Integrated Care Pathways in Neurosurgery
White Paper and Toolkit
Medical Practice Committee
Council of State Neurosurgical Societies

Brett E. Youngerman, MD,[1] Justin Singer, MD,[2] Darlene A. Lobel, MD[3], *on behalf of the Medical Practice Committee of the Council of State Neurosurgical Societies*

1. Department of Neurological Surgery, Columbia University College of Physicians and Surgeons, New York, NY
2. Division of Neurosurgery, Department of Clinical Neurosciences, Spectrum Health, Grand Rapids, MI
3. Department of Neurologic Surgery, Mayo Clinic, Rochester, MN

Background

Recent trends in health care reform emphasize quality and efficiency across the continuum of care.[1] Public and private payers are adopting alternative payment models including pay-for-performance, bundled and episode-based payments, and accountable care organizations to promote these goals for certain conditions and specific episodes of treatment.[2,3] Care pathways have emerged as a tool for clinical organizations to standardize care based on available evidence and integrate resources with the goal of optimizing both quality and efficiency.[4,5]

A care pathway is a sequence of steps or processes of care in the management of a specific condition or treatment. A Cochrane review[6,7] proposed several criteria for an intervention to meet the definition of a care pathway, including that it: (1) is a structured multidisciplinary plan of care, (2) translates guidelines or evidence into local structures, (3) details the steps in a course of care, (4) employs timeframes or criteria-based progression, (5) aims to standardize care for a specific clinical problem, procedure, or episode of care in a specific population. Care pathways aims to maximize clinical efficacy and efficiency by improving adherence to steps believed to add value for the patient and eliminating those that do not.[5]

Neurosurgeons work in a complex and high-stakes health care environment where many people and systems must come together seamlessly to provide the optimal care for patients. Care pathways grew from process mapping in manufacturing and other industries where it has been used for decades to improve quality and efficiency. It has been adopted in a variety of health care specialties and settings with largely positive results.[4,5,7] The impact on outcomes and efficiency can be difficult to prove or quantify and there remain concerns about potential detrimental effects on clinical practice.[8] However, care pathways are a powerful and increasingly popular tool. Neurosurgeons should understand how they are developed and be able to lead their design and implementation so that they align with the interests of their patients.

Toolkit for Developing an Integrated Care Pathway

The following toolkit was designed as a practical guide for developing a care pathway with nuances specific to neurosurgical patient populations and practice. It was developed from several resources for process mapping and redesign,[5,9-11] which can be

referenced for further guidance. Clinical pathway implementation follows the Plan, Do, Study, Act (PDSA) cycle for testing change ideas[12] and process map redesign is heavily rooted in lean management principles adopted from manufacturing.[4,13,14] Institutions mays also have their own site-specific resources that include integration into electronic clinical information systems. Many medical centers also employ quality improvement personnel, service line directors, or clinical engineers who can support care pathway redesign. **Table 1** outlines the key steps described in this toolkit. While there is some variability in the precise sequence and organization of care pathway development, most resources include these common key steps.

Table 1. Key steps in care pathway development

Step		Responsible personnel
1.	Define aim • Population: diagnosis or procedure • Goals: measurable targets	Key stakeholders
2.	Assign team and timeline	Key stakeholders, project leader, clinician champion, administrative coordinator
3.	Draw preliminary process map	Interdisciplinary team: project leader, clinician champion, clinical engineer, administrative coordinator, team members
4.	Data collection and pathway observation	Individual team members, data collector, data analyst
5.	Analyze map and data (steps 3-5 may be iterative)	Interdisciplinary team
6.	Prioritize improvement opportunities	Key stakeholders, interdisciplinary team
7.	Modify map and implement planned changes	Interdisciplinary team, administrators
8.	Measure adherence to change (repeat steps 4-8)	As above

Step 1: Define aim

The first step in developing an integrated care pathway is to decide on the scope of the project. Key stakeholders should work together to determine the target population and the goals of the intervention. Any individual within a neurosurgery department can initiate a new care pathway for the types of patients they see most frequently. Hospital administrators, neuroscience division leaders, operating room directors, quality improvement officers, and nurse administrators may also initiate projects or be key stakeholders in projects that cross multiple clinical disciplines.

