PAC3

Chest Tube Change Package

VERSION 1.1

Pediatric Acute Care Cardiology Collaborative

Table of Contents

1 Introduction

Background

Chest tube (CT) placement after congenital heart surgery is a nearly ubiquitous experience. The management of CTs in the early post-operative period can be variable, as we described in previous ***publications.****** This includes discrepant criteria for removal, daily monitoring, and timing of discharge after removal.

In 2017, PAC^3 launched an initiative to describe the variability in management after placement of chest tubes following cardiothoracic surgery. We collected data from over 1,000 patients undergoing one of nine surgeries benchmarked by the Society of Thoracic Surgeons (STS) benchmark surgeries, from 9 centers across the country.

We found a vast range of management strategies, including a stand-out center with consistently low duration of CT placement across all benchmark surgeries, and a culture of early removal. Notably, this site had a comparably low rate of reinsertion for CTs, no different from the other sites studied. They also had a shorter length of stay (LOS) for multiple operation types. Based on this data, the **PAC^3 Chest Tube Project** was proposed—sites could choose strategies that work within their local context, with the overall aim of reducing the duration of chest tube.

Data on patients undergoing 10 STS benchmark surgeries was collected across two cohorts. The Pioneer cohort consisted of 9 original centers (began 6/2017), while the Spread cohort included 9 new centers with an aim of spreading success (began 5/2019). Each cohort consisted of a baseline phase (Pinoneer: 6/2017–6/2018, Spread 2: 5/2019–8/2019) and an intervention phase (Pioneer 1: 7/2018–12/2020, Spread 2: 9/2019–12/2020). Our SMART Aim was to reduce overall post-operative chest tube duration by 20% from baseline. Monthly webinars with peer support, data transparency, and quality improvement (QI) education fostered collaborative learning. Statistical process control methods and traditional statistics were used to analyze chest tube duration and LOS changes over time.

A total of 5,377 patients from 18 centers are included in the combined era analysis. No demographic differences in eras were found. The Pioneer cohort (n=3547) has sustained a 23.69% reduction in CT duration (median 88.76 vs 67.73 (p=<.0001) and a 12.5% reduction in LOS days (median 8 vs 7, p=0.005). The Spread cohort (n=1596) shows a 5.09% reduction (median 68.17 vs 64.7, p<.0001) in CT duration in the first 15 months of the intervention phase. Rates of reinsertion (1.78% vs 2.00% , p=0.6584) and readmission for effusion have not changed (1.27% vs 2.00%, p=1.0000). See ***Heart Leader Meeting Presentation*** template in ***Folder A*** to view control charts.

TOTAL CHEST TUBE PROJECT DATA COLLECTED OVER TIME FROM:

5,377
PATIENTS

10
KINDS OF SURGERIES

18
CENTERS IN THE U.S. & CANADA

RESOURCES

See ***Folder 1*** for pdfs of each of the following ***Publication References***:

- Bates KE, Madsen NL, Khadr L et al. (2018) Center variation in chest tube duration and length of stay after congenital heart surgery, *Annals of Thoracic Surgery*. https://doi.org/10.1016/j.athoracsur.2019.09.078
- Taylor AC, Bates KE, Kipps AK, (2018) Variability in paediatric cardiac postoperative chest tube management, *Cardiology in the Young*. doi: 10.1017/S104795111800152X
- Abstract: Bates KE, Khadr L, Donohue J, et al. (2018) Variation in chest tube duration and length of stay across centers in the Pediatric Acute Care Cardiology Collaborative and Pediatric Cardiac Critical Care Consortium, *Circulation*.
- Abstract: Bates KE, Madsen NL, Khadr L, et al. (2019) Successful reduction of postoperative length of stay after congenital heart surgery: a multicenter Pediatric Acute Care Cardiology Collaborative and Pediatric Cardiac Critical Care Consortium improvement project, *Circulation*.

