



Basics of Nontechnical Skills

Last Updated: March 28, 2021



INTRODUCTION

The technical demands of high-stakes, high-risk professions such as neurosurgery, aviation, and nuclear power management are vast and ever more complex. As a result, current training programs have evolved to address technical skills in these fields in great detail.

However, although most pilots, for example, are highly skilled and well-trained practitioners, several high-profile aviation disasters have been attributed to errors in cockpit communication or cognitive pitfalls than to the pilot's lack of training or expertise. The civil aviation community has responded to these incidents with a steadfast dedication to training in nontechnical aspects of aviation. Similarly, it has been found that up to 43% of errors during surgery and 27% of claims against health care

organizations stem from errors in communication and cognitive bias.

Although many of these skills have been emphasized to a greater degree in nonsurgical training programs, education in this realm for surgeons and surgical trainees has been rare. Neurosurgeons and neurosurgical trainees now have a remarkable opportunity to adapt best practices in nontechnical skills (NTSs) training from the cockpit to use in the operating room.

WHAT ARE NTSs?

One of the most used medical training and assessment tools is the Non-Technical Skills for Surgeons (NOTSS) system. It defines NTSs as “the cognitive and social skills that underpin knowledge and expertise in high-demand workplaces.” The goal of NTS education and assessment is to allow teams operating in high-stakes environments, such as surgical teams in an operating room, to develop shared mental models of rapidly changing situations and to communicate about them effectively to prevent errors and promote good outcomes. The NOTSS system defines four categories of skills with three elements each:

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

Situation Awareness

Arguably the most important of the NTSs, situation awareness is crucial for neurosurgeons to master, both inside and outside the operating room. Gathering, understanding, and interpreting information and then using what has been learned to predict future states underlie every aspect of medicine, including triage, history taking, physical examination, diagnosis, treatment planning, operative intervention, and postoperative care. These skills are particularly important inside the operating room, where information sources are varied and often subtle, for example, the sound and cadence of a cardiac monitor, the pulsations of blood vessels or cerebrospinal fluid spaces, and the tactile feedback given by an instrument interfacing with an unidentified structure. Successful surgeons must learn to

- be sensitive to information from the patient, their colleagues, and their instruments;
- be receptive to this information during both rote “autopilot” portions of a procedure and during the intense focus on the critical portion of the operation;
- triage which information sources are important to pay attention to and at which times;
- **recognize their own internal biases that might prevent proper information gathering and handling;** and
- use available information to create a model of what will happen in the next seconds to minutes (the next steps of the operation), hours to days (potential complications), and weeks to months (postoperative care and recovery)

Trainees might be sensitive and receptive to information during surgery but lack the experience necessary to fully interpret its significance and decide on a course of action based on it. It is crucial, therefore, for more senior surgeons to verbalize their thought processes to junior trainees at every step of an operation, erring toward more discussion of available information and its future implications.

Decision-Making

Making intraoperative decisions is one of the most important, but difficult-to-acquire, skills in neurosurgical practice. Although surgeons and trainees can discuss patient selection and operative planning at length before a procedure, decisions made during surgery are often intuitive and take place on a time scale that makes it difficult to communicate their nuances to trainees. Because of the importance of developing intraoperative judgment and decision-making skills, surgeons should make every effort to “think out loud” and inform their trainees and colleagues about the information they used to make a decision, any rules or heuristics they used to make it, the implications of that decision and its alternatives, and any caveats that apply.

A full recounting of the rich science of human cognition and decision-making is certainly beyond the scope of this chapter, but in general, surgeons make intraoperative decisions in four ways:

- **Analysis:** surgeons consider a set of options, comparing and evaluating them on their relative benefits and risks. (“We could approach this tumor via a pterional or a retrosigmoid approach. This is why I think a pterional approach might be better.”)
- **Use of rules:** surgeons apply a personal, institutional, or regional rule or best practice that dictates how to approach a specific situation. (“At our institution, we tend to use this brand of dural graft with this suture and this adhesive to repair cerebrospinal leaks.”)
- **Heuristics:** surgeons intuitively use heuristics developed over years of honing their pattern-recognition systems to decide how to proceed. (“I knew that the increased amount of bleeding we saw laterally on the C1 posterior arch meant that we were getting close to the venous plexus and that we had exposed enough laterally.”)
- **Creativity:** surgeons develop novel approaches to problems when limited established protocols to solve them exist. (“The only way to control this difficult aneurysm was to occlude an important vessel, so I had to design a bypass to restore perfusion to the affected area

safely.”)

