Adverse Events in Neurosurgery and Their Relationship to Quality Improvement

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KEYWORDS

• Adverse events • Neurosurgery • "Never events" • Quality improvement • N2QOD

KEY POINTS

- Adverse events in neurosurgery are common and their reporting is nonuniform and variable across reports and institutions; retrospective data tend to underestimate the rate of adverse events.
- The National Neurosurgery Quality and Outcomes Database (N2QOD) is a prospective, multi-institutional database in its pilot form that allows the generation of national normative data for outcomes and adverse events and allows for interinstitutional benchmarking.
- The results of primary research should be synthesized to guide the formation of standards and guidelines that can serve as the evidence basis for targeted quality improvement initiatives.
- Targeted quality improvement initiatives can reduce adverse events and improve outcomes; quality improvement initiatives differ based on the nature of the adverse event targeted and range from technical education to systems-based protocols and checklists.

INTRODUCTION

Adverse events are the sine qua non of quality improvement initiatives. They serve as the prime motivator behind systematic efforts to improve outcomes and to reduce error and associated harm. Adverse events in neurosurgery can be defined as both the unexpected perioperative complications as well as the anticipated neurologic or general deterioration related to surgical approach or other known causative factors. In addition to factors that result in actual harm to patients, it is also important to recognize those events that result in "near misses": events that are unexpected and/or dangerous, but that are caught in time or for various reasons do not result in patient harm. It is important to capture these events in any reporting because these "near misses" are often harbingers of actual patient harm if the proximate systemic causes continue without remedy. Furthermore, those events that are "expected" due to surgical approach, for instance, may still be targets of interventions that may reduce the rate of approach-related morbidity. Examples of this include awake craniotomy for lesions in eloquent cortex and minimally invasive approaches for certain pathologies of the spine.[1,2]

Avoiding, or mitigating the effects of adverse events, with resultant reduced harm and improved outcomes, requires multiple simultaneous efforts. These include defining adverse events, collecting standardized data, targeting systematic improvement initiatives, and studying the results of those initiatives, feeding back again to the collection of primary data. The field of neurosurgery has been

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historically slow to adopt robust data collection of adverse events compared with general and cardiac surgery disciplines,[3,4] although this is rapidly changing. The collection of these data and the resultant benchmarking this allows is paramount to being able to target initiatives aimed at reducing adverse events. This article reviews the role of adverse events in neurosurgery in relation to their role in quality improvement, taking into account what is known of the patterns of adverse events, the collection of data related to adverse events, and current and future quality improvement initiatives aimed at reducing adverse events and subsequent patient harm.

ADVERSE EVENTS IN NEUROSURGERY: DATA COLLECTION

Any effort to reduce adverse events requires comprehensive data capturing such events. Historically, the broad collection of these data has been sparse. Additionally, it is important to capture patient-centered outcomes, as adverse events are materially related to these outcomes. This is particularly important because adverse events and complications in neurosurgery are not rare.[5] Previous work by Wong and colleagues[6–10] aimed at describing patterns of adverse events in 4 major realms of neurosurgery:

1. Intracranial neoplasm surgery
2. Cerebrospinal fluid shunt surgery
3. Open cerebrovascular neurosurgery
4. Endovascular neurosurgery

Reported adverse event rates for these subspecialties were common, and variable. Reported rates for the most common complications in these specialties, respectively, were (1) 9% to 40% for intracranial neoplasm surgery (all adverse events); (2) 8% to 64% for mechanical shunt malfunction and 3% to 12% shunt infection for cerebrospinal fluid shunt surgery; (3) 27% to 71% hemorrhage-related hyperglycemia for open cerebrovascular neurosurgery, with the estimated rate of new infarct associated with subarachnoid hemorrhage (SAH) being 40% and technical adverse events (eg, incomplete clipping or infarct due to major vessel occlusion) occurred 3% to 18% of the time; and (4) 2% to 61% for endovascular neurosurgery (all adverse events).[6–10] These data highlight a number of important features of adverse events in neurosurgery:

1. Adverse events are not rare.
2. Adverse events are variable between institutions and reports.
3. Adverse events differ between subspecialties and patient condition and can be categorized into technical adverse events and nontechnical adverse events.

These data demonstrating such variability between adverse event rates in differing reports likely represents both a true difference in occurrence rates among institutions and inconsistency in reporting. Factors influencing these differences include nonuniform definitions of adverse events, nonstandardized collection techniques, and retrospective collection of adverse event data.[11,12] Accordingly, other studies have demonstrated that prospective data collection aimed specifically at the collection of adverse events identify higher rates of adverse events than retrospective studies.[13–16] A prospective study of 942 consecutive patients undergoing major adult spinal surgery who were part of a cohort analyzed prospectively using an adverse event collection tool demonstrated that 87% of patients experienced at least one adverse event (including major and minor, surgical and medical), with 39% of those adversely impacting length of stay.[15] Before the introduction of the prospective adverse evaluation tool, the authors' documented perioperative morbidity rate had been 23%.[15] Similarly, a prospective study of 1000 consecutive pediatric neurosurgical procedures at a single institution focused on adverse events documented 229 complications in 202 procedures and an overall complication rate of 20.2%, with an unplanned return to the operating room occurring in 52% of procedures associated with an adverse event.[13] These data from prospective studies highlight the need for prospective data collection aimed specifically at identifying adverse events in the perioperative period. It is important for this data collection to be standardized across institutions to make an "apples-to-apples" comparison of adverse event rates and to therefore learn from institutions that are performing well in studied areas, and those that are performing poorly. In concert, overall outcomes data, which includes adverse event data, must be collected, as this will inform development of practice standards and guidelines that can function as the evidence basis for quality improvement initiatives aimed at reducing adverse events, the results of which can cycle back to inform further primary data collection (**Fig. 1**).

Historically, such concerted efforts at large-scale, interinstitutional data collection lagged in neurosurgery. Recently, however, organized neurosurgery has attempted to address this lack of standardized, prospectively collected outcomes data. The most comprehensive project to acquire this