Teamwork to Improve Cardiac Kids' End Results (TICKER):

A Quality & Safety Toolkit for Pediatric Congenital Heart Surgery Programs

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UNC SCHOOL OF MEDICINE

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Overview

A decade after the publication of the Institute of Medicine report *To Err is Human*[1], health care in the United States continues to cause unnecessary deaths and morbidities.[2,3] In the 2002 Agency for Healthcare Research and Quality (AHRQ) report to U.S. Senate Committee on Appropriations regarding medical errors, the most common causes of medical errors were problems with communication, standardization of care, adherence to guidelines and protocols, and information flow between and within service areas.[4] That is, the majority of adverse events and medical errors are attributable to poor teamwork and variation in care practices. Consequently, opportunities for errors are greater in high-risk groups, such as pediatric congenital heart surgery patients who receive care throughout a complex system of hospital units provided by a number of multidisciplinary care teams.

This toolkit is presented as a result of Project TICKER, which aimed to implement a patient- and family-centered safe practice infrastructure for pediatric congenital heart surgery patients by incorporating teamwork training and integrated clinical pathways (ICPs) into the existing program at N. C. Children's Hospital. During the first phase of the project, health care providers throughout the pediatric congenital heart surgery service line were trained in TeamSTEPPS®. During the next phase, expert panels from each clinical area designed, tested, and implemented ICPs for two congenital heart conditions: ventricular septal defect (VSD) and tetralogy of Fallot (TOF).

A toolkit, as defined by AHRQ, is an action-oriented compilation of related information, resources, or tools that together can guide users to develop a plan or organize efforts to conform to evidence-based recommendations or meet evidence-based specific practice standards. The Project TICKER toolkit combines evidence-based safe practices (TeamSTEPPS and ICPs) in order to have more of an impact than either safe practice by itself.

We divided the toolkit into five main sections: Getting Started, Teamwork, Integrated Clinical Pathways, Measurement, and Lessons Learned. In each section, we provide suggestions for organizing and implementing project activities to address the topic and recommendations based on what we learned. Tools are described and linked throughout the toolkit and listed at the end of each section.

This toolkit is specifically designed for use in pediatric congenital heart surgery programs. However, much of the information and processes we describe could also be relevant (with adaptations) to other pediatric or adult surgical or medical service lines with or without national databases such as adult congenital heart, adult cardiovascular surgery, solid organ transplant, trauma, inflammatory bowel disease, cystic fibrosis, or sickle cell disease programs. In particular, much of the "Getting Started" section applies to patient- and family-centered safe practice infrastructures in general. Teamwork training and coaching, as described in the "Teamwork" section, are applicable for all clinical areas. Finally, the process we present for

developing ICPs can be used in various settings, even though the conditions and content of the pathways would be different.

References

[1] Institute of Medicine. *To err is human: Building a safer health system*. Washington, D.C.: The National Academies Press, 1999.

[2] Clancy CM. Ten years after to err is human. *Am J Med Qual.* 2009 Nov-Dec; 24(6): 525-528.

[3] Agency for Healthcare Research and Quality. National Healthcare Quality Report. Report No.: 09-0001. c2008. [cited 2010 January 13]. Available from: http://www.ahrq.gov/qual/qrdr08.htm

[4] Agency for Healthcare Research and Quality. AHRQ's patient safety initiative: Building foundations, reducing risk. Interim report to the senate committee on appropriations. Report No.: 04-RG005. c2003 December. [cited 2010 January 13] Available from: http://www.ahrq.gov/qual/pscongrpt/

Getting Started

In this section, we describe how to plan your project with a focus on developing a sustainable infrastructure, pieces of which include governance, communication, utilization of resources, and incentives for participation. We also describe structural elements of a pediatric congenital heart surgery program as recommended by the Society for Thoracic Surgeons (STS). When you start your project, your institution may be missing some of these elements, as we were. Therefore, it is important to remember that, although the program structure elements are presented at the beginning of the toolkit, you will develop these pieces as you work throughout your project.

Readiness Assessment

Because teamwork is fundamental to supporting efforts of implementing any changes in practice, it is critical that you start by assessing your organization's readiness for TeamSTEPPS® (*Team Strategies and Tools to Enhance Performance and Patient Safety* is described in "Teamwork" on page 8). The national TeamSTEPPS Web site provides valuable tools and guidelines for this process – the Organizational Readiness Assessment Checklist and Tips and Suggestions for Enhancing Organizational Readiness. With these tools, you will address topics such as culture change, time and resources needed, and sustainment in a step-by-step fashion. If barriers are too great to begin an organization-wide effort, then you can use the suggested tools to start on a smaller scale.

In addition to the organizational readiness assessment, you will want to examine the various clinical areas along the pathway for pediatric congenital heart surgery patients and assess each unit itself. TeamSTEPPS at UNC Health Care has developed a readiness checklist for this purpose. This unit-based assessment can usually be accomplished in one half-hour meeting with the lead physician and nurse manager, and will enable your understanding of what is already in place and what challenges and barriers you may face.

As part of this critical assessment process, you will need to ensure buy-in (agreement to support your project) from at least one of the cardiothoracic surgeons. In discussions with surgeons about the project, it is important to emphasize the benefits of increased communication between the surgical and anesthesia teams, better handoffs to the ICU, and standardization of care. You should also listen to their concerns and discuss how the project team could address those concerns throughout the project.

Advisory Council

The Advisory Council is a key ingredient for a multidisciplinary, cross-unit effort such as Project TICKER. The Advisory Council should have members representing all areas involved and include clinical and administrative leaders as well as frontline clinical staff and families. You might already have a group or committee that can function in this role with some additional members. For Project TICKER, this meant hospital and service line directors, medical and nursing staff from service units (pediatric intensive care unit/cardiac intensive care unit, children's cardiac intermediate care unit, operating room, neonatal intensive care unit), diagnostic and therapeutic teams focusing in pediatrics (respiratory therapy, nutrition, pharmacy, patient- and family-centered care specialists, chaplain, etc.), surgeons and providers from various medical teams (cardiothoracic surgery, cardiology, anesthesiology, pediatric/cardiac critical care, neonatology), and families of congenital heart patients. The Advisory Council will likely need to meet monthly for the first 1 or 2 quarters of the project and then quarterly or bi-annually for the rest of the project. The frequency of meetings in the beginning is based on the importance of agreeing on goals and execution of the project and removing any initial barriers.

The responsibilities of the Advisory Council include:

- Establishing the project charter,
- Providing input for the timing and phasing of the project,
- Serving as communication liaisons for their clinical areas,
- Assessing progress on a regular basis,
- Reporting and removing barriers,
- Working in small groups to address specific processes, such as unit handoffs, and
- Determining incentives for participation, such as continuing education credits for teamwork training and maintenance of certification for physicians.

Project Resources

Along with the Advisory Council, there are several key roles that should be considered critical for this effort. In most cases, the project leader will be a physician leader (such as a medical or surgical director) within the pediatric congenital heart surgery service line, and he or she will work with a small core team to run the project. The main functions of this core team are project management, process improvement support, data management, quality analysis, and communication. Depending on the size and complexity of your program and the resources available, you might have 3-6 people on this core team fulfilling these functions (see the project charter for more details regarding roles and time commitments). In addition, the TeamSTEPPS facilitator (described in "Teamwork" on page 8) is a member of the core team.

Family advisors are another key resource that might or might not be a regular part of teams within your institution. For Project TICKER, we recruited parents of children who had been cardiac surgery patients at our hospital to be part of the Advisory Council. We also held separate discussions with them to address topics such as communication between provider and family, unit transitions, orientation materials, and facilities. The feedback from these discussions was used in two ways: 1) incorporation directly into ICP materials and 2) initiation of side projects.

