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A clinical care pathway to improve the acute care of patients with glioma

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Background. Patients with glioma are at increased risk for tumor-related and treatment-related complications. Few guidelines exist to manage complications through supportive care. Our prior work suggests that a clinical care pathway can improve the care of patients with glioma.

Methods. We designed a quality improvement (QI) project to address the acute care needs of patients with gliomas. We formed a multidisciplinary team and selected 20 best-practice measures from the literature. Using a plan-do-study-act framework, we brainstormed and implemented various improvement strategies starting in October 2013. Statistical process control charts were used to assess progress.

Results. Retrospective data were available for 12 best practice measures. The baseline population consisted of 98 patients with glioma. Record review suggested wide variation in performance, with compliance ranging from 30% to 100%. The team hypothesized that lack of process standardization may contribute to less-than-ideal performance. After implementing improvement strategies, we reviewed the records of 63 consecutive patients with glioma. The proportion of patients meeting criteria for 12 practice measures modestly improved (65% pre-QI; 76% post-QI, $P > .1$). Unexpectedly, a higher proportion of patients were readmitted within 30 days of hospital discharge (pre-QI: 10%; post-QI: 17%, $P > .1$). Barriers to pathway development included difficulties with transforming manual measures into electronic data sets.

Conclusions. Creating evidence-based clinical care pathways for addressing the acute care needs of patients with glioma is feasible and important. There are many challenges, however, to developing sustainable systems for measuring and reporting performance outcomes overtime.

Keywords: glioma, outcomes, quality improvement.

The majority of primary malignant brain tumors are diffuse infiltrating gliomas.[1] Glioblastoma (GBM), the most aggressive form, accounts for the largest number of these cases.[1,2] Due to their aggressive nature, gliomas are often associated with poor survival.[1] Furthermore, patients with glioma are at increased risk for developing tumor-related and treatment-related complications such as cognitive dysfunction, fatigue, pain, and disability.[3,4] These symptoms may affect quality of life to varying degrees during the course of a patient's illness.[3] Elderly patients with glioma are more likely to suffer from medical comorbidities, have poorer tolerance of chemotherapeutic agents, and be at increased risk for developing radiation-induced neurotoxicty.[5] Finally, brain tumors are an independent risk factor for falls,[6] the seventh leading cause of death in those over age 65.[7]

Few guidelines are available to direct decisions about how to effectively address the supportive care needs of patients with glioma and there are wide variations in patterns of care.[8] Cancer-specific clinical care pathways may assist in selecting evidence-based care and lead to improved quality of care.[9] We previously developed a clinical care pathway to address the needs of patients with glioma during the perioperative period.[10] We found that quality improvement (QI) methods could be used to improve the care provided to patients with glioma.[10] Furthermore, we observed a significant improvement in several quality measures

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including more prompt presentation of patients at tumor board and earlier assessment by social workers.[10] These results suggest that it may be beneficial to develop pathways that address other aspects of care of patients with glioma.

Here we report on the second component of this multi-phase project. Using QI methodology, we developed a clinical care pathway to address the needs of patients with glioma during the acute phase of their treatment. The overall aim of our project is to ensure that patients with glioma receive comprehensive, consistent and timely care, with the ultimate goal of improving outcomes.

Materials and Methods

Organizing for Improvement

Approximately 30% of the patients with primary brain tumors treated at our institution carry a diagnosis of glioma. As previously reported, we chartered a multi-phase QI project, beginning with the patients entering into the Neuro-Oncology microsystem and ending with discharge to survivorship or death.[10] We defined the microsystem as a group of multidisciplinary, health care professionals who came together to care for a defined population of patients.[11]

This phase of the project focused on the care of patients from the time of neurosurgery through the first 10 weeks after diagnosis, a period that included the completion of treatment with chemotherapy and/or radiation. The specific aim was to improve the quality of care, to reduce process variation, and to maximize patient safety. We assembled an interdisciplinary team that was comprised of physicians, nursing staff, schedulers, a social worker, and QI experts. The team represented several disciplines including neuro-oncology, neurosurgery, radiation oncology, care management, and Cancer Center leadership. The team met weekly between February and March 2013, monthly April through July 2013, bimonthly August through May 2014, and then quarterly to maintain project gains.

