Institute for Healthcare Improvement

Better Quality Through Better Measurement: Case Study

Note: Although the case study is based on several actual improvement initiatives and draws upon the infection control literature and government sources, it is fictitious and does not reflect care at any specific institution or facility.

For Your Own Project

- What are you trying to accomplish (your aim?)
- What is the outcome measure that best captures the aim of your project?
- What is the baseline level of performance on the outcome? How much does the outcome need to improve?

THE CAUTI CASE STUDY

1. Background: Reducing Catheter Associated Urinary Tract Infections (CAUTIs)

A medium sized acute care hospital has noticed that there has been an increasing occurrence of catheter associated urinary tract infections (CAUTIs) over the past year. Not only has the occurrence of CAUTIs been gradually going up but also the severity of the infections has been increasing.

Indwelling urinary catheters are commonly used medical devices within acute and non-acute settings. But their use does increase the risk of CAUTIs by:

- Enabling organisms to gain entry to the bladder via external surface or opened connections
- Reducing the body's defense of flushing out organisms during urination
- Facilitating biofilm formation

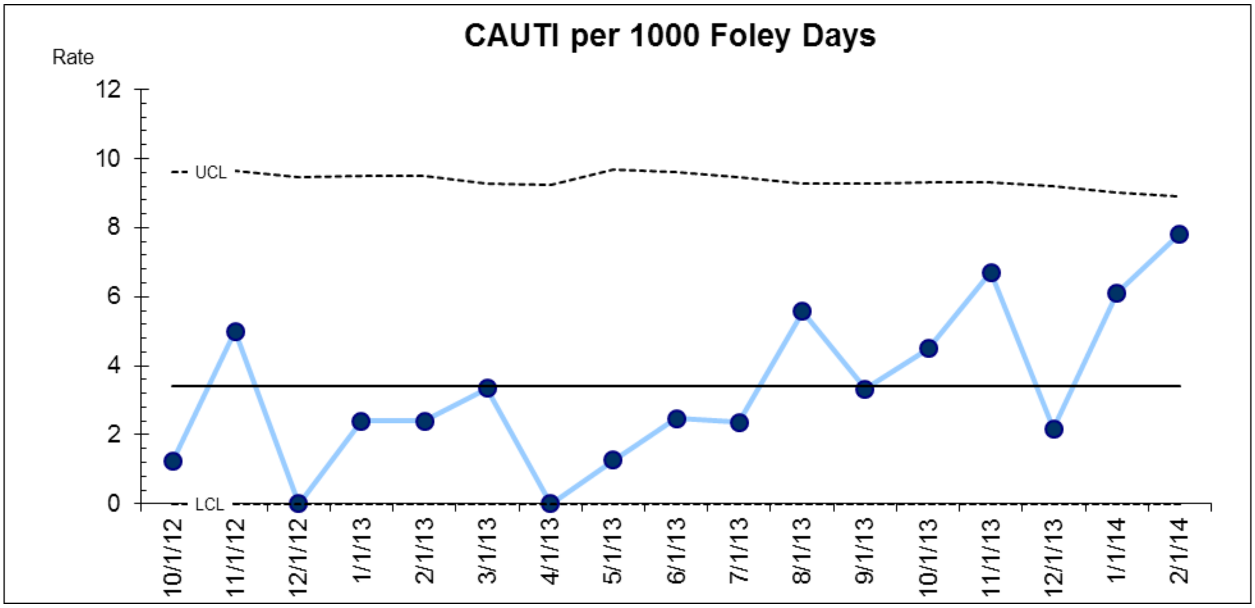
Reducing CAUTIs would contribute to:

- Improving the patient experience
- Reducing the cost of antibiotic prescribing
- Reducing inpatient length of stay
- Reducing readmissions
- Improving patient outcomes

2. Organizing the Initiative

A core improvement team was identified, which included an Executive Sponsor, a Project Manager, an Improvement Advisor, a staff urologist with a keen interest in CAUTI reduction, a Staff Development representative, clinical nurses from an ICU and a general med/surg unit, an Infection Control nurse and a member of the Patient and Family Engagement team.