After a decision is made and implemented, surgeons must gather new information to evaluate whether their intervention was effective or whether further steps are needed to reach the intended outcome. This thought process, too, must be communicated to trainees and colleagues (such as surgical technicians, circulators, and anesthesiologists), who depend on surgeons to vocalize their decision-making process to do their jobs equally well.

Communication and Teamwork

Although both information management and decision-making involve communication, the NOTSS system specifically highlights communication and teamwork as a core NTS for surgeons and trainees to practice and master. The entire surgical team, including the surgeon, assistant, surgical technician, circulator, anesthesiologist, and others, must develop a “shared mental model” of the operation, how each of their roles fit overall, and what steps they must take at each juncture.

Clear and understandable communication is crucial for each team member to understand what is happening during surgery and what he or she must do to keep the procedure running smoothly. Closed-loop communication, in which statements or requests are acknowledged clearly and audibly, ensures that messages are not lost in the often loud and “chaotic” operating theater. Trainees often require more communication than senior surgeons realize, because they might not have a wealth of experience with a given operation, and they might not yet have the skills to anticipate what is expected of them or what the next steps of the operation are. Surgeons should always err on the side of communicating more to keep their trainees and colleagues informed. Please refer to the [Operating Room Etiquette](#) chapter for more details.

Leadership

Despite the ever-more team-based nature of modern medicine, complex operations require clear leadership to ensure that surgical goals are

accomplished safely, thoroughly, and efficiently. Surgeons are role models for residents, medical students, visiting scholars, and all other operating room personnel. Good behaviors must be modeled consistently so that they can be mimicked and adopted by others in the future. Please refer to the [Leadership Principles](#) chapter for more details.

Surgeons must do the following:

- Set and maintain high standards: clear expectations for team performance should be outlined with specific and detailed surgical plans that are communicated to key team members before a complex operation. Feedback should be both elicited from and provided to team members. Surgeons should adhere to guidelines regarding patient safety, preoperative time-out, surgical field sterility, and other areas.
- Support each member of the surgical team: **because of the absolute focus required of surgeons during an operation, it is often easy for them to miss errors or fail to detect impending dangerous situations.** Other team members are often in a more advantageous position to notice such situations and should feel empowered by the surgeon to speak up and alert the team to a possible hazard; these types of communications should be encouraged by surgeons and never punished, even if the team member's concern was ultimately unwarranted.
- Cope with pressure: critical portions of a surgery must be highlighted by the senior surgeon, who should advise the team to be on heightened alert for specific phases of an operation when necessary. Surgeons must lead their team calmly and effectively through any crises that arise.

WHAT'S MISSING?

Often absent from discussions of both technical skills and NTSs in medicine are the nuances of human interaction required to teach these techniques effectively and to model them for colleagues in the operating room. Although the situation has certainly improved over time, kindness

and friendliness are often conspicuously lacking in neurosurgical training.

A large body of research has shown that learning is often inhibited by stress and negative emotions, yelling, throwing instruments, or giving the “silent treatment.” Treating colleagues and subordinates with congeniality and civility works synergistically with other NTSs to enhance team performance and enjoyment of their demanding high-stakes work.

Contributor: David A. Purger, MD, PhD

DOI: <https://doi.org/10.18791/nsatlas.v0.5.00>

References

- Doumouras AG, Hamidi M, Lung K, et al. Non-technical skills of surgeons and anaesthetists in simulated operating theatre crises. *Br J Surg* 2017;104:1028–1036. <https://doi.org/10.1002/bjs.10526>.
- Gostlow H, Marlow N, Thomas MJW, et al. Non-technical skills of surgical trainees and experienced surgeons. *Br J Surg* 2017;104:777–785. <https://doi.org/10.1002/bjs.10493>.
- Jung JJ, Borkhoff CM, Jüni P, Grantcharov TP. Non-technical skills for surgeons (NOTSS): critical appraisal of its measurement properties. *Am J Surg* 2018;216:990–997. <https://doi.org/10.1016/j.amjsurg.2018.02.021>.
- Smink DS, Yule S. Non-technical skills for surgeons: the NOTSS behaviour marker system. In Flin R, Youngson GG, Yule S, eds, *Enhancing Surgical Performance: A Primer in Non-technical Skills*. CRC Press, Boca Raton, FL. 2015;37–49.
- Yule S, Flin R, Paterson-Brown S, Maran N. Non-technical skills for surgeons in the operating room: a review of the literature. *Surgery* 2006;139:140–149. <https://doi.org/10.1016/j.surg.2005.06.017>.