This project was QI work with no research component. Therefore, it was exempt from review by our local institutional review board, the Dartmouth College Committee for the Protection of Human Subjects.

Planning and Implementation

Prior to starting this QI effort, we reviewed the available literature. With the exception of some evidence on rates of perioperative complication[12,13] and guidelines that direct chemotherapy, surgery, and radiation,[14–16] we found minimal information for which measures led to improved outcomes in patients with glioma during this phase of care. Based on the limited evidence and brainstorming, we proposed 20 objective process and outcome measures that delineated timely and comprehensive care.

We used commonly accepted QI methods to conduct our project,[17,18] including the Define-Measure-Analyze-Improve-Control (DMAIC) model. In the define phase, we described the current system of care and created flowcharts to summarize processes of care. The team members created three process maps, representing neurosurgery, chemotherapy, and radiation therapy and then combined these into one process map. In the measure phase, the team assigned the 20 objective best practice measures to relevant steps in the process (see Supplementary Table S1).[19–31]

In the analyze phase, we obtained performance data from available electronic medical records (EMR) and from an existing database created through prior QI work. Using a plan-do-study-act framework and tools such as fishbone diagraming,[17,18] the team then evaluated how well the current process was performing. The team postulated that there were at least 8 reasons for less-than-ideal process performance and designed 10 improvement interventions to address these concerns (the improvement phase). Once the changes were successfully implemented, the team crafted a more formalized strategy for maintaining the gains that we achieved and identifying additional strategies for improvement (the control phase).

Proposed Improvement Strategies

The team found that there were several reasons for less-than-ideal process performance. For instance, while we assumed that clinicians routinely discuss symptoms of concern and risk factors for venous thrombo-embolic events (VTE) with patients, this was not consistently documented in the medical record. Because clinical documentation plays a key role in facilitating communication between patients and the health care team,[32] we were concerned that a lack of written information about the plan of care may result in poorer quality care. Delays in the turn-around time for pathology results to be available in the EMR also disrupted treatment planning in some cases. Furthermore, there was no reliable mechanism for assessing baseline compliance with 8 of the best practice measures and some measures were not even part of the current process. For example, the definition of chemotherapy education varied between team members and there was no agreed upon time when this education should take place.

The team also discovered that there were other nuances in the workflow patterns that may be problematic. For example, the social worker typically met with patients during their scheduled visit with the neuro-oncologist. In the event that this visit went longer than planned, the social worker was unable to complete her psychosocial assessment. Thus, the social worker was unable to assess patients for relevant complications such as psychological distress, depression, and financial concerns. Untreated cancer-related depression may contribute to poorer quality of life and shortened survival.[33,34] Furthermore unaddressed financial concerns may result in unnecessary delays in the start of treatment.

In October 2013, the team piloted several small tests of change to address these concerns. The team created a standardized template to document that patients were counseled about symptoms of concern and informed of the availability of clinical trials. The clinic secretary scheduled independent visits for the social worker to meet with patients and families. Clinicians were encouraged to document clinical outcomes such as treatment complications and interruptions. Pathology was involved in establishing a target goal of providing results within 5 business days. Fig. 1 highlights key process changes.

The team added these newly identified measures to an existing data dashboard to facilitate ongoing measurement and reporting of process performance. The project leader reviewed the measures on the dashboard each month with the statistician. The team met quarterly to review system performance and to continue to modify the process as necessary.

