The Role of Neurosurgery Journals in Evidence-Based Neurosurgical Care

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INTRODUCTION

Throughout the past several decades, the neurosurgery publishing community has undertaken an active role in improving the quality of neurosurgical care over the past several decades, in part by endorsing an evidence-based view of neurosurgery practice. Notably, in recent years, neurosurgery journals have provided the main conduit through which the techniques of evidence-based medicine, originating outside the field, have illuminated the data produced by neurosurgery researchers. In particular, journals have promoted improvements in patient care by endorsing an evidence-based view of neurosurgical practice and actively safeguarding the quality of the review process.

In the early twentieth century, as neurosurgery matured, Osler’s “medico-chirurgical neurologists” split from general surgery to form their own discipline. The Society of Neurologic Surgeons was founded in 1920, followed by the Harvey Cushing Society (now the American Association of Neurologic Surgeons [AANS]) in 1931. With these professional accretions, a gradual awareness of the need for neurosurgery-specific journals dawned on that burgeoning community. The Journal of Neurosurgery (1944), Surgical Neurology (1975), and Neurosurgery (1977) were among the earliest and most influential journals devoted to neurosurgery in North America. The emergence of such periodicals stemmed from the recognition that despite sharing subject matter with related fields, such as neurology and general surgery, the peculiar complexities of neurosurgical care and its reliance on new science demanded discipline-focused venues for publication. Harvey

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Cushing, writing in 1929, famously recognized the binding influence of scientific publications in cultivating disciplinary consensus.\(^4\) The promulgation of independent neurosurgery journals over the course of the twentieth century reflects, in microcosm, the evolution of neurosurgery itself as a self-governing specialty with its own set of professional mores and standards.

Over the past century, the quantity of scientific information available to neurosurgeons has expanded dramatically. Neurosurgery journals have proliferated at an exponential rate, reflecting a trend seen across all scientific disciplines. This has been accompanied by a concomitant increase in the number of published articles, and increased pressures to organize that knowledge into useful forms for the clinical practitioner. At the same time, as the sea change of evidence-based medicine swept through the medical world in the 1990s, exhortations for achieving an “evidence-based neurosurgery” resulted from convincing arguments that the insistence on evidence-based patient care is applicable to neurologic surgery.\(^5\) Quality and quantity of the data have become paramount.\(^6\)

Organizing the ever-expanding mass of research data into the kind of knowledge that can guide clinical practice has proved a demanding feat. On this front, neurosurgery journals have been responsible for spearheading or facilitating many of the key initiatives. With assistance from professional societies, such as the AANS and Congress of Neurologic Surgeons (CNS), journals have improved the quality of neurosurgical knowledge by enforcing reporting standards, promoting meta-analysis, disseminating evidence-based clinical practice guidelines, and governing the process of peer review.

**NEUROSURGERY JOURNALS AND PROLIFERATION OF SCIENTIFIC INFORMATION**

The proliferation of neurosurgery journals and their quantitative impact over time is not well described in the primary literature, in part because categorizing scientific periodicals by discipline can be a deceptively difficult task. However, irrespective of which method is applied, it is clear that over several decades the number of neurosurgery journals has increased dramatically. In the mid-1970s, three major journals dominated the field. Today, there are dozens in the English language alone. One popular neurosurgery community World Wide Web portal lists 35 neurosurgical journals, rank-ordered by impact factor, in its resources section.\(^7\) Another source identified 182 neurosurgery-related journals and found 2522 distinct journals cited by neurosurgical literature during a 3-month period.\(^8\) New neurosurgery journals have been incepted de novo from professional interest groups, by evolution from pre-existing journals (eg, the continuation of *Surgical Neurology as World Neurosurgery*), or by splitting from a parent journal. The latter mechanism is represented, for example, by the recent spinoff of *Operative Neurosurgery* from its parent journal, *Neurosurgery*.\(^9\)

The importance of a periodical within its field is classically measured by metrics based on citation analysis.\(^10\) For example, the impact factor is defined as the average number of citations per paper published in that journal over the preceding 2 years. The \(h\) index reflects number of publications and citations; a journal with an \(h\) index of \(N\) has published \(N\) papers that have each been cited a minimum of \(N\) times. Both the impact factor and the \(h\) index have been applied to individual authors and to journals, although their dominance as metrics of scientific importance has been debated.\(^10-13\) Citations in neurosurgical literature have been described as following a clear clustering pattern, with a recent analysis identifying the six “core” neurosurgery journals, in order of citations for a given time period, as *Journal of Neurosurgery, Neurosurgery, Spine, Acta Neurochirurgica, Stroke, and Journal of Neurotrauma*.\(^8\)

In modern neurosurgery publishing, several safeguards are put in place to ensure the quality of research publications and, by consequence, the contribution of literature to the quality of patient care.

