Institutional Review of Mortality in 5434 Consecutive Neurosurgery Patients: Are We Improving?

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BACKGROUND: Despite increasing emphasis on quality improvement in neurosurgery, few studies have evaluated the impact of quality initiatives on health-assessment metrics including risk of mortality (ROM), severity of illness (SOI), case mix index (CMI), and mortality index.

OBJECTIVE: To evaluate the impact of a multifactorial quality initiative on mortality and quality metrics on a neurosurgical service.

METHODS: Records of 5434 consecutive neurosurgery inpatients and consults including all inpatient mortalities were prospectively collected and reviewed from July 2014 to June 2016 at major academic institution. A multifactorial quality improvement intervention was implemented in July 2015. UHC risk models mortality index, CMI, ROM, SOI present on admission (POA), and at hospital discharge (DC) were compared in the prior 12 mo and the 12 m after implementation. For mortality cases, diagnosis-related group codes, procedure type, and etiology of mortality were collected.

RESULTS: Compared to the pre-intervention cohort (n = 2793), the postintervention cohort (n = 2641) trended to have a decreased mean-observed monthly mortality (3.08 vs 4.17) and mean-monthly mortality index (0.73 vs 0.98). Additionally, the postintervention cohort had significantly higher CMI (3.14 vs 2.96, $P = .02$), POA-ROM (1.52 vs 1.46, $P = .02$), POA-SOI (1.97 vs 1.84, $P = .0002$), DC-ROM (1.69 vs 1.58, $P = .003$), and DC-SOI (2.1 vs 1.95, $P < .0001$). Of 131 mortalities (pre-intervention: n = 70, postintervention: n = 61), the postintervention cohort had a higher proportion of moralities due to emergent and trauma admissions than elective.

CONCLUSION: Our study suggests that our quality initiative impacted observed mortality, improved documentation, and enhanced overall quality of care on a neurosurgical service.

KEY WORDS: Documentation, Mortality, Neurosurgery, Quality improvement, UHC

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With the passage of the Affordable Care Act in 2010, healthcare metrics and patient outcomes, especially mortality rates, are increasingly emphasized as integral measures of overall quality of care and hospital reimbursements.[1-4] Therefore, the performance of individual neurosurgical departments is assessed through comparison of departmental outcomes measures with national standards. One such comparison tool is the University Health System (UHC) Consortium, a data assessment tool utilized by many hospitals for both benchmarking and performance improvement. UHC is a member-owned consortium representing 120 academic medical centers, including over 300 hospitals, and contains self-reported data that are evaluated with risk adjustment. UHC data often serve as a proxy for Centers for Medicare & Medicaid Services (CMS) risk-adjustment data, data that are utilized by nationally recognized external rating systems.[1]

Due to the intrinsically high risk of adverse events in neurosurgery, compared to other

ABBREVIATIONS: CMI, case mix index; **CMS,** Centers for Medicare & Medicaid Services; **DRG,** diagnosis-related group; **ICD-9-CM,** International Classification of Diseases, Ninth Revision, Clinical Modification; **LOS,** length of stay; **POA,** present on admission; **ROM,** risk of mortality; **SOI,** severity of illness; **UCLA,** University of California, Los Angeles; **UHC,** University Health System surgical subspecialties, mortality rates are one of the most frequently assessed measures of departmental- and hospital-level performance.[5] Due to the acuity and complexity of many neurosurgical patients' conditions, preoperative risk stratification can have significant implications for mortality on neurosurgical services. Commonly, assessment involves documentation of health-assessment metrics that include a 1 to 4 rating of risk of mortality (ROM) and severity of illness (SOI) on admission and discharge, which are reflections of patients' risk of in-hospital death and degree of illness, respectively. Case mix index (CMI) assesses the complexity of care and accounts for patient comorbidities.[2] Notably, mortality index, a measure calculated from the observed or actual mortality and expected or predicted mortality based on documentation and risk assessment, is particularly utilized in neurosurgical services as a metric of quality of care. Diagnosis and treatment provided at admission is defined by a diagnosis-related group (DRG) code that is generated at discharge and CMS determines reimbursement based on DRG codes, which are adjusted according to both ROM and SOI.[2]

In the past decade, there have been various quality initiatives implemented by a few neurosurgery departments across the country to better hospital- and departmental-quality metrics and healthcare reimbursements.[2,6-10] However, while the improvement of patient care has been demonstrated through better-quality documentation initiatives, the impact that quality initiatives have on patient mortality, overall CMI, mortality index, ROM, SOI, and other metrics is not well described.[2,8] As a department, we evaluated the impact of a multifactorial quality initiative on mortality and quality metrics in a hospital neurological surgery service.

