Neurosurgical Checklists
A Growing Need

Scott L. Zuckerman, MD[a], Kyle M. Fargen, MD, MPH[b], J. Mocco, MD, MS[a,*]

KEYWORDS

• Quality improvement • Time-out • Checklist • Patient safety • Neurosurgery

KEY POINTS

- Checklists act as forcing functions, mandating series of evidence-based steps that reduce the potential for error caused by inherent human biases.
- The neurosurgical literature contains 2 different types of checklists: (1) routine checklist to be used in planned interventions and (2) emergent checklist to be used in the unplanned event of a complication.
- Neurosurgical checklists, though in their infancy, are continuing to be developed across all subspecialties.
- Most checklists reported in the neurosurgical literature are single-center studies without external validation.
- After checklist development, successful implementation is a nuanced process, requiring collaboration and commitment from all involved parties.

INTRODUCTION

In 1999, the Institute of Medicine published the seminal article "To Err is Human: Building a Safer Health System,"[1] suggesting that anywhere from 44,000 to 98,000 deaths occurred annually in the United States secondary to avoidable medical errors.[1,2] Earlier reports in the 1980s found that 41% of hospitalized patients were admitted because of iatrogenic disease.[3] Gawande and colleagues[4] postulated that of all hospital admissions nationally in 1992, 3% resulted in adverse events and 50% of these events were preventable. The cost of adverse events is not trivial.[4–8] One state documented that adverse medical events led to a mortality rate of 13.6% and costs more than $800 million in a single year.[2,9] The prevention of these avoidable medical errors has contributed to the evolving interest in quality improvement measures, with heavy emphasis on surgical checklists.

In 2008, The World Health Organization (WHO) created the WHO Surgical Safety Checklist.[10] The 19-item checklist sought to address infection prevention and anesthesia-related complications in surgery. In his 2009 book, *Checklist Manifesto: How to Get Things Right,* Atul Gawande espoused the utility of the checklists in error prevention through systematic corrective measures for generally routine tasks.[11] Gawande's work popularized the notion of intrinsic human fallibility and the inability to provide excellent outcomes with total reliance on individual performance.

Medicine has seen an explosion in checklists aimed at improving patient safety. Where general surgery[12–22] and anesthesiology[23–28] have published extensively on the use of checklists, neurosurgery is now following suit. In a field fraught with life-and-death decisions, where a seemingly minor mishap can lead to unforeseen death, the need for

There were no external sources of financial support for this article.
[a] Department of Neurological Surgery, Vanderbilt University School of Medicine, 1211 Medical Center Dr, Nashville, TN 37232, USA; [b] Department of Neurological Surgery, University of Florida, 1149 Newell Dr, Gainesville, FL 32610, USA
* Corresponding author. Department of Neurological Surgery, Vanderbilt University Medical Center, T-4224 Medical Center North, Nashville, TN 37232-2380.
E-mail address: jmocco@yahoo.com

Neurosurg Clin N Am 26 (2015) 219–229
http://dx.doi.org/10.1016/j.nec.2014.11.009
1042-3680/15/$ – see front matter

standardizing perioperative activities is paramount. The authors summarize procedural checklists in neurosurgery, from intensive-care-unit (ICU) procedures to specialty-specific operating room (OR) protocols, in hopes of expanding a growing cornerstone of medical and surgical care.

PREPROCEDURE TIME-OUT

The preprocedural time-out is now a universally performed confirmation of the correct patient and correct operative site and side in virtually every OR in the United States, if not the world. One of the earliest studies of a neurosurgical perioperative checklist was conducted by Lyons[29] whereby one US institution published 8 years of experience with an operative checklist across 6313 operations in 6345 patients. Compliance was extremely high at 99.5%, with no episodes of wrong patient or wrong-site surgery. Oszvald and colleagues[30] conducted a similar advanced perioperative checklist in Germany. The investigators identified 1 wrong-sided emergent burr hole and 1 wrong-sided lumbar approach across 8795 procedures involving 12,390 patients.

Two additional studies modified a general surgical checklist in a neurosurgical population. Da Silva-Freitas and colleagues[31] evaluated the previously mentioned modified WHO surgery safety checklist in 44 neurosurgical operations and identified 51 possible sentinel events in 44 operations. Matsumae and colleagues[32] implemented a similar checklist and used an on-duty safety nurse to ensure all safety practices were being met. Since the widespread adoption of the surgical time-out checklist, specialty- and procedure-specific checklists have gained popularity within neurosurgery (summarized in **Table 1**). The sections that follow discuss such checklists by specialty or procedure.

External Ventricular Drain

External ventricular drain (EVD) insertion is a common procedure performed in the ICU setting whereby a catheter is inserted into the cerebral ventricular system, thereby allowing drainage of cerebrospinal fluid. EVDs are integral to the ICU management of neurosurgical patients, most common in aneurysmal subarachnoid hemorrhage[33] and intracranial pressure (ICP) management.[34,35] Several checklists have been developed aimed at preventing infection, as infection may result in increased ICU length of stay and cost as well as patient morbidity and mortality.[36–38]

Kubilay and colleagues[38] evaluated 2928 ventriculostomies over a 4-year period and documented a reduction in EVD infection rate from 9.2% to 0% after implementation of a best-practice protocol. The protocol was summarized and distributed in succinct checklist form.[38] The checklist included several tasks, including antibiotic administration, hand washing, hair clipping, wide hair clip space for dressing, spectator use of hats and masks, and tunneling the catheter exit site 5 cm from the scalp incision. The investigators successfully implemented a best-practice model in the form of a checklist at a single institution.[39]

A similar study exclusively in cerebrovascular patients showed an equally encouraging decline in EVD infection rates. In more than 1961 ventriculostomies, Harrop and colleagues[40] showed a precipitous decline in infection rate when 2 different antibiotic-impregnated catheters were used, from 6.7% to 1.0% and 7.6% to 0.9% in 2 study time periods. Their procedural protocol included reducing room traffic, electric clippers for hair shaving, full barrier precautions, and a fully gowned surgical scrub for assistance.

Vascular

The treatment of neurovascular patients is complex. The surgical treatments for cerebrovascular disorders continue to evolve and include open surgery or minimally invasive endovascular techniques. Whether for an aneurysm embolization, open clipping, or emergent thrombectomy, checklists have the potential to improve safety in this high-risk patient population.

Endovascular complications range from benign puncture-site hematomas or transient neurologic deficits to aneurysm rupture, arterial dissection, stroke, and thromboembolism.[41,42] Complications of open clipping occur in approximately 20% of patients, including direct brain injury, cranial nerve injury, postoperative hematoma, and ischemic event.[43] Wong JM, et al[44] reviewed the adverse events of open vascular neurosurgery and concluded a significant proportion of technical adverse events could be reduced by standardized protocols, increased teamwork, and communication.

The current literature contains 2 brands of vascular checklists: routine and emergent. Fargen and colleagues[45] proposed that an endovascular checklist should be completed before any endovascular intervention. Checklist implementation in 60 procedures led to a significant reduction in adverse events as well as improved communication among team members.[45] In emergent situations, Taussky and colleagues[46] postulated a checklist in case of aneurysm perforation during coiling. Similarly, Chen[47] formed 2 checklists in the cases of aneurysmal rupture, with the overall