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Addressing Problems in Reporting and Classification of Complications in Neurosurgery

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Abstract. *Objective.* The purpose of this study was to quantify the rate of adverse events associated to in neurosurgery interventions, to evaluate the differences in reporting of such events among different authors and reviews, and to find the reason behind the occurrence of this differences. *Methods.* A systematic literature review of scientific publications on existing classifications and reports of frequency on complications in neurosurgery was performed by analysing articles from international databases. *Results and conclusion.* This current overview is taking an outlook on the existing issues in the classification and reporting of complications in neurosurgery. Complications are common in neurosurgery. Because of nonuniform criteria, unstandardized data gathering procedures, and retrospective data collection, their reporting is inconsistent and varies considerably among authors and reviews. The best way to address this issue is by gathering prospective, multi-institutional outcomes data on neurosurgical patients. The data collection initiatives in the future should be using same terminology and be based on the same universally accepted criteria.

Key words: postoperative complications, neurosurgery, neurosurgery complications, classification of surgical complications.

Introduction

Despite the rapid development and use of new technologies and novel approaches that considerably improve treatment efficiency and quality, the occurrence of complications in neurosurgery remains a significant problem today. Neurosurgical procedures have a greater morbidity and mortality rate than many others, thus minimizing complications is one of the key priorities of neurosurgeons during both perioperative and postoperative care. When compared to other surgery disciplines, the area of neurosurgery has historically been reluctant to implement systematic data collecting of adverse events. In part because detailing specifics concerning neurosurgical procedure consequences is intrinsically difficult due to considerable heterogeneity of neurosurgical operations, patient characteristics, and case acuity, as well as previous inaccurate reporting in the literature, however, this is gradually improving.

Complications in neurosurgery include both unforeseen perioperative complications (medical) and anticipated neurologic or general impairment due to surgical strategy or other known causal factors (therapeutic). The causes of their emergence may be related to the surgical intervention itself, the course of the postoperative period, the characteristics of the patient's somatic status before the operation, and the original pathology that necessitated medical care. In addition to factors that cause actual injury to patients, it is critical

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to distinguish those that cause "near misses": situations that are unexpected and/or dangerous but are caught in time or for other reasons that do not cause patient harm. It is critical to include these "near misses" in any reporting since they are frequently precursors to actual patient harm if the underlying systemic reasons are not addressed. Furthermore, occurrences that are "anticipated" as a result of a surgical method, for example, may still be targets of interventions that can minimize the rate of approach-related morbidity. Examples include awake craniotomy for lesions in the eloquent cortex and minimally invasive treatments for specific spine disorders [1].

Complications have a substantial impact on the success of treatment, decreasing the operation's outcome, lowering the quality of life, and raising economic costs due to extended hospital stays and repeated hospitalizations. Furthermore, the most severe complications frequently result in disability and death in patients. Avoiding or minimizing the effects of complications necessitates several simultaneous efforts, which include defining them, collecting standardized data, focusing on systematic improvement actions, and analyzing the outcomes of those initiatives.

Understanding and preventing surgical complications has become increasingly important in the era of quality-based compensation.

Methods

A systematic literature review of scientific publications on existing classifications and reports of frequency on complications in neurosurgery was performed by analyzing articles from PubMed, SpringerLink, and ScienceDirect databases. The reported complication rates and used classifications were compared among different studies with the goal of identifying those frequently occurring. The articles accepted for the review were both English and non-English dating from 1998 to 2022.

Classification

Before looking into the incidence of complications following neurosurgical procedures and their impact on the overall result of therapy let's analyze how complications are classified.

In 1998 Sawaya et al. grouped all neurosurgical complications into three categories. The first category is neurological complications, those that directly cause the neurological disability. The second category is regional complications that occur at the site of surgery and are mostly connected with the injury or the central nervous system problems, but do not immediately lead to neurological deficiency. The third category is systemic complications that develop in body areas remote from the brain [2].