METHODS

Quality Improvement Intervention

On July 1, 2015, a multifactorial quality improvement intervention was initiated for the neurological service at a major academic institution designed to reduce overall mortality rates, improve quality of care, and to document patients' comorbidities accurately. The intervention involved the following components: (1) all surgeons in the department started receiving monthly email dashboard displaying month and year-to-date detailed reports on their metrics compared to departmental peers and national neurosurgery groups; (2) initiation of monthly departmental presentations during Neurosurgery Grand Rounds displaying department and surgeon-level data including outliers and rankings; (3) initiation of standardized (best evidence-based) care protocols for common and severe neurosurgery diagnoses and tracking to assess impact; (4) ongoing education for all attending surgeons, residents, physician assistants, and nurses about accurate documentation for neurosurgery diagnoses with lectures, one-on-one training, emails, and access to electronic health record smart phrases; (5) implementation of system-based progress note templates; (6) communication to surgeons on all deaths with ROM and SOI < 4 and mortality index > 1.0; and (7) initiation of private meetings between surgeons to further define and explain the quality data results.

Furthermore, we formulated and incorporated into our clinical practice evidence-based protocols and algorithms for the management of (1) acute and chronic subdural hematomas; (2) reversal of anticoagulation before surgery; (3) carotid stenosis; (4) spinal trauma including fractures and spinal cord injury; (5) gunshot injuries; (6) hemicraniectomy, closed head injury, and intracranial hypertension; (7) shunt failure; (8) brain and spinal metastasis; (9) reduction in surgery infections; and (10) brain hemorrhages including subarachnoid and intraparenchymal hemorrhages. Once the evidence-based protocols and algorithms were formulated, the following occurred for each protocol: (1) a departmental presentation on the protocol and discussion of how to approach different patient scenarios using the protocol was conducted and (2) the written protocol was sent to all attending surgeons, residents, physician assistants, and nurses in the neurosurgery department who assessed the clinical impact of the protocols.

Data Analysis

The medical records and data of 5434 consecutive neurosurgery patients who were either admitted or were consulted upon by the neurosurgery service were prospectively collected and reviewed over a 24-mo period. We included all patients that were on other services and co-managed by neurosurgery. Institutional review board approval was obtained prior to initiation of the study. There were 131 inpatient mortalities during this time period, which included all mortalities whether they were on the neurosurgery service or if we were consultants and they were on another service including hospice. Any patient that was assessed or treated by neurosurgery was included. We reviewed and collected data on deaths prospectively. Patients and mortality cases were grouped by date, July 2014 to June 2015 (pre-intervention: total n = 2793, mortality cases n = 70) vs July 2015 to June 2016 (postintervention: total n = 2641, mortality cases n = 61). Specifically, mortalities prospectively collected occurred on the neurosurgery service, on other services in the hospital, as well as on the hospital inpatient hospice service. Of note, outpatient hospice resources and care were underutilized in 2015 and 2016 time periods, and were identified and developed as an option in 2017 after the study period. We utilized UHC risk models to assess mean per month reporting of present on admission (POA)-ROM/SOI, discharge (DC)-ROM/SOI, mortality, morality index, and CMI for the neurosurgery population and mortality cases. For all mortality cases, we also collected DRG codes, whether a procedure was performed and appropriate details, whether the admission was elective or emergent, and type of case (vascular, spine, trauma, cranial, or other).

Parametric data were expressed as means ± standard deviation and compared using the Student's *t*-test. Nominal data were compared with the Chi-square test. All tests were 2-sided and were statistically significant if the *P*-value was less than .05. Statistical analysis was performed using JMP, Version *12* (SAS Institute Inc, Cary, North Carolina, 1989-2007).