The team reviewed infection data for the past 17 months, and created a control chart to assess the current state of the system. The chart below is a u-chart which is used for rate based measures such as the CAUTI rate per 1000 Foley days.



The graph shows the number of CAUTI infections per 1000 catheter days. Since the risk of a UTI is roughly proportional to the time that the catheter is in place, this measure adjusts for patients with longer or shorter catheter durations. The graph is a U-type control chart, which is appropriate for rates. The chart exhibits a strong special cause – 8 sequential points below the mean from Dec-12 through Jul-13 – which is consistent with a rising rate of infections since that time.

The team also reviewed benchmark data from comparable institutions that revealed a median of 2.31 and a 10th percentile of 1.60 CAUTIs per 1000 Foley days..

After considerable discussion of the current state of their system and the potential for successfully completing an improvement initiative to reduce CAUTIs, the team formulated the following aim statement:

> ***AIM: Reduce CAUTI infections in all units below 1.6 (10th percentile) within 12 months and to zero within 24 months.***

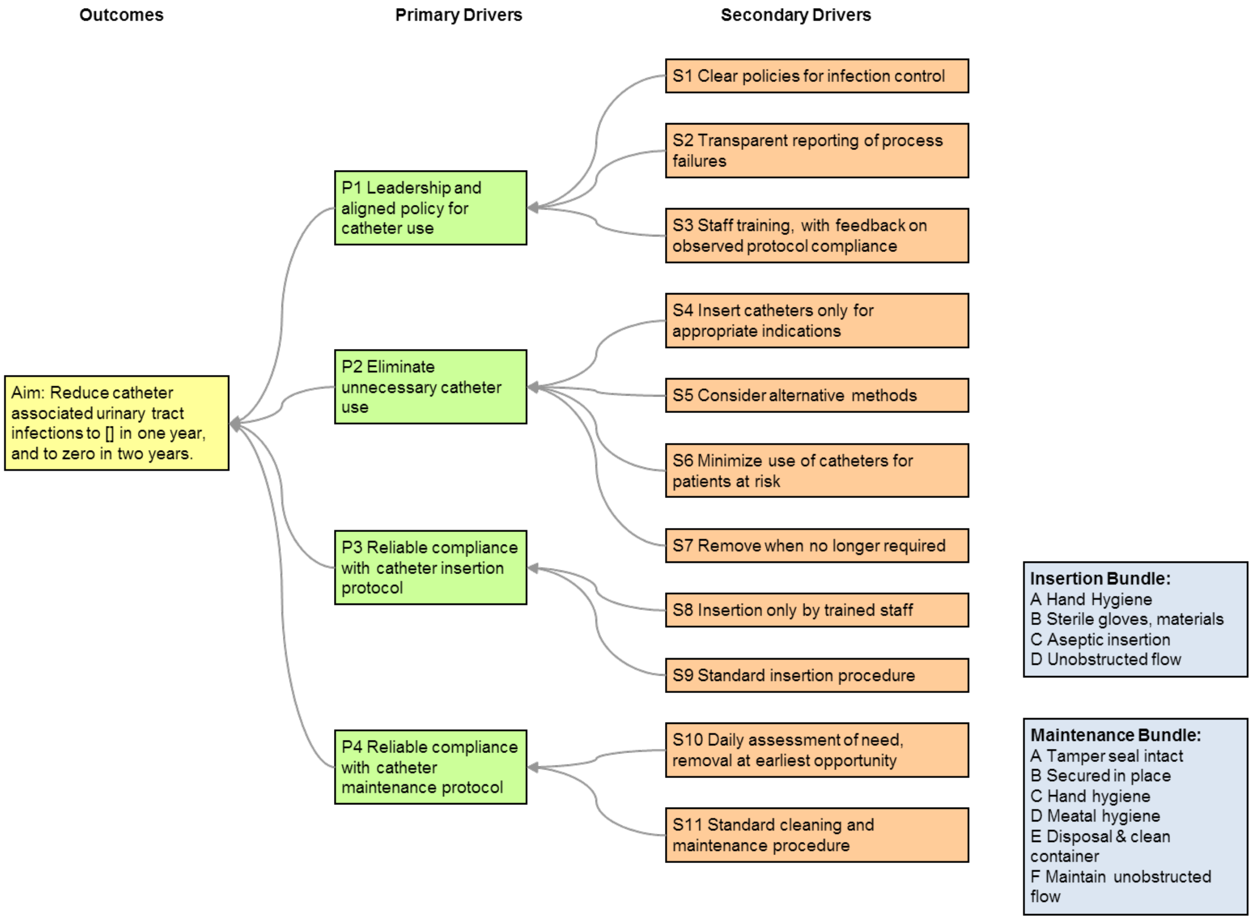
3. Developing an Improvement Theory

Led by the infection control nurse with the assistance of the team Improvement Advisor (IA), the team reviewed literature from the CDC and other sources, and constructed a *driver diagram* to capture their best thinking about

For Your Own Project

- What are the factors that will drive improvement in your system?
- What changes will need to occur to achieve your aim?

what factors would be important for achieving their aim.



4. Identifying Outcome Measures

The outcome measure for the CAUTI initiative is based on standard industry practice. As noted above, it is the infection rate: the number of infections per 1000 Foley catheter days.

