AHRQ Safety Program for Improving Surgical Care and Recovery

Final Report

Agency for Healthcare Research and Quality

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Glossary of Terms and Abbreviations

ACS: American College of Surgeons
AHRQ: Agency for Healthcare Research and Quality
BMI: Body mass index
CC: Coaching call
CFIR: Consolidated Framework for Implementation Research
CI: Confidence interval
COVID-19: Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)
CPT: Current procedural terminology
CUSP: Comprehensive Unit-based Safety Program
DVT: Deep vein thrombosis
EGS: Emergency General Surgery
EHR: Electronic Health Record
EMR: Electronic Medical Record System
FTP: File transfer protocol
HCAHPS: Hospital Consumer Assessment of Healthcare Providers and Systems survey
ISCR: AHRQ Safety Program for Improving Surgical Care and Recovery
ILOS: Ileus and length of stay >75th percentile
Intraop: Intraoperative
JHU: Johns Hopkins University Armstrong Institute for Patient Safety and Quality
LOS: Length of stay
MIS: Minimally invasive surgery
NLW: National leader webinar
NPO: Nothing by mouth
NPT: National Project Team
NSQIP: ACS National Surgical Quality Improvement Program
OAS-CAHPS: Outpatient and Ambulatory Surgery Consumer Assessment of Healthcare Providers and Systems survey
OR: Odds ratio
OR: Operating Room
ORCA: Organizational Readiness to Change Assessment
Orthopedic surgery or orthopedic service line: refers to both hip fracture surgery/service line and hip/knee replacement surgery/service line
PE: Pulmonary embolism
POD: Postoperative day
Postop: Postoperative
PPX: prophylaxis
Preop: Preoperative
p.r.n: Pro re neta, meaning as the need arises
PROMIS: Patient-Reported Outcomes Measurement Information System Global Health Outcomes Scale
QI: Quality Improvement
RBC: Red blood cell and whole blood products
ROBF: Return of bowel function
Rx: Prescription
SIRS: Systemic inflammatory response syndrome
SSI: Surgical site infection
TXA: Tranexamic acid
UTI: Urinary tract infection
VTE: Venous thromboembolism
VUS: Composite outcome comprising VTE, UTI, or SSI

Executive Summary

Project Background

Surgical enhanced recovery practices are an innovative and integrated approach to delivering standardized, evidence-based care that concurrently addresses multiple types of perioperative patient harms and aims to improve overall quality of care. Enhanced recovery pathways have been associated with reducing surgical complications, improving patient experience, and decreasing length of hospital stay without increasing readmission rates.[1–5] Given such evidence, the goal of the Agency for Healthcare Research and Quality (AHRQ) Safety Program for Improving Surgical Care and Recovery (ISCR) is to measurably improve patient outcomes by increasing the implementation of enhanced recovery practices, within the Comprehensive Unit-based Safety Program (CUSP) framework, in hospitals across the United States. CUSP is well-known for sustaining patient safety improvement work and associated with preventing harm in multiple areas.[6–14] Thus, the AHRQ ISCR program, an integration of clinical and cultural interventions, is a collaborative program to enhance the recovery of surgical patients. The AHRQ Safety Program for Improving Surgical Care and Recovery consisted of five 18-month cohorts, spanning from the inception of the program in July 2017 through the last cohort period ending in February 2022. See Table 1 for details of cohort timelines. Hospitals within the United States (including Washington, DC) participated across the following service lines: elective colorectal, orthopedic (i.e., hip and knee replacement, hip fracture surgery), gynecologic, and emergency general surgery (e.g., bowel obstructions and urgent and emergent appendectomy and cholecystectomy). See Figure 8 for enrollment spread by state. Participating hospitals had access to U.S. leaders in enhanced surgical recovery, including representatives of surgery, anesthesiology, and nursing; prototype-enhanced recovery pathways based on up-to-date evidence review; literature to support pathways; tools and educational materials to facilitate implementation; quality improvement support from a nurse consultant; and coaching calls to support hospital work.

AHRQ contracted with the Johns Hopkins University Armstrong Institute for Patient Safety and Quality (JHU) and its partners, including the American College of Surgeons (ACS), the University of California San Francisco, Westat, and the Johns Hopkins Applied Physics Lab. For this report, the collective team will be known as the National Project Team (NPT), and the program name will be abbreviated to AHRQ ISCR program (or ISCR program).

Main Outcomes and Measures

Hospitals participating in the AHRQ ISCR program submitted clinical process and outcome data to the ACS ISCR registry, and datasets from the ACS registry were analyzed to monitor progress. Pre- and post-ISCR implementation patient experience data were collected from hospitals who agreed to participate. Finally, self-reported program implementation progress was also collected at 4, 8, and 12 months as well as through surveys and interviews with a sample of participating facilities.