2 Using the Change Package

Congratulations on your commitment to improving pediatric post-operative care by decreasing CT duration in your heart center!

This change package is designed to enhance the efficiency of your quality improvement (QI) efforts. It is built on well-proven QI principles and personal experiences of the PAC^3 CT project conducted at 18 sites.

Essential stages dicussed in this change package include:

A Project Planning
B Document Current State & Set Goal
C Develop Theory for Improvement
D Design and Test Changes
E Implement
F Sustain

— PRO TIP —

"The formal QI tools can really be helpful. I wish I had done a formal stakeholder assessment up front as I would have been more likely to identify a group I needed specific buy in from."

ALAINA KIPPS
Lucile Packard Children's Hospital

Document Components:

Summary
A narrative summary of each of the essential elements.

Tasks
Tasks for your team to complete throughout the project.

QI Tools
Links to QI education and tools through the Institute for Healthcare Improvement (IHI)*

Resources
Examples and resources from the PAC^3 chest tube member centers' experiences.

*Resources to support each element can be found on the ***PAC^3 SharePoint site.***

*Many of the resources on IHI are free and open to the public. Some of the resources referenced will require an IHI Open School license. If your center is a member of any of the Cardiac Networks United collaboratives (including PAC^3), you can email **pac3@childrens.com** to get a license through the collaborative.*

*Participating centers are mentioned throughout this document. You can find a list of clinical champions to connect with on the **PAC3 website.***

*The **IHI QI Essentials Toolkit** contains many of the tools you will need.*

3 Chest Tube Project Road Map

This section outlines the steps your team should take to ensure the successful implementation of a new CT process. While the steps are listed in a linear fashion, please note they should often be done in parallel. Furthermore, many of these steps are synergistic.

Start by reading the entire project road map so you can approach the tasks most efficiently.

RESOURCES

See *Folder 3* to download the *Chest Tube Project Road Map* below.

STAGE	STEPS	TOOLS & TIMING
A Project Planning	• Engage stakeholders (A–F)* • Build team • Set up recurring meetings	• Stakeholder Analysis • Project Charter 1 month
B Document Current State & Set Goal	• Understand operational definitions and measures • View data in Arbormetrix • Understand current chest tube removal process • Set SMART AIM	• Statistical Process Control Charts (B-F)* • Process Map • SMART AIM • Operational Definition 1 month
C Develop Theory for Improvement	• Determine: What key drivers need to be addressed? What changes might work in your specific environment to drive improvement?	• Key Driver Diagram 1 month
D Design & Test Changes	• Build and test PDSAs around interventions on your KDD • Monitor and learn from variation (D–F)* • Ensure reliability (C–F)*	• PDSA and PDSA ramps • Pareto Charts • Levels of Reliability • Change Concepts 3 – 6+ months
E Implement	• Implement changes based on PDSA testing • Monitor and learn from variation • Address challenges to implementation • Ensure reliability • Spread to desired patient populations	• IHI Psychology of Change • Implementation Plan 3 – 12+ months
F Sustain	• Move project into sustain	• 5 Whys • Sustain Plan ... ongoing

**Steps and tools highlighted are to be used in more than one stage of the project.*

A
Project Planning

In this stage you will focus on setting up the foundational items that are necessary for a sucessful project. Many of the items can be worked on concurrently.

STEPS include:

- Engage Stakeholders
- Build Project Team
- Set Up Recurring Meetings

QI TOOLS recommended:

- *Stakeholder Analysis*

RESOURCES – *Folder A*

- Surgeon's Viewpoint: Dr. Tweddell
- Stakeholder Engagement PDSA Ramp
- Parent's Viewpoint: Mariel
- Stakeholder Tips from the Trenches
- Stakeholder Analysis Examples
- Heart Center Leader Meeting Template
- Quality Improvement Team Member Matrix Worksheet
- Project Meeting Schedule Example

"Short chest tube durations mean less time being uncomfortable, less time getting pain meds, a faster recovery process and hopefully shorter hospital stay." ***—Sameer, dad of Dev***

Engage Stakeholders

A stakeholder is a person whose perspective and/or role is critical to a process. There are many stakeholders in the chest tube management process and it is important to ensure they are either on your team or part of early discussions to get their approval.