RESULTS

Total Neurosurgical Population

A total of 5434 patients representing all consecutive patients on the neurosurgical service and consulted at a major academic institution (pre-intervention: n = 2793, postintervention: n = 2641) were included in this study. Compared to the pre-intervention cohort, the postintervention cohort trended to have a decreased mean-observed monthly mortality (3.08 vs 4.17, *P* = .19)

TABLE 1. Mortality and Documentation Metrics Before and After Quality Initiative in the Total Neurosurgery Patient Population

Total neurosurgery population (n = 5434) Variables (mean per month)	Earlier (n = 2793)	Later (n = 2641)	P-Value
Mortality observed (n)	4.17	3.08	.19
Mortality expected (n)	4.09	4.28	.74
Mortality index (observed/expected)	0.98	0.73	.11
CMI	2.96	3.14	.02*
POA – ROM	1.46	1.52	.02*
POA – SOI	1.84	1.97	.0002*
DC – ROM	1.58	1.69	.003*
DC – SOI	1.95	2.1	<.0001*

POA, present on admission; DC, discharge; ROM, risk of mortality; SOI, severity of illness; CMI, case mix index.

and increased mean-expected monthly mortality (4.28 vs 4.09, P = .74), resulting in an overall decreasing trend in the mean-monthly mortality index (0.73 vs 0.98, P = .11; Table 1, Figure 1). The length of stay (LOS) index was similar between both cohorts (Table 1). CMI, POA-ROM/SOI, and DC-ROM/SOI were significantly higher in the postintervention cohort (Table 1, Figures 2 and 3). Compared to the pre-intervention, the post-intervention had significantly higher CMI (3.14 vs 2.96, P = .02), POA-ROM (1.52 vs 1.46, P = .02), POA-SOI (1.97 vs 1.84, P = .0002), DC-ROM (1.69 vs 1.58, P = .003), and DC-SOI (2.1 vs 1.95, P < .0001; Table 1). The significant trends in per-month documentation of POA-ROM, POA-SOI, DC-ROM, and DC-SOI increased from the pre-intervention 12-mo time period through the postintervention 12-mo time period**.** Importantly, higher CMI, SOI, and ROM reflect sicker patients with more severe illness.

Mortality Cases

Of the 5434 total consecutive neurosurgery cases, 131 mortalities were identified (pre-intervention: n = 70, postintervention: n = 61). In patients who died, there was no significant difference in the incidence of having a neurosurgery performed during the hospitalization before and after the intervention (64.7% vs 59.7%, P = .55; Table 2). A higher proportion of mortality cases were from emergent admissions compared to elective cases after the intervention (pre-intervention: 75.0% vs postintervention: 88.7%, P = .09; Table 2). Postintervention, fewer number and percentage of elective neurosurgery patients died. Different from the total neurosurgery cohort, the documentation metrics for cases of mortality between the pre- and postintervention cohorts were similar, including expected mortality (P = .97), POA-ROM (P = .84), POA-SOI (P = .50), DC-ROM (P = .56), and DC-SOI (P = .60; Table 2).

The majority of mortality cases (n = 131) were attributable to trauma (39.70%) or vascular (34.35%) etiologies (Table 3). After the intervention, a higher proportion of mortalities were attributable to trauma (pre-intervention: 36.23% vs postintervention: 43.55%; Table 3). Conversely, after the intervention a lower proportion of mortalities were due to stroke/thrombosis (pre-intervention: 13.04% vs postintervention: 6.45%; Table 3). The other etiologies, including tumor and spine, were similar between the cohorts (Table 3). The 5 most common DRG classifications among the mortalities and the corresponding definitions are indicated in Table 3. The most common DRG classifications were as follows: DRG 023 (28.24%), DRG 025 (16.79%), DRG 020 (12.21%), DRG 064 (7.63%), and DRG 530 (5.34%; Table 3).