Results

Program Enrollment

The program overall consisted of 342 hospitals actively participating in one or more of the available service lines. 213 unique hospitals withdrew from the program overall due to budget constraints, limited resources, staff turnover, low case volumes, electronic health record transitions, and/or an inability to meet program requirements. ISCR NPT surveys found that the impact of COVID-19 to later cohorts was minimal as these sites were in the sustainability phase of their respective cohorts. There was no fee to participate in the program; therefore, the ISCR NPT concluded that the budget constraints cited by hospitals as a reason for withdrawal were not directly related to participation, but to the local resources required for implementation (e.g., staff time).

Hospitals from 44 of the 50 U.S. states and Washington, DC, participated in one or more cohorts of the program. Hospital participation in the program spanned the spectrum from small, rural, and/or critical-access hospitals to academic and community medical centers with bed sizes ranging from 25 to 500+ beds. Hospitals enrolled in the project cited reasons for participating including the ability to partner with JHU, ACS, and AHRQ; a desire to implement an enhanced recovery pathway; a desire to gain access to a central location for data entry; an opportunity to work on a quality improvement program that spans all phases of perioperative care; and a desire to collaborate and learn from other hospitals.

Pathway Implementation

For each service line, evidence reviews and Technical Expert Panel input informed the development of a clinical care pathway and supporting program resources including patient education materials and the data registry variables. Cohort 1 consisted entirely of the colorectal service line. A new service line was added in each subsequent cohort, with orthopedic surgery being introduced in cohort 2, gynecologic surgery in cohort 3, and emergency general surgery in cohort 4. Table 1 provides details on the timing of program offerings across cohorts. Measures differed across service lines but included process measures for adherence to pathway components (e.g., patient education, mobilization) and patient outcomes (e.g., surgical site infections, length of stay). Tables 13a–h detail process and outcome measures for each service line. Each participating site formed a multidisciplinary team and engaged in an individualized consultation call with the NPT. Site teams had at least one member complete data abstraction training, and then performed a structured gap analysis process where they identified priority areas of pathway implementation. Using the CUSP principles, teams then developed an implementation plan driven by process and outcome data feedback.

Impact on Process and Outcome Measures

Colorectal Surgery Pathway

Overall, the colorectal ISCR cohorts, focusing on nonemergent colorectal procedures, showed improvement in pathway implementation over time. Mechanical bowel preparation, preoperative oral antibiotics, use of regional analgesia, multimodal pain management, and indwelling urinary catheter duration all had significantly increased adoption over time in the colorectal service line. Overall compliance with pathway recommendations regarding multimodal pain control and appropriate indwelling urinary catheter duration were high, each exceeding 75

percent by month 10. Oral antibiotics and early solid food intake showed increased compliance over time, but frequently showed monthly compliance rates less than 50 percent. This may represent the time required to engage all stakeholders in the most current practice and standardization of clinical care. This finding may suggest that the implementation period required for adoption of more controversial elements may be longer than initially anticipated at the beginning of this project. The one process measure in which there was no demonstrated improvement over time was early mobility, which may represent difficulty in data documentation and collection for this registry variable. These mostly significant increases in process measure adherence largely suggest success of ISCR in Colorectal pathway adoption. We hypothesize that hospitals will continue to improve their pathway implementation with increased experience and team buy-in.

Of the colorectal outcomes measured, length of stay and the timing of return of bowel function showed significant decreases in duration over time. No statistically significant decrease was observed in venous thromboembolism (VTE), urinary tract infection (UTI), surgical site infection (SSI), or the binary composite of these 3 outcomes, VUS (though, with the exception of SSI, they do suggest a nonsignificant decreasing trend). There may be several explanations for these findings. Unadjusted rates of UTI and VTE were low throughout the duration of the cohort (both approximately 2%). Additionally, compliance for indwelling urinary catheters included patients who had no indwelling urinary catheter placed, so, the UTI rate reported here was an overall UTI rate, not solely catheter-associated UTIs. The small number of UTI events seen in this population may represent unmeasured factors, such as improper insertion techniques and individual patient risk factors that may predispose a patient to UTI. Appropriate indwelling urinary catheter usage may have additional benefits to patient care outside of UTI prevention, such as decreasing risk of delirium, patient comfort, and increased ease of mobilization. VTE events, although low, may represent patients with a high baseline risk for VTE despite timely and appropriate dosing of prophylactic medications and adequate mobilization. SSI showed some evidence of an upward trend, though not statistically significant, over the duration of the colorectal cohort. Possible explanations include the relatively slow adoption of consistent adherence to oral antibiotics and mechanical bowl prep. Unadjusted SSI rates in our ISCR program did not exceed 9.9 percent for the duration of the cohort and averaged 9.0 percent over 18 months. Additionally, this program focused on two important process measures that contribute to SSI risk: oral antibiotics and mechanical bowel prep. However, compliance with other elements of a more comprehensive SSI reduction bundle (including abdominal/genital area hair clipping, skin prep, wound protectors, glucose control, perioperative normothermia, antibiotic choice, dosing, etc.) are unknown.

Both length of stay (LOS) and return of bowel function (ROBF) following colorectal surgery demonstrated substantial decreases over time. These results may be feasibly associated with particular process measures. ROBF may be impacted by early intake of liquids, early mobilization, multimodal pain control, and regional analgesia. LOS is likely to be impacted in a similar way by these process measures. In addition to the parsimonious set of outcomes measured here, the increased adoption of multimodal pain control has potentially broad public health impacts on overall reduction of opioid use.