It is essential to secure **sponsorship and support** from the institution (e.g., division chief, head of cardiothoracic surgery, quality officers; leaders from the ICU and acute care areas of your heart center; nurse managers in the ICU and acute care areas). Beyond simply removing barriers, having support and engagement from your senior leaders can help facilitate change and improvement.

TASKS

1. Heart Center Leader Meeting

Meet with members of your heart center leadership/administration and have prepared "talking points". Ideally, these would include some preliminary data demonstrating the need for their attention to this issue. See *Folder A* for a slide deck that you can customize for these meetings.

Use this meeting to identify all key stakeholders. In addition to heart center leaders, other stakeholders include cardiothoracic surgeons, the cardiac ICU attending group, surgical and CICU APPs, bedside providers, and patients and families.

2. Complete Stakeholder Analysis and Engage Key Stakeholders

Once your key stakeholders are identified, meet with them to gain their support. Consider including the following:

- Aligning goals of the improvement effort with the strategic goals of the organization
- Showing data about shortened LOS and relative safety as demonstrated by stable reinsertion and readmission rates at participating sites
- Provide local data regarding CT duration and LOS for benchmark surgeries compared with the model site and post-implementation CT duration/LOS of pioneer sites.
- Consider interviewing one or more families with long chest tube duration about the impact on their child's experience during the hospitalization.

"The biggest breakthrough was activating the Advanced Practice Providers group to take over the process."

—Shreya Sheth, Texas Children's Hospital. *See more Tips from the Trenches in Folder A.*

QI TOOL

Stakeholder Analysis Template

RESOURCES

See *Folder A* for the following resources:

- A *Surgeon's Viewpoint: Dr. Tweddell* discusses his experience with the chest tube project at Cincinnati Children's
- *Stakeholder Engagement PDSA Ramp* example
- *Stakeholder Tips from the Trenches*
- A folder containing *Stakeholder Analysis Examples*
- A *Parent's Viewpoint: Mariel*

Build Project Team

It takes a full team to implement change effectively. The team should include members who understand current practice, providers who can influence future practice, facilitators who understand QI principles and methodologies, and those who are needed for specific tasks related to the effort, such as data gathering.

Participating sites identified Advanced Practice Providers, physicians, surgeons, and data champions as team members critical to the success of the project. Other team members should include nurses and other bedside providers, CICU providers, and fellows.

TASK

Build Chest Tube Project QI Team

RESOURCES

Need some guidance? Download the *Quality Improvement Team Member Matrix Worksheet* from IHI.

Set Up Recurring Meetings

Regular team meetings are key to making progress. Set up recurring meetings at the project start and ensure team members have support to attend.

TASK

Set up Recurring Meeting for Chest Tube Project Team

RESOURCES

See the *Project Meeting Schedule Example* in *Folder A* for ideas.

"Invest in your stakeholders. Share your data."
—Nicolas Madsen, Cincinnati Children's

B
Document Current State & Set Goal

In this stage you will focus on understanding the current state by reviewing local data and processes. This process will help to inform your goal.