The population can be defined as those patients with a given condition (ie. specific diagnosis or clinical presentation) or those undergoing a certain procedure (ie. a type of surgery or other treatment intervention).[9] **Table 2** provides examples of care pathways developed for several target conditions and neurosurgical procedures. Clinical pathways targeting a population based on a clinical condition are more likely to cross between the outpatient and inpatient setting, involve multiple related departments that collaborate in a clinical area (ie. neuro-oncology, cerebrovascular, epilepsy), and include diagnosis and management algorithms. Pathways focused on interventions are more likely to begin with preoperative planning and hospital admission, involve multiple inpatient ancillary services, and include contingencies for different postoperative scenarios. Depending on the goals of the project, stakeholders may wish to begin with a population that is high volume, high cost, or high risk.[11]

The goals of the project can vary widely with the objectives of the key stakeholders. Common goals include improving outcomes or patient satisfaction, reducing complications, improving efficiency, or reducing variation in clinical practice. If the goal is to improve adherence to standards of care or eliminate unnecessary care, the Joint Guidelines Committee of the American Association of Neurological Surgeons (AANS) and the Congress of Neurological Surgeons (CNS),[15,16] provides consensus best clinical practices for a variety of clinical conditions and procedures that can be used as a starting point. Many hospitals also have clinical practice guidelines that should be consulted and incorporated into clinical pathways where relevant.

It is important that the stated goals are measurable and achievable. Stakeholders should establish specific numeric targets so that there is clarity and consensus on the objectives.[9] The NeuroPoint Alliance Quality Outcomes Database (QOD, formerly N^2QOD)[17,18] provides several outcomes and process of care measures within neurosurgical disciplines that can be used as targets for a care pathway intervention. By collecting and targeting QOD measures, neurosurgery teams can design care pathway interventions that simultaneously build towards a broader quality improvement initiative at their own institution and contribute to a registry designed to advance quality nationally.

Table 2. Examples of integrated care pathways in neurosurgery

Publication/Initiative	Condition/Process	Outcome measures
Condition Pathways		
Cleveland Clinic Neurological Institute Care Paths[22]	>29 disease-specific care paths (interdisciplinary Neurologic Institute initiative)	Adherence to internally developed evidence-based guidelines; multiple outcomes and process measures
Godbolt (2015)[19]	Severe traumatic brain injury	Length of intensive care and floor stays, 1-year functional outcomes
Bapat (2015)[20]	Chronic subdural hematomas	Surgery rate, morbidity/mortality, LOS
Treatment Pathways		
UCLA Neurosurgery NERVS project[11,21]	Multiple care paths as part of department-wide quality improvement initiative	Outcomes, patient satisfaction, cost
McLaughlin (2014)[22]	Microvascular decompression surgery	Cost
Riblet (2016)[23]	Postoperative care of glioma	12 best-practice process measures, readmission
Wang (2016)[24]	ERAS approach to lumbar spinal fusion	Operative time, blood loss, LOS, functional outcomes
Bradywood (2017)[25]	Lumbar spine fusion	LOS
Titsworth (2016)[26]	Standardized analgesia protocol to reduce postoperative pain among neurosurgery patients	Pain scores, medication dose, HCAHPS score
Au (2016) [27]	Outpatient brain tumor craniotomy under general anesthesia	LOS, adverse events

LOS – length of stay; UCLA – University of California Los Angeles; NERVS – Neurosurgery Enhanced Recovery after surgery, Value, and Safety; ERAS – Enhanced Recovery After Surgery; Hospital Consumer Assessment of Healthcare Providers and Systems

Step 2: Assign interdisciplinary teams and timeline

Once stakeholders establish the target population and goals they will likely need to assign an interdisciplinary team of personnel to map the existing process and develop a detailed care pathway. Stakeholders may choose to be involved in the entire process but will often need to assign personnel from their and other departments who are familiar with the intricate details of daily operations and can commit greater time to the project. This is particularly true if multiple care pathways are being developed simultaneously as part of a broader quality improvement initiative.

