Harvey Cushing's Open and Thorough Documentation of Surgical Mishaps at the Dawn of Neurologic Surgery

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The recognition of surgical mishaps and their correction in subsequent cases was critical in the evolution of the discipline of neurosurgery during its infancy. The Johns Hopkins Hospital surgical records from 1896 to 1912 were reviewed, and 30 cases documenting the self-reported surgical errors of Harvey Cushing, MD, were selected for further analysis. We demonstrate that alongside pioneering profound advancements in medical care, Cushing openly acknowledged and described significant instances of human error, mistakes in judgment and technique, and equipment and supply oversights, regardless of whether these events affected patient outcome. Mistakes were analyzed and recorded to be drawn on as lessons to improve future care. This review defines the attitude toward documenting and reporting medical errors present at the founding of the field of neurosurgery as one of forthright acknowledgment in the pursuit of innovation.

Since the Institute of Medicine published its 2000 report *To Err Is Human*, increased attention has been given to the prevalence and reporting of medical errors.[1] In response to this "new" focus on error reporting by regulatory bodies, we aimed to provide a historical perspective on reporting and acknowledgment of medical errors by examining the error reporting of Cushing at the turn of the 20th century.

Cushing oversaw one of medicine's greatest improvements in medical care. His meticulous surgical techniques and attention to clinical observation paved the way for the mortality of the surgical treatment of brain tumors to decline from approximately 50% to less than 13%.[2] Distinct from his publication of complications throughout his career, Cushing's original surgical records provide a unique benchmark of accountability for mistakes in the files of specific patients during a period of historical advancement and, consequently, also present a reminder of the types of challenges that current safety standards and technological advancements have evolved to address. These century-old cases also offer an early point of reference from which to understand the effect that subsequent events have had on the acknowledgment of medical errors.

Cushing began to carve out his surgical specialty during his time at Johns Hopkins. He arrived in 1896 to complete his residency training and stayed until September 1912, when he moved to the Peter Bent Brigham Hospital at Harvard. Harvey Cushing conducted his surgical procedures and wrote his operative notes in an era of intensely increasing attention to medical errors. Lack of governmental regulation had allowed numerous "quack" physicians without adequate training to practice,[3] which prompted public concern and the publication of pamphlet expositions on inferior-quality care and medical mistakes.[4] The American Medical Association worked to standardize care throughout the latter part of the 19th century,[4] and, in 1913, the American College of Surgeons was established and developed the Hospital Standardization Program.[5] By 1951, the successes of the Hospital Standardization Program and the

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efforts of individuals such as Evarts Graham, MD, had facilitated the union of the American College of Surgeons, the American Medical Association, the American Health Association, and the American College of Physicians into the Joint Commission on Accreditation of Hospitals.[5,6]

Although successful, each step toward standardization of the medical field further engrained malpractice into American society because official standards for appropriate care and training provided legal experts with better arguments on how such principles could be violated.[3] As early as 1878, physicians such as Eugene Sanger, MD, began reporting high malpractice statistics against American physicians.[7] News of such lawsuits literally hit close to home for Cushing; in point of fact, in 1906, the *Baltimore Sun* chronicled a case against Herman Boldt, MD, for leaving a towel in a patient.[4]

The malpractice trend troubled many physicians because unerring judgment and complete avoidance of mistakes required an unattainable degree of perfection.[8] In 1890, David Yandell, MD, published an article suggesting that a physician should not "be accountable for errors of judgment, unless they were from want of proper care and diligence, which were in his power to have used."[9(p180)] Nevertheless, although it was possible to find unreported errors, several physicians used the focus on errors to advance public acknowledgment of common mistakes and to improve medical care.[10-14] A particularly defining moment known in the United States and abroad occurred when 2 surgeons in Warsaw, Poland, were sued for leaving cotton gauze in the peritoneal cavity of a patient.[4,13] The plaintiff won the case, and the physician who served as the expert witness responded by publishing 2 reports in 1899 and 1904 highlighting the commonality of the situation.[4,13] Physicians in the United States published additional cases along with recommendations to prevent such occurrences.[13,15] It was not unheard of during Cushing's time to find articles discussing mistakes and, moreover, openly admitting to personal errors. For example, Archibald Mac Laren, MD, published a well-received[16] 1907 *JAMA* article titled "Personal Surgical Errors."[13] Samuel Kelley, MD, published a similar article in 1910.[12] Errors with equipment also were viewed as important to impress on students.[17]