STEPS include:

- Understand Operational Definitions and Measures
- View Data in ArborMetrix
- Understand Current Chest Tube Removal Process
- Set SMART AIM

QI TOOLS recommended:

- *Statistical Process Control Charts (B-F)*
- *Process Map*
- *SMART AIM*

RESOURCES – *Folder B*

- Operational Definitions
- ArborMetrix Video
- Baseline Process Map Examples
- Site SMART AIM Examples

"Shorter chest tube duration for patients and families in general means that kids feel better faster and can more quickly and easily move the way kids want. Especially important for those toddlers who have trouble being chained to a drainage box with their active little bodies!"
—Missy, mom of Bernie

Understand Operational Definitions and Measures

Work with your team to identify the family of measures.
Examples of measures used in the PAC^3 CT project are below:

Outcome Measure = Chest Tube Duration
Balancing Measure = Chest Tube Replacement Rate
Balancing Measure = Readmission for effusion within 7 days of discharge

Process measures to consider:

- Chest tubes pulled on Post-op day 1
- Chest tubes pulled by Post-op day 2

- Pain medication use*
- Diuretics use* *(Note: This was originally tracked by the collaborative, but abandoned because the project had no measurable effect on diuretics use.)*

** Additional measures included at individual centers.*

Population (see SMART AIM below):

- Inclusion criteria
- Exclusion criteria

A clearly written, concise operational definition ensures the data will be collected and understood consistently across your team, stakeholders, and department.

TASKS

1. Determine inclusion/exclusion criteria for your site project
2. Determine all measures to be collected, operational definition of measures and method for collection.

RESOURCES

See *Folder B* for the *Operational Definitions* examples.

View Data in ArborMetrix

Coming Soon!

This data will be available after the release of Version 1.5 of the registry.

QI TOOL

Statistical Process Control (SPC) Charts

RESOURCES

The ArborMetrix video on how to access chest tube data and apply filters will be available after the release of Version 1.5 of the registry.

Understand Current Chest Tube Removal Process

Understanding current practice will help guide testing, identify opportunities for change and help team leaders prioritize efforts. While CT removal may seem very simple, the steps leading to the decision to remove the tube are complex and involve stakeholders with differing workflows and priorities. Process mapping can clarify the gap between current and optimal practice. Members of the team with the most detailed understanding of the best practice will be able to recognize and highlight the gaps.

— PRO TIP —

"Frequent review of patient data by entire project team can lead to better understanding of process and decision making."

NANCY RUDD
Children's Hospital of Wisconsin

TASK

Complete a Process Map

QI TOOL

Process Map

RESOURCES

See *Folder B* for *Baseline Process Map Examples*.

Set SMART Aim

The aim for the project will guide all future work so it is important to create an aim that is SMART (Specific, Measurable, Achievable, Realistic, and Time Defined). As an example, the pioneer phase SMART aim was: *The collaborative will decrease CT duration by 20% from 144 hours to 115 hours in single ventricle (1V) patients and from 90 to 72 hours in two ventricle (2V) patients, with ≤4% overall reinsertion rate by May 31, 2019.*

Determine the target population(s) and clearly define the scope of your efforts. Consider these questions:

- Which patient population(s) will be targeted and which specifically excluded?
- Will you target the patients of one or more surgeons?
- How long will the pilot test last?

We encourage a broad scope of efforts to reduce your CT duration, but it is often helpful to start with a small aim and expand over time.

TASK

Refine the General Aims

Add an expectation of time to achieving the aim and define the patient population in question, following the SMART criteria:

SMART Aims

- Specific
- Measureable
- Achievable
- Realistc
- Time Defined

QI TOOL

SMART Aim

RESOURCES

See *Folder B* for the *Site SMART Aim Examples*.

C

Develop Theory for Improvement

In this stage you will focus on developing your theory for improvement by building a Key Driver Diagram (KDD).

STEPS include:

- Create Key Driver Diagram

QI TOOLS recommended:

- *Key Driver Diagram*

RESOURCES – *Folder C*

- PAC³ Network Key Driver Diagram
- Site Example Key Driver Diagrams

"I could feel the chest tubes whenever I moved. I hated having to walk with them in... the pulling sensation was uncomfortable. Honestly, I still think about them occasionally." ***—Eli, patient***

Create Key Driver Diagram (KDD)

This step will help focus your selection of changes to test by identifying key factors that affect your process. A KDD is a living document that states your team's theory about what changes will ensure the SMART aim is achieved.