In addition to personnel, we found that some non-personnel resources were critical to project success. For example, our training supplies included TeamSTEPPS pocket guides and ID badges that identify staff as TeamSTEPPS coaches or as having completed TeamSTEPPS training. Inclusion of family advisors meant that we had to budget for tele- or web-conferencing equipment, printing and postage for recruitment materials, and parking vouchers and amenities for attending meetings at the hospital. Another budget consideration might be expenses for patient- and family-centered care training for one or more project team members.

Communication

With a project's communication plan, the goal is to reach all stakeholders in a way that will speak to them. First, list all stakeholders (anyone who will be impacted in any way by the project) and then, for each stakeholder, think about communication goals, what type of information to communicate, when, how, and which core team member is responsible. You can include this information in your project charter and/or create a separate document for communication planning.

Some of the communication methods recommended are:

- Progress reports presented at in-person meetings,
- Quarterly newsletters distributed via email,
- Web site to post announcements and updates as well as draft tools,
- Feedback surveys regarding project activities like cardiac rounds and peer review conferences, and
- Informal one-on-one meetings.

Program Structure

The following structure elements, with the exception of teamwork training, were recommended by STS for consideration in the recent National Voluntary Consensus Standards for Pediatric Cardiac Surgery. However, in the final report, only the cardiac surgery registry participation and surgical volume were endorsed by the consensus recommendations as structure measures. The others listed below were withdrawn to be considered at a later date due to several issues including poor documentation and exclusion criteria, evidence required for structural

measures, and lack of specificity. We believe structure and process measures are important in moving toward optimal quality outcomes, and therefore, we recommend all of the following structure elements. In "Measurement" on page 18, we describe how to measure progress related to partial or full implementation of each element.

- **Cardiac Surgery Registry (Now Endorsed by NQF Measure 0734)**: The purpose is to have your program's data for quality performance measures compared to national participants. The STS National Database is a systematic multi-institutional database for cardiac surgery. At our institution, all pediatric congenital heart surgery patients are entered into the database by the cardiothoracic team's nurse practitioner; these data are uploaded from the institutional site to the national database twice per year.
- **Pre-operative Multidisciplinary Conference (STS recommendation)**: The purpose is to plan surgical cases with representatives from cardiology, cardiac surgery, anesthesia, and critical care. Our program holds a weekly meeting with participation from all groups.
- **Multidisciplinary Rounds (STS recommendation)**: The purpose is to review the status and care plan for each cardiac surgery patient with representatives from cardiology, cardiac surgery, and critical care. We made changes to our timing of ICU rounds (which were already in a standardized format[1]) in order to have participation from all teams.
- **Peer Review Conference (STS recommendation)**: The purpose is a regularly scheduled multidisciplinary quality improvement conference. We held these meetings following one of the weekly pre-operative conferences every other month. The agenda consisted of reviewing mortalities since the last meeting, reviewing STS data and dashboards, and discussing topics related to standardized care and prevention and treatment of complications.
- **Teamwork Training & Coaching (UNC Project TICKER recommendation)**: The purpose is to create an infrastructure to support training in teamwork and ongoing coaching for continued development of teamwork skills. We have a TeamSTEPPS® training program with Master Trainers throughout the organization (visit TeamSTEPPS at UNC Health Care for more information).
- **Transesophageal Echocardiography (TTE) & Extracorporeal Life Support (ECLS) (STS recommendation)**: These were both available at our institution at the start of the project.
- **Surgical Volume for Pediatric and Congenital Heart Surgery (Now part of Endorsed NQF Measure 1815 Pediatric Cardiac Surgery Stratified Mortality & Volume Measure Pair):** The purpose is to know the numbers and size category for your institution and understand how your volume might affect your outcomes. [2,3]

Recommendations

- Take the time to do a readiness assessment to understand your organizational culture.
- Include someone with clinical expertise on your core team (not just the Advisory Council).
- Plan discussions with family members from your patient population early in the project.
- Communicate in various ways with all stakeholders and solicit feedback for improvement throughout the project.

Tools & Resources for Getting Started	
Organizational Readiness Assessment	http://teamstepps.ahrq.gov/readiness/
Tips to Enhance Organizational Readiness	http://teamstepps.ahrq.gov/abouttips.htm
TeamSTEPPS Readiness Checklist	http://www.med.unc.edu/ticker/toolkit/getting-started/teamstepps-readiness-checklist
Project Charter	http://www.med.unc.edu/ticker/toolkit/getting-started/ticker-project-charter
American Board of Pediatrics Maintenance of Certification Activity Manager	http://mocactivitymanager.org/overview/index.php?board=1
Family Advisor Recruitment Packet	https://www.med.unc.edu/ticker/toolkit/getting-started/family-recruitment
TeamSTEPPS at UNC Health Care	http://www.med.unc.edu/cce/programs-initiatives/teamstepps
Institute for Patient and Family Centered Care (IPFCC)	http://www.ipfcc.org/

References

[1] Whalen L et al. Herding Cats: The Successful Implementation of Standardized Multidisciplinary Bedside Rounds Including the Use of Pediatric ICU Daily Goals *submitted for publication 2012*

[2]Pasquali SK, Jacobs JP, He X, et al. The Complex Relationship Between Center Volume and Outcome in Patients Undergoing the Norwood Operation. *The Annals of Thoracic Surgery* 2012;93(5):1556-1562.

[3] Welke, KF. Interpreting Congenital Heart Disease Outcomes: What Do Available Metrics Really Tell Us? *World Journal for Pediatric and Congenital Heart Surgery* 2010;1(2): 194-198.

Teamwork

TeamSTEPPS®, *Team Strategies and Tools to Enhance Performance and Patient Safety*, is an evidence-based framework to optimize team performance among health care professionals. The TeamSTEPPS training curriculum includes a comprehensive set of ready to-use tools, materials, and instructions for integrating teamwork principles successfully into the health care system.

In this section, we review the facilitator and coach roles and describe our approach to training. We also present some of the communication tools that we found were critical to effective teamwork (namely, briefings, debriefings, and handoffs) and provide sample tools. Further training and coaching materials are available at the national TeamSTEPPS Web site.

The Facilitator's Role

The facilitator should be a TeamSTEPPS Master Trainer who has primary responsibility for facilitating the training of staff in all units and for supporting coaches in early implementation of TeamSTEPPS in the units. Master Trainers have advanced teamwork training and can provide consultation to units and departments implementing teamwork, perform site assessments, and determine performance gaps. When first working with a particular unit, the facilitator should partner with a clinical team member interested in TeamSTEPPS, who can affirm and further describe findings from the readiness assessment completed earlier (described in "Getting Started" on page 3).

The facilitator's role in the training process involves both working with nursing and physician leaders to schedule the training sessions and leading the sessions along with a TeamSTEPPS Master Trainer from the unit. It is advantageous to have skilled trainers from the unit co-lead the training sessions for that unit because staff members are able to relate to them, and they can provide real life examples. In addition, if the Master Trainer is also a formal unit leader, his/her active involvement in the training sessions is a visible indication of leadership support.

Following the training phase, the facilitator continues to work with the unit teams, providing process improvement support for implementation of tools and strategies (e.g., adapting the debrief form per the unit team's specifications, providing copies of the form, and following up with the unit team after they have tried a few debriefs). It is important for the facilitator to be aware of the team dynamics in the unit, identify informal leaders and understand their level of buy-in, and be able to adapt to the environment.

Tailored Training

At the core of the TeamSTEPPS framework are four skills: leadership, situation monitoring, mutual support, and communication. In Project TICKER, we trained all units in these four core skills through either "Ready Training," a modification of the national AHRQ training for staff members who are new to TeamSTEPPS, or "Booster Training," a refresher session for staff members who had been trained in TeamSTEPPS previously. The training sessions are led by two Master Trainers: the project's TeamSTEPPS facilitator and a clinical provider in the participating unit.