**REPORTING GUIDELINES AS A TOOL FOR LITERATURE QUALITY**

Around the turn of the twenty-first century, there emerged a growing awareness of the poor quality of reporting in medical research literature.\(^14-16\) Selective reporting of data, incomplete listing of interventions, problematic conclusions, and unclear methodologies plagued many papers. In neurosurgery, these deficiencies were particularly profound. Despite the well-known preeminence of randomized controlled trials (RCTs),\(^17\) these were scarce in the neurosurgery literature even when compared with general surgery or other surgical subspecialties.\(^18-20\) Moreover, under close examination, neurological RCTs as a group showed many flaws. In a survey of 108 RCTs on neurosurgery procedures during a 36-year span, underpowered trials and inadequate design reporting were widespread.\(^21\) Another survey of 159 neurosurgical RCTs found, among other pitfalls, that
nearly half of trials had inadequate reporting of allocation concealment, a core feature of proper RCT design.22

Beginning in the 1990s, the advent of consensus reporting guidelines from internationally recognized working groups has revolutionized the ability to objectively qualify clinical studies. The most widely accepted of these, introduced in 1996 and last revised in 2010, is known as the CONSORT statement (Consolidated Standards of Reporting Trials)16 and centers on a 25-item checklist for RCT reporting. CONSORT has been recognized as an important tool for ensuring the quality RCTs in the literature. Because RCTs are uncommon in neurosurgery, the variety of guidelines developed for other study designs are of considerable importance. Prominent examples include GRADE (2004)23 for formal grading of evidence, AMSTAR (2007)24 for systematic reviews, PRISMA (2009)25 for systematic reviews and meta-analyses, and MOOSE for meta-analyses that include observational studies. Collectively, these reporting guidelines have standardized and strengthened the organization of clinical knowledge.

The first publicized effort by a major neurosurgical journal to improve the quality of its literature by applying internationally recognized guidelines took place in 2011, when Neurosurgery endorsed and began requiring several of these guidelines.26 This followed comparable initiatives by top-tier journals in other biomedical disciplines, and endorsements of CONSORT by the International Committee of Medical Journal Editors (www.icjme.org) and other associations.

Today, Neurosurgery endorses and requires authors to adhere to several key reporting guidelines. Research articles that must be submitted according to the appropriate reporting guidelines include, but are not limited to, randomized trials, systematic reviews, meta-analyses of interventions, meta-analyses of observational studies, diagnostic accuracy studies, and observational epidemiologic studies (eg, case series, cohort, case-control, and cross-sectional studies). For manuscripts that report statistics, the journal requires that authors provide evidence of statistical consultation or expertise. As of October 2014, Neurosurgery explicitly requires the reporting guidelines listed in Table 1.27

Myriad resources exist to assist authors and reviewers in the task of understanding and meeting reporting guideline requirements. Authors are referred to the EQUATOR Network, which was established in 2006 to promote transparent and accurate reporting of research studies by providing an up-to-date list of guidelines.31 These include reporting guidelines for niche topics, such as neurooncology trials, and other nonrequired checklists and consensus statements designed to ensure research quality.

ORGANIZATION OF KNOWLEDGE: SYSTEMATIC REVIEWS AND META-ANALYSES

In tandem with efforts to improve the reporting and methodology of primary research, such as RCTs, renewed emphasis has been placed on secondary analyses of primary data, such as systematic reviews and meta-analyses.15 This attention is justified by the fact that meta-analyses can represent powerful levels of evidence.26 Current initiatives to improve the quality of meta-analyses and systematic reviews in the neurosurgery literature have mirrored efforts in the larger world of medical publishing. The most successful of these has been the Cochrane Database of Systematic Reviews, established in 1993 as an electronic collection of “living documents” representing systematic