TASK

Create Your KDD

KDDs are meant to be updated throughout the project to track your progress and changes as you further build your theory for improvement. Use this document at meetings to ground the team in the theory as well as specific interventions.

QI TOOL

KDD

RESOURCES

See *Folder C* for the *PAC³ Network Key Driver Diagram* and *Site Example Key Driver Diagrams* resources.

D
Design and Test Changes

In this stage you will focus on testing changes through Plan-Do-Study- Act (PDSA) Cycles.

STEPS include:

- Build and Test PDSAs Around Interventions on Your KDD
- Monitor and Learn from Variation
- Ensure Reliability

QI TOOLS recommended:

- *PDSA & PDSA Ramps*
- *Control Charts*
- *Pareto Charts*
- *Reliability / Levels of Reliability*

RESOURCES – *Folder D*

- Practice change in sites that demonstrated shifts in CT duration
- PDSA Examples
- Pareto Chart Examples
- August 2020 Reliability Webinar

"Getting [chest tubes] out was one step closer to my being able to hold him, so I was glad to see them go!" ***—Corey, mom of Noah***

Build and Test PDSAs Around Interventions on Your KDD

You have now reached the point of testing changes through plan–do–study–act (PDSA) cycles. Remember that PDSAs are meant to be small tests of change focused on rapid learning, and the changes are *temporary*. These tests should start small and increase in size to test for a variety of conditions. You should continue to test until you have a high level of confidence that tests show improvement and do not create any adverse effects. Reviewing the data is essential.

TASK

PDSA Cycles

Run PDSA Cycles to test the effectiveness of proposed interventions on your KDD.

QI TOOL

PDSA and *PDSA Ramps*

RESOURCES

See *Folder D* for the following resources:

- A list of participating *sites that demonstrated shifts* in chest tube duration. It may help to find centers whose pre-intervention CT removal strategy is similar to your own and view examples of their PDSA cycles.
- A folder of *PDSA Examples* tested at member centers

Monitor and Learn From Variation

Monitor your SPC charts as you test changes. Visualizing the data will be the best way to understand whether your tests are leading to improvement.

When studying the results of a test, record barriers and issues encountered during testing.

There will be patients who don't fit perfectly into your intervention process; similarly, chest tubes will not all be pulled when criteria is met. Documenting why these patients did not have CTs pulled when they met criteria will allow you to identify appropriate reasons for deviation and to intervene when needed.

TASK

Track Deviations

Devise methods to track deviation from your CT removal process. Revise your intervention on the basis of feedback from users and patient needs. Share these deviations with stakeholders.

QI TOOLS

Control Charts
Pareto Chart

RESOURCES

See *Folder D* for *Pareto Chart Examples*.

Ensure Reliability

Reliability is the capability of a process to perform its intended function in the required time under existing conditions. In the CT project this means the extent of failure free removal of CTs. "Failure" in this case could mean not removing the tubes when your protocol outlines, or it could be an effusion requiring reinsertion.

QI TOOLS

Reliability / Levels of Reliability

RESOURCES

See *Folder D* for the *August 2020 Reliability Webinar* including a presentation from *Sick Kids* sharing on building reliability via training nurses to remove chest tubes.

— PRO TIP —

If the project is stalling, take a step back and ask which stakeholders might not have been brought into the discussions. (e.g. are the adult patients having tubes stay in longer than they should?) Go back to ACHD colleagues to discuss.

E
Implement

In this stage you will focus on implementing the changes you have previously tested that demonstrated progress toward your outcome measure.