The scenarios and role play exercises used in the Ready Training should be tailored to each particular clinical area and the patient population it serves. So, for example, the teamwork scenarios used during the training of the operating room would not be the same as those for the cardiac intermediate care unit. In developing the scenarios, we suggest seeking input from Master Trainers in each unit. For the Booster Training, rather than use role play, you can emphasize the importance of using tools and strategies as soon as possible. Ask participants, "What would you be comfortable trying today?"

Scheduling and staff turnover can be issues for some units being trained, so we decided to hold multiple training sessions until we had trained 85% of staff from each clinical area. We thought that reaching this critical proportion of staff trained would help ensure spread of the communication techniques to the 15% of untrained staff. Once we had documented that 85% of staff from a particular unit received the training, we considered the training phase to be complete. The facilitator then worked with unit staff to try out the tools and address structured handoffs.

Tools in Practice

In Project TICKER, we found that briefings, debriefings, and handoffs were three powerful tools for building teamwork capacity. Here we describe each of these tools and provide specific examples for how you might incorporate them into your program. Teamwork events as discussed here could be emergent situations such as codes, falls, or unplanned extubations, or they could be planned teamwork events such as morning rounds or staff meetings.

Briefing. Prior to the start of a teamwork event, teams should hold a briefing. During this short planning session, teams:

- Discuss team formation,
- Assign essential roles,
- Establish expectations and climate,
- Anticipate outcomes, and
- Develop contingency plans.

The designated team leader is responsible for calling a briefing, but if the leader has not done so, anyone on the team can request one. In the briefing, the leader should empower all team members to speak up about concerns during the event and encourage the use of TeamSTEPPS skills. Documenting the discussion using a brief/debrief form can help teams with future teamwork planning and performance improvement.

Debriefing. Debriefings can be used after any team event—simple and routine, or complex and emergent. During a debriefing, teams recount and document key events; analyze why the event occurred; review what worked and what did not work in regards to teamwork; and discuss lessons learned and how they will alter the plan next time.

Debriefings can be structured by asking three questions:

1. What went well?
2. What didn't go well?
3. What could we do better next time?

Key considerations during the discussion include whether communication was clear and effective both before and during the event, whether all team members understood their roles and responsibilities, whether team members maintained situational awareness, whether the workload was efficiently and effectively distributed, whether team members asked for or offered assistance when needed, and whether errors were made or avoided.

Debriefings should be initiated by the team leader, but any member of the team should feel comfortable asking for a debriefing if the leader has not called for one. Ideally, all team members should participate in the debriefing, but if some members are not able or willing to participate, the debriefing is still valuable. During the discussion, the team leader should not assign blame or failure to an individual; mistakes should be viewed as learning opportunities. Whenever possible, a team member should document the discussion and save it for future reference using a form such as the one at the end of this section.

Project TICKER's family advisors suggested using a debrief approach with families when a child has an unexpected cardiac event. The clinical team should find out the family's perspective on what went well, what needed improvement, and how a similar unexpected event could be better handled in the future. This allows the clinical team to have a fuller perspective.

Handoff. During a handoff, care of a patient and pertinent information about the patient's state are transferred across the care continuum in a structured communication format. An effective handoff provides both parties with an opportunity to ask questions and clarify/confirm the transfer of responsibility and accountability.

It is important to communicate verbally and, when uncertainty exists, clear up all ambiguity before the transfer is completed. Until it is acknowledged that the handoff is understood and

accepted, responsibility for the patient should not be relinquished. Handoffs are a good time to review and confirm a shared mental model for both safety and quality.

In Project TICKER, we focused specifically on handoffs that we knew needed to be improved: OR to ICU and NICU to PICU/CICU. The OR to PICU/CICU handoff tool describes the communication and steps leading up to the PICU/CICU team's acceptance of responsibility from the anesthesia team. The NICU to PICU/CICU tools include: 1) a process flow diagram using a format known as SBARq (Situation, Background, Assessment, Recommendation, Questions) and 2) a nurse handoff/communication form with a more detailed SBARq.

The Role of the Coach

The coach's primary role is to observe teamwork events and check in with people to find out how things are improving following TeamSTEPPS training. This coaching period is critical and helps reinforce teamwork training and sustain teamwork improvements. The best coaches are unit-based and have the skills and confidence to mentor their peers in best teamwork behavior. Some characteristics used to describe an effective coach are well-respected, positive, enthusiastic, supportive, and observant. Generally, coaches emerge during the training and early implementation phases as individuals who try the tools immediately and are respected by their peers in doing so. For Project TICKER, we asked unit leaders to help identify the coaches and recognize them in the role.

We tried coaching entire teams at the same time, but found that coaching sometimes works best on an individual level. In addition, we found that some units can be difficult to coach because of the nature of their work/the system (e.g., operating room). One coaching strategy would be to observe team events, and then provide coaching to the team leader afterward. Over time, that person will begin to serve as a champion/model for best teamwork behavior and will be able to coach others to do the same.

The UNC Health Care TeamSTEPPS Web site includes examples of coaching for each of the four skills.

Recommendations

- Find advocates/champions in each unit early on by training unit leaders first and asking them to help identify these individuals.
- Build relationships within each unit to gain buy-in.
- Know the audience being trained and adapt to their needs.
- Try using the tools, especially debriefing, early in implementation.
- Keep in mind that change takes time and you may encounter resistance because people are overworked or may not buy in to the philosophy of TeamSTEPPS.

Tools & Resources for Teamwork	
National TeamSTEPPS Web site: Master Trainer sessions Tools and materials	 http://teamstepps.ahrq.gov/trainingEligibility.htm http://teamstepps.ahrq.gov/abouttoolsmaterials.htm
TeamSTEPPS at UNC Health Care Web site	http://www.med.unc.edu/cce/programs-initiatives/teamstepps
Ready Training for OR	https://www.med.unc.edu/ticker/toolkit/teamwork/ready-training-for-or
Ready Training (generic)	https://www.med.unc.edu/ticker/toolkit/teamwork/ready-training-generic
Booster Training	https://www.med.unc.edu/ticker/toolkit/teamwork/booster-training
Brief/Debrief Form	http://www.med.unc.edu/ticker/toolkit/teamwork/brief-debrief-form
Cardiac OR to ICU Handoff Packet	http://www.med.unc.edu/ticker/toolkit/teamwork/cardiac-or-to-icu-handoff-packet
NICU to PICU/CICU Handoff Packet	http://www.med.unc.edu/ticker/toolkit/teamwork/nicu-to-icu-handoff-packet
Coaching examples	http://www.med.unc.edu/cce/programs-initiatives/teamstepps/unit-based-coaching
TeamSTEPPS Pocket Guide	http://www.med.unc.edu/ticker/toolkit/teamwork/ts-pocket-guide
TeamSTEPPS Ready Badge	http://www.med.unc.edu/ticker/toolkit/teamwork/ts-ready-badge
TeamSTEPPS Coach Badge	http://www.med.unc.edu/ticker/toolkit/teamwork/ts-coach-badge

Integrated Clinical Pathways

Integrated Clinical Pathways (ICPs) are care team management plans that display goals for patients and provide the sequence and timing of actions necessary to achieve these goals with optimal efficiency.[1] The purposes of an ICP are to decrease variation in care, to increase adherence to clinical guidelines, to improve efficiency, and, most importantly, to improve patient outcomes.

ICPs have four specific features[2]:

1. An explicit statement of the goals and key elements of care based on evidence, best practice, and patient expectations;
2. The facilitation of the communication, coordination of roles, and sequencing the activities of the multidisciplinary care team, patients and their families;
3. The documentation, monitoring, and evaluation of variances and outcomes; and
4. The identification of the appropriate resources.