To enhance the understanding of the state of error reporting early in the field of modern neurologic surgery and to document reporting during a period of medical advancement, this review examined Cushing's self-reporting of medical errors in the Johns Hopkins Hospital surgical records between 1896 and 1912.

METHODS

The operative notes from the files of 845 patients treated by Cushing during his time at Johns Hopkins were reviewed. Although Cushing reported his mistakes in general surgical and neurosurgical cases during this period, this analysis focused on his documentation. The 30 cases in which error(s) seemed to be clearly delineated in the operative notes were selected for further analysis. These cases were divided into 3 categories: errors in judgment, human error, and equipment and supply oversights in neurosurgical patients.

RESULTS

Among the 30 cases reviewed, inpatient outcomes revealed that 21 patients (70%) were discharged with a condition of well or improved, 2 (7%) were unimproved, 1 (3%) was in poor condition, and 6 (20%) died. Although the surgical errors did not contribute to all the poor outcomes and deaths in this series, the degree to which certain errors affected a patient's poor outcome could not be accurately garnered from these historical records. Outcome data evidence Cushing's willingness to report mistakes regardless of the surgical result.

Cases were subdivided based on the type of error that occurred: errors in judgment, human errors, and oversights related to surgical equipment and supplies. There were 12 cases of errors in judgment (**Table 1**). The inpatient outcomes were recorded as 5 well or improved (42%), 2 unimproved (17%), 1 poor (8%), and 4 dead (33%). There were 17 cases of human error (**Table 2**). The inpatient outcomes were recorded as 14 well or improved (82%), 1 poor (6%), and 2 dead (12%). There were 3 cases of equipment and supply oversights (**Table 3**); of these patients, 2 had a discharge condition of well or improved (67%), and 1 died (33%). The errors that Cushing reported in this series include failures to provide necessary equipment in the operating room, a wrong-side operation, mistakes made due to sleep deprivation, and loss of grip on surgical tools while operating (**Figure**). We include, herein, a more detailed review of 3 representative cases, 1 of each error type.

ERROR IN JUDGMENT

In November 1904, a 5-year-old boy (case 2) presented in a state of stupor. The mother detailed a 5-month history beginning with headache, nausea, and vomiting that progressed to left-sided paralysis and spasms. During an operation to remove a presumed cerebral tumor, Cushing noted:

> An unfortunate delay was necessitated in the early steps of the operation owing to the inefficient tourniquets, two of which were tried but both of which leaked. Consequently . . . much more blood was lost than would otherwise have been the case and this the patient could ill spare . . . At the last moment, however, freeing the growth the child's respiration became very bad and the pulse could no longer be palpated.

After detailing the child's death and resuscitation efforts, Cushing continued:

> In view of the outcome it is evident that the operator would doubtless have shown better judgment had he after completely outlining the surface extent of the growth on the hemisphere, removed the osseous portion of the Wagner flap and so far as possible closed over the protruding growth the scalp alone and have left the enucleation for a subsequent sitting.