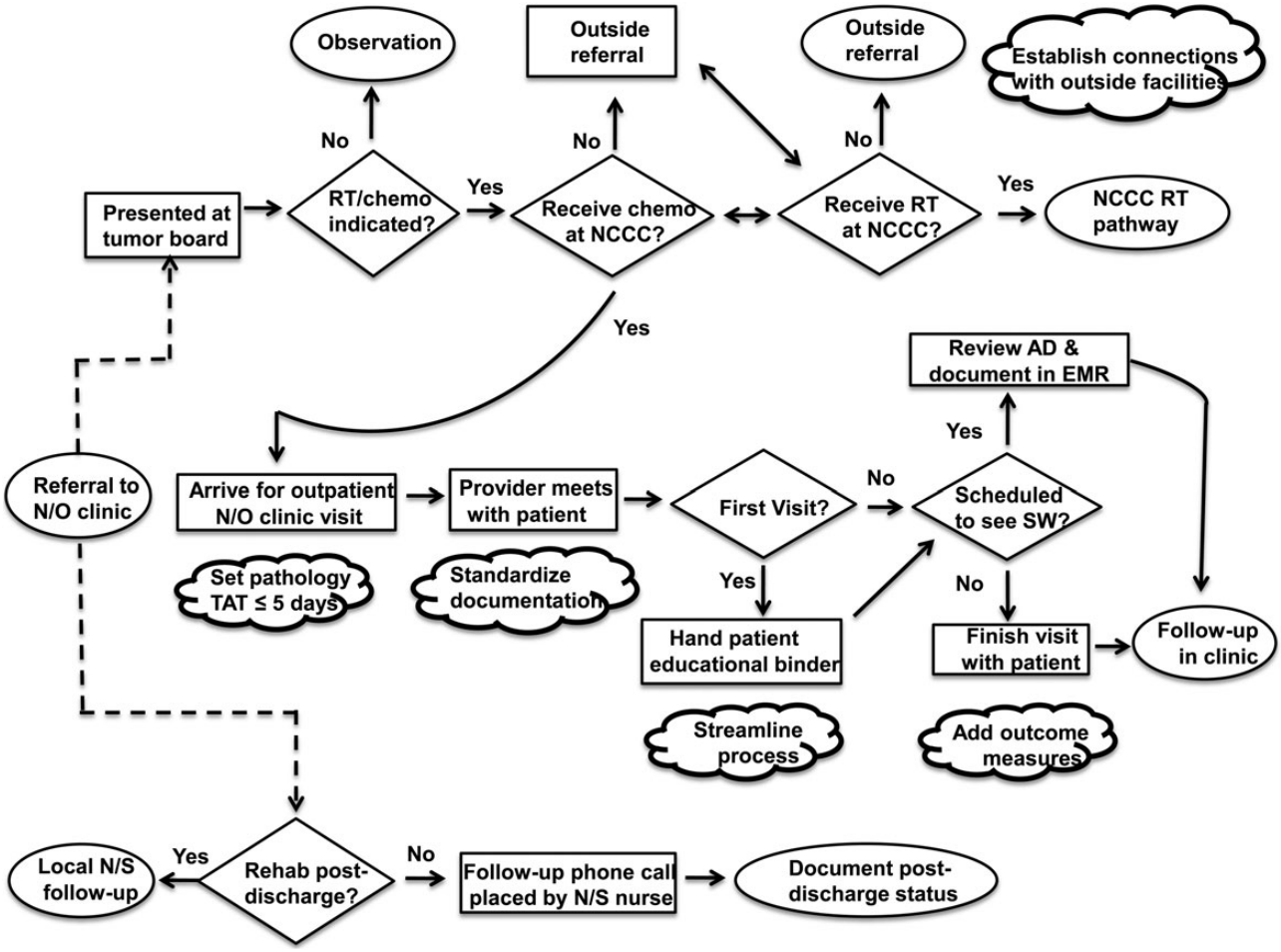

Fig. 1. Process flow map for the care of patients with glioma (postintervention phase). AD = advanced directive; Chemo = chemotherapy; EMR = electronic medical record; NCCC = Norris Cotton Cancer Center, Lebanon, NH; N/O = neuro-oncology; N/S = neurosurgery, Rehab = rehabilitation facility; RT = radiation oncology; SW = social worker; TAT = turn-around time. [cloud shaped image] summarize key changes that were made at the respective steps of the process.

Outcome Measures

We generated a score for each patient based on maximum standards of care achieved. This score was comprised only of the 12 best-practice measures for which baseline data was available. The numerator represented the number of standards of care met and the denominator represented the number of standards of care that should be achieved by each patient. Depending on symptoms and grade of glioma, certain standards of care did not apply to a subset of patients. For example, patients who were discharged to a rehabilitation facility did not receive a follow-up phone call from nursing staff.