In addition to the rate, the team felt that it was important to track the number of infections. Since this is the count of actual patients who suffered avoidable harm, it more directly engages staff in adhering to prevention procedures.

5. Identifying needed process measures

In discussion with their infection control specialists, the team identified secondary drivers that would have the highest impact on infection rates. (Note: The letter/number references below – e.g. S4, S7 – refer to the Secondary Divers in the driver diagram on the previous page.)

- ***S4****: Insert catheters only for appropriate indications.* The most effective way to eliminate the possibility of a CAUTI is to eliminate an unneeded catheter.

- ***S7**: Remove when no longer required*. Since the risk of infection is roughly proportional to the time the catheter is in place, removing catheters as soon as possible will reduce the risk.
- ***S9**: Standard insertion procedure*. If trained staff follow strict protocols for aseptic insertion of catheters, the risk of bacterial infection will be minimized.
- ***S11**: Standard cleaning and maintenance procedure*. Similarly, careful adherence to the components of the maintenance bundle will reduce risk.

> **For Your Own Project**
>
> - What are the key processes or other drivers that will need to be improved to achieve your aim?
> - What measures might you use to track improvement in those processes?

These drivers involve care processes that are critical to reducing CAUTI risk. The improvement initiative will concentrate on increasing the reliability of these processes. To track the progress of their work, the team will measure these processes for change over time as well as the number of CAUTIs and the CAUTI rate.