DISCUSSION

In this prospective adverse event review of health-assessment metrics and mortality data, we demonstrate a reduced mortality

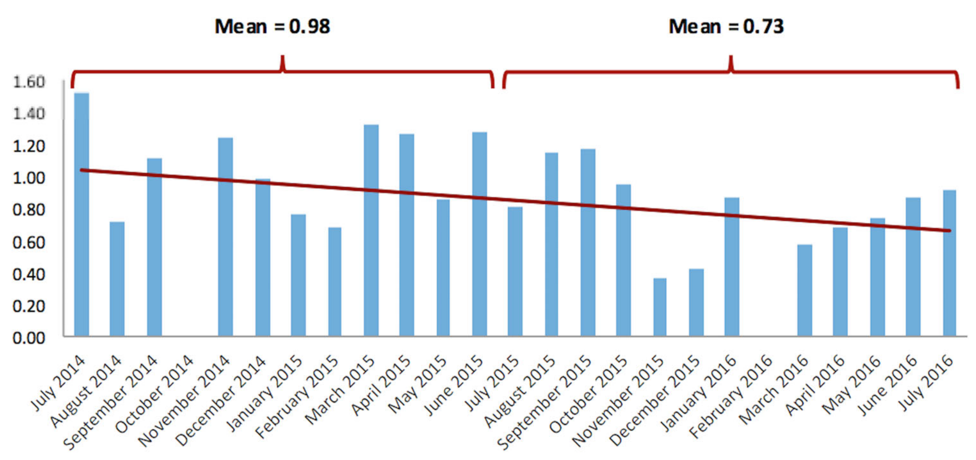

FIGURE 1. *Mortality index throughout overall time period.*

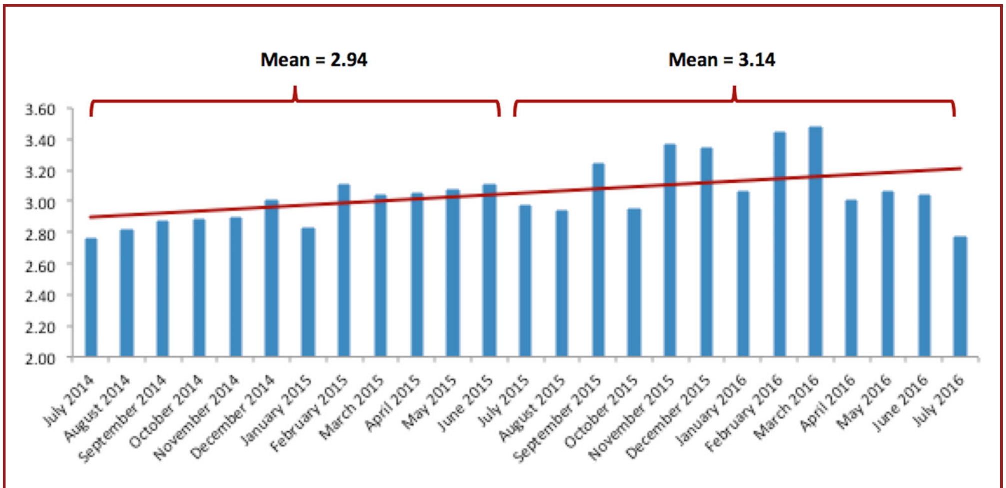

FIGURE 2. *Case mix index during overall time period.*

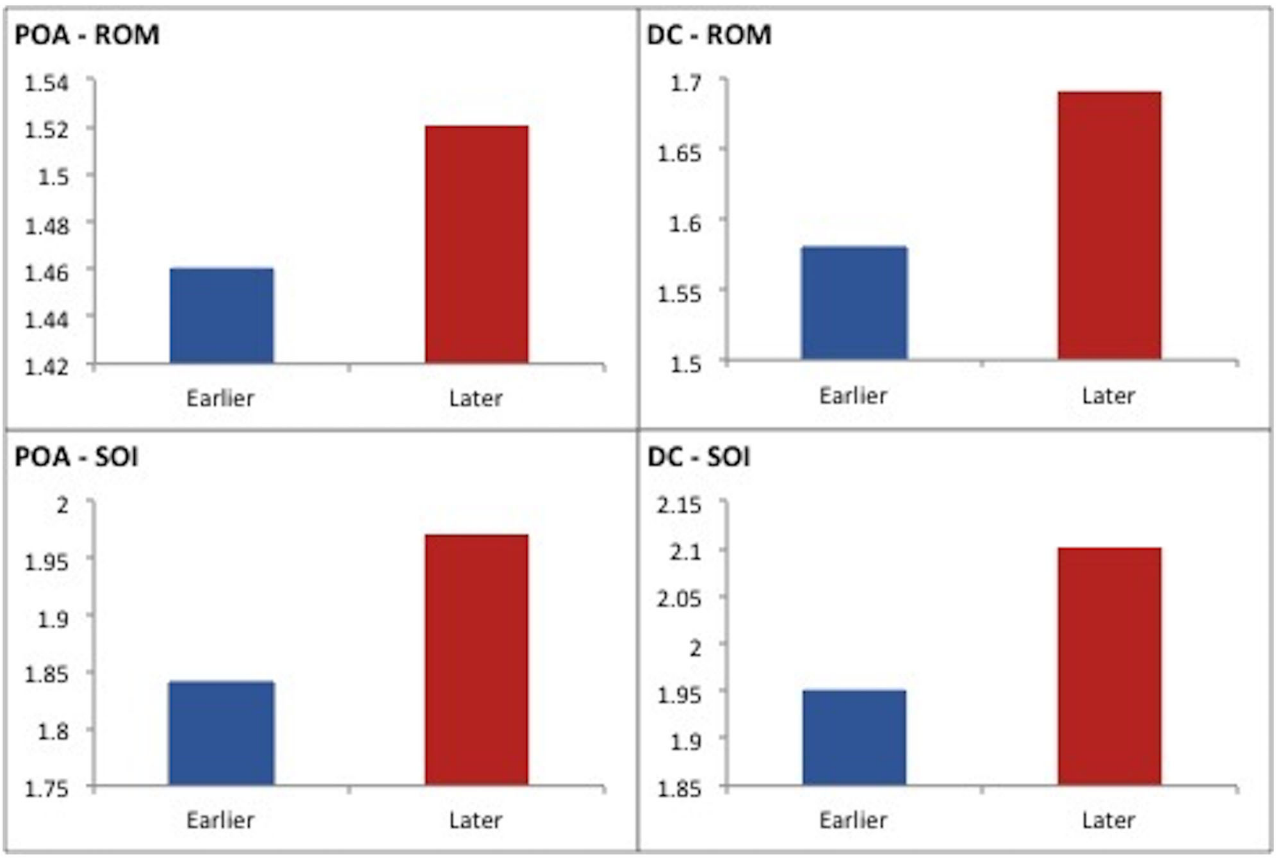

FIGURE 3. *POA-ROM/SOI and DC-ROM/SOI (mean per month) between the earlier and later cohorts.*

TABLE 2. Mortality and Documentation Metrics Before and After Quality Initiative in the Mortality Cohort

Neurosurgery mortality cases (n = 131)	Earlier (n = 70)	Later (n = 61)	*P*-Value
Neurosurgery performed (%)	64.7	59.7	.55
Emergency admission (%)	75.0	88.7	.09
Mortality expected	0.49	0.50	.97
POA—ROM	3.70	3.67	.84
POA—SOI	3.75	3.69	.50
DC—ROM	3.97	3.95	.56
DC—SOI	3.94	3.92	.60

POA, present on admission; DC, discharge; ROM, risk of mortality; SOI, severity of illness; CMI, case mix index.

index after implementing a quality initiative program that attempted to improve overall mortality rates and documentation within our neurosurgical service. In addition to achieving increased awareness, education, and improvements in documentation of metrics (ie, CMI, ROM, and SOI), we demonstrated a reduction in the observed mortality rate by a mean of 1 patient per month in the year of our quality intervention, which reflect improved care independent of documentation efforts. Our study utilized all prospectively collected patient mortalities occurring on the neurosurgery service, on other services in the hospital, as well as on the hospital's inpatient hospice service to formulate overall, nonconfounded mortality rates. While the increased CMI, ROM, and SOI seen after implementation of our intervention may be attributable to improved documentation or a worsening patient-health population, our lower observed/actual mortality, despite an unchanged expected mortality, is not a result of only enhanced documentation and reflects the capabilities of our multifactorial intervention in reducing overall neurosurgical mortality.