Statistical Analysis

To ascertain whether the maximum standard of care improved over time, we analyzed the results for consecutive patients in an individual values and moving range (XmR) chart. In this statistical process-control (SPC) chart, each data point represents a single observation.[35] The SPC chart contains upper and lower control limits, which are set at 3-sigma to minimize the risk of a type I error.[35] SPC charts differentiate between 2 types of variation, common and special cause. Processes are considered to be in statistical control when rates over time fall within the upper and lower control limits.[35] A statistically significant change or a special cause variation occurs when 1 or more points go beyond the control limits or when there is a process shift in which 8 or more successive values fall on the same side of the overall rate.[35,36]

SPC charts are useful statistical tools for detecting special cause variation when the control limits are set at 3-sigma. Here the probability of a type 1 error (ie, point falling outside the control limits due to chance) is small ($P < .01$).[37] Similarly, the probability of 8 or more successive values falling on the same side of the overall rate is low.[37] Therefore, it is appropriate to infer that a statistically significant change occurred and recalculate the overall rate and limits.

We used a histogram plot to compare the proportion of eligible patients meeting each of the individual 12 measures pre-QI and post-QI work. We relied on the χ^2 statistic to evaluate associations between categorical variables. We defined statistically significant as $P < .05$.

Results

Baseline Performance

The baseline population consisted of 98 patients with newly diagnosed glioma who received surgical care at our institution between June 2011 and September 2013. We found that retrospective data were available for only 12 of the 20 identified best-practice measures; 6 of which could be electronically abstracted from medical records. There was also wide variation in performance, with compliance ranging from 30% to 100%. Table 1 compares the baseline characteristics of the populations included in the pre-QI and post-QI phases.

Table 1. Baseline characteristics of subjects before and after quality improvement work, June 2011 – September 2013 and October 2013 – March 2015

	Pre-QI, *N* (%)	Post-QI, *N* (%)
Total	98 (100)	63 (100)
Sex, Male	65 (66)	35 (56)
Mean age in years [SD]	59.6 [15.7]	59.7 (16.6)
Tumor Grade		
Grade I	3 (3)	5 (8)
Grade II	9 (9)	5 (8)
Grade III	10 (10)	7 (11)
Grade IV	76 (78)	46 (73)
Surgical Management		
Resection	82 (84)	48 (76)
Biopsy	16 (16)	15 (24)
Median length of stay, days	5	5

QI, Quality Improvement; %, percent, SD, standard deviation.

Impact of Process Improvement

Figure 2 depicts consecutive patients and the proportion of the 12 best-practice measures that were met pre-QI and post-QI work. Before the QI work, the overall mean was 65% and there was wide variation (the lower and upper control limits were 18% and 100%, respectively). After we implemented the improvement interventions starting in October 2013, compliance with the best-practice measures improved with an overall mean of 76%, although the result was not statistically significant ($P > .1$). There was less variation in the post-QI group, meaning that best practices would be met from 24% (lower control limit) to 100% (every time). The team also identified 1 patient whose best-practice measures fell below the lower control limit of 24% (special-cause result). The team investigated this event and discovered that language barriers likely contributed to a breakdown in the care pathway.

Figure 3 demonstrates the degree to which individual measures changed with these QI efforts. There were significant improvements in measures assessing for (i) educational binder provided to patient (57% vs 81%, $P < .01$); (ii) discussion of VTE symptoms and risks (56% vs 77%, $P = .01$); (iii) discussion of fertility risks (18% vs 62%, $P = .02$); (iv) neurosurgery follow-up call placed within 2 weeks of hospital discharge (26% vs 44%, $P = .03$); and (v) smoking status assessed by the third neuro-oncology visit (77% vs 98% %, $P < .01$). Conversely, provision of advanced directives (75% vs 66%, $P > .1$) and 30-day readmission rates