In 2009 based on three variables, Houkin et al. identified five types of complications in neurosurgery. The first type, if the complications are not directly related to surgery, are random, and can occur throughout the entire perioperative time. The second type is if complications develop in connection with the surgical intervention, but are impossible to predict. The third type is connected to the surgery and predictable but cannot be avoided, while complications of the fourth type can be avoided with appropriate preventive actions. The fifth type is iatrogenic complications [3].

The most recent general classification that appeared in 2011, was presented by Landriel Ibañez et al. and offered a completely new approach. Authors classified adverse events into four levels based on the procedures necessary to treat them. Thus, Grade I are any complications that do not endanger the patient's life and do not require invasive measures to manage. There are two subgroups among them, depending on the requirement for drug therapy. Complications of Grade II necessitate invasive treatment, further divided as requiring interventions without general anesthesia (Grade IIa) or requiring general anesthesia (Grade IIb). Grade III are those life-threatening complications that necessitate ICU (intensive care unit) treatment, Grade IIIa is defined by organ insufficiency and malfunction, whereas Grade IIIb is characterized by the development of

multiple organ failure. Complications of Grade IV include those that result in death. In terms of the duration of neurological disorders, the authors distinguished between transient complications, which were defined as a new neurological deficit that developed as a result of surgery and regressed within 30 days of surgery, and persistent complications, which were defined as neurological deficits that persisted for more than 30 days after surgery. Furthermore, researchers classified all complications as surgical (directly related to surgery and surgical method) or medical (not directly related to surgery and surgical technique). While presenting an easy and practical way of reporting, the authors were also implying further discussion on the topic of standardization in the classification of neurosurgery complications [4].

Data reporting

High heterogeneity between complication rates in different reports most likely reflect both an actual difference in occurrence rates among institutions and reporting discrepancy. Imprecise definitions of adverse events, nonstandardized collecting methodologies, and retrospective collection of adverse event data are all factors impacting these disparities. As a result, additional research has shown that prospective studies targeted specifically at adverse event collection identify a higher incidence of adverse events than retrospective studies (Tables 1 and 2).

Table 1. Comparison of complication rates in studies based on database review [3, 4, 7–10]

Authors	Type of study	Analyzed period	Number of analyzed patients or cases	Type of analyzed interventions	Results
Linzey JR et al. (2018)	Database review	2007–2014	15 807 patients	Various neurosurgical procedures	Overall complication rate – 4.9%.
Cote DJ et al. (2016)	Database review	2006–2013	94 621 patients	Various neurosurgical procedures	Overall complication rate from 11.0% in 2006 to 7.5% in 2013.
Bydon M et al. (2015)	Database review	2006–2012	16 098 patients	Various neurosurgical procedures	15.8% of all patients had at least one post-operative complication.
Rolston JD et al. (2014)	Database review	2006–2011	38 000 neurosurgical cases	Various neurosurgical procedures	Overall complication rate after neurosurgical procedures is 14.3%; the complication rate after cranial procedures was 23.6%, which was 2.6 times the rate of spinal procedures (11.2%).
Theodosopoulos PV et al. (2012)	Database review	2009	5 361 cases	Predominantly spinal procedures	Complication rate as low as 4.9%.
Landriel Ibañez FA et al. (2011)	Database review	2008–2009	1 190 patients	Various neurosurgical procedures	Overall complication rate – 14%.
Houkin K et al. (2009)	Database review	2007–2009	643 neurosurgical interventions	Various neurosurgical procedures	Overall complication rate – 28.3%.