In the literature, there have been a few neurosurgical quality improvement initiatives that have also shown promise in reducing mortality rates. For example, Spurgeon et al[2] implemented a quality improvement intervention at the University of Missouri's neurosurgery service involving educational in-services about coding metrics, the implementation of a new neurosurgical progress note template, and designation of a 'nurse reviewer' to provide immediate feedback to physicians about medical record coding during patients' inpatient stays. While the reported pre-intervention mortality rate in this neurosurgery service was 6.38%, the mortality rate declined to 3.59% during their documentation intervention and was maintained at a lower rate of 5.61% after the intervention.[2] In another study at the University of California, Los Angeles (UCLA), Afsar-Manesh and Martin[9] found that medication errors result in a 2-fold increase in mortality, whereby implementing quality initiatives can reduce such errors and lessen the mortality burden. In our study, the mean number of neurosurgical mortalities per month was 4.17 in the pre-intervention time period, this mortality incidence decreased to 3.08 per month after implementation of our intervention. Reducing mortality by 1 patient a month has a significant value on the overall quality of care provided by neurological service. This mortality reduction demonstrates the potential a multifactorial quality initiative can have on patient care.

Mortality rates are frequently used as outcome measures by hospitals, healthcare providers, CMS, and third parties like

TABLE 3. Mortality Etiology and Most Common DRG Classifications in the Patient-Mortality Cohort

	Total (n = 131)	Earlier (n = 70)	Later (n = 61)
Mortality etiology			
Vascular (ie, hypertensive and aneurysmal bleeds) (%)	34.35	34.78	33.87
Trauma (ie, subdural hematoma)	39.70	36.23	43.55
Tumor (ie, resection, biopsy)	12.21	13.04	11.29
Stroke/thrombosis (ie, embolic and thrombotic stroke)	9.92	13.04	6.45
Spine (ie, elective, nontrauma spinal procedures)	1.53	1.45	1.61
Other (ie, infection, sepsis)	2.29	1.45	3.22
Most common DRG classifications			
023	28.24	21.74	35.48
025	16.79	20.29	12.90
020	12.21	8.70	16.13
064	7.63	13.04	1.61
530	5.34	10.14	0.00
DRG definitions			
023	Cranio W major dev impl/acute complex CNS PDX W MCC or chemo implant		
025	Craniotomy & endovascular intracranial procedures W MCC		
020	Intracrania vascular procedures W PDX hemorrhage W MCC		
064	Intracrania hemorrhage or cerebral infarction W MCC		
530	Craniotomy W major CC		

insurance companies to assess quality of care.[1] Reporting and comparison of mortality rates is especially important in fields such as neurosurgery, where baseline mortality rates are high due to the frequency of life-threatening pathology.[5] Our reported mortality rates lie within those reported in the literature: Sandeman[11] reported an overall mortality rate of 2.7% of 6006 admissions, Chen et al[12] reported a mortality rate of 4.52% in 531 consecutive patients, Hammers et al[1] reported a mortality rate of 1.7% in 3650 neurosurgical procedures, and Houkin et al[5] reported a 3.3% mortality rate among 643 neurosurgical interventions over 2 yr. Direct comparison of reported mortality rates across the literature is difficult due to variation between institutions, patient populations, and individual surgeon-experience. However, these studies also report similar trends to our study in the distribution of mortalities among neurosurgical subspecialties.[1] Similar to our distribution of mortalities across DRG codes, Hammers et al[1] reported that trauma, stroke, tumor, spinal disease, and infection were the most common etiologies in descending order underlying mortality. Sandeman[11] similarly reported that trauma was the most common mortality etiology, followed by subarachnoid hemorrhage, tumor, and infection in a general neurosurgery practice. In this study, 94% of mortalities occurred in patients with cranial pathology, and only 6% stemmed from spinal pathologies.[11] While Chen et al[12] reported a mortality rate of 6.53% among patients with cranial pathology, no spinal surgery mortalities were reported in this cohort. Due to the high intrinsic mortality risk in neurosurgery, further characterization of neurosurgical mortality across the literature is necessary.