6. Defining the measures

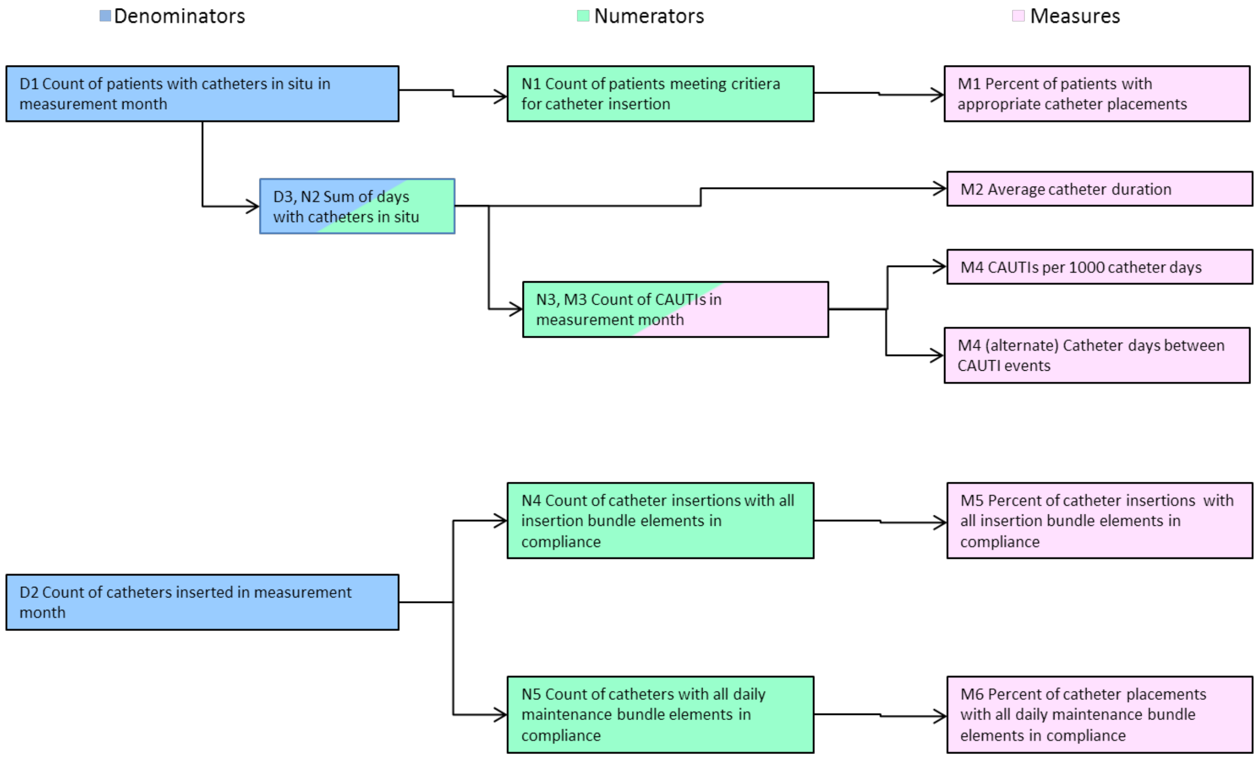
The Improvement Advisor led a session to acquaint the team with the principles of good improvement measure design. She stressed that to be useful for guiding improvement, measures must have certain attributes. The IA used the following slide as a guide for the discussion.

Attributes of Useful Improvement Measures

Responsive	The measure is sensitive to changes in the system state. When the system improves, the measure says so.
Valid	The measure aligns with the theory of changes (driver diagram). Improvement in the measure means improvement in the system.
Comprehensible	The intended audience understands the meaning of the measure for system improvement.
Timeliness	The data are available soon enough to inform improvement decisions (project planning, PDSA testing).
Feasible	The data can be collected with minimum effort and cost, and in a timely fashion.
Relevant	The measure supports problem identification and testing at the appropriate level of management.
Consistency	The measure has a clear definition: it yields consistent results when applied in different places and at different times.
Ownership	Someone is explicitly assigned to monitor the measure on a regular basis, detect problems, and initiate change.

After considerable discussion about the attributes of various alternatives, the team settled on a set of 6 measures for their project.

They then created a *measure tree* diagram (below) in order to further clarify their measures and to support a discussion with their infection control staff and clinicians.



A measure tree shows the relationship a between measure's numerator and denominator. In this case measures will be reported once per month. Note that item **D3,N2** is both the denominator for **M4** and the numerator for **M2**. Similarly, item **N3,M3** is the numerator for **M4** and a measure in its own right: 'Count of CAUTIs in the measurement month'.

For Your Own Project

- Consider the numerators and denominators you will need to calculate the key process measures for your system.