<table>
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<tr>
<th>Type of Submission</th>
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<th>Online Information</th>
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| Randomized trials  | Revised CONSORT     | http://www.consort-
|                    |                     | statement.org       |
| Systematic reviews | Preferred PRISMA    | http://www.prisma-
| and meta-analyses  |                     | statement.org       |
| and meta-analyses  | Observational Studies| MOOSEstatement     |
| of observational   | (MOOSE)             |                    |
| studies            |                     |                    |
| Studies of         | Standards for the   | http://www.stard-
| diagnostic         | Reporting of         | statement.org       |
| accuracy           | Diagnostic Accuracy  |                    |
|                    | Studies (STARD)     |                    |
| Observational      | Strengthening the    | http://www.strobe-
| research           | Reporting of         | statement.org       |
|                    | Observational Studies|                    |

Data from Refs.16,25,28-30
reviews of primary research in health care and health policy. In 2011, the Cochrane Database of Systematic Reviews was recognized with a seat on the World Health Organization's World Health Assembly. Although the Cochrane Database of Systematic Reviews contains more than 5000 reviews, a keyword search of that database for “neurosurgery” yielded only 13 reviews.\textsuperscript{32} This validates the need for more neurosurgery-specific efforts to organize data from clinical studies into systematic reviews.

Attempts to quantify the quality of evidence in the neurosurgical literature have yielded varying results. A recent study found that higher levels of evidence (levels I and II) represented only 1 in 10 clinical papers from the top neurosurgical journals.\textsuperscript{33} Publications with larger sample size were significantly associated with a higher level of evidence. The authors of that study compared their data with that obtained for the year 1999,\textsuperscript{34} concluding that the proportion of high-quality evidence in neurosurgery journals had not significantly changed.

In the realm of methodologic and reporting quality for neurosurgery studies, there remains significant room for improvement. By some measures, the quality of meta-analyses in the neurosurgical literature seems to be improving.\textsuperscript{18,35} However, among 72 papers in neurosurgery journals self-described as meta-analyses, one study found that on average only 53\% of PRISMA items and 31\% of AMSTAR items were completed.\textsuperscript{35} Only 15\% of the papers mentioned using a content checklist, and none mentioned using a methodology checklist. According to an editorial accompanying that study, these results demonstrated that neurosurgery had one of the worst quality meta-analyses of any medical field.\textsuperscript{36} Concerns about literature quality have emerged not only for meta-analyses, but also for observational study designs, which are more numerous. A 2014 study found that most papers in the neurosurgical literature self-identifying as “case-control studies” are labeled incorrectly, with several attendant concerns in methodology.\textsuperscript{37} In evaluating those papers that met the definition as case-control studies, the authors applied the Strengthening the Reporting of Observational Studies in Epidemiology Checklist and found examples of reporting deficiencies, such as reporting of bias (28\%), missing data (55\%), and funding (44\%). Evidence is emerging, however, that the intervention of enforcing reporting guidelines may measurably improve the quality of published literature. In at least one editorial position statement,\textsuperscript{28} this has been noted as a promising way forward for quality of the neurosurgery literature. For instance, comparison of RCTs published before and after the advent of CONSORT\textsuperscript{38–40} and of RCTs in journals that do or do not endorse CONSORT reporting,\textsuperscript{39,41–43} supported a beneficial effect of the CONSORT statement on literature quality.\textsuperscript{44,45}

**ORGANIZATION OF KNOWLEDGE: CLINICAL PRACTICE GUIDELINES**

Initiatives to improve the quality of primary and secondary clinical research studies have been accompanied by coordinated efforts to develop comprehensive clinical practice guidelines for specific conditions. Neurosurgery journals have often worked in conjunction with professional societies to develop and disseminate the guidelines produced via these efforts. The CNS has formalized an in-house infrastructure to curate clinical practice guidelines, which it defines as including recommendations intended to optimize patient care and informed by a systematic review of evidence along with an assessment of benefits and harms.\textsuperscript{46}

The most concentrated large-scale efforts to develop evidence-based clinical practice guidelines in neurosurgery have occurred over the past 15 years. In chronologic order of their date of publication, Table 2 lists clinical practice guidelines publicly endorsed by the CNS\textsuperscript{47} and other neurosurgery-related guidelines.