HUMAN ERROR

In April 1910, Cushing attempted an exposure of the sella turcica via the labial-basal route in a 36-year-old farmer (case 14) diagnosed as having a pituitary tumor. In his operative note, Cushing confessed:

> A large crowd of interested bystanders and a tired operator led to a mistaken direction of the exploration which in all probability amounted

Table 1. Self-reported Errors in Judgment by Harvey Cushing During His Years at Johns Hopkins

Case No.	Surgery Date	Diagnosis	Inpatient Outcome	Follow-up Time	Last Known Outcome	Quoted Mistake
1[a]	5/29/1902	Trigeminal neuralgia	Poor	0.1 mo	Unreported	All the gauze was then withdrawn and the spurting vessel . . . was very easily controlled by . . . wax . . . had this been carried out early in the operation it would have been possibl[e] to have done a complete extirpation [of the ganglion].
2	11/9/1904	Cerebral tumor	Died	None	Died during operation	The operator would doubtless have shown better judgment had he . . . left the enucleation for a subsequent sitting.
3	6/15/1905	Microencephaly, spastic paraplegia	Died	1 h	Died	The operator decided to expose the right side at this same sitting. It was doubtless a mistake in judgment. [The child] died about an hour later.
4	8/17/1905	Bilateral facial neuralgia	Unimproved	40.1 mo	Unimproved	Subsequent events proved that the operation on the left had been incomplete.
5	1/13/1906	Fracture of the skull	Well; no further operation was necessary	0.8 mo	Well	It is presumable that I decompressed this patient on the wrong side. In the former case we decompressed on the side opposite to the greatest choked disc; here we opened the side corresponding to the greatest choked disc.
6	11/26/1906	Trigeminal neuralgia	Well; subsequent operations necessary to complete procedure because most time was spent defining anatomy in this case	87.1 mo	Died, cardiac failure	[A light streak] closely resembled a bundle of nerve fibers . . . the operator had himself been deceived.
7	12/21/1907	Trigeminal neuralgia	Well	76 mo	Died	The structure broke off behind the third division . . . this is the third or fourth time in this later series that this has occurred, possibly due to the fact that the operator did not go far enough toward the median line. . . .
8	2/12/1909	Cerebral tumor	Unimproved	1.8 mo	Died	In gross pathology notes: [After locating the tumor it was evident that] the diagnosis of uncinate gyrus was correct. The final operation was conducted at too high a level [within the cortex].
9[b]	6/30/1910	Endothelioma of the right hemisphere	Died	None	Died in operating room	Throughout this entire performance there was a constant loss of blood. . . . At this period the operator should have desisted but the temptation to continue was too great for him.
10	8/8/1911	Spina bifida	Died	None	Died during operation	The sac was then excised: with it unfortunately the entire relic of the cord.
11	10/4/1911	Trigeminal neuralgia	Well	26.3 mo	"Not doing well"	A mistake possibly was made in not fully opening the dura propria of the ganglion.
12	2/7/1912	Temporal lobe tumor	Improved	0.5 mo	Improved	It was possible to explore between the bone and the dura well under the temporal lobe. I think this was possibly a mistaken maneuver. . . . It would have been better to have left the membrane adherent.

[a] Judgment error case 1 (Table 1) and human error case 1 (Table 2) occurred in a single operation.
[b] Judgment error case 9 (Table 1) and equipment/supply oversight case 3 (Table 3) occurred in a single operation.

to the same performance that was carried out in the case of [reference deleted]. How this should have occurred seems now inexplicable where in every respect the procedures were similar, the operator even felt that he had even gotten into the sphenoidal cells and on introducing the probe felt the posterior wall. . . . It was most evident that the patient should have a pneumococcus meningitis. Uratropin has been given freely. Now three days after the operation by misdirection 325 grains in 24 hours without any nephritic disturbances.

Seven days postoperatively, the patient was found to have become septic. An abscess was discovered and evacuated. A second-stage surgery was completed in May 1910. In that operative note, Cushing acknowledged:

It was obvious that the original operation had been made somewhat higher than usual and the floor of the sphenoidal cells were less well rongered away than had been expected. At the present stage therefore the operator devoted himself chiefly to the removal of more of the sphenoidal boundaries.