Elective cases have become the target of many neurosurgical mortality reduction initiatives, as acuity of many neurosurgical traumas and nonelective cases make mortality less avoidable.[1] The increased mortality rate inherent to neurosurgical operations for acute etiologies has been previously reported.[1,11-13] In a retrospective review of 531 consecutive neurosurgical cases, Chen et al[12] reported a mortality rate of 12.41% for acute and emergent cranial neurosurgery compared to 2.73% for elective cranial cases. In another retrospective review of 4904 consecutive neurosurgical cases at a single institution, Zygourakis et al[13] reported that elective admissions were significantly associated with decreased mortality compared to emergent admissions. Moreover, Hammers et al[1] reported that the majority (85%) of their single institutional neurosurgical mortalities stemmed from emergent, nonelective cases. In Hammers' study, trauma was the most common etiology underlying neurosurgical mortality.[1] Finally, in a prospective, longitudinal analysis of 6006 neurosurgical admissions seen in 1 general neurosurgery practice over 15 yr, Sandeman[11] reported that 90% of mortalities were admitted from the emergency department and were documented with a preoperative surgical aim of "to save life." We similarly report a preponderance of emergent-trauma etiologies leading to mortalities both before and after our intervention.[1] Notably, however, after implementation quality intervention, a lower proportion of mortalities occurred during elective cases, while a higher proportion of occurred due to trauma cases. Furthermore, while our mortality per month pre-intervention was 4.17, the mortality index decreased to 3.08 after the intervention despite a more complex and acutely ill patient population. These findings further highlight the promise of our intervention: while the time sensitivity of many neurosurgical traumas may preclude benefit from better preoperative risk stratification, mortality after elective cases was reduced after our intervention.

One target of our multifocal intervention involved improving preoperative assessment of patients' mortality risk and severity of illness through better documentation. By improving documentation of health assessment metrics, we aimed to more accurately reflect the severity of patients' conditions, a goal with implications for preoperative risk stratification about whether patients are too sick to operate and subsequent mortality. While our reported increased CMI, POA-ROM/SOI, and DC- ROM/SOI in the postintervention time period likely represents an overall sicker patient population, this increase may also reflect improved documentation of health-assessment metrics after our documentation intervention. Utilizing UHC we were able to assess the quality of our documentation efforts with the expected mortality, while the observed mortality were the actual deaths occurring on the neurosurgery service, on other services in the hospital, and on the hospital's inpatient hospice service. Components of our efforts to improve documentation included departmental education sessions, detailed emails, and Grand Rounds presentations about health assessment metrics. Neurosurgery in particular has been shown to have high rates of undercoding of health-assessment metrics, a problem that has implications for quality of care.[1-3,6] Inadequate documentation of these metrics often leads to underrepresentation of the complexity of patients' illnesses, which can lead to misinformed decisions to operate on high-risk patients and subsequent mortality.[1,2] Therefore, improvement of these metrics has been suggested as a target of neurosurgical quality improvement initiatives to reduce mortality.[1,2] Previous studies in other departments have improved overall outcomes and mortality rates by implementing a more accurate representation of the complexity of patients' illnesses on admission and discharge.[14] In a neurosurgical quality improvement intervention conducted by Rosenbaum et al involving educational sessions for the entire neurosurgery department including physicians, residents, nurse practitioners, and physician assistants about the MS-DRG system, the group monitored progress using billing documentation and found that documentation of CMI, MS-DRG, LOS, and documentation of International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis codes increased within 1 yr of intervention, lending more accurate representations of patients' medical conditions.[6] Therefore, implementation of departmental initiatives about documentation has the potential to improve the overall accuracy and consistency of documentation on a neurosurgical service, an improvement with implications for both preoperative risk stratification and mortality. Overall, it is important to have accurate documentation and understanding of the relative sickness of a patient when making decisions whether to attempt to operate on someone or to decide if the intervention is futile, too high risk, too late in the disease process, or without potential benefit.