In addition to the guidelines listed in Table 2, ongoing work of interest to neurosurgeons has led to the development of clinical practice guidelines for deep brain stimulation,\textsuperscript{70} lumbar radiculopathy,\textsuperscript{71} normal pressure hydrocephalus,\textsuperscript{72} neuro-oncology (eg, low-grade glioma, new glioblastoma, progressive glioblastoma, metastasis),\textsuperscript{73} and concussion.\textsuperscript{74} The impact of clinical practice guidelines on patient care is difficult to assess directly, because the mere publication of guidelines does not guarantee their adoption or provide mechanisms to record outcomes. Adoption of guidelines will likely be reflected by long-term changes in neurosurgery patient management. In their introduction to the 2013 cervical spine injury guidelines, Hadley and Walters\textsuperscript{57} describe the role and limitations of evidence-based guidelines from the standpoint of a practicing neurosurgeon:

> Medical evidence-based guidelines, when properly produced, represent a contemporary scientific summary of accepted management, imaging, assessment, classification, and treatment strategies on a focused series of medical and surgical issues. They are an evidence-based hierarchal ranking of the scientific literature produced to date…
Medical evidence-based guidelines are not meant to be restrictive or to limit a clinician’s practice. They chronicle multiple successful treatment options (for example) and stratify the more successful and the less successful strategies based on scientific merit. They are not absolute, “must be followed” rules…

Guidelines documents are not tools to be used by external agencies to measure or control the care provided by clinicians. They are not medical-legal instruments or a “set of certainties” that must be followed in the assessment or treatment of the individual pathology in the individual patients we treat. While a powerful and comprehensive resource tool, guidelines and the recommendations contained therein do not necessarily represent “the answer” for the medical and surgical dilemmas we face with our many patients.

The concept of guidelines based on evidence- and expert-based consensus has influenced neurosurgery not only in the realm of clinical decision-making, but also in the realm of clinical education. Inspired in part by the growing body of clinical practice guidelines, a collaborative curriculum of educational guidelines was developed for neurosurgery trainees, based on the Self-Assessment in Neurologic Surgery educational tool.75–77 The Self-Assessment in Neurologic Surgery curriculum is now available as a free resource template to aid program directors in defining a body of knowledge to be attained by neurosurgical trainees.

PEER REVIEW

Peer review continues to be a core feature of neurosurgery publishing that serves to safeguard the quality of the literature. A historical perspective shows that peer review has long been a venerated aspect of the neurosurgery publication process.78 To maintain community standards, the neurosurgery editorial community has sought to provide guidance to peer reviewers in published form.79 All original material published by Neurosurgery undergoes “rigorous multi-factorial double-blind peer-review by carefully selected panels of knowledgeable and dedicated individuals who are highly versed in the academic process and the given topic.”27 The JNS Publishing Group journals (Journal of Neurosurgery, Journal of Neurosurgery: Spine, Journal of Neurosurgery: Pediatrics, and Neurosurgical Focus) share a similar requirement.80

The generally accepted methodology of peer review has been sustained despite several controversies, including those that are ethical and cultural in nature. Sources of controversy and potential pitfalls in peer review have received much scrutiny.76,81–84 The validity of the modern peer review process itself has been questioned by investigators, such as John Ioannidis, who have suggested that most clinical studies published in prestigious peer-reviewed journals are ultimately proved false.85 The problem of articles retracted because of scientific misconduct muddies these waters still further. The journals with the highest impact factor tend to have the highest incidence of articles retracted because of scientific fraud, and in one study, only 6% of downstream citations were found to mention the cited article’s retraction.86 When these retracted articles continue to be cited, a worrisome cycle is set in motion. Conflicts of interest also represent a potentially pernicious source of reviewer bias.81–83 It has become commonplace for journals and meetings to mitigate conflicts of interest, financial or otherwise, by mandating disclosures.84,87,88 A concise definition of such conflicts is provided by the Journal of Neurosurgery submission guidelines: “a situation in which a person has competing loyalties or interests—financial, personal, or professional—that may make it difficult to fulfill his or her duties impartially.”80 To reduce bias and potential conflicts in analysis, both Neurosurgery and the JNS Publishing Group journals extend the strict requirement of disclosure to authors and peer reviewers.