In this section, we describe a process for developing and implementing ICPs for any patient population. For Project TICKER, our ICPs focused on pediatric congenital heart surgery patients undergoing repairs for ventricular septal defect (VSD) and tetralogy of Fallot (TOF). We intend for you to follow the processes outlined here for tool development and implementation in order to customize the ICPs as much as needed for your patient population.

Tool Development

In order to customize existing ICPs or to develop new ones, we recommend the following steps:

1) Identify unit-based, multidisciplinary expert panels within your institution. Involving frontline clinicians, who make decisions for these patients on a daily basis, will increase buy-in for the implementation process. These are the tasks for the expert panels:
    - Complete chart reviews, using several agreed upon categories (such as inotropes, monitoring, pain/sedation, timing of echocardiograms, etc.), to learn how care was provided and with what degree of consistency.
    - Review evidence and clinical pathways from other institutions (see bibliography).
    - Discuss and decide on standard practices. Areas of high inconsistency found in the chart reviews will be your top priorities to address in terms of standardizing care.

2) Use the TICKER ICP for either VSD or TOF as a template to draft the ICP for your patient population, starting with standards of care immediately following surgery and

continuing with each post-operative day until expected discharge. Following are some strategies we developed as we drafted and tested our ICPs:

- Use the Integrated Clinical Pathways Checklist to ensure that all components are addressed.
- Establish eligibility criteria, as well as a list of circumstances when a patient should come off the pathway.
- Create a cover page for each packet, including the inclusion/exclusion criteria as well as instructions for preparing the packets and identifying pathway patients on census sheets.

Family advisors suggested these strategies:

- Leave some space on the sheet for each day devoted to summarizing the daily goals in simpler, less clinical terms to aid parents in understanding the goals for the day and to help their child make progress.
- Post photos of the physician team for the week in each PICU/CICU room to help parents put faces to names.

3) Test and refine your draft ICP using the rapid improvement method of PDSA (Plan-Do-Study-Act) cycles, a simple quality improvement tool based on the scientific method.
    - Complete a PDSA cycle for each patient you are testing on the ICP.
    - Evaluate the ICP with various methods, including debriefs in person with the front line staff who used the template, feedback surveys delivered electronically, and simple auditing of the completed forms.
    - For example, some of our PDSA cycles revolved around where to keep the ICP packets that were in progress in the ICU. We started with a plan to keep the packet in the patient's door to be filled out on morning and evening rounds by the fellow physician. (This process was already in place for standardized PICU daily goals sheets, which have been used on our ICU for several years.) The "do" step involved the unit coordinator's making a copy of the packet and placing it in the patient's door. We studied by observation that the packet did not stay in the patient's door but was often carried back to the physician work stations by the resident physicians to enter orders and then did not return to the door pocket. The "act" step was to add a note to each page of the packet that it should stay in the patient's door when not being filled out.
    - Plan on completing approximately 10 cycles or cases before moving on to the full implementation phase.

Implementation Process

There are several components necessary for successful implementation: training, education, process measurement, communication, ownership, and governance structure. In this section, we describe important points for each component.

- **Training**: Once PDSA cycles are successful in finalizing the ICP format and best use design, the next step is training service line personnel through various formats, such as staff meetings, faculty and physician conferences, real-time in the units, as well as multidisciplinary meetings related to the project. The ICPs are designed with a "how to use" section on the cover page in order to reinforce the process learned in training.
- **Education:** Assess the need in each unit for clinical education and make a plan for who will lead the educational sessions and how. The education required will take more or less effort depending on how significant the changes in practice are. An essential aspect for everyone to understand is that the ICP provides a general guideline and should not be seen as rigid. Be sure to include a note such as the one below on all pages of the ICP.

  > *This pathway is a general guideline and does not represent a professional care standard governing providers' obligations to patients. Care is revised to meet the individual patient needs.*

- **Process measurement**: Your core team should collect the completed ICPs and review them for compliance, which is defined as documented utilization in all inpatient units, including pathway variation, when applicable (see "Measurement" on page 20). Feedback related to compliance and clinical pathway variations can be reviewed at the peer review quality improvement conference (see "Getting Started" on page 6).
- **Communication**: Develop various methods of communication and prompting to remind clinicians to use the ICP and keep the documentation near the patient. Possible options are email prompts to physician providers and unit directors with upcoming patients scheduled for one of the ICP procedures, patient/census lists with patients highlighted, identification of patients at weekly cardiac surgery conferences, and a prompt added to nurse handoff sheet.
- **Ownership**: Identify an owner for the ICP who will be responsible for monitoring the process measurement and intervening when a problem arises. At the start of the project, the owner will likely be the physician leader but could transition later in the project to another provider who treats these patients.
- **Governance structure:** Find out whether your institution has a governance group for clinical pathways, and, if so, investigate the process in the early planning phase of your project. The governance group can help determine an electronic (Web-based) home for all ICPs and standardized guidelines for management of surgical complications. They will also keep track of review dates for each ICP. Since our institution did not have an established governance structure, we created our own Web site to make the tools available.

Recommendations

- Follow the Integrated Clinical Pathway Checklist like a roadmap throughout the ICP development.
- Take advantage of unit coordinators, or unit secretaries, who know what works and what does not and can help with process changes.
- Keep in mind that ICP development will take less time and fewer resources after the initial one is completed.
- Plan some time to review morbidities or complications in detail and realize that you may need to spend time addressing prevention and treatment of complications using evidence-based standardized guidelines along with the development of the ICPs. For example, we developed a standardized management approach to post-operative chylothoraces. A small expert group consisting of members of our multidisciplinary ICU team, cardiothoracic surgery team, and nutrition team were brought together to complete an evidence-based approach for treating these patients. The completed treatment algorithm and guidelines can be found on the project Web site.
- Realize that existing ICP templates from other centers or publications are not necessarily up-to-date with current evidence and plan time for literature reviews and internal expert panel review.
- Do not underestimate the importance of context; customization of the progression of care and adaptation of materials for your institution will be required for ICPs to be successful.

Tools & Resources for ICPs	
Bibliography	http://www.med.unc.edu/ticker/toolkit/integrated-clinical-pathways/icp-bibliography
Integrated Clinical Pathway Checklist	http://www.med.unc.edu/ticker/toolkit/integrated-clinical-pathways/icp-checklist
AHRQ Innovations Exchange: PDSA cycle	http://www.innovations.ahrq.gov/content.aspx?id=2398
Pediatric OR Antibiotics Guideline	https://www.med.unc.edu/ticker/toolkit/integrated-clinical-pathways/pediatric-abx-surg-proph-guideline
VSD pathway packet	http://www.med.unc.edu/ticker/toolkit/integrated-clinical-pathways/vsd-asd-pathway-packet
TOF pathway packet	http://www.med.unc.edu/ticker/toolkit/integrated-clinical-pathways/tof-packet
Cardiac OR to PICU/CICU handoff packet	http://www.med.unc.edu/ticker/toolkit/teamwork/cardiac-or-to-icu-handoff-packet
NICU to PICU/CICU handoff packet	http://www.med.unc.edu/ticker/toolkit/teamwork/nicu-to-icu-handoff-packet

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[1] Every N, Hochman J, Becker R, et al. Critical pathways : A review. Committee on Acute Cardiac Care, Council on Clinical Cardiology, American Heart Association. *Circulation.* 2000; 101(4): 461-5.

[2] Davies R, Gray C. Care pathways and designing the health-care built environment: An explanatory framework. *J Integr Care Pathw.* 2009 April 1; 13(1): 7-16.