The patient's condition was noted to be improved on discharge. Letters from the patient's wife tracked a gradual

Table 2. Self-reported Human Errors by Harvey Cushing During His Years at Johns Hopkins

Case No.	Surgery Date	Diagnosis	Inpatient Outcome	Follow-up Time, mo	Last Known Outcome	Quoted Mistake
1[a]	5/29/1902	Trigeminal neuralgia	Poor	0.1	Unreported	By ill luck or carelessness, the operator retracted the dura to too great an extent and tore off the meningeal artery at the foramen spinosum.
2	10/31/1902	Fractured skull base	Died	0.6	Died	Unfortunately, in withdrawing the needle, it was broken off an inch below the skin.
3	1/22/1903	Trigeminal neuralgia	Well	26.8	Letter: well	The clamp had not been put on in the position the operator intended, [therefore there was] a copious welling up of blood.
4	12/17/1903	Cerebellar (fossa) tumor	Improved	2.3	Improved	The operator stupidly did not recognize that this was a new growth.
5	4/10/1905	Old skull fracture, supraorbital neuralgia	Improved	Patient sent undated letters "a few years later"	Improved	The button [of bone] slipped and fell upon the operating floor.
6	9/7/1906	Trigeminal neuralgia	Well	57.2	Died	In splitting dura, blunt dissector slipped and plunged into dura just above opening where trigeminous emerges.
7	4/10/1907	Trigeminal neuralgia	Well	57.7	Letter: well	There was a large water shed of bone . . . causing a partial split of the external layer of the dura. . . . Fortunately the error was seen before the dura was completely dissected through.
8	4/3/1908	Trigeminal neuralgia	Well	15.8	Letter: alive, unable to pay for surgery	One accident happened . . . a small lesion in the dura underneath the temporal lobe which resulted in the extrusion of a portion of the temporal lobe.
9	5/20/1908	Trigeminal neuralgia	Improved	67.3	Letter: well	A large cell in the temporal bone was opened . . . this accident, together with the possible leaving in the wound fragments of wax . . . may possibly lead to subsequent complications.
10	7/2/1908	Trigeminal neuralgia	Well	23.4	Letter: "unsatisfactory case"	Unusual difficulties were experienced . . . owing to a stupid accident in injuring the dura. . . . The particular apprehension which is felt is due to the fact . . . that a completely new staff of assistants was employed.
11	5/14/1909	Trigeminal neuralgia	Well	10.3	Well	Cerebrospinal fluid escaped from several openings, the first one of which was accidentally made in the dura.
12	7/9/1909	Trigeminal neuralgia	Well	0.6	Well	Perhaps due to too much pressure with the spatula [the sensory root] was torn across just posterior to the ganglion.
13	4/15/1910	Trigeminal neuralgia	Improved	35	Letter: died, bronchopneumonia	It is possible that the operator may have been holding the ganglion too tight with the spatula.
14	4/30/1910	Tumor hypophysis	Improved after subsequent operation	18	Died	A large crowd of interested bystanders and a tired operator led to a mistaken direction of the exploration.
15	7/19/1910	Congenital hydrocephalus	Died	0.1	Died	The child, unfortunately, by some mistake had no preparation for operation [the intestines were full].
16	10/12/1910	Spinal cord tumor	Improved	11.8	Letter: worse	An ugly accident at the upper part of the incision due to the slipping of the perforator through into the canal.
17	10/24/1910	Endothelioma	Well	56.7	Letter: well	Unquestionably, overlying an endothelioma a [condition] unrecognized in 1910 by me. -HC . . . A curious mishap occurred in that the saw was led down through the dense bone so that at the anterior part of the exposed area the dura was laid bare.

[a] Judgment error case 1 (Table 1) and human error case 1 (Table 2) occurred in a single operation.

Table 3. Self-reported Equipment and Supply Oversights by Harvey Cushing During His Years at Johns Hopkins

Case No.	Surgery Date	Diagnosis	Inpatient Outcome	Follow-up Time, mo	Last Known Outcome	Quoted Mistake
1	4/26/1905	Trigeminal neuralgia	Improved	0.6	Improved	Owing to the fact that the dissectors all had very blunt edges . . . the third division was torn off from the ganglion.
2	12/1/1905	Trigeminal neuralgia	Well	30.4	Returned for photographs; condition unrecorded	Owing to not having exactly the right tools [the Gasserian ganglion] extraction proved somewhat difficult.
3[a]	6/30/1910	Endothelioma of the right hemisphere	Died	0	Died in operating room	We temporarily ran out of wax and had to send across town for some.