As a whole, neurosurgery journals have maintained the peer review process as a cornerstone of literature quality, with a constantly evolving appreciation of ethical and procedural safeguards.

NEUROSURGERY JOURNALS AND FUTURE INNOVATIONS

In the past decade, neurosurgery journals have responded proactively to the technological and cultural changes sweeping the publishing industry. Business model innovations in publishing have led to opportunities and grave challenges. Among the most significant of these developments is the introduction of open access publishing, with the annual volume of articles published in open access journals increasing from 20,702 in 2000 to 340,130 in 2011, or 17% of all articles published.89–91 Controversies over open access publishing have centered on concerns about endangering scholarly institutions and unethical behavior by investigators and journals alike.89 Although open access publishing has not been significantly adopted within the world of neurosurgery, the globalization of neurosurgery has made it increasingly important to make evidence-based
<table>
<thead>
<tr>
<th>Guidelines Endorsed by CNS</th>
<th>Year</th>
<th>Publisher</th>
<th>Sponsor</th>
</tr>
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<tbody>
<tr>
<td>Guidelines for the Management of Severe Traumatic Brain Injury (Third Edition)</td>
<td>2007</td>
<td><em>Journal of Neurotrauma</em></td>
<td>Brain Trauma Foundation, AANS, CNS</td>
</tr>
<tr>
<td>Guidelines for the Treatment of Newly Diagnosed Glioblastoma</td>
<td>2008</td>
<td><em>Journal of Neuro-Oncology</em></td>
<td>CNS/AANS Joint Section on Tumors</td>
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<tr>
<td>Evidence-Based Clinical Practice Parameter Guidelines for the Treatment of Patients with Metastatic Brain Tumor</td>
<td>2009</td>
<td><em>Journal of Neuro-Oncology</em></td>
<td>CNS/AANS Joint Section on Tumors, in collaboration with McMaster Evidence-Based Practice Center</td>
</tr>
<tr>
<td>Guideline for the Surgical Management of Cervical Degenerative Disease</td>
<td>2009</td>
<td><em>Journal of Neurosurgery: Spine</em></td>
<td>CNS/AANS Joint Section on Spine</td>
</tr>
<tr>
<td>Guidelines for the Management of Spontaneous Intracerebral Hemorrhage in Adults</td>
<td>2010</td>
<td><em>Stroke</em></td>
<td>American Heart Association/American Stroke Association/American College of Cardiology</td>
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<tr>
<td>Guidelines for the Prevention of Stroke in Patients with Stroke and Transient Ischemic Attack (Secondary Stroke Prevention)</td>
<td>2011</td>
<td><em>Stroke</em></td>
<td>American Heart Association/American Stroke Association</td>
</tr>
<tr>
<td>Guideline on the Management of Patients with Extracranial Carotid and Vertebral Artery Disease</td>
<td>2011</td>
<td><em>Circulation</em></td>
<td>American Heart Association/American Stroke Association/American College of Cardiology and others</td>
</tr>
<tr>
<td>Guidelines for the Acute Medical Management of Severe Traumatic Brain Injury in Infants, Children, and Adolescents</td>
<td>2012</td>
<td><em>Pediatric Critical Care Medicine</em></td>
<td>Brain Trauma Foundation</td>
</tr>
<tr>
<td>Guidelines for the Management of Aneurysmal Subarachnoid Hemorrhage</td>
<td>2012</td>
<td><em>Stroke</em></td>
<td>American Heart Association/American Stroke Association/American College of Cardiology</td>
</tr>
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### Consensus Statements Endorsed by CNS

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<thead>
<tr>
<th>Statement</th>
<th>Year</th>
<th>Journal</th>
<th>Endorsing Societies</th>
</tr>
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<tbody>
<tr>
<td>Position Statement on Percutaneous Vertebral Augmentation</td>
<td>2007</td>
<td><em>Journal of Vascular and Interventional Radiology</em></td>
<td>Multiple including AANS, CNS, American Society of Interventional and Therapeutic Neuroradiology</td>
</tr>
<tr>
<td>Reporting Standards for Angioplasty and Stent-Assisted Angioplasty</td>
<td>2010</td>
<td><em>Journal of NeuroInterventional Surgery</em></td>
<td>Society of Interventional Radiology</td>
</tr>
<tr>
<td>Reporting Standards for Endovascular Repair of Saccular Intracranial Aneurysms</td>
<td>2010</td>
<td><em>American Journal of Neuroradiology</em></td>
<td>Society of Interventional Radiology</td>
</tr>
<tr>
<td>Diagnosis and Management of Cerebral Venous Thrombosis</td>
<td>2011</td>
<td><em>Stroke</em></td>
<td>American Heart Association/American Stroke Association/American College of Cardiology</td>
</tr>
<tr>
<td>Key Data Elements and Definitions for Peripheral Atherosclerotic Vascular Disease</td>
<td>2012</td>
<td><em>Journal of the American College of Cardiology</em></td>
<td>American College of Cardiology/American Heart Association</td>
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### Guidelines and Statements Reviewed but not Endorsed by CNS

