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Checklists and Safety in Pediatric Cardiac Surgery

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In rebuilding Tulane's pediatric heart center after Hurricane Katrina, the use of checklists proved to be essential, not only in rebuilding inventory and systems, but the culture of continued debriefing around their use was seminal in establishing a culture of safety and trust between caregivers; safety that ultimately benefitted our patients.
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Introduction

When Hurricane Katrina ravaged New Orleans in August 2005, a breach was forced in her levees, compromising design and construction that had occurred years before the storm. Tulane and her School of Medicine were not spared, and both were temporarily forced to close. Tulane released or lost half of her faculty and, as a result, years of institutional memory and experience, particularly in pediatric cardiac care. There were no surgeons, cardiologists, pediatric perfusionists, one intensivist, and nursing staff was limited. With respect to physical infrastructure, there was no pediatric cardiac operating room, no functional catheterization lab, no instruments, no pump, and all other disposable inventory was either damaged by the flood or expired. The inventory and expertise one typically takes for granted were absent after the storm. Although helping to rebuild the pediatric cardiac surgery program sounded like the challenge of a career, what I did not realize at the time was that checklists would be seminal in that rebuilding.

Most medical professionals unwittingly benefit through the uninterrupted functioning of their programs. Daily processes, ingrained and refined over years of practice, act invisibly to sustain a culture. The unique disruptions in Tulane's environment after Hurricane Katrina destroyed that culture. In short order it became clear that the number of people that needed to be involved and the magnitude of rebuilding required the development of exhaustive checklists to efficiently disseminate information. In time we developed nearly every checklist that one could imagine for a pediatric heart program. In turn, those checklists created a culture, an expectation, and a standard that held us to task and helped keep mortality low in a system that literally started from ground zero.

Checklists: Efficacy, Resistance, and Benefits

Several years after Hurricane Katrina, Atul Gawande extolled the use of checklists in his book, *The Checklist Manifesto.*[1] Therein, he made the case that medicine has become unmanageably complex. Although many of us believe that what we do cannot be reduced to a checklist, or that the time it takes to go over a checklist is beneficial, Gawande argues, "defeat under conditions of complexity occurs far more often despite great effort rather than from a lack of it."[1] Cardiac surgery is arguably one of the most complex fields in medicine, and stands to benefit greatly by managing some of that complexity though the use of checklists.

In 2004, Berenholtz et al[2] investigated the efficacy of checklists in reducing catheter-related bloodstream infections (CR-BSI) from central line placement in the ICU. Faculty were educated on CR-BSI and proper central line placement. Importantly, nurses were empowered to stop a procedure if they observed a breech in technique. A standardized cart (also a checklist) containing all necessary equipment for the procedure was created. Before and during the procedure the patient's nurse assured each checklist item was completed. Nurses reported that the checklist helped them feel more comfortable in stopping a procedure if a violation was observed because concrete expectations were set from the beginning. CR-BSIs were significantly decreased from 11.3/1,000 in the first quarter to 0/1,000 in the fourth quarter. Checklist detractors went on to criticize this study as being too simple and overly specific to central line placement.