STEPS include:

- Implement Changes Based on PDSA Testing
- Address Challenges to Implementation
- Spread to Desired Patient Populations

QI TOOLS recommended:

- *IHI Psychology of Change*
- *Implementation Plan*

RESOURCES – *Folder E*

- Example Algorithm for Chest Tube Removal
- Overcoming Barriers
- Internal Site Spread Tool

"Going forward, having a shorter chest tube duration means that there is the possibility that families of kids who have heart surgery can get back to their "normal" lives sooner, which is always a good thing." ***—Mariel, mom of Eli***

Implement Changes Based on PDSA Testing

Implementation is the process of making the changes tested during PDSA cycles permanent. Your team should have a high level of confidence in the positive effect of the new process.

When moving to Implementation, focus on developing processes to maintain the change. Ensure the change is integrated into processes and consider how to make it the standard care practice. This requires focus on change management.

TASK

Implement Change

QI TOOLS

IHI Psychology of Change

Implementation Plan

RESOURCES

See *Folder E* for an *Example Algorithm for Chest Tube Removal* from Childrens Heart Center at the University of Michigan

Address Challenges to Implementation

The most reliable way to ensure sustainability is to thoroughly complete the early steps. However, resistance to improvement is expected and may be ameliorated by:

- Assessing the stakeholders' beliefs, knowledge, and attitudes towards the new process
- Ongoing PDSA cycles around adherence to the processes
- Listening to concerns from stakeholders and publicize actions taken to address them
- Training new staff (e.g. new fellows and advance practice providers) in the new process
- Transparent sharing of center data

RESOURCES

See *Folder E* for tips on *Overcoming Barriers.*

Spread to Desired Patient Populations

Spread is when you disseminate the implemented changes beyond the improvement team's initial aim population to new populations. For example, if you began by only implementing changes on 2V patients you could consider spreading your changes to 1V patients or a subset of this population.

RESOURCES

See *Folder E* for the *Internal Site Spread Tool.*

— PRO TIP —

"Present this project widely at Heart Center meetings so others who find this work important can engage the surgeons. Having just a few people trying to lift this project doesn't work."

RONN TANEL
UCSF Benioff Children's Hospital

For more tips to address challenges, see the Overcoming Barriers document in Folder E.

F
Sustain

In this stage you will focusing on ensuring the new process will continue reliably and indefinitely.

STEPS include:

- Move Project Into Sustain

QI TOOLS recommended:

- *5 Whys: Finding the Root Cause*
- *Sustain Plan*

RESOURCES – *Folder F*

- 5 Whys CT Example
- Sustain Plan Cincinnati Example

Move Project Into Sustain

To be able to successfully sustain a change, a system must be in place to monitor the data. This allows the team to detect and respond to special cause variation and maintain improvements over time. To accomplish this, consider six areas:

- **Standardization:** define, document, disseminate the process, clearly stating what to do and how to do it.
- **Accountability:** monitor the process to ensure compliance
- **Visual Management:** Information (quantitative or qualitative data) about the new process is available to staff
- **Problem Solving:** As problems arise there are methods the front line staff should be empowered to address using tools like *5 Why's: Finding the Root Cause.* See the *5 Why's CT Example* in *Folder F.*
- **Escalation:** If front line staff is not able to resolve the problem, there is a clear escalation path and process to manage
- **Integration:** the goals and standard work are coordinated among the units and departments.

We recommend accomplishing this through developing a Sustain Plan.

QI TOOLS

5 Whys: Finding the Root Cause
Sustain Plan

RESOURCES

See *Folder F* for the *5 Why's CT Example* and the *Sustain Plan Cincinnati Example*.

— PRO TIP —

Congratulations on improving patient care! Don't stop now—create a manageable plan for sustaining your improvement to ensure you don't slip back to "the way things were!"

4 Acknowledgments

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- Cincinnati Children's Hospital
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- Medical University of South Carolina
- The Hospital for Sick Children
- UCSF Benioff Children's Hospital
- University of Michigan / C.S. Mott Children's Hospital
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Pediatric Acute Care Cardiology Collaborative

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