Process Measures

D1 is the count of patients with catheters; **N1** is the subset of those patients who met criteria for a catheter. These two counts yield the percentage of patients for whom catheters were appropriate. Increasing this number indicates progress on Secondary Driver **S4**.

The table below shows the relationship between measures and drivers.

Measure	*Type*	*Driver*	*Desired Direction of Change*
M1 Percent of patients with appropriate catheter placements	Process	S4 Insert catheters only for appropriate indications	Increase
M2 Average catheter duration	Process	S7 Remove when no longer required	Decrease
M4 CAUTIs per 1000 patient days	Outcome	N/A	Decrease
M3 Count of CAUTIs	Outcome	N/A	Decrease
M4 (alternate) Catheter days between CAUTI events	Outcome	N/A	Increase
M5 Percent of catheter insertions with all insertion bundle elements in compliance	Process	S9 Standard insertion procedure	Increase
M6 Percent of catheter placements with all maintenance bundle elements in compliance	Process	S11 Standard cleaning and maintenance procedure	Increase

Notes on the Measures

M4 (alternate): Should the infection rate (number of CAUTIs per 1000 catheter days) become very low, months can go by with no CAUTIs at all, and graphs of the measure become difficult to interpret. Hence the team specified an additional measure, *Catheter days between CAUTI events.* This measure can reveal increasing intervals between infections, thus tracking improvement even when CAUTIs are rare.

M5, M6: The measures of insertion procedure and maintenance procedure are both *all-none* reliability measures (aka 'bundle measures'). Because effective infection control requires adherence to multiple steps in the insertion and maintenance protocols, these measures require that all of the protocol elements be successfully enacted in order to be counted in the numerator of the measures. In addition, M6 requires that the maintenance protocol be enacted perfectly for every day that the catheter is *in situ*.

7. Operational Definitions and the Measurement Plan

The specifics of measurement are captured in *operational definitions*, which describe step-by-step procedures for calculating a measure, along with the data elements, criteria for inclusion and exclusion, and other details needed to ensure that measures are consistent over time and comparable across settings.

> **For Your Own Project**
>
> - Identify key terms that appear in your measures: can you define them in specific detail to enable someone else to calculate the value?