Measurement

A measurement strategy is a balanced set of measures designed to tell us whether changes we are making are actually improving the systems of care and patient outcomes. The measurement strategy for Project TICKER contains structure, process, and outcome measures to 1) evaluate the patient- and family-centered, safe infrastructure and 2) measure quality outcomes for pediatric cardiac surgery at our institution. The full set of measures presented in this toolkit provides a wide range of options that could be narrowed down depending on the focus of your project, your team's resources for quality analysis, and the feasibility within your institution of obtaining certain data. As a general rule, most improvement projects should not have such large numbers of measures to follow for improvement. For Project TICKER, we followed a very large number of measures due to the inclusion of a national database. Projects that include measures already collected as part of a database may be different than typical quality improvement projects in that the outcome measures may be much larger in number. In this section, we provide descriptions of the measures with tables outlining the specifications for data collection and analysis of each measure, as well as some tips on presenting your data.

STS National Database

The Society of Thoracic Surgeons (STS) National Database is divided into adult cardiac, general thoracic, and congenital heart surgery divisions. Established in 1989 as a repository for clinical quality and safety indicators, the Database collects over 500 data elements per surgical patient. Operational definitions containing inclusion and exclusion criteria are determined by STS and followed by data managers at contributing institutions. Information regarding participation, harvest schedule, software vendors, and a sample national report can be found on the STS Web site.

Structure Measures

Structure measures indicate aspects of the care system, such as organizational support, infrastructure, and dedication of resources.[1,2] Table 1 shows the structure measures recommended by STS, with the exception of teamwork training, which we added. The table presents how to measure progress related to full implementation of each element or partial implementation, if it is in progress. In "Getting Started" on page 5, we describe the purpose of each structure measure and how we addressed it.

Table 1. Project TICKER Structure Measures for Full or Partial Implementation[1]

Measure	Full Implementation	Partial Implementation
Participation in a systematic multi-institutional database (registry) for cardiac surgery	Participation in the Society of Thoracic Surgeons National Congenital Heart Surgery Database	Resource identification and planning underway for future participation
Participation in pre-operative multidisciplinary conference involving cardiology, cardiac surgery, anesthesia, and critical care to plan surgical cases	Weekly pre-operative, multidisciplinary conference to plan and discuss upcoming surgical cases	Regular conferences with representation from as many disciplines as possible while planning for the addition of the remaining disciplines
Multidisciplinary rounds involving cardiology, cardiac surgery, and critical care	Daily multidisciplinary rounds during patient's critical care stay	Increased representation from as many of the disciplines as possible while planning for the addition of the remainder disciplines
Regularly scheduled peer review quality improvement conference	Bimonthly (or other regular interval) quality and safety conference	Inclusion of quality and safety review in current pre-operative conferences while planning for the development of regular interval quality and safety conferences
Availability of intraoperative TEE	TEE available at all times in the OR	If not already available at all times, multidisciplinary planning group including any needed disciplines such as cardiac anesthesiology and cardiology for preparation and roll out of TEE availability at all times
Availability of institutional pediatric ECLS Program	Pediatric ECLS Program available	Resource identification and planning underway for ECLS program development including what the current options are for patients not able to successfully wean from cardiopulmonary bypass. Recommend ECLS program development as recommended by the ECLS Organization
Teamwork training and coaching infrastructure	Implementation of TeamSTEPPS® training and coaching infrastructure	Resource identification and planning underway for future implementation

Abbreviations: TEE, transesophageal echocardiography; OR, operating room; ECLS, extracorporeal life support

(1) Our institution tracked compliance with structure measures with stoplight indicators: green spheres represented full implementation, yellow for partial, and red for non-compliance. See an example of our how we tracked our progress on the project's sample dashboard.

Process Measures

Process measures should indicate whether certain pieces or steps of an improvement system are functioning at the level desired. For Project TICKER, we focused on teamwork training and integrated clinical pathway (ICP) utilization. Table 2 presents the measures we found to be most critical to understanding our processes. The target populations at our hospital were:

(A) All team members caring for inpatient pediatric congenital heart surgery patients,

(B) All team members caring for inpatient pediatric congenital heart surgery patients who attended tailored TeamSTEPPS training for Project TICKER,

(C) All inpatient pediatric congenital heart surgery cases, and

(D) All ASD/VSD/TOF inpatient pediatric congenital heart surgery patients that meet ICP criteria.

In addition to the measures listed in Table 2, we identified supplementary measures as important, but optional, depending on resource availability. The process measures listed below are not included in the measurement table, but examples of charts are available on our dashboard.

- Learning Benchmarks assessment to evaluate participants' learning during training.
- Teamwork behavior scores based on observation (see TENTS Tool for Teamwork Observation: An Instructional Guide).
- Unit-based use of standardized communication tools, such as brief or debrief.
- Prophylactic antibiotic administration. Full compliance with this measure includes documentation of antibiotic administration by both anesthesia and perfusion technicians. Neither is collected in the STS database, but may be abstracted from anesthesia and perfusion records at your institution.
- Peripheral Vascular Lab orders (for use with investigating DVT rates). Our Advisory Council was interested in data related to incidence of deep vein thrombosis among pediatric congenital heart surgery patients. These data are not collected in the STS database, but we were able to obtain billing data for investigational studies from our own institution. Clinicians were responsible for manually reviewing patient records to determine which tests were positive.

Table 2. Project TICKER Process Measures

Measure	How Calculated	X-Axis	Y-Axis	Graph Title	Goal Line	Data Collection Instrument
Teamwork training participation	Target Population: A Numerator: Number of trained team members Denominator: Total number of team members Chart type: Table	Label: Unit Scale: [OR/PICU/NCCC/CICC]	Label: Percentage Scale: 0-100%	TeamSTEPPS Training Participation (% by unit)	85%/ unit	Sign-in Sheet at Project TICKER TeamSTEPPS training sessions
Training evaluation reactions	Target Population: B Numerator: Number of responses choosing each of the 7-point Likert scale ratings Denominator: Total number of responses Chart type: 100% stacked bar chart	Label: Questions 1-7	Label: Percentage Scale: 0-100%	TeamSTEPPS Training Evaluation Level 1: Reactions	N/A	Training evaluation adapted from survey used by Weaver, et.al.[1]
Prophylactic antibiotic administration (anesthesia)	Target Population: C Numerator: Patient records containing documented adherence to each of the three UNC Health Care pediatric antibiotic prophylaxis guidelines for surgical procedures. Denominator: Total number of opportunities Chart type: P Chart Note: 2	Label: Month Scale: January 2010 - present	Labels: Percentage Scale: 50% -100%	Pediatric Cardiac Anesthesia Prophylactic Antibiotic Administration Monthly Compliance	Goal: 100%	Anesthesia Record (CPA)
ICP tool compliance	Target Population: D Numerator: Pathways containing documented utilization in all inpatient units and pathway variation, if applicable. Denominator: Total number of opportunities. Chart type: Run chart; stratified by lesion (VSD/ASD or TOF) pathway.	Label: Month Scale: December 2012 - present	Labels: Percentage Scale: 0-100%	ICP Tool Compliance	Goal: 100%	TICKER ICPs

Abbreviations: ICP, integrated clinical pathway; CPA, GE Centricity Perioperative Anesthesia; OR, Operating Room; PICU, Pediatric Intensive Care Unit; NCCC, Newborn Critical Care Center; CICC, Children's Intermediate Cardiac Care; VSD, Ventricular septal defect; ASD, Atrial septal defect; TOF, Tetralogy of Fallot.

(1) Weaver S. Does teamwork improve performance in the operating room? A multilevel evaluation. *Joint Commission Journal on Quality and Patient Safety*. 2010-03; 36:133-42.

(2) UNC Health Care pediatric antibiotic prophylaxis guidelines for surgical procedures: administration within one hour of surgical incision, body weight appropriate dosage (variance of 10% above/below is acceptable), and according to standardized intra-operative redosing schedule (administration within one hour window is acceptable).