Table 2. Comparison of complication rates in prospective studies [11–16]

Authors	Type of study	Analyzed period	Number of analyzed patients or cases	Type of analyzed interventions	Results
Meyer HS et al. (2022)	Prospective study	September 2019 to September 2020	4 176 patients	Various neurosurgical procedures	25.0% of patients had at least one adverse event.
Sarnthein J et al. (2016)	Prospective study	2013 to December 2015	2 880 patients	Cranial neurosurgery	Overall complication rate – 24%.
Schiavolin S et al. (2015)	Prospective study	January 2012 to September 2013	1 008 patients	Various neurosurgical procedures	Overall complication rate – 22.6%.
Street JT et al. (2012)	Prospective study	April 2008 through April 2009	942 patients, adult	Spinal neurosurgery	87% of patients experienced at least one adverse event.
Van Lindert EJ et al. (2013)	Prospective study	January 2004 through August 2008	581 patients, pediatric	Pediatric neurosurgical procedures	Overall complication rate of 20.2%.

Any effort to avoid complications necessitates extensive data collection of such incidents. Historically, there has been a shortage of this type of data. This is especially significant because complications in neurosurgery are not rare. This data collection must be consistent across institutions to undertake a proper comparison of adverse event rates and so to learn from institutions that are performing well and those that are performing poorly in studied areas. Overall outcomes data, including adverse event data, must be collected, as this will inform the development of practice standards and guidelines that can serve as the evidence basis for quality improvement initiatives aimed at reducing adverse events [1]. The irregular reporting of any surgical complication is a common obstacle to its treatment. Many cases go unreported due to the surgeon's avoidance of filling documentation. However, with the implementation of electronic data recording systems and mandatory checklists maintained by independent teams, there has been an improvement in reporting of complications [5]. The most comprehensive recent project to acquire this type of data is the National Neurosurgery Quality and Outcomes Database (N2QOD) [6].

Many national databases in the United States have committed to collecting data on complications based on objective criteria over the last decade. American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP), for example, includes well-defined criteria for documenting surgical complications, as well as regular assessment of the reporting system to ensure that it is honest and reproducible, making it the most reliable source of data for neurosurgical complications at the current moment.

Discussion

When it comes to characterizing complications in neurosurgery now, there is a clear lack of agreement. Multiple classifications of complications in neurosurgery, that are based on different classification principles, coexist and are being separately used by authors for reporting, leading to either over-or underestimation of the importance of particular neurosurgical complications and to the distorted overall perception of ranges of their occurrence.

As multiple different-type classifications already exist and the work on this issue continues, more general classifications can be used in order to create more detailed ones (i.e., classifications that provide thorough detail concerning special complications related to a specific surgical procedure).

We support the idea that any deviation from the optimal postoperative course should be recorded in the complications report, even if they are asymptomatic and resolve spontaneously. Every adverse event, whether surgical or clinical in origin, should be recorded in order to have an exact understanding of the end result. Complications that are not directly connected to surgery or a surgical method affect our patients as well, and we should be able to identify them in order to enhance overall multidisciplinary patient treatment. A universally acknowledged classification will eventually lead to the unification of outcome criteria and provide a comprehensive objective experience to enhance medical care quality and prevent adverse events [4].

To avoid using vague terminology in the classification of complications and to eliminate any individual predisposition to minimize or deny complications, systematic and stratified categorized data should be collected in every neurosurgical department. To objectively compare morbidity or mortality in two or more distinct institutions at various periods, the differences in reporting processes and unstandardized terminology should be eliminated in future reports.

Conclusions

The complication risk in neurosurgical practice is quite significant, ranging usually, with rare but major variations, from 4.9% to 28.3%, according to different studies. In the majority of cases, those are surgical complications. Furthermore, brain surgeries are by far more frequently associated with the development of adverse events than spine procedures. In general, more experienced surgeons face fewer surgical complications. Otherwise, complication rates are also greatly dependent on clinical case type, in other words, more complications in more complex and high-acuity instances.

Avoiding surgery-related complications is a critical step in achieving a more viable healthcare system. A determined reporting method would aid in defining the occurrence of complications and in comprehending issues in their management. Complication reports should use the same terminology and be based on the same criteria so that outcomes can be compared objectively across various institutions and periods, with the ultimate goal of improving patient care. Further investigation in the field of classification of complications in neurosurgery, and continuation of the discussion on this topic, is required.

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