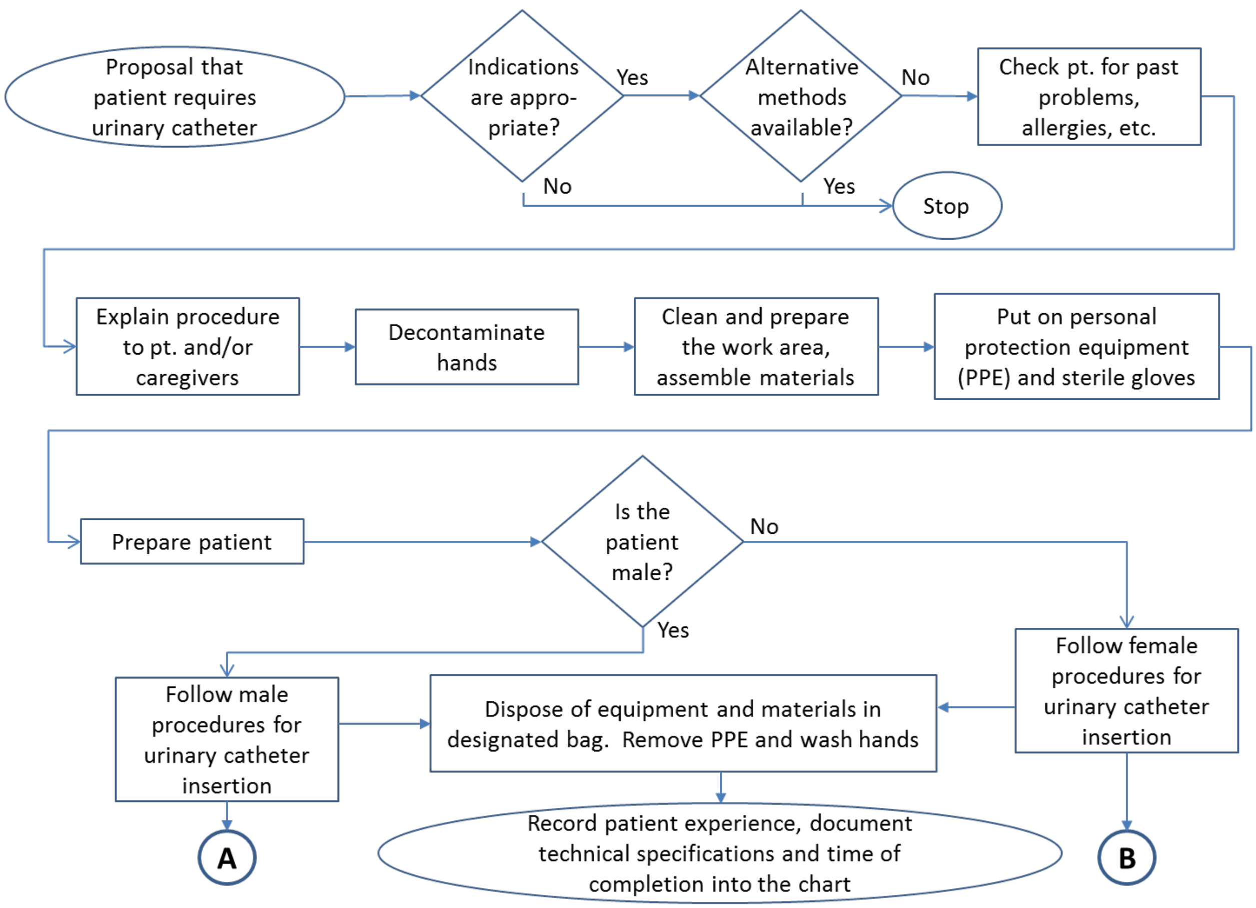
Note that the details of clinical operational definitions can be quite complicated, including specific diagnostic codes, risk factors, treatment types, or lab results. For example, CDC guidance on identifying catheter-associated urinary tract infections includes the following:

> Patient had an indwelling urinary catheter in place for > 2 calendar days, with day of device placement being Day 1, and catheter was in place when all elements of this criterion were first present together
>
> …and…
>
> at least 1 of the following signs or symptoms:
>
> fever (>38°C), suprapubic tenderness*, or costovertebral angle pain or tenderness*
>
> …and…
>
> a positive urine culture of ≥105 colony-forming units (CFU)/ml with no more than 2 species of microorganisms.
>
> -----OR-----
>
> Patient had indwelling urinary catheter in place for > 2 calendar days and had it removed the day of or the day before all elements of this criterion were first present together
>
> …and…
>
> at least 1 of the following signs or symptoms: fever (>38°C), urgency*, frequency*, dysuria*, suprapubic tenderness*, or costovertebral angle pain or tenderness*
>
> …and…
>
> a positive urine culture of ≥ 105 colony-forming units (CFU)/ml with no more than 2 species of microorganisms.
>
> * With no other recognized cause.
>
> (Source: http://www.azdhs.gov/phs/oids/hai/training/documents/nhsn/day1/6-CAUTI.pdf)

NOTE: The details of operational definitions are often subject to much discussion or disagreement by clinical staff. Even measures approved by national professional groups or accreditation organizations may not be readily accepted by all clinical faculty. Thus it is important that an organization embarking on an initiative like the one described here work with staff to develop standard definitions of key clinical concepts that can form the basis for consistent operational definitions.