Outcome Measures

Outcome measures should indicate how patients are affected by the system as a whole. For Project TICKER, this meant understanding whether the care provided was patient-centered, efficient, effective, and free of complications. With the exception of hospital-acquired infection rates, all outcome measures presented below were collected according to STS database operational definitions. If your institution does not yet participate in the STS database, then you might select a few of these measures based on data that you can already obtain at your institution for your patient population while you are preparing for STS database membership.

We used statistical process control methods (SPC)[3,4] to study how processes changed over time. Data were presented in control charts with upper and lower control limits, which allow for distinguishing between common cause variation (naturally occurring and always present) and special cause variation (indicating external influence on the process causing it to be out of statistical control). Run charts are a simpler tool that can also be used to detect changes in a process over time and do not require sophisticated analysis, but will not be able to show process stability and capability.

Table 3 presents outcomes measures for our institution that could be analyzed with a control chart, and Table 4 presents those measures that could not be analyzed with a control chart because the incidences were too rare. You will want to follow SPC guidelines and techniques when determining measure feasibility and chart selection for your own institution's data. The notes presented in the second column are described after Table 4, and the target populations are the same as those described in the process measures section on page 20.

In addition to the measures presented in Tables 3 and 4, the following measures are considered important, but optional, depending on your resource availability:

- Financial implications, such as total lab charges, chest radiographs, pain medication charges, sedation medication charges, cardiac medication charges, total hospital charges.
- Thromboses – deep vein and arterial. As previously mentioned, these data are not collected through STS, but may be available through your organization's internal databases.
- Patient safety culture as measured by AHRQ's Hospital Survey on Patient Safety Culture.

Table 3. Project TICKER Outcome Measures to be Analyzed with a Control Chart

Measure[1]	How Calculated	X-Axis	Y-Axis	Graph Title	Goal Line	Data Collection Instrument
CPB time	Target Population: C Chart type: I Chart Notes: 2,3	Label: Date of Surgery Scale: January 2004 - present	Labels: CPB Time (minutes) Scale: 0 -500	[Benchmark operation] – Cardiopulmonary Bypass Time	Context – to be set by institution	STS Congenital Heart Surgery Database Data Collection Form; Apollo Advance
XClamp time	Target Population: C Chart type: I Chart Notes: 2,3	Label: Date of Surgery Scale: January 2004 - present	Labels: XClamp Time (minutes) Scale: 0 -300	[Benchmark operation] – Cross Clamp Time	Context – to be set by institution	See above
Length of Case	Target Population: C Chart type: I Chart Notes: 2,3	Label: Date of Surgery Scale: January 2007 - present	Labels: Case Length (minutes) Scale: 0 -1000	[Benchmark operation] – Length of Case	Context – to be set by institution	See above
Total hospital LOS	Target Population: C Chart type: I Chart Notes: 2,3	Label: Discharge Date Scale: January 2004 - present	Labels: LOS (days) Scale: 0 -200	[Benchmark operation] – Total Hospital Length of Stay	Context – to be set by institution	See above
Post-operative LOS	Target Population: C Chart type: I Chart Notes: 2,3	Label: Discharge Date Scale: January 2004 - present	Labels: Post-op LOS (days) Scale: 0 -200	[Benchmark operation] – Post-operative Length of Stay	Context – to be set by institution Example: Goals: VSD ↓25% (4.875) TOF ↓40% (6.66)	See above
Open chest days	Target Population: C Chart type: I Chart Note: 4	Label: Date of Surgery Scale: January 2006 - present	Labels: Days Scale: 0 -120	Open Chest Days	Context – to be set by institution	See above
Re-operations due to bleeding	Target Population: C STS Complication Code: 240 Chart type: G Chart; annual & cumulative complication rate (crude). Notes: 5,6	Label: Date of Complication Scale: January 2004 - present	Label: Cases Between Scale: 0 - 200	Pediatric congenital heart surgeries between re-operations due to bleeding	Infinity	See above

Measure[1]	How Calculated	X-Axis	Y-Axis	Graph Title	Goal Line	Data Collection Instrument
Cardiac re-operations, exclusive of bleeding	Target Population: C STS Complication Code: 22 Chart type: G Chart; annual & cumulative complication rate (crude). Notes: 5,6	Label: Date of Complication Scale: January 2010 - present	Label: Cases Between Scale: 0 - 125	Pediatric congenital heart surgeries between unplanned cardiac re-operations exclusive of bleeding	Infinity	See above
Chylothorax	Target Population: C STS Complication Code: 210 Chart type: G Chart; annual & cumulative complication rate (crude). Notes: 5,6	Label: Date of Complication Scale: January 2004 - present	Label: Cases Between Scale: 0 - 160	Pediatric congenital heart surgeries between chylothoraces	Infinity	See above
Vocal cord dysfunction (possible recurrent laryngeal nerve injury)	Target Population: C STS Complication Code: 310 Chart type: G Chart; annual & cumulative complication rate (crude). Notes: 5,6	Label: Date of Complication Scale: January 2004 - present	Label: Cases Between Scale: 0 - 150	Pediatric congenital heart surgeries between possible recurrent laryngeal nerve injuries	Infinity	See above
Paralyzed diaphragm (possible phrenic nerve injury)	Target Population: C STS Complication Code: 300 Chart type: G Chart; annual & cumulative complication rate (crude). Notes: 5,6	Label: Date of Complication Scale: January 2004 - present	Label: Cases Between Scale: 0 - 160	Pediatric congenital heart surgeries between possible phrenic nerve injuries	Infinity	See above
Neurological deficit persisting at discharge	Target Population: C STS Complication Code: 320 Chart type: G Chart; annual & cumulative complication rate (crude). Notes: 5,6	Label: Date of Complication Scale: January 2004 - present	Label: Cases Between Scale: 0 - 160	Pediatric congenital heart surgeries between neurological deficits persistent at discharge	Infinity	See above
Cardiac arrest during or following procedure	Target Population: C STS Complication Code: 30 Chart type: G Chart; annual & cumulative complication rate (crude). Notes: 5,6	Label: Date of Complication Scale: January 2004 - present	Label: Cases Between Scale: 0 - 100	Pediatric congenital heart surgeries between post-operative cardiac arrests	Infinity	See above

Measure[1]	How Calculated	X-Axis	Y-Axis	Graph Title	Goal Line	Data Collection Instrument
Post-operative/ Post-procedural mechanical circulatory support (IABP, VAD, ECMO, CPS)	Target Population: C STS Complication Code: 40 Chart type: G Chart; annual & cumulative complication rate (crude). Notes: 5,6	Label: Date of Complication Scale: January 2004 - present	Label: Cases Between Scale:0 - 125	Pediatric congenital heart surgeries between cases requiring post-operative mechanical circulatory support	Infinity	See above
Renal failure requiring replacement therapies	Target Population: C STS Complication Codes: 230, 223, 224 Chart type: G Chart; annual & cumulative complication rate (crude). Notes: 5,6	Label: Date of Complication Scale: January 2004 - present	Label: Cases Between Scale: 0 - 400	Pediatric congenital heart surgeries between cases requiring replacement therapies	Infinity	See above
Unplanned readmission to the hospital within 30 days of discharge	Target Population: C STS Complication Code: 360 Chart type: G Chart; annual & cumulative complication rate (crude). Notes: 5,6	Label: Date of Surgery Scale: January 2007 - present	Label: Cases Between Scale: 0 - 100	Pediatric congenital heart surgeries between readmissions within 30 days of discharge	Infinity	See above
Operative mortality (risk-adjusted)	Target Population: C Chart type: G charts, stratified by STS-EACTS risk category; cumulative mortality rate. Notes:5,7	Label: Date of Surgery Scale: January 2005 - present	Label: Cases between Scale: 0-140	STS-EACTS Category [1-5] Cases Between Operative Mortalities	N/A	See above
VAP	Target Population: C Chart type: T Chart Note: 8	Label: Date of Infection Scale: January 2006- present	Label: Calendar Days Between Scale: 0 - 500	Calendar Days Between Pediatric Cardiac Surgery VAP	Infinity	Hospital Epidemiology or your institution's source for reporting hospital-acquired infections
CLABSI	Target Population: C Chart type: T Chart Note: 8	Label: Date of Infection Scale: January 2006 - present	Label: Calendar Days Between Scale: 0 - 500	Calendar Days Between Pediatric Cardiac Surgery CLABSI	Infinity	Hospital Epidemiology or your institution's source for reporting hospital-acquired infections