Stakeholders can select interdisciplinary team members or choose a clinical champion and/or a project leader from the managerial staff who can make such decisions.[9] Appropriate personnel for the team will depend on the precise nature and setting of the care pathway being developed. **Table 3** suggests potential interdisciplinary team members to consider for different settings and processes relevant to neurosurgery. If one is available, a clinical engineer or person with experience in process mapping can act as a facilitator and scribe during process mapping and redesign. An administrative assistant is essential to coordinate interdisciplinary team meetings and take minutes. A data analyst may also be valuable depending on the type and quantity of data to be collected to evaluate the current process and the new care pathway. Recommended team size ranges from 10 to 25 representatives with any more making it difficult to manage the meeting and allow everyone to give input. [9,11]

It is important to establish a timeline for completing the initial process mapping and care pathway redesign. Drawing the preliminary process map (step 3) may require several longer meetings but should be completed within an approximately 2-week window to avoid repeating past efforts. An off-campus retreat can be useful to avoid personnel being pulled away by clinical responsibilities. Individual team members can then be assigned to data collection and pathway observation (step 4), with a timeframe to report back to the full team and stakeholders in a series of shorter meetings for steps 5-7.

Table 3. Potential interdisciplinary team members (in addition to neurosurgeon)

Setting/Process	Possible interdisciplinary team members
Outpatient	
Condition management	• Interdisciplinary clinician consultants (ie. for oncologic neurosurgery, representatives from neuro-oncology and radiation oncology) • Clinic/office administrator/staff • Radiology
Preoperative planning	• Clinic/office administrator/staff • Preoperative medical clearance clinician/administrator • Radiology • Operating room scheduler / hospital admitting
Postoperative management	• Clinic/office administrator/staff • Interdisciplinary consultants • Outpatient acute rehabilitation and physical/occupational therapy • Pharmacy
Inpatient	
Operating room	• Preoperative area administrator/nursing • Anesthesia attending/resident • Operating room administrator, nursing, and staff • Neurosurgical resident/PA/NP
Postoperative management	• Neurosurgical resident/PA/NP • Consulting clinical services (ie. pain management, intensivist/hospitalist, endocrinology) • Recovery room, intensive care unit, and floor administrator/nursing • Physical/occupational/speech therapy • Social work • Other ancillary services (ie. transport, phlebotomy, laboratory, nutrition)

PA – physician assistant; NP – nurse practitioner.

Step 3: Draw preliminary process map

During the initial interdisciplinary team meetings or retreat, the team should draw a preliminary map of the process as it currently exists. At this stage, the goal should be to capture all of the relevant steps in as much detail and as accurately as possible. If there is uncertainty regarding an appropriate step, criteria, or responsible personnel these items should be flagged for future discussion. Similarly, ideas for process improvement can be noted and flagged but, in the interest of completing the initial map in a reasonable amount of time, discussion should be saved for a later meeting.

Maps can be drawn on paper, a whiteboard, or using dedicated process-mapping software. The clinician champion or the senior manager assigned as project leader should chair the meeting but a clinical engineer or other neutral staff member familiar with process mapping should draw the map, leaving the chair free to steer the meeting and engage team members. There are a variety of free or commercially available software and cloud-based platforms available. **Table 4** lists some of these tools. Electronic maps may be easier to modify, work collaboratively on, and disseminate. If paper or a white board is used, moveable notes are useful for placing steps in the process map. There are several conventions that employ shapes, colors, and symbols for conveying the type of process, who is involved, where the process occurs, and how the next step may depend on several

contingencies.[28] **Figure 1** shows one such convention. Color-coding can be added to indicate which personnel are responsible for each step. Stylized icons, available in some software platforms, may be more easily relatable to the health care team.[28] Icons or flags can also be used to distinguish between processes as they exist and identified problems or proposed solutions.

Regardless of format, a consistent approach should be used and team members should be trained and provided with adequate reference resources. A process map must be able to capture starting point criteria, action steps and tasks, information collection or review steps (ie. forms, checklists), questions or decision points, and an end point. Mapping a clinical pathway may be an iterative process that needs to be repeated after additional data collection and observation.