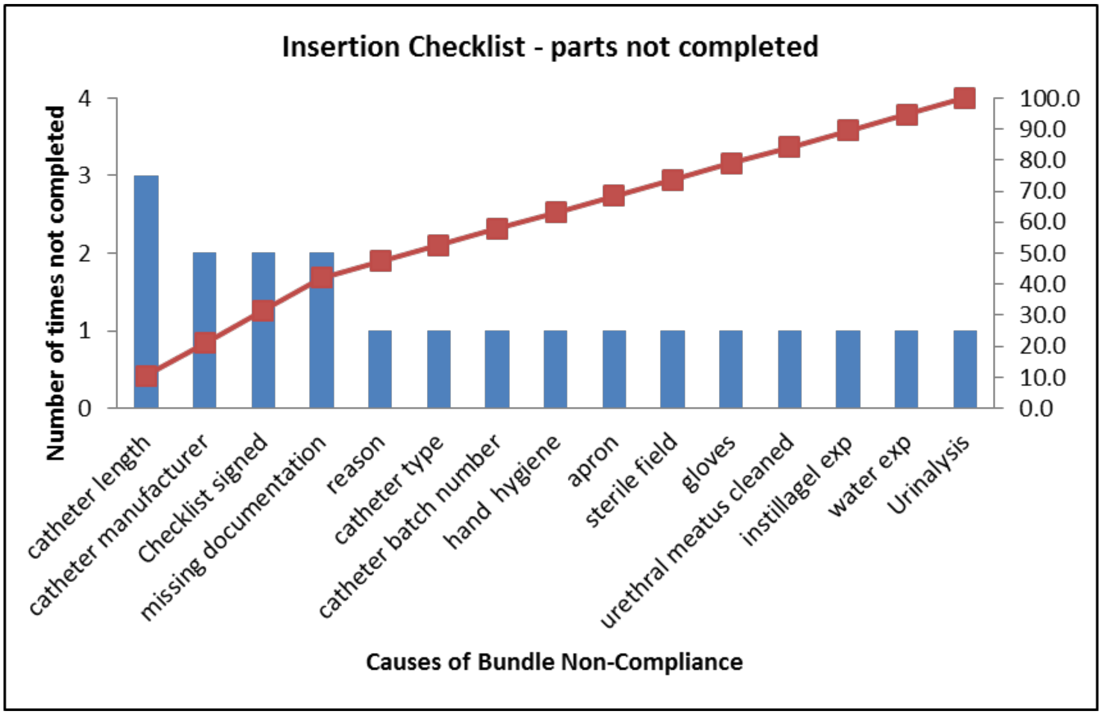
8. Process Map

Based on their driver diagram and the informed opinion of the nursing staff, the team decided to focus their initial work on the catheter insertion process on Floor 7 in the South Wing of the hospital (a critical care unit) in order to begin testing process changes to increase the reliability of insertion bundle compliance. In preparation for the meeting, the team drafted the following process map, which served to organize discussion about process problems that needed attention.



9. Logging Data, Diagnosing Process Failures and Testing Changes

In order to track the impact of their process changes, and to gather useful information about bundle failures, the team created a 'Foley Log' for Floor 7; the nurse supervisor (a member of the QI team) was tasked with logging each catheter insertion, including patient number, compliance with each of the bundle elements, reasons for non-compliance, and any contextual issues that might affect reliability. During the first month of the project, they organized their data into the following Pareto Chart, which revealed multiple lapses in documentation and technique.



In order to improve CAUTI bundle compliance, the team began a series of PDSA cycles to address problems revealed in their Pareto analysis. The team tested detailed process changes involving the following ideas:

- Provide a daily review of catheter documentation in connection with Foley Log
- A checklist of required indications for catheterization, with suggested alternatives
- Standardize catheter manufacturer
- Assemble standard 'Foley kits' that include catheters of various lengths, visual aid for insertion procedures, and a checklist
- Spot observations of aseptic technique including hand hygiene
- Maintain a sterile, continuously closed drainage system
- Keep collection bag below the level of the bladder at all times

For Your Own Project

- What changes have you identified that can improve the drivers of your aim? How can you test them on a small scale?
- How will you measure and communicate the impact of your changes?