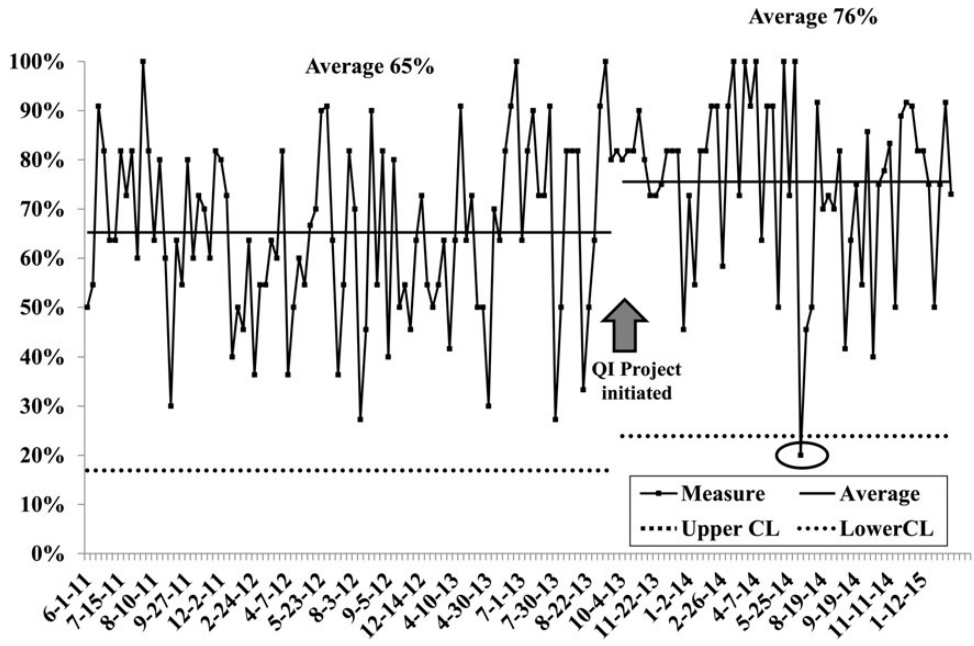

Fig. 2. Individual value and moving range (XmR) chart of percent standards of care achieved by patients with glioma pre- and post-quality improvement work, June 2011 – September 2013 and October 2013 – March 2015.[a,b] CL = control limit, % = percent; QI = quality improvement. [a]Circle delineates a special cause event. [b]Each data point represents a single observation. Upper and lower control limits are set at 3-sigma to minimize the risk of a type I error.