Table 4. Select process-mapping software

Process-mapping	Website	Pros	Cons
Microsoft Visio	https://products.office.com/Microsoft/Visio/	Easy to use; large selection of templates and objects; one-time software purchase	Windows only; limited collaboration
Edraw	https://www.edrawsoft.com/flowchart/	Less expensive alternative to Visio; easy to use; large selection of templates and objects; one-time software purchase	Windows only; limited collaboration (with basic version)
Lucidchart	https://www.lucidchart.com/	Cloud-based; real-time collaboration; easy to use	Fewer templates; paid subscription
SmartDraw	https://www.smartdraw.com/lean/	Cloud-based; large selection of templates and objects; easy to use	Weak collaboration
Draw.io	https://www.draw.io/	Free; real-time collaboration through Google Drive	Fewer templates and shapes
ProcessMaker	https://www.processmaker.com/	Enterprise scale	Expensive for individual use

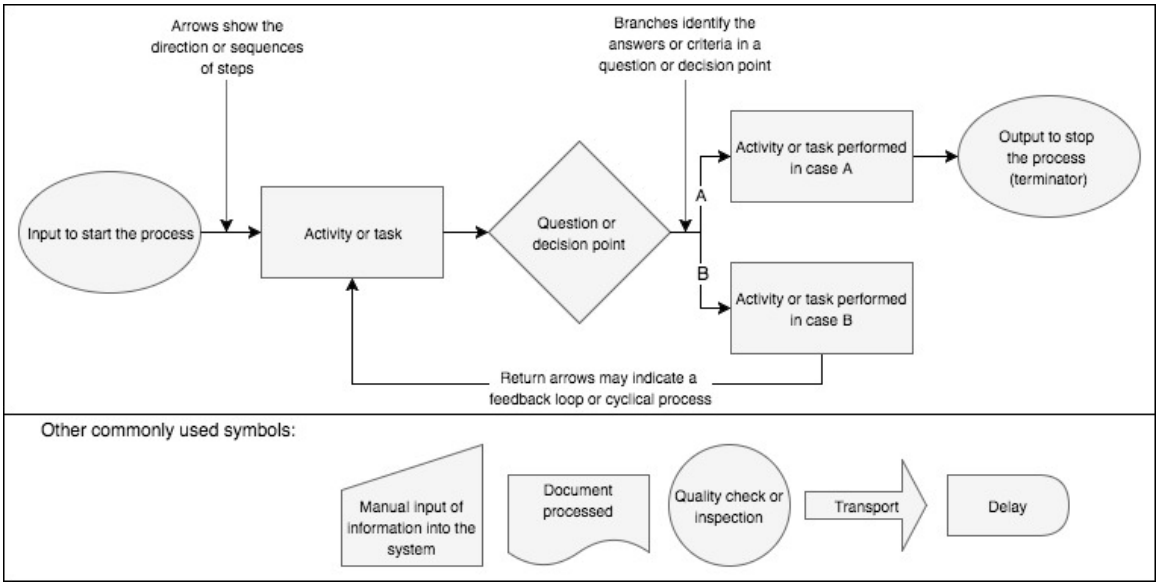


Figure 1. Commonly used symbols and conventions in health care process mapping. Modified from McLaughlin, et al. (2014).

Step 4: Pathway observation and data collection

Creating a preliminary process map may raise questions about how certain steps in the process are performed or how reliably or efficiently each step is completed. These questions should be noted during the initial meetings and team members assigned to observe the process and, if necessary, collect data. Many clinical pathway proponents begin with an approach known as walking the patient's journey.[5] Team members can follow patient's from the beginning to end of the process. It may also be helpful to interview patients and staff or have them answer surveys about their experience. Depending on the goal of the care pathway, data can be collected specifically on adherence (ie. how reliably is each step performed), time (ie. how long does each step take), or physical route (ie. how far do the patient and staff travel and how many trips do they take). Depending on the scale of the project and the resources available, it may be worthwhile to query electronic medical record data, employ a data collector to observe steps in the process, and involve a data analyst or statistician to analyze the data. These observations and data can then be brought back to the interdisciplinary team for analysis.

Step 5: Analyze maps and data

Once team members have had an opportunity to observe the process and collect data the full team should use that new information to re-evaluate the preliminary process map and identify opportunities for improvement. Guided by the primary goals of the care pathway, the team should make a list of problematic steps that do not align with those goals and potential process improvements. **Figure 2** provides an example of an incomplete process map in the analysis stage for the postoperative care of patients with glioma. Icons, in this case cloud shapes, can be used to identify problematic steps and potential changes.

If the goal is to improve adherence to a standard of care, the team should identify areas of unwarranted variability or uncertainty. Unintended variability, due to an unclear sequence of steps, criteria, or person responsible, should be distinguished from

appropriate variability where the next step may be contingent on certain variables. Standardization of steps and clarification of contingencies and responsibilities is often warranted.

