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Nontechnical skills in pediatric surgery: Factors influencing operative performance

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ABSTRACT

Technical competence is an essential aspect of intraoperative performance but is in itself insufficient to ensure an optimal surgical outcome. A list of other skills complement technical ability and these relate, among others, to surgical judgment and intraoperative decision-making processes as well as the role of the operating surgeon as leader of the surgical team. This article outlines the composite set of nontechnical skills (NTS) and the factors which influence surgical performance by virtue of this skill set. A framework has been developed to allow identification, teaching, and assessment of NTS known as Nontechnical Skills for Surgeons (NOTSS), and the relevance and influence of NOTSS during the intraoperative performance of pediatric surgery is presented.

Assessment of surgical performance can be made on the basis of an analysis of patient outcomes. However, using outcomes as a surrogate of performance is more often a measure of the effect of the multidisciplinary team than the skill of the individual pediatric surgeon. There is also general recognition that outcome data may relate to factors such as caseload, experience of the teams, units and institutions involved, rather than the specific quality of the individual operative intervention. Direct measurement of surgical technique is difficult to align precisely with patient outcome but analysis and rating of operative performance (by video recording of endoscopic surgery) has been directly correlated with the incidence and severity of postoperative complications [1].

What remains harder and more distant still, however, is the recognition, assessment and measurement of the many other factors which may influence the intraoperative performance of the individual surgeon beyond surgical technique. Intraoperative judgment [2,3], risk tolerance [4,5], and decision-making [6] are vitally important skills which may become critical, particularly during adverse intraoperative circumstances. They may be just as influential in dictating outcome as anastomotic technique, methods of securing hemostasis, the choice of maneuver or any other technical consideration and are included in the term "nontechnical skills" (NTS). An understanding of this term has been promoted by a range of classifications and taxonomies—prime among these being NOTSS (Nontechnical Skills for Surgeons) [7]. This classification was designed for surgeons – by surgeons – but employed an appreciation of the relevance of these skills in task execution in other high-risk/decision reliant industries [8]. NOTSS includes both thinking skills (cognitive components) and interpersonal skills (social categories) relevant to operative surgery (Table 1).

NTS are a component feature of human factors engineering and the contribution of human factors in general, and human performance limitation in particular, is recognized in adult practice as an important cause of surgical error and postoperative complications [9]. No such studies yet exist in pediatric care. As the scope of the problem of surgical error begins to emerge, the role of NTS and the susceptibility of individual surgeons to factors which may compromise operative performance begin to be better defined. NTS provide a pivotal role in complementing the technical ability of the pediatric surgeon in this regard [10].

1. Nontechnical Skills for Surgeons (NOTSS)

Nontechnical skills (NTS) are defined as … "the cognitive and social skills which underpin knowledge and expertise in high demand workplaces" [11]. They include the thinking skills and personal interactions that take place at the operating table which are required to accompany the knowledge and technical competence essential for safe pediatric surgery. The NOTSS taxonomy, as developed by the University of Aberdeen and the Royal College of Surgeons of Edinburgh (see Fig. 1) consists of four major categories:

- situation awareness
- decision-making
- teamwork and communication
- leadership

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Table 1
NOTSS skills taxonomy.

Category	Element
Situation awareness	Gathering information
	Understanding information
	Projecting and anticipating future state
Decision making	Considering options
	Selecting and communicating option
	Implementing and reviewing decisions
Communication and teamwork	Exchanging information
	Establishing a shared understanding
	Coordinating team
Leadership	Setting and maintaining standards
	Supporting others
	Coping with pressure

Each category contains three elements as outlined in Table 1. Until recently, these have all been referred to as "soft skills" to be used intuitively and in an implicit manner but the reality is that their acquisition is crucial for high-quality surgical performance and explicit identification of these items and provision of a vocabulary through the NOTSS taxonomy, adds to their usage, teaching and assessment. As awareness and familiarity with the skills improves, so does an appreciation of the factors which will promote and enhance their usage along with those circumstances where their deployment and execution may be degraded or compromised with a resultant reduction in surgical performance [12].

1.1. Cognitive skills: situation awareness

Situation awareness (SA) is defined as … "the skills required for diagnosing a situation and reaching a judgment in order to choose an appropriate course of action". It comprises the three elements of gathering information (*perception*), understanding information (*comprehension*) and projecting future state (*anticipation*) [13]. The concept originated in military operations but is highly relevant to intraoperative surgery and is critical since surgeons are continuously gathering information, making sense of it and anticipating what may happen next. SA requires such things as attending to visual information such as found in the operative field, an understanding of the anatomy, monitoring screens and listening to auditory information from alarms and conversations between other staff and the sounds of equipment. It also requires attention to tactile/haptic information, noticing tissue consistency and color or levels of vascular pulsation and tensions placed on sutures and tissues. That gathering of information often happens at a subliminal level and there are those surgeons who will appreciate those cues at an early stage but there are also those who fail to notice the information that is present and further still, those that fail to comprehend or make a misperception of that data (Fig. 2).