Measure[1]	How Calculated	X-Axis	Y-Axis	Graph Title	Goal Line	Data Collection Instrument
CAUTI	Target Population: C Chart type: T Chart Note: 8	Label: Date of Infection Scale: January 2006 - present	Label: Calendar Days Between Scale: 0 - 500	Calendar Days Between Pediatric Cardiac Surgery Foley CAUTI	Infinity	Hospital Epidemiology or your institution's source for reporting hospital-acquired infections
Patient and family satisfaction	Target Population: C Questions: "How well staff worked together to care for you," "Likelihood of recommending this hospital to others," and "Overall rating of care given at hospital" Chart type: Xbar and S Charts	Label: Date of Discharge Scale: October 2008 - present	Label: Mean Scale: 0 - 5	Patient and Family Satisfaction [Question]	N/A	Press-Ganey (Discharge Unit)

Abbreviations: CPB, cardiopulmonary bypass; XClamp, cross clamp; LOS, length of stay; IABP, intra-aortic balloon pump; VAD, Ventricular assist device; ECMO, Extracorporeal membrane oxygenation; CPS, Cardiopulmonary support; VAP, ventilator-associated pneumonia; CLABSI, central line-associated bloodstream infection; CAUTI, catheter-associated urinary tract infection

Notes:

(1) All outcome measures operationalized through STS definitions unless otherwise indicated.
(2) Data are stratified by benchmark operation (VSD repair, TOF repair, AVSD repair, ASO, Fontan, Norwood (Stage 1) and are depicted in separate charts.
(3) Chart reviews of cases with data points outside the upper and lower control limits are conducted by subject matter experts. If it is determined that the special causes are related to patient condition and not systems issues affected by this project, the data points are ghosted, thereby removing those values from the calculation of the mean and control limits.
(4) Post-operative patients with delayed sternal closures are captured via STS. A quality analyst abstracted chest closure dates from patient records and calculated patient level open chest days.
(5) Opportunities include one per patient per surgical admission and are attributed to the date of the primary surgery. Multiple events for the same patient during the same admission, are flagged in the database as high risk patients, however are not included as multiple events in the analysis.
(6) Members of our advisory council asked to also have these measures reported as incidence rates.
(7) Data are stratified by a multi-institutional validated complexity tool (STS-EACTS) and depicted in separate charts.
(8) Opportunities include calendar days between infections.

Table 4. Project TICKER Outcome Measures Too Rare to Analyze with a Control Chart

Measure	How Calculated	Graph Title	Goal Line	Data Collection Instrument
Arrhythmia necessitating permanent pacemaker	Target Population: C STS Complication Code: 74 Chart type: Annual & cumulative complication rates (crude). Note: 5	Arrhythmia necessitating permanent pacemaker rate	0.0%	STS Congenital Heart Surgery Database Data Collection Form Apollo Advance
Mediastinitis	Target Population: C STS Complication Code: 270 Chart type: Annual & cumulative complication rates (crude). Note: 5	Mediastinitis rate	0.0%	STS Congenital Heart Surgery Database Data Collection Form Apollo Advance
Superficial wound infection	Target Population: C STS Complication Code: 263 Chart type: Annual & cumulative complication rates (crude). Note: 5	Superficial wound infection rate	0.0%	STS Congenital Heart Surgery Database Data Collection Form Apollo Advance
Stroke	Target Population: C STS Complication Code: 420 Chart type: Annual & cumulative complication rates (crude). Note: 5	Stroke rate	0.0%	STS Congenital Heart Surgery Database Data Collection Form Apollo Advance
Unplanned interventional cardiovascular catheterization procedure during the post-operative or post-procedural time period	Target Population: C STS Complication Code: 24 Chart type: Annual & cumulative complication rates (crude). Note: 5	Unplanned interventional cardiac catheterization rate	0.0%	STS Congenital Heart Surgery Database Data Collection Form Apollo Advance

Data Management

In order to use your institution's STS data and perform analysis as outlined for the outcome measures, you will need to extract the patient-level data and organize it for analysis. This process will vary, depending on resources available at your institution, as well as which vendor and software package you are using. Following are tips we identified as helpful for completing this process:

- Ask to receive the following elements for each project measure:
    - Unique identifiers for surgery/case
    - Medical record number
    - Dates: admission, surgery, discharge, and complication(s)
    - Primary surgery during that admission
- Group data according to type: continuous or discrete.
- For each measure, establish which date is most appropriate and meaningful for subgroup assignment. For example, length of stay may be best grouped according to discharge date, whereas open chest days may be better suited to surgical date. Sort data in chronological order according to the determination.
- When data are too rare to plot in run charts or control charts, consider communicating as crude incidence rates (see Table 4 on page 27 for examples).

Data Reporting

Planning for sharing the data should coincide with communication planning, as described in "Getting Started" on page 5. In most communications, you will want to include written descriptions of progress and results along with visual representation of data. Following are recommendations related to data reporting:

- Develop a color scheme for the project and be consistent across various types of communication (i.e., Web site, charts, newsletters, etc.).
- Include only the most important information in your charts and keep the format simple.
- Engage key stakeholders to learn what measures they want to review, in what format, and with what frequency.
- To the extent that your resources allow, tailor the measurement focus to various groups and clinical areas involved. Unit teams will likely want to see their data in more detail or separated from the aggregate.

Recommendations

- After an initial look at data for all measures, choose an expert group to narrow the focus to about 10 high-priority measures.
- Utilize data already collected as much as possible; and if you need to collect new data, keep it very simple.
- Map the process at your own institution from patient-level data collection and entry through submission to STS in order to understand resources at your institution as well as vendor capabilities. This can be as simple as just writing down the steps or constructing a flowchart.
- Include someone on your team who has been trained in statistical process control methods.

Tools & Resources for Measurement	
Science of Improvement: Establishing Measures	http://www.ihi.org/knowledge/Pages/HowtoImprove/ScienceofImprovementEstablishingMeasures.aspx
STS National Database	http://www.sts.org/national-database
Sample Dashboard	https://www.med.unc.edu/ticker/toolkit/measurement/ProjectTICKER_SAMPLEDashboard.pdf
Run chart tool	http://www.ihi.org/knowledge/Pages/Tools/RunChart.aspx
The run chart: a simple analytical tool for learning from variation in healthcare processes	http://qualitysafety.bmj.com/content/20/1/46.full
QI Macros for Excel	http://www.qimacros.com/six-sigma-software.html
AHRQ Quality Indicators™ Toolkit for Hospitals	http://www.ahrq.gov/qual/qitoolkit/
Learning Benchmarks Questionnaire and Answer Key	https://www.med.unc.edu/ticker/toolkit/measurement/learning-benchmarks-questionnaire-and-answer-key
TENTS Tool for Teamwork Observation: An Instructional Guide	https://www.med.unc.edu/ticker/toolkit/measurement/tents-tool-guide
TENTS Tool	http://www.med.unc.edu/ticker/toolkit/measurement/tents-tool
AHRQ Hospital Survey on Patient Safety Culture	http://www.ahrq.gov/qual/patientsafetyculture/hospsurvindex.htm

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Lessons Learned

Throughout the project, we gathered feedback from clinical personnel and family advisors regarding various processes and materials in order to improve things as we went along. In this section, we summarize key learning from that feedback as well as reflections from the core project team.