For improving efficiency and reducing waste, the lean methodology emphasizes identifying steps that are value-adding, necessary but not value-adding, or waste-generating.[4,13] Value-adding steps should be enhanced, necessary but not value-adding steps simplified, and waste-generating steps eliminated. Non-value steps often account for more effort than those that add value.[29] **Table 5** identifies common types of waste in health care. Delays are often indicative of other types of underlying waste. Parallel processes (ie. for tests or administration) should be examined closely as they often lead to waits and delays for the patient and staff.[9] Bottlenecks often occur where multiple processes are stalled until a team comes together at a particular space and time such as an operating room time out or daily or weekly interdisciplinary meeting. These team steps may be necessary but it is often possible for preceding steps to be reworked or automated to avoid delays. Of note, duplication of steps or redundancy may be appropriate in health care processes for patient safety.

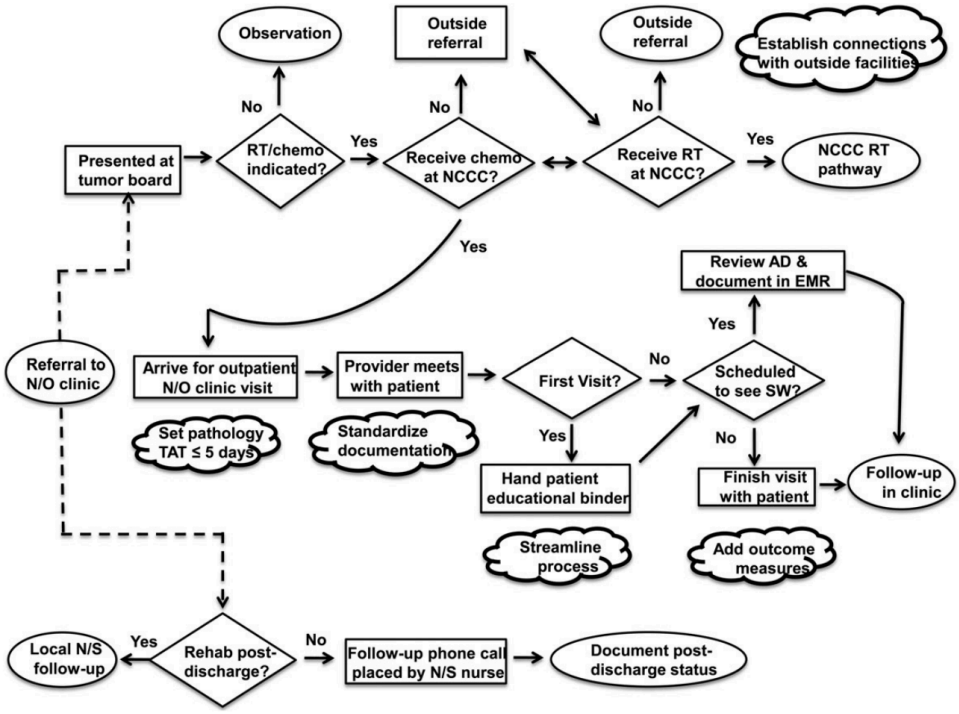


Figure 2. Incomplete process map in the analysis stage – postoperative care of patients with glioma. Cloud shapes represent potential changes under consideration to improve the pathway. From Riblet, et al (2016).[23]

Table 5. Common types of waste in health care

Type	Etiology/opportunities
Defects/errors	Often occur when patient or paperwork is handed off from on person or department to another; opportunities for automation, reminders, checklists, and protocols.
Overproduction	Volume may be above capacity; often due to inappropriate scheduling.
Transportation/ motion	Excess distance between related departments; poor ergonomics; multiple visits or trips.
Waiting/delays	By patients or staff; look for parallel processes (ie. for tests or administration) that occur while patient or staff wait; bottlenecks occur where individuals have to wait for multiple people to come together.
Inventory	Excess stores that expire.
Overprocessing/ duplication	Question if each step is really necessary and value-adding; duplication may be appropriate for patient safety.
Human potential	Those with expertise (ie. experienced or specialized surgeon, nursing, administrative, or technical staff) are spending time on less specialized tasks; activity and role lane mapping: list all of the component activities and who currently performs them and ask who should do each activity if it were redesigned; consider extending some staff roles[9]; avoid batching (ie. leaving a set of similar tasks to accumulate for someone else rather than dealing with them as part of the routine process).