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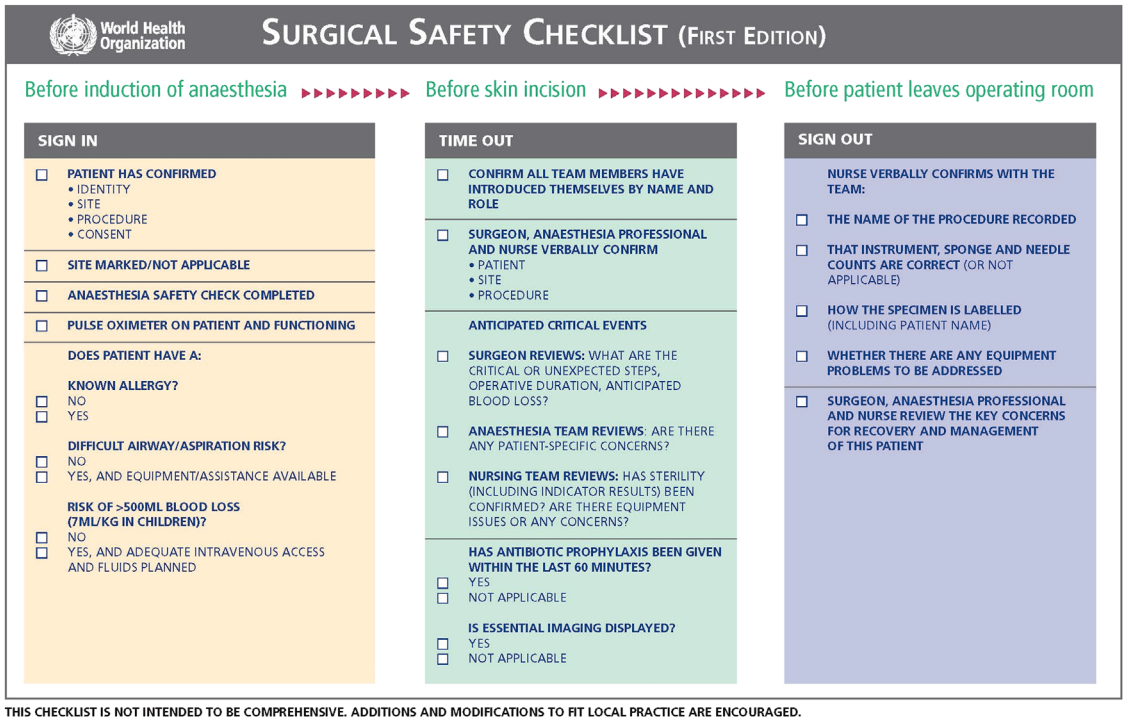
World Health Organization

SURGICAL SAFETY CHECKLIST (FIRST EDITION)

Before induction of anaesthesia ▸▸▸▸▸▸▸▸▸ Before skin incision ▸▸▸▸▸▸▸▸▸▸▸▸▸ Before patient leaves operating room

SIGN IN

☐ PATIENT HAS CONFIRMED
- IDENTITY
- SITE
- PROCEDURE
- CONSENT

☐ SITE MARKED/NOT APPLICABLE

☐ ANAESTHESIA SAFETY CHECK COMPLETED

☐ PULSE OXIMETER ON PATIENT AND FUNCTIONING

DOES PATIENT HAVE A:

KNOWN ALLERGY?
☐ NO
☐ YES

DIFFICULT AIRWAY/ASPIRATION RISK?
☐ NO
☐ YES, AND EQUIPMENT/ASSISTANCE AVAILABLE

RISK OF >500ML BLOOD LOSS (7ML/KG IN CHILDREN)?
☐ NO
☐ YES, AND ADEQUATE INTRAVENOUS ACCESS AND FLUIDS PLANNED

TIME OUT

☐ CONFIRM ALL TEAM MEMBERS HAVE INTRODUCED THEMSELVES BY NAME AND ROLE

☐ SURGEON, ANAESTHESIA PROFESSIONAL AND NURSE VERBALLY CONFIRM
- PATIENT
- SITE
- PROCEDURE

ANTICIPATED CRITICAL EVENTS

☐ SURGEON REVIEWS: WHAT ARE THE CRITICAL OR UNEXPECTED STEPS, OPERATIVE DURATION, ANTICIPATED BLOOD LOSS?

☐ ANAESTHESIA TEAM REVIEWS: ARE THERE ANY PATIENT-SPECIFIC CONCERNS?

☐ NURSING TEAM REVIEWS: HAS STERILITY (INCLUDING INDICATOR RESULTS) BEEN CONFIRMED? ARE THERE EQUIPMENT ISSUES OR ANY CONCERNS?