<table>
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<tr>
<th>Statement</th>
<th>Year</th>
<th>Journal</th>
<th>Endorsing Societies</th>
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<tbody>
<tr>
<td>Occupational Medicine Practice Guidelines, Chronic Pain</td>
<td>2008</td>
<td><em>American College of Occupational and Environmental Medicine</em></td>
<td>American College of Occupational and Environmental Medicine</td>
</tr>
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### Other Notable Neurosurgery-Related Guidelines

- Guidelines for Field Management of Combat-Related Head Trauma            | 2005 | *Brain Trauma Foundation*                   | Brain Trauma Foundation                                                             |
- Guidelines for the Surgical Management of Traumatic Brain Injury         | 2006 | *Neurosurgery*                              | N/A                                                                                 |

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Data from Refs. [57-69]
information available to those in developing nations. Alternatives to journals as sources of clinical information—once limited to professional conferences and books—now include Web sites, social media, and nontraditional publishing models based on the early examples of ArXiv.org and Wikipedia, which have achieved some success by supplementing editor-mediated peer review with crowd intelligence. Free online initiatives by professional societies, such as the CNS University of Neurosurgery,95 NeuroWiki,93 AANS Operative Grand Rounds,94 and the AANS Neurosurgery YouTube channel,95 have now expanded the reach of global neurosurgery education.

In the context of these technological and business model challenges, neurosurgery journals have stayed competitive and relevant. Amid an ocean of non–peer reviewed information, journals have found themselves in the position of being arbiters of authenticity. They have been early adopters of new technologies to disseminate their original research publications, such as podcasting, QR codes, videos, electronic editions formatted for tablets, and mobile applications. The ubiquity of Internet access has changed neurosurgery publishing in beneficial ways, including facilitating more widespread access to content.

Perhaps most importantly, this ready availability of evidence-based information at the point of care, particularly in electronic format and on mobile devices, has allowed it to become a day-to-day element of neurosurgery training. The feasibility of teaching evidence-based practice to residents in neurosurgery and other surgical subspecialties has previously been confirmed.96–98 Building on the long tradition of the academic journal club in neurosurgery training,99,100 in 2012 Neurosurgery launched a Neurosurgery Journal Club enabling residents and fellows to perform critical commentaries on previously published original research.101 Structured as a competition, this quarterly feature is designed to hone the next generation of peer reviewers and editors by engaging neurosurgery trainees in the editorial process, and to contribute to trainees’ understanding of statistical evidence.

SUMMARY

Since their rise to prominence in the twentieth century, neurosurgery journals have played an active role in improving the quality of the neurosurgical literature. Over the past two decades, as the number and variety of journals devoted to neurosurgery has increased, this role has expanded to improve the quality of care by incorporating an evidence-based view of neurosurgery practice. The explicit endorsement of reporting guidelines, such as CONSORT and PRISMA, promises to generate much-needed improvements in the quality of neurosurgery research articles. Reflecting secular trends in the world of evidence-based medicine, neurosurgery journals have facilitated the organization of knowledge into clinically useful forms via the publication of meta-analyses and dissemination of clinical practice guidelines. Peer review continues to be a core feature of neurosurgery publishing, with attendant ethical and procedural safeguards. Finally, neurosurgery journals have spearheaded innovative responses to cultural and technological changes, including initiatives to deliver high-quality research in electronic formats and support the education of future neurosurgery investigators.

REFERENCES


57. Hadley MN, Walters BC. Introduction to the guidelines for the management of acute cervical spine and spinal cord injuries. Neurosurgery 2013;