Modified from Trebble, et al. (2010).

Step 6: Prioritize improvement opportunities

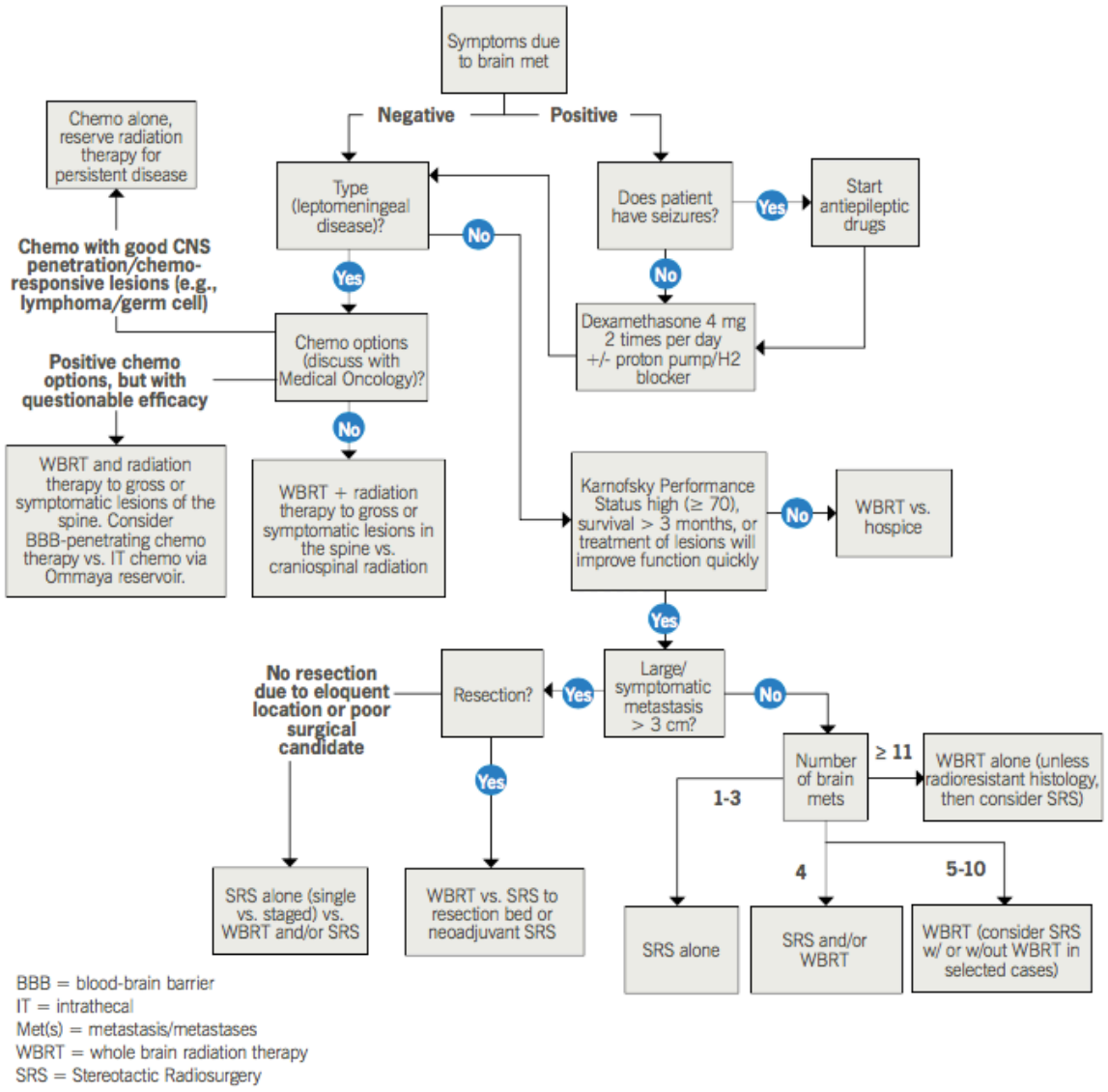
Once the team has assembled a comprehensive list of problematic steps and potential process improvements, they and the key stakeholders will likely need to prioritize improvement opportunities for the initial care pathway redesign. Decision-makers must balance the potential impact of improvements with the feasibility of their implementation. Developing a new care pathway is an excellent opportunity to implement multiple changes simultaneously but caution should be exercised not to take on too much in the first overhaul and recognize that quality improvement is an iterative process.[12] The availability of resources may also influence what changes can be made and therefore key stakeholders and administrators should be involved in prioritizing process improvements and allocating resources.