- Empty collection bag regularly, using a separate collecting container for each patient, and avoid allowing the draining spigot to touch the collecting container

For Your Own Project

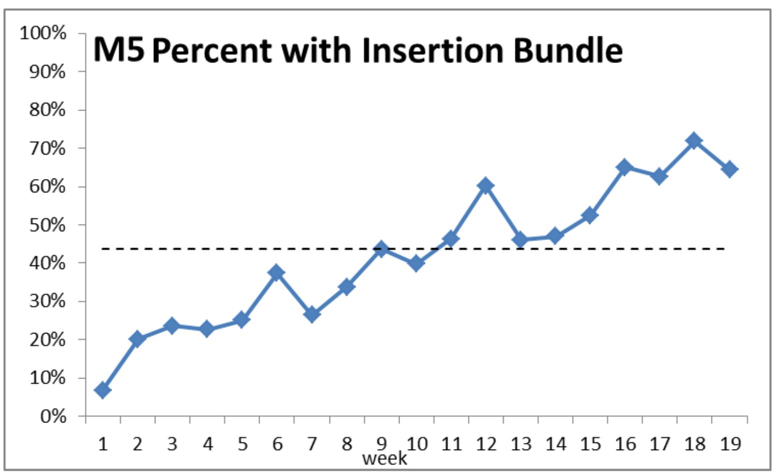
- How can you provide feedback to your team about progress? What opportunities will you have to discuss changes, testing, and data? Who needs to be involved in those discussions?

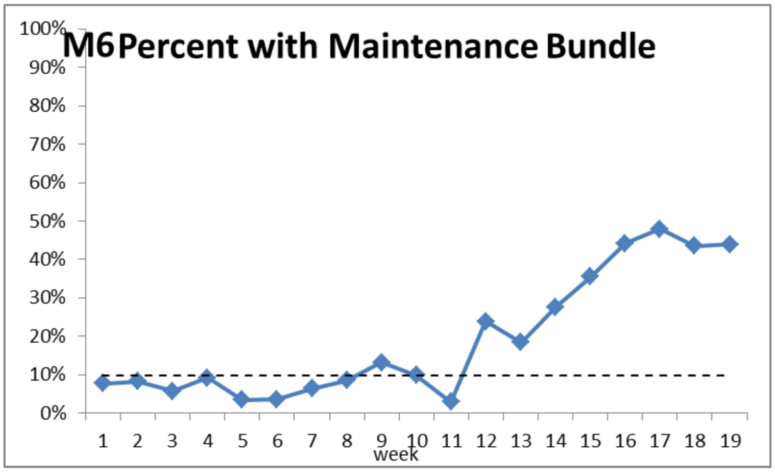
During PDSA testing the team used a number of '*PDSA measures*' to assess the impact of the changes. For example, they tracked the contents of the catheter kits, and when items were initially missing they tested a stocking process to ensure that the kits were complete. They kept close track, via direct observation, of hand washing technique, and gave feedback on proper procedures. They used a 'mini checklist' on index cards to measure the reliability of the bag emptying process. These items were reviewed with project staff each day during shift changes.

10. Results

The team recorded bundle compliance on a weekly basis. The following *run charts* show results for measures M5 and M6 over the course of the succeeding four months. These graphs were posted in the break room on Floor 7, and updated weekly. Results were reviewed in staff huddles at shift changes on Mondays.

In addition to the positive trends in the bundle measures, staff report that checklist and documentation compliance is high, and that the situational awareness of staff during insertion and maintenance procedures has been good.





The key outcome measure, CAUTI rate, is shown in the following U-Chart. While it is too soon to say that the project has prompted a drop in infections, the team is encouraged by the last three months' data, which correspond well with the increases in CAUTI bundle compliance.