HAS ANTIBIOTIC PROPHYLAXIS BEEN GIVEN WITHIN THE LAST 60 MINUTES?
☐ YES
☐ NOT APPLICABLE

IS ESSENTIAL IMAGING DISPLAYED?
☐ YES
☐ NOT APPLICABLE

SIGN OUT

NURSE VERBALLY CONFIRMS WITH THE TEAM:

☐ THE NAME OF THE PROCEDURE RECORDED

☐ THAT INSTRUMENT, SPONGE AND NEEDLE COUNTS ARE CORRECT (OR NOT APPLICABLE)

☐ HOW THE SPECIMEN IS LABELLED (INCLUDING PATIENT NAME)

☐ WHETHER THERE ARE ANY EQUIPMENT PROBLEMS TO BE ADDRESSED

☐ SURGEON, ANAESTHESIA PROFESSIONAL AND NURSE REVIEW THE KEY CONCERNS FOR RECOVERY AND MANAGEMENT OF THIS PATIENT

THIS CHECKLIST IS NOT INTENDED TO BE COMPREHENSIVE. ADDITIONS AND MODIFICATIONS TO FIT LOCAL PRACTICE ARE ENCOURAGED.

Figure 1 WHO surgical safety checklist.[4]

In 2009, Gawande and colleagues reported on the use of a surgical safety checklist in 3,733 consecutive operations compared with 3,955 controls in which a checklist was not used.[3] The study occurred in first- and third-world countries. The checklist contained 19 items including verification of the patient's demographic and procedural information, use of a pulse oximeter, examination of the airway, documentation of expected blood loss, and the need for antibiotic prophylaxis before induction of general anesthesia (Fig. 1).[3,4] The checklist incorporated redundancy at several points, with repeat checks at both the initial sign-in and during surgical time-out. The list in this study was designed to be globally applicable, and to facilitate communication among surgical staff. After implementation, complications decreased from 11% to 7% and in-hospital mortality decreased from 1.5% to 0.8%. Improvement was actually more dramatic in low-income sites compared with high-income sites. Adherence was evaluated according to the completion of six measures included in the checklist. Before implementation, all six measures were completed 34.2% of the time, compared with 56.7% after implementation.

Three months later, 250 participating surgeons were surveyed on the use of the checklist.[5] Most physicians were skeptical at the onset of the study, but 80% stated that the checklist was easy to use and improved patient safety; 78% of surgeons stated that the checklist actually prevented an error. The most telling figure, however, was that 93% of surgeons would want a checklist used in an operation performed on themselves.

A 2014 study in the United Kingdom interviewed 119 surgeons, anesthesiologists, nurses, radiographers, and other perioperative personnel to identify factors that encouraged or inhibited the implementation of the WHO checklist.[6] A lack of planning and education regarding the benefits of the checklist was associated with poorer compliance. Many stated that the checklist "just showed up" in the operating room. Without evidence supporting improved quality associated with the checklist, many assumed it was just more redundant paperwork. Moreover, many institutions in this study adopted the checklist without modification. Altering the checklist to suit needs specific to the institution and eliminating other checklists to limit excess redundancy were both associated with better compliance. Regarding personnel, faculty stated that communication failures occurred often on the part of the attending surgeons and/or anesthesiologists. Those with the most experience tended to be the most resistant to the adoption of the checklist. Surgeons and anesthesiologists cited delays in care and over-generalization as major issues with the checklist. While operative times were not recorded in this study, it is unlikely that the checklist would cause significant delays in care as long as it was tailored to its specific need. Furthermore, as physicians, a small delay in care is a small price to pay when it improves safety and/or outcome. Support from the senior faculty was strongly associated with successful checklist implementation. The point regarding customization is particularly important. To illustrate, we have included our actual intraoperative four-part checklist for pediatric cardiothoracic surgery (Fig. 2). This is included to show how the checklist can be highly customized to essential items that the team believes are important, and certainly modifying it to include items that have caused historical issues. It can still highlight the necessary administrative points, but customization ensures that it is more than redundant paperwork because it touches items that the team may have identified as important.

Another 2014 study conducted a literature review to assess the overall impact of checklist use.[7] In addition to corroborating