[a] Judgment error case 9 (Table 1) and equipment/supply oversight case 3 (Table 3) occurred in a single operation.

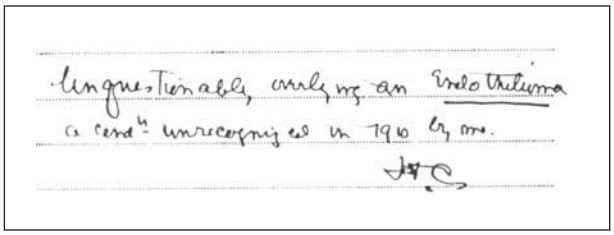

Figure. Dr Harvey Cushing's original note in the file of a human error case stating, "Unquestionably overlying an Endothelioma a cond[n] [abbreviation for *condition*] unrecognized in 1910 by me. H.C."

return of the symptoms a year later and his subsequent death.

EQUIPMENT AND SUPPLY OVERSIGHT

In June 1910, a 23-year-old African American woman (case 3) presented with seizures, left-sided numbness, and a headache. Cushing planned a 2-stage operation for a right-sided tumor. During the second-stage procedure he noted:

> Almost every bite through the bone was followed by spurting arteries which bulged in all directions. So much wax was used that we temporarily ran out of wax and had to send across town for some . . . Throughout this entire performance there was a constant loss of blood and at one time the pulse had run up as high as 120. . . . Patient's condition at the end of the operation was critical.

The patient died 2 hours after the procedure. Cushing provided a 2-page autopsy note.

COMMENT

This review of Cushing's original operative notes documents an early openness toward admission of medical errors in the files of patients and a belief in their importance for advancement. Cushing openly acknowledged mistakes that may have resulted in patient deaths and instances in which patients ultimately had positive outcomes despite any medical error. Frequently, Cushing explained the specific knowledge that he derived from recognizing a mistake and made a deliberate point of cross-referencing previous errors whenever they helped him avoid making a new mistake. For example, when performing a spinal accessory/facial nerve anastomosis on a patient in 1906, Cushing wrote:

> It is worth noting that this inferior division bifurcated in very much the same way as the main facial trunk bifurcates and it was from a mistake recognizing this fact that I once anastomosed to the spinal accessory the lower branch of the facial alone, thinking that I had the entire trunk.

Clearly, Cushing derived personal satisfaction in righting past wrongs. In fact, he actively attempted to identify errors by tracking similar undesirable outcomes in his operative notes, acknowledging unfortunate events as a "first" or "third or fourth" occurrence in a particular series. Cushing attempted to establish an objective tone by writing or dictating his descriptions of surgical procedures almost exclusively in the third person; Cushing referred to himself as "the operator" when describing his successes and failures and, at times, disparaged himself by dubbing the operator "stupid" or "careless" for making mistakes.

This attitude of Cushing toward acknowledging mistakes matches his firm belief in the importance of thorough documentation of poor outcomes. In 1914, he advised fellow physicians:

> Statistics are dreary matters, but it is periodically incumbent upon us to assemble our cases not only for our own instruction lest we bury in obscurity our mistaken and bad results, but also to acquaint others with the standing of operative measures. We have become confronted of late years with new surgical problems . . . and, hesitating as our steps may be in meeting these problems, our operative experiences must from time to time be recorded in all their lights and shadows.[18(p1525)]

Cushing set a high moral standard in this respect by publishing statistics on complications for which he is credited.[19,20] He was correct; identification of common challenges has led to the development of numerous technological advances and has improved patient safety during the past century.[20,21] Nevertheless, although Cushing's diligent compilation of statistics holds its own historical merit, his forthright documentation of fault should be seen as distinct because the practice of assuming fault for a personal mistake regarding a particular patient is arguably more difficult. Moreover, this series of operative notes was drawn from the early years of Cushing's career, when he had the least clout to buffer his mistakes.

