were not surgical in nature, articles making no reference to the search term, articles that were purely interview or opinion based, previous systematic reviews or meta-analyses, articles not exploring intraoperative nontechnical skills, or nontechnical skills of theater staff members not including surgeons. Articles involving patient perspectives or using patients (simulated or otherwise) as assessors were also not included, owing to the need to standardize the training tools for those who have prior experience with nontechnical skills and the methods of training them. Textbooks and posters were not included.

Data Extraction and Critical Evaluation

Data were to be extracted by a single author, using a standardised extraction form agreed before the searches being performed. Data extracted included demographic details of the participants, specialities the studies were aimed at (or from which the participants came), the study design and setting, the nontechnical skills being trained or assessed, and the outcome of the study.

Study quality was formally evaluated using a modified Oxford Centre of Evidence-Based Medicine score[7,8] and the JADAD[9] score for randomized controlled trials. The criteria for the level of evidence for each study are provided in Table 1, while the recommendations based on each level of evidence is provided in Table 2. Bias was evaluated in association with guidelines from the Cochrane Risk of Bias Tool.[10] Risk of bias has been stated in the critical analysis section of Tables 3-14. Study quality has been included in the critical analysis sections.

RESULTS

Articles

The search terms generated 13,980 potentially relevant articles. Each article was screened according to the aforementioned criteria. A total of 1068 articles were considered to have met these criteria. Identification of duplications, systematic reviews, and meta-analyses were then undertaken. Remaining articles were put forward for abstract screening, of which 163 abstracts met the criteria and underwent full text review. Furthermore, 84 of these articles