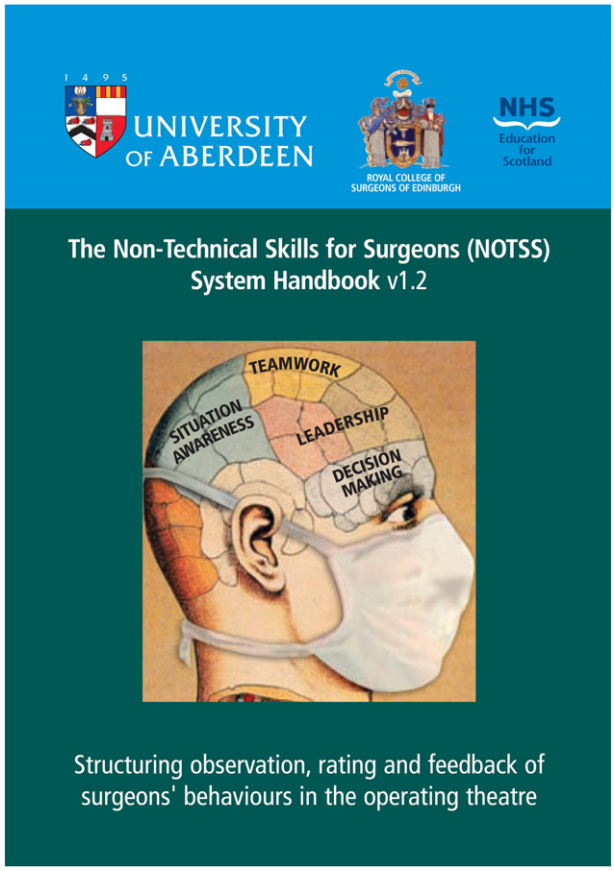

Fig. 1. NOTSS handbook. Available at: www.abdn.ac.uk/iprc.

Similarly, comprehension of these cues will be influenced by prior experience (if already an experienced surgeon) or require analysis if a more junior surgeon, (who has access to fewer and less rich mental models and past exposures). Trainee surgeons have necessarily spent more time and mental energy trying to comprehend patterns of cues and made comparison with possible interpretations [14]. The comprehension or "mental model" of any situation is formed not only from past experience but also by the current availability of information.

The third element of situation awareness is projection and anticipation in an attempt to eliminate any surprises. Familiarity with the operative procedure is clearly valuable but a prediction of what might happen next can fail if there is a lack of diligence or attention paid through presumption and overfamiliarity. Additionally, good behaviors in this aspect of situation awareness include having a contingency plan ("plan B") in the event of failure or unsatisfactory progress of a procedure.

Cognitive processes such as situation awareness can be influenced by a number of external events that are commonplace in the operating room such as distraction and interruptions [15], confirmation bias, fixation or indeed a lack of information available to the surgeon [12]. However there are also matters that relate to well-being which can impede performance. Self-calibration of personal well-being on a day-to-day basis is not a practice familiar to most pediatric surgeons and yet the aviation industry encourages pilots to formulate an appreciation of their ability status on a daily basis using the "I'm SAFE" acronym [16]. This tool uses the following checklist:-

- I (illness)
- M (medication)
- S (personal stress)
- A (prior alcohol usage or substance abuse)
- F (fatigue)
- E (eating/hypoglycemia, or emotion)

While all of these are important and can limit performance (much is already written on duty hours/fatigue/safety), the last item of emotion is of particular interest given that interpersonal conflict is not uncommon within the operating theater environment. The deleterious impact of aggression and rudeness not only is increasingly appreciated as prejudicial to the performance of the recipient of the rudeness but also disables cognitive ability, therefore the performance of onlookers—i.e., the rest of the surgical team. What may be interpreted as assertiveness and discipline by some, may be perceived as insulting and bullying behaviors by others. The scale of this type of problem – adversely affecting performance – is being increasingly recognized in surgical communities across a range of countries [17–19].

1.2. Cognitive skills: decision-making

Decision-making is considered an integral component of surgical practice and is an ability that almost all surgeons rate highly. There is however little written about this process as it relates to intraoperative