Our implementation of other quality improvement measures, including best-evidence-based care protocols along with enhanced communication with clinical documentation analysts and performance services, also likely contributed to our reported mortality reduction. The successful incorporation of care protocols for quality improvement on neurosurgical services has been previously described.[7,8] Care protocols were implemented in the "Clinical Quality Program" developed by the neurosurgery department at the UCLA.[9] In their initiative, improvement processes included preoperative creation of a multidisciplinary Care Coordination Committee, intraoperative introduction of a comprehensive time out including a safety checklist and care protocols for operative techniques, and postoperative communication templates, standardization of discharge procedures, and more multidisciplinary approaches to morning and afternoon rounds.[8,9] These initiatives were found to improve the overall quality of care on their service.[8] McLaughlin et al[8] measured the success of the UCLA Clinical Quality Program in a retrospective review of 49 patients undergoing microvascular decompression and found that the intervention led to decreased time spent in the operating room, a decreased in LOS, as well as a reduction in complication and readmission rates. While we did not find a similar association between our intervention and reduced LOS, these studies' findings along with our reported decreased postintervention observed mortality rate highlight the promise that care protocols and integration of quality improvement personnel within the neurosurgical service show in improving outcomes. Of note, individual assessment and judgment should not be seen as inferior to evidence-based protocols, but rather an additional resource that may better patient care. We suspect the ongoing education was the aspect of our quality initiative that most improved patient care and mortality rates. There are many facets of patient care that attending surgeons, residents, physician assistants, and nurses have to know and understand in order to provide optimal care. The educational component consists of understanding patient risk of mortality and severity of illness when presenting or being discharged from the hospital, accurate diagnosing criteria, and optimal treatment algorithms all of which allows the different members of the neurosurgery team to better understand patients' presenting conditions and how to accurately and efficiently treat these patients. Overall, while attributing our reported mortality reduction to a single intervention is difficult, we demonstrate the potential ability of collective efforts to increase education, documentation, and communication among neurosurgical services in reducing mortality.

Limitations

There are several limitations of this study, with implications for its interpretation. First, our results are subject to the inherent limitations of assessing population-level data and databases, such as the size of our cohorts, which may have implications on results. Furthermore, despite showing similar demographics, the 2 populations could still have unidentified differences confounding the patient metric and mortality results. While the intervention went live on July 1, some of the proposed initiatives were discussed before this date, which may potentially impact of the outcomes attributed to the intervention. Moreover, we are not able to rule out the impact that the Hawthorne effect may have on our institutional improvements after implementing a multifactorial intervention that includes awareness of patient illness and mortality metrics, which may have implications on our results. Finally, we primarily assessed in-hospital deaths occurring on the neurosurgery service, on other services in the hospital, and on the hospital's inpatient hospice service, and did not collect data on mortality that occurred after discharge. Moreover, the exact grading and specifics of the patients' cause of mortality were not collected, only the broad etiology (ie, tumor, vascular, trauma, spine, stroke) which may have implications on our results. This analysis showed us that we did not use outpatient hospice as a resource, which is now utilized as an alternative option for some of our sickest patients. Despite these limitations, we demonstrate the potential of our multifactorial quality initiative program to improve documentation of health-assessment metrics and lower mortality rates within neurosurgical services. Further assessment of mortality rates in subsequent years after the intervention will be necessary to assess its longitudinal impact.

CONCLUSION

Our study demonstrates a reduced actual mortality rate and a risk-stratified mortality index after the implementation of a quality initiative program. While attributing our reported mortality reduction to a single intervention is difficult, we highlight the potential ability of collective efforts to increase education, documentation, and communication among neurosurgical services to reduce mortality. Our assessment of mortalities suggests that quality initiatives have an impact on reducing mortality and improving overall quality of care for elective neurological cases, while emergent/trauma cases may not benefit as much due to the acute severity of those cases. Further studies are necessary to identify modifiable hospital, departmental, and patient risk factors that contribute to inferior outcomes, in order to better overall quality of care and reduce mortality rates on a neurological surgery service.

Disclosure

The authors have no personal, financial, or institutional interest in any of the drugs, materials, or devices described in this article.

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