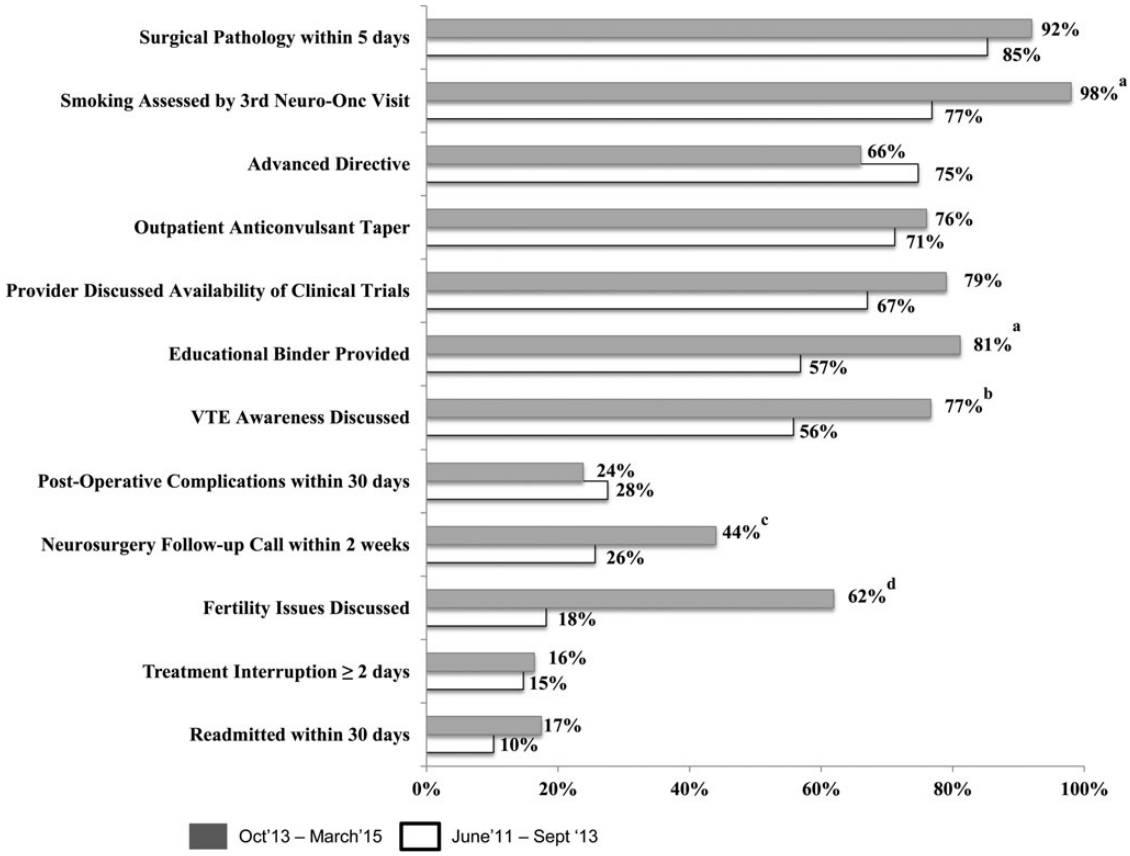

Fig. 3. Proportion of patients with glioma meeting criteria for individual best-practice measures pre- and post-quality improvement initiative, June 2011 – September 2013 and October 2013 – March 2015. AED = antiepileptic medications; F/u = follow-up; Neuro-Onc = Neuro-Oncology Program; post-op = postoperative; surg path = surgical pathology; VTE = venous-thromboembolic events. [a]$P < .01$. [b]$P = .01$. [c]$P = .03$. [d]$P = .02$.

(10% vs 17%, $P > .1$) worsened, but these results were not significant.

Challenges and Barriers

The team encountered several challenges in conducting this QI work. Roughly 60% of patients received a portion of their treatment (eg, radiation) at outside sites. These facilities were not part of the institutional network and used different EMRs. This made it difficult to track all aspects of patient care. Similarly, there was no standardized system for documenting certain measures such as treatment complications. Instead, this process was highly dependent on patient self-report and provider documentation. Manual data abstraction from the EMR was also quite labor intensive. The team worked with the institution's information technology department to develop more reliable and valid electronic measures. The team also contacted other radiation oncology facilities (involved in the care of our patients) to initiate conversations about improving the system of communication between sites.

We observed that the process for carrying out the post-discharge follow-up phone call was highly operator dependent. If the designated nurse was not available, there was no other staff member assigned to this role. We also observed that the limited amount of social work support available to the clinic impacted at least one of the performance measurements. This prompted a needs assessment for additional social work support for the program.

Unanticipated Opportunities for Improvement

As shown in Table 2, the team found that several patients were readmitted within 30 days of hospital discharge (pre-QI: 10%; post-QI: 17%, $P > .1$) and/or experienced tumor-related and treatment-related complications (pre-QI: 28%; post-QI: 24%, $P > .1$). The most frequent potentially avoidable complications included: postoperative urinary tract infections (UTI) (pre-QI: 40%; post-QI: 9%), VTE (pre-QI: 17%; post-QI: 27%), and outpatient falls (pre-QI: 33%; post-QI: 27%). Two falls were associated with significant complications requiring a higher level of care. The team analyzed each of these cases to identify additional opportunities for improvement.

Although there was a hospital-wide program to address inpatient falls, there was no standardized protocol for addressing fall risk at the time of discharge. The team collaborated with rehabilitation, care management, and inpatient nursing to begin to develop a protocol for improving the management of outpatient fall risk. These discussions also enabled the team to learn about (and learn from) a similar program that was already underway in the emergency room.

Concurrent with our QI work, the hospital implemented a nursing-led effort to minimize inpatient UTIs. Subsequent to the

Table 2. Hospital readmissions and postoperative Complications, pre-QI and post-QI work; June 2011 – September 2013 and October 2013 – March 2015

	Pre-QI, *N* (%)	Post-QI, *N* (%)
Total	98 (100)	63 (100)
Patients with ≤30-day Hospital Readmissions	10 (10)	11 (17)
Patients with any ≤30-day Complications	27 (28)	15 (24)
Patients with Potentially Avoidable ≤30-day Hospital Readmissions[a]	3/10 (30)	2/10 (18)
DVT/PE	1	0
Wound Infection	0	2
Anticipated Physiologic or Accidental Fall[c,d]	2	0
Patients with Potentially Avoidable ≤30-day Complications[b]	24 (89)	11 (73)
Falls		
Anticipated Physiologic[c]	9	3
Accidental[d]	1	0
Post-op UTI	12	1
DVT/PE	5	3
Wound Infection	3	3
Seizure	0	1

DVT, deep vein thrombosis; N, number; %, percent; PE, pulmonary embolism; Post-op UTI, postoperative urinary tract infection; QI, quality improvement.

[a]We defined potentially avoidable hospital readmissions as any events that were clinically related to the patient's initial hospitalization for surgical resection (or biopsy) of glioma and may have been prevented if evidence-based care processes had been followed.[38] For example, patients with DVT did not receive postoperative chemoprophylaxis and patients with a history of seizure were not prescribed antiepileptic drugs.

[b]We defined potentially avoidable complications as any events that were clinically related to the patient's glioma diagnosis and may have been prevented if evidence-based care processes had been followed. For example, patients who had not received a home safety evaluation and later had an accidental fall in the home.

[c]Anticipated physiologic falls are due to intrinsic physiological factors such as delirium or confusion. These falls may be preventable.[39]

[d]Accidental falls are due to extrinsic factors in the environment such as a patient slipping on a wet surface or tripping over a loose carpet.[39] These falls may be preventable.[40]

implementation of this intervention, the team observed that there were no further cases of UTIs among patients with glioma. The team also shared the VTE findings with the section of neurosurgery. These discussions resulted in the formation of a separate interdisciplinary QI initiative to evaluate the role of chemical VTE prophylaxis for patients with glioma. As a result of this work, the neurosurgery service decided to change the protocol for managing VTE risk in hospitalized patients with glioma. Patients without evidence of bleeding on a postoperative MRI will receive chemical prophylaxis with heparin.

Discussion

Developing clinical care pathways to ensure that patients receive comprehensive, consistent, and timely care may reduce their risk for complications and potentially improve their quality of life. Our prior work demonstrated that a clinical care pathway that addressed the needs of patients with glioma during the perioperative period led to significant improvements in several areas of care.[10] Similarly, Back et al found that a well-coordinated, multidisciplinary approach resulted in significant improvement in survival for patients with high-grade glioma.[41]

We used QI methodology to develop a clinical care pathway to address the needs of patients with glioma during the acute phase of their care. We found that the proportion of patients meeting best-practice measures, as defined by the group, improved from 65% pre-QI work to 76% post-QI work, although the results were not statistically significant. There was, however, a change in several best-practice measures including a statistically significant increase in the number of patients who received an educational binder, were assessed for smoking by the third neuro-oncology visit, received a neurosurgery follow-up call within 2 weeks of hospital discharge, and were informed of VTE symptoms and risks and fertility risks. Ongoing engagement of team members in these QI efforts was necessary for maintaining project gains. It was also critical to develop systems of care that incorporated the EMR in order to facilitate project sustainability. Finally, the development of a data dashboard to track measurements over time facilitated root cause analysis of protocol deviations, revealed unexpected areas in need of additional improvement, and enabled us to develop interventions to address these concerns and improve care.

Similar to other studies, we found a high proportion of hospital readmissions and tumor-related and treatment-related complications.[42,43] Marcus et al reported a baseline 30-day readmission rate of 13.2% among patients discharged after craniotomy for malignant supratentorial tumors.[42] Unlike our results, however, these authors found that these admissions were largely driven by seizures.[42] These differences may be attributed to several factors. We had smaller sample sizes and a large proportion of patients in our analysis were diagnosed with GBM. In a separate review of patients with glioma undergoing biopsy or tumor resection, Dickinson et al found that 7.5% experienced an unplanned readmission within 30 days of discharge.[43] The authors felt that the majority of these readmissions were preventable.[43] In our study, we also found that a large proportion of readmissions were due to potentially avoidable causes.

The high proportion of patients experiencing symptomatic VTE complications after surgery, in spite of the standardized use of external pneumatic devices, was unanticipated. While patients with glioma are known to be at higher risk for developing VTEs,[44,45] clinicians are reluctant to use chemical prophylaxis in this population.[46,47] Establishing standards of care around VTE prophylaxis in the glioma population is necessary and the benefits of chemoprophylaxis may outweigh the harm.[48–50] Relying solely on pneumatic compression devices may not be advisable since compliance with these devices is generally poor, even with patient and staff education.[51,52] Furthermore, risk stratification may help to identify those who would most benefit from chemoprophylaxis.[45,53] As a result of our work, prophylactic heparin is being incorporated into the routine care of patients with glioma who do not have evidence of bleeding on postoperative MRI. The dashboard will allow us to monitor the incidence of VTE and hemorrhagic complications over time and make modifications accordingly.

Another significant finding was the high proportion of patients having outpatient falls and UTIs. Patients with glioma are at higher risk for falls and yet, as far we know, there has been no study of interventions to reduce fall risk in the glioma population.[6,54,55] Exercise and home safety interventions have been proven to be very effective in minimizing outpatient fall risk in other at-risk populations.[56] Similar to other studies, we found that a comprehensive, nursing-led initiative eliminated postoperative, catheter-associated UTIs.[57,58] These results suggest that there is a need for institutions to develop standardized practices for addressing tumor-related and treatment-related complications affecting patients with glioma.

Unfortunately, we found that the proportion of patients meeting criteria for advanced directives worsened during our QI initiative. While this process step is overseen by the social worker, only a small portion of social work full-time equivalent is currently allocated to our program. These findings combined with a high number of readmissions and tumor-related and treatment-related complications suggest that social work services should be expanded within the clinic. Some studies have found that the inclusion of social work services in the management of complex medical illness can improve overall care.[59–60] For example, Lipani et al found that the use of a preventable admission care team, which was largely led by social work, resulted in a 43% reduction in hospital readmissions and 70% reduction in emergency room visits for patients with complex medical illness.[60]

There were a number of limitations to our work. We were unable to demonstrate that improvements in our quality measures yielded improved survival, better use of resources, or more satisfied patients and staff. While some studies have found that educating patients about their disease and following up with patients by phone postdischarge may result in better outcomes such as improved patient satisfaction, prior reviews have found that there is limited evidence to support such an association.[61,62] Although smoking cessation may not improve the overall survival of patients with glioma, there is modest evidence to suggest that smoking cessation may have other important clinical benefits including a reduction in the risk of VTE.[63] During the course of our work, there was also a change in the QI leadership at our institution that may have resulted in some uncertainty among our team and staff members regarding the long-term sustainability of our work. Our small sample size may have limited our ability to demonstrate significant improvement, though we observed positive trends in many of our best-practice measures. Finally, while the best-practice metrics we developed may apply to the care of patients at other institutions, our pathway may not be generalizable. Each institution may need to go through their own QI process to identify a pathway that addresses their unique context.

We hope to address some of the above-named limitations in our future work. Our institution recently implemented a cancer-specific, patient satisfaction survey. These results should provide more insight into the potential effects of QI initiatives on patient satisfaction. We also incorporated questions on patient satisfaction into the postdischarge follow-up phone call. We have shared our results with other neuro-oncology groups with similar QI projects to examine the applicability to other institutions. Finally, we have integrated 8 additional process and outcome measures to the data dashboard with plans to continue to evaluate these with the next phase in the continuum of care.

Conclusions

We believe it is important to develop evidence-based, clinical care pathways to address the needs of patients with glioma during the acute phases of care. However, there are challenges to developing these pathways including lack of consensus or clear evidence about which process measures are associated with improved outcomes. With the arrival of programs such as the Center for Medicare and Medicaid's Hospital-Acquired Condition, which ties reimbursement to quality rather than quantity, there are growing financial pressures on cancer programs to improve the overall quality of care delivered to patients.[64]

As part of the next steps of our work, we are re-evaluating the protocol for managing VTE risk in our patient population. We are also working with other programs within our institution to develop a protocol for reducing fall risk. The next phase of our project will then focus on developing a pathway to address the chronic care needs of patients afflicted with glioma.

Supplementary Material

Supplementary material is available online at *Neuro-Oncology* (http://neuro-oncology.oxfordjournals.org/).

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