Step 7: Modify maps and implement planned changes

The team should then meet again to finalize the new care pathway with the agreed upon process improvements and assign any tasks necessary for implementation. Stakeholders should ensure that administrators and resources are committed to any planned changes. **Figures 3-5** provide examples of completed care pathways.

All clinicians and staff involved in a clinical process must be educated about the new pathway and their roles and responsibilities in it. Education can take the form of meetings, didactic sessions, or online modules. There should be some intervention beyond simply an email communication or notice to ensure that the information has been digested and that all staff have an opportunity to raise any questions or concerns.[4] The process map of the pathway should remain accessible to members of the team either electronically or in printed form.

Electronic clinical systems and paper documents must also be updated to reflect the new clinical pathway. Information technology staff may need to program changes including orders or order sets, alerts and reminders, and note templates. Printed forms and checklists need to be revised, approved, and made available. Old versions should be found and discarded to avoid confusion.



BBB = blood-brain barrier
IT = intrathecal
Met(s) = metastasis/metastases
WBRT = whole brain radiation therapy
SRS = Stereotactic Radiosurgery

Figure 3. Care pathway for management of a condition – treatment algorithm for symptomatic brain metastases. From Cleveland Clinic Care Path Guide Brain Metastases (unpublished).

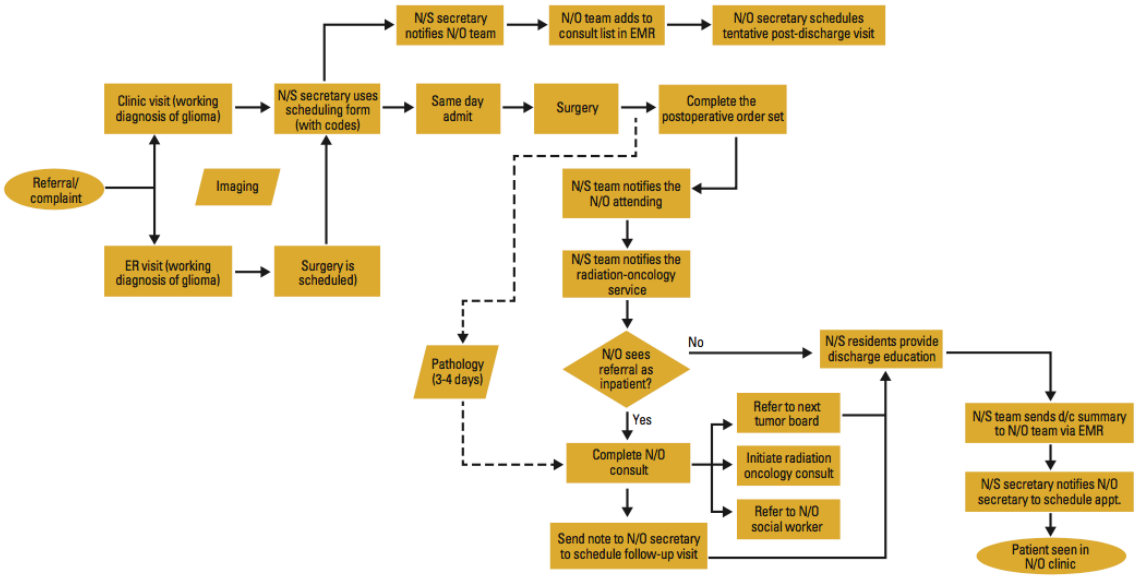


Figure 4. Care pathway for management of a condition – care coordination for patients with working diagnosis of glioma. From Riblet, et al (2014).[30]