Orthopedic Surgery Pathway

The orthopedic service line included pathways for hip and knee replacement surgery as well as hip fracture surgery. The orthopedic hip fracture surgery cohort trended upwards over time in compliance with some

process measures, although no metrics reached statistical significance. The case numbers for hip fracture surgery procedures remained low throughout the cohort. It is possible that relatively low case numbers at any given hospital made consistent pathway implementation difficult. Process measure compliance may additionally reflect the challenges in a population that is often elderly and frail. Low compliance to process measures such as early mobilization and multimodal pain control may reflect these characteristics of the population. Given the complicated nature of this hip fracture surgery population, there are likely unmeasured factors such as frailty and delirium, contributing to outcomes and length of stay.

The orthopedic hip/knee replacement surgery cohort largely did not demonstrate significant changes in any process measures over time. Rates of transfusion, however, did demonstrate significant increases over time. It is difficult to interpret whether this finding represents increased perioperative blood loss or increased attention to perioperative optimization of patient risk factors (e.g., low hemoglobin). It is worthwhile to note that most process measures demonstrated high compliance over the duration of the cohort despite no significant changes over time, with overall average rates of: multimodal pain management at more than 85 percent, appropriate Foley duration at more than 90 percent, mobilization at more than 85 percent, and weight-bearing activity at more than 90 percent.

Apart from intra/postoperative transfusions, hip/knee replacement surgery binary outcome measures did not show significant change over time, although the continuous length of stay model did show a significant decrease in duration. Moreover, all outcome measures other than binary length of stay had unadjusted rates less than 4 percent for the duration of the cohort. Length of stay did demonstrate a relative decrease by 12 percent over the 18-month cohort. This decrease may suggest that overall care standardization across total joint pathways may impact length of stay despite lack of evidence of increased compliance in any one element.

Gynecologic Surgery Pathway

The gynecologic surgery service line saw a significant improvement over time in the process measure analgesia for superficial surgical wound and a significant decline over time in patient-controlled analgesia. This shift seems like a natural tradeoff, given the focus on reducing opioid use; as patients receive more local wound care, there may be less need for patient-controlled IV opioid analgesics. The reduction in patient-controlled analgesia could also be indicative that many gynecologic procedures are done as outpatient procedures. Once again, the only significant outcome reductions were for the length of stay models, and unadjusted rates for VTE, UTI, and SSI rarely exceeded 4 percent in any given month, leaving little room for improvement other than reduced stays. The decreasing length of stay, like the decreasing patient-controlled analgesia, could reflect an increasing trend toward outpatient procedures.

Emergency General Surgery Pathway

The emergency general surgery (EGS) – appendectomy and cholecystectomy service line saw significant improvements in patient education and multimodal pain management over the 18-month cohort. There was a large focus on opioid use reduction in the EGS service lines, which called for an increase in multimodal pain management as compensation. While appendectomies and cholecystectomies failed to have significant reductions in the rate of naïve opioid prescriptions at discharge, there was a decreasing yet not statistically significant trend suggestive that the two approaches to pain control may be close to compensating for each

other as hoped. However, none of the outcomes for this service line had significant changes over time. For VTE, UTI, SSI, binary composite VUS, intra/postoperative transfusion, and ileus, this is unsurprising due to overall low occurrence rates (never above 6% in any given month for any of these outcomes). Similarly, because LOS (mean LOS never exceeding 1.6 overnights in any given month), and days until return of bowel function (mean days never exceeding 1.3 overnights) there was not much room for improvement for prolonged length of stay or ileus, respectively.

The emergency general surgery – major abdominal procedures service line had very high morbidity. The outcomes didn't improve significantly. Enhanced recovery is new to this area and given the complexity of the patients, and the fact that the EGS cohort started after the COVID-19 pandemic, it is plausible that 18 months was not sufficient time to achieve improvement in outcomes. The cohort did show significant improvements over time in advanced care planning (i.e., documentation of a healthcare proxy, living will, or advanced directives prior to the operation), patient education, indwelling urinary catheter compliance, and timely first dose of postoperative VTE chemoprophylaxis. Since these major abdominal procedures are typically more complex, an increase in advanced care planning and patient education both represent an emphasis on preparation—first for what to expect, and then how to proceed if circumstances become dire. As with the EGS appendectomy and cholecystectomy cases, again, none of the outcomes experienced significant reductions over 18 months, although all except for extended length of stay had nonsignificant reductions. Although complication rates for the major abdominal procedures are higher than for the appendectomies and cholecystectomies, uncaptured pathway elements and the fact that the COVID-19 pandemic was ongoing during the entirety of the cohort, may have presented complicating factors towards event reduction.

Impact on Patient Experience

The ISCR Patient Experience Survey was based on items from the Outpatient and Ambulatory Surgery Consumer Assessment of Healthcare Providers and Systