

Online Appendix: Description of PDSA cycles leading to implementation of medical directive to remove unnecessary urinary catheters on a general medicine ward.

Cycle #1 Do we have a problem worth tackling?

We predicted that we had unnecessary urinary catheter use at our hospital. To test this hypothesis, we performed a point prevalence study. We decided a priori that a threshold of 80% appropriateness or greater would be an acceptable performance target while less than this would suggest that we have a problem of unnecessary urinary catheter use. One afternoon, six Infection Prevention Coordinators each went to an inpatient ward and walked through patient rooms counting urinary catheters. For each patient with a urinary catheter, the clinical team was asked about the current reason for catheterization. In 278 patient rooms, 54 (19%, 95% Confidence Interval (CI), 15-24%) patients were catheterized, of whom only 17 (31%, 95% CI, 21-45%) met an appropriate clinical indication based on published international guidelines.⁶ This performance fell significantly below the 80% threshold of appropriateness ($p < 0.001$).

Cycle #2 Further characterization of the problem: should we tackle catheter insertion, duration or both?

Having confirmed significant unnecessary urinary catheter use in our institution, we set out to identify whether the unnecessary use was driven by inappropriate insertions as opposed to appropriately inserted urinary catheters that were simply left in too long. We could have tested this hypothesis in different ways, but we chose to use the existing data from PDSA #1 and adjudicate how many unnecessary catheter days were related to insertion versus maintenance. We defined unnecessary insertion days as those related to inappropriate insertion. Unnecessary

maintenance days were defined as each day the initial appropriate reason for insertion was no longer present. The following table displays the data from 4 different wards.

Unit	Insertion days (%)	Maintenance days (%)
A	127 (64)	72 (36)
B	80 (47)	92 (53)
C	65 (47)	72 (53)
D	140 (57)	105 (43)

Based on this data, an intervention to limit inappropriate insertion days was predicted to have slightly more impact than one that promoted prompt removal of urinary catheters. Since most urinary catheter insertions occur in the Emergency Department (ED), we decided that an intervention in the ED would be the most effective by acting upstream of the problem.

Cycle #3 Testing a change idea in the Emergency Department to re-assess urinary catheters on admission

We predicted that partnering with the ED could reduce unnecessary urinary catheter insertions. To test different strategies, we first met with ED stakeholders who suggested adding urinary catheter insertion to an ongoing intervention aimed at improving staff accountability. This intervention involved a form that nurses were asked to complete to facilitate transition to the ward. In a subsequent meeting with the team responsible for implementation, we identified that this form was not intended to be left in the patient's medical record and that there would be no way to ensure that it was being used. In addition, we learned through our meetings that some

nurses perceived that this project could increase their workload. Due to lack of staff engagement and inability to track fidelity measures, we concluded that this change is unlikely to lead to improvement.

Cycle #4 Testing a change idea to remove urinary catheter insertion on admission ordersets

Following our lack of success with the ED, we shifted our attention to other ways of reducing unnecessary urinary catheter insertions for patients admitted to the ward. We predicted that our admission order sets were promoting routine urinary catheter insertions and to test this hypothesis, we audited admitted patients to determine how many urinary catheters were inserted due to a checked off order set. On our stroke unit, we found that 89% (8/9) unnecessary urinary catheter insertions were associated with the order set. The next action was to modify the order set to remove urinary catheter insertion as the default option. This change was put in motion through our institutional forms committee but because this process takes several months, we proceeded with other aspects of our improvement project.

Cycle #5 Shifting to urinary catheter removal on the ward: can we achieve consensus?

With an intervention under development to reduce urinary catheter insertion that was not yet deployed, we shifted our focus on removal of urinary catheters on the ward. We hypothesized that in principle most physicians are aware that leaving a urinary catheter in place can be harmful to their patients, but that in a busy clinical environment, urinary catheters are often a lower priority and left in place longer than necessary. To test this hypothesis, we wanted to see

whether a medical directive could be developed to have nurses assist in urinary catheter removal. The first step was to determine whether we could achieve consensus on the criteria from removing the urinary catheter. We surveyed all of the general medicine physicians and following multiple meetings, came up with a list of criteria that were agreed upon by everyone. In the course of this discussion, we discovered that there were concerns raised by some physicians about whether nurses would be able to recognize these criteria and remove urinary catheters appropriately.

Cycle #6 Can nurses recognize criteria for removing urinary catheters?

Informed by our discussion with physicians, we set out to determine whether nurses could enact a medical directive to remove urinary catheters. As a test of change, we performed usability testing with six nurse volunteers to see if they could apply the criteria for urinary catheter removal appropriately to different patient scenarios. In this process, they pointed out a number of usability problems including how following urinary catheter removal, nurses would be unclear about what to do next. Following multiple meetings and online discussions, the group of nurses expanded and they developed a post-catheter algorithm.⁵ At conclusion of this step, senior nurses who developed the medical directive felt that it was ready to be piloted.

Cycle #7 Will nurses use the medical directive?

When the medical directive was ready for use, we wanted to confirm that it was actually being used by front-line nurses. During the first week of its launch, we performed audits on the wards to look for urinary catheters left in place that should have been removed based on the directive.

We audited 30 consecutive patients with urinary catheters on transfer to the ward of whom 18 lacked exclusion criteria for the medical directive and each (100%; 95% CI, 82-100) had their urinary catheter removed within 24 hours suggesting greater than 80% fidelity of our intervention. In performing these audits, several nurses mentioned that applying the medical directive at 6am was the most efficient timing because it allowed the day-time nurse starting at 7am to provide post-catheter care. This timing was incorporated in the training of front-line nurses.

Cycle #8: Will the medical directive result in reduced urinary catheter days and/or inappropriately removed urinary catheters?

We predicted that use of this medical directive could result in less urinary catheter days and no inappropriate catheter removals. We tested the medical directive at a small scale on two units while two other units continued to receive usual care. Nurses on intervention wards each received a 20-minute training session on when and how to use the directive. Because we anticipated potential resistance from some physicians based on cycle #5, we gave nurses a telephone number to call if they were ever given a difficult time for following the directive. At baseline, control and intervention units had similar baseline urinary catheter use (18.7% vs. 18.9%), but utilization on the intervention wards decreased within 1-month to 7.9%, significantly below control wards (12.6%) ($p < 0.001$). An electronic trigger tool was created for any urinary catheter re-inserted within 48-hours of removal and these cases were reviewed to make sure that the initial reason for urinary catheter removal was appropriate. Of 4 catheter re-insertions, none met exclusion criteria for the medical directive. Based on this promising pilot study, use of the medical directive was extended for two additional months before determining whether to spread to all inpatient medical units.