Composition of core team

- In addition to a physician lead, we felt that it was important to have a clinical team member (in this case a congenital heart surgery nurse practitioner) who had knowledge of the patient population. It was especially helpful that she was the same person who managed the data collection and entry for the STS database.
- One of the challenges we faced was the multiple roles for the TeamSTEPPS facilitator. We started out with the same person having responsibility for training, coaching and observing teamwork behaviors. Not only was this a lot for one person to do, but it introduced potential bias to have the same person training a team and then scoring their teamwork behavior. We addressed this issue by training student interns to conduct teamwork observations post-training.

Inclusion of family advisors

- Participation from family advisors was extremely valuable, even more so than we had anticipated. Their feedback helped us prioritize and gave us direction for communication areas in which to focus. For example, the idea to summarize daily goals for families in such a way that empowers them to be proactive in helping their child get better came directly from discussions with families.
- The coordination and time required to include family advisors was more involved than what we had planned and required some reprioritizing on our part. Because these families are busy and volunteering their free time, we often ended up engaging them one or two at a time rather than finding time when they could all meet together. We would suggest planning specifically for this area, given its importance, and utilizing patient- and family-centered resources in your institution, if available.
- In addition, our physician leader completed training through the Institute for Patient and Family Centered Care, and we suggest including someone with experience and training in this area to oversee appropriate incorporation of family and patient advisors in a project.

Incentives for participation

- Although the process to have our project approved for credit for the quality improvement portion of Maintenance of Certification (MOC) through the American Board of Pediatrics was cumbersome, it turned out to be a huge incentive for physician participation. Participating physicians were required to complete TeamSTEPPS training and several project activities, such as attending peer review conferences, piloting tools, and submitting feedback surveys. We believe the MOC credit was a large part of our having 100% of the physician faculty participating fully in the requirements without difficulty.
- Continuing education for completing TeamSTEPPS training was also helpful. Another suggestion would be to include activities as part of hospital credentialing and resident education requirements so that participation in this project fulfills already existing requirements.

Cardiac rounds

- Respondents to a feedback survey reported that having standardized cardiac rounds in the intensive care unit improves communication among cardiothoracic surgery, cardiology, and ICU teams. It allows everyone to be present at the same time and cuts down on time required to follow up later and potential miscommunication.
- However, efficiency is a challenge since cardiac patients are not grouped together in our intensive care unit, and the cardiologists are competing with timing of rounds for the intermediate care unit.
- Suggestions for improvement include grouping cardiac patients together, limiting the time for each patient, having more consistency in reporting, and bringing in additional subspecialties, when needed.

Peer review quality improvement conference

- We initially found timing of this conference difficult, so to optimize attendance, we placed it immediately after the standing weekly cardiac catheterization/surgical conference, which already included several of the teams. In addition to cardiology, cardiothoracic surgery, anesthesiology, and critical care, we expanded the attendance to include medical staff from neonatology and perfusion.
- We found that the attendees were very eager to participate in this conference when real time institution-specific data was made available in addition to the typical morbidity and mortality discussions of peer review.
- Through this forum, we formed subcommittees or expert panels that worked at standardizing different practices and created guidelines for certain areas of care such as operative (regional anesthesia, fast track extubation, surgical access issues), NICU to PICU/CICU transition (handoffs, timing of transfers, coordination of care efforts), PICU/CICU to cardiac intermediate care (handoffs, clinical pathway continuation,

preparation of families to leave ICU). These subcommittees were not originally planned but were natural progressions of this structure.

- We found that soliciting feedback from this peer review group to include format, frequency of meetings, and topics to be discussed was important for participation. Though this conference was initially planned quarterly, the conference attendees voted to hold the meeting bi-monthly rather than monthly or quarterly.

Teamwork training

- In the evaluations of Ready Training, participants indicated that the most valuable parts of training were learning effective communication techniques and tools, and examining the importance of teamwork and team organization. Several participants also noted that the training helped them feel more empowered and confident in their role and ability to speak up.
- Those who attended Booster Training said that a review of the communication tools was helpful.
- Participants in both trainings liked having examples that were specific to their unit or role, and a few Ready Training participants suggested that the training could be improved by having more interaction or role play and more instruction on use of the tools.

Implementation of integrated clinical pathways

- We found the development of clinical pathways more time consuming than we had anticipated originally. Although we had access to existing clinical pathway templates and designed our own template with key components of the ICP Checklist in mind for completeness, placing these pathways into the correct context of our institution was complicated. For example, we do not have a separate ICU for pediatric cardiac surgery patients, so we needed strategies for identifying the pathway patients (as described in "Integrated Clinical Pathways" on page 13).
- Another complication of ICP implementation was that each clinical team had to address separately its role and process in the pathway. For example, the person completing the ICP might have been a fellow or attending physician in the ICU and a resident physician or nurse in the intermediate care unit.
- Once we found our way in designing and implementing our first pathway, the approach to other pathways was easier to envision and complete. Because we had developed a process and educated staff on using ICPs, significant ground work was already done for the second pathway.
- Reviewing the pathways with the expert panels also led to collaborative efforts to address transfer criteria between units in order to be more consistent and have more agreement across groups.

- For the most part, physician groups welcomed the standardization of the ICPs presented. There was some concern that the daily template could get too busy, especially with more complex patients, but this did not turn out to be a problem.
- After the first year of the project, we realized that, in addition to clinical pathways for specific surgical procedures or patient populations, we needed clinical pathways and guidelines for the management of morbidities or complications common to this patient population. This was a natural response to our multidisciplinary discussions regarding our dashboard and outcomes, and was further justified by analysis of the STS database[1].
- As the patients reached transition to the cardiac intermediate care unit, a more generic discharge goals sheet was developed for all cardiac patients in that unit (including those not on a specific pathway) to improve utilization. The frontline staff and medical team in the intermediate care unit felt that if discharge goals sheets were used for all of the cardiac patients, then there would be improved adherence to pathway goals for the ICP patients.
- As the clinical pathways were implemented and accepted by frontline staff, we found that some of the team members wanted to spread the ICPs to similar patient populations not necessarily fitting one of the clinical pathway diagnoses. For example, a patient that had a cardiac surgical procedure that allowed for a short ventilation period and ICU stay (atrial septal defect) may have a similar post-operative plan and goals as the VSD patient. In these cases, the team requested to use the VSD clinical pathway to standardize the care of these patients. In response, we are creating generic cardiac clinical pathways that focus on expected length of stay for patients that do not fit a current specific pathway. This process could be designed from the beginning focusing on similar surgical populations and not specific surgical repair types. This may allow for a decreased total number of clinical pathways or may allow for standardized care while more specific clinical pathways are developed.

Measurement

- We found it extremely helpful that the cardiothoracic nurse practitioner, who treats all of our patients, also had been the STS data manager for our congenital heart surgery patients for the past several years. She had the historical perspective of STS and data definitions, and could remember details about the patients.
- Some of the institutional data (not from STS) had not been reviewed in this way before, and it took several rounds of running the data to get what we needed. Given that this challenge is likely unavoidable in your institution as well, we recommend gathering a data team with clinical and data experts from both the project team and the data source or department as early in the project as possible in order to figure out the best way to obtain data.

Reference

[1] Pasquali SK, He X, Jacobs JP, et al. Evaluation of Failure to Rescue as a Quality Metric in Pediatric Heart Surgery: An Analysis of The STS Congenital Heart Surgery Database. *Ann Thorac Surg*. 2012;94:573-80.