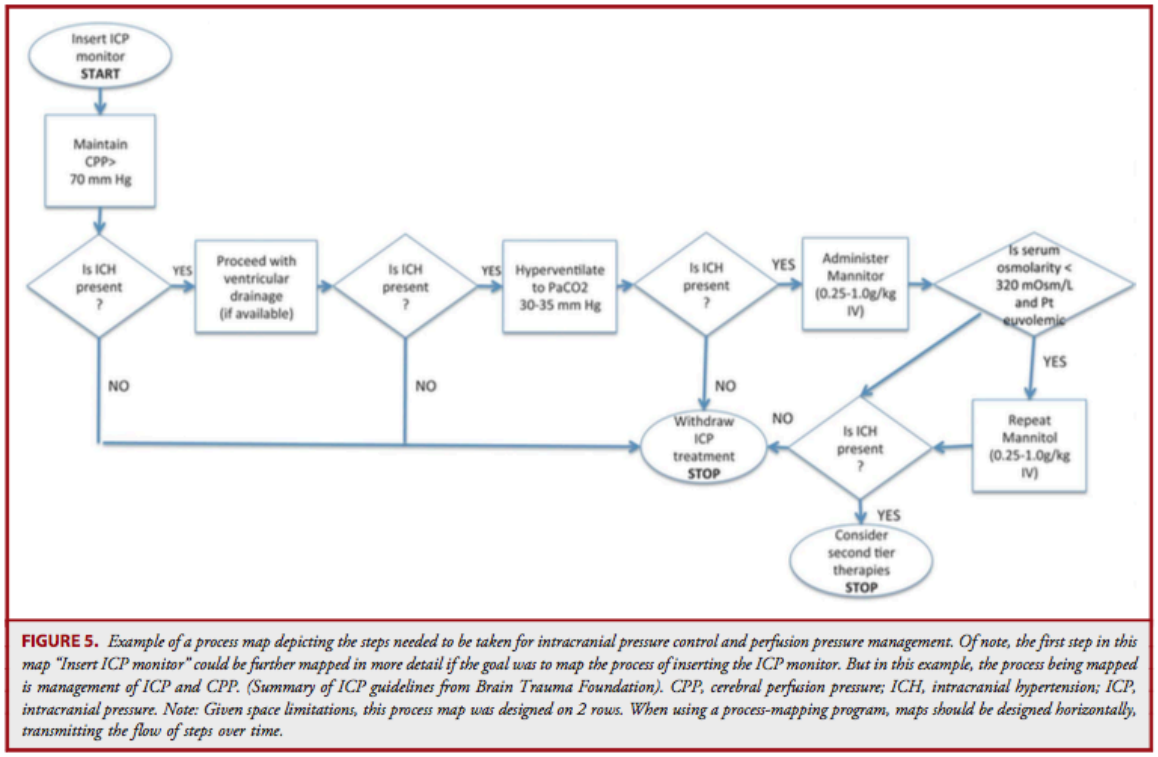


FIGURE 5. *Example of a process map depicting the steps needed to be taken for intracranial pressure control and perfusion pressure management. Of note, the first step in this map "Insert ICP monitor" could be further mapped in more detail if the goal was to map the process of inserting the ICP monitor. But in this example, the process being mapped is management of ICP and CPP. (Summary of ICP guidelines from Brain Trauma Foundation). CPP, cerebral perfusion pressure; ICH, intracranial hypertension; ICP, intracranial pressure. Note: Given space limitations, this process map was designed on 2 rows. When using a process-mapping program, maps should be designed horizontally, transmitting the flow of steps over time.*

Figure 5. Care pathway for management of a condition – intracranial pressure management after placement of a monitor. From McLaughlin, et al. (2014)[11]

Step 8: Measure adherence to change

When implementing changes to clinical processes, the team should ensure that mechanisms are in place to measure adherence and outcomes and establish targets and a timeline for evaluation. Measures of adherence, or process measures, should reflect the key items or changes in the care pathway. Outcomes measures should be based on the original aims of the project. The team may rely on a similar process of direct pathway observation and data gathering used during the initial evaluation in step 4 or, if possible, they can build automated processes of data capture into the electronic systems and documentation used in the care pathway. The latter allows for continuous data monitoring and supports frequent PDSA improvement cycles[9,12] and a rapid learning health care system.[31] Specific targets and timepoints for evaluation will allow the team to know if the project goals were achieved and consider what interventions to maintain, improve, or discard in future cycles of care pathway development. A care pathway is always a work in progress that can be further improved on through repeated quality improvement cycles.[9,12]

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