Cushing's frank reporting style makes it worthwhile to note that his operative records and bad outcomes were not beyond public scrutiny or safe from the threat of malpractice. The *Baltimore Sun* commonly chronicled the outcomes of Cushing's patients and would report on their deaths.[22] In the event of a malpractice suit during Cush-

ing's time, surgical notes were considered to be the most essential document in the case because trials often took place years after the surgery. Operative notes were believed to be more accurate than testimonies from memory and were weighed heavily.[8] Further proof that the possibility of legal action in response to a mistake was a reality for Cushing can be found in a personal letter that Walter Dandy, MD, at that time one of Cushing's residents at Hopkins, wrote to his mother in 1912. In that missive, Dandy confided:

> Did I tell you about Dr Cushing leaving a piece of cotton in a woman's neck at operation. The wound broke down and has been discharging ever since, about 2 months ago. He went to Europe and left her to incur expense and discomfort here until he came back. He remitted her operation fee of $500 but I think they are going to sue him for damages.[19(p245)]

Although some members of the Harvey Cushing Society have gone so far as to imply that malpractice could not have been a concern for Cushing,[23] Dandy's letter provides further evidence that it was, in fact, a reality, albeit at the time not strong enough of a force to deter his candor.

In light of Cushing's unabashed reporting and his advice to fellow surgeons to commit themselves to this practice, the question arises as to why a similar degree of forthrightness is not readily apparent today. Admittedly, current safety measures and technological advancements help alleviate some of the specific challenges faced by Cushing.[20,21] Nevertheless, medical errors still occur; and although modern physicians recognize that reporting of errors improves care,[24,25] a significant percentage of physicians acknowledge failure to report such instances.[25-28] Many of them cite fear of judgment by patients, colleagues, and family members as a result of such reporting.[28] Historically, this situation was evident in 1967 when Hugo Rizzoli, MD, a former student of Dandy, and Norman Horwitz, MD, published a book about postoperative complications in neurosurgery in which they acknowledged that "the natural aversion to publicizing one's unfavorable results somewhat vitiates the reliability of the literature as an index of the incidence of a given complication."[20(pvii)] Nevertheless, both authors recognized the importance of such admissions; their tome details information garnered from unfortunate postoperative events and provides advice on how to prevent these outcomes.[20]

In examining factors that have changed since Cushing reported his mistakes, there has been a significant increase in survival rates,[29,30] which has obviously increased the expectation of outcomes. Improved and numerous standards of care have been added, each of which presents a regimen from which physicians could be judged should their treatments deviate. The attitudes of patients as recipients of care have also changed as a result of increased consumer consciousness that harkens to the 1960s.[3]

Since Cushing's time, the threat of malpractice has become a significant barrier to reporting.[31,32] First, the frequency of lawsuits has risen. By 1929, physicians of the time noted a marked increase in suits filed during the past decade.[33] On a financial level, the amount of an award sought in a case has greatly increased[3]; between 1975 and 1985 alone, the average amount more than tripled.[3] As early as 1961, surgeons lamented whether Cushing "could do today what he did in his pioneer labors and escape the harassment of a plaintiff's attorney . . . of possible legal reprisals for such actions, progress in surgery would be slowed to a snail's pace and the public will be the loser."[23(p570)]

It is, perhaps, equally important to observe what has remained since Cushing openly acknowledged his own errors. As important today as ever, a need exists for innovation to advance the medical field. Because perfection is impossible, physicians remain vulnerable to error and must continue to learn from mistakes. As Cushing astutely remarked in his 1920 address before the New England Otological and Laryngological Society, "Errors will be made, but it is from our mistakes, if we pursue them into the open instead of obscuring them, that we learn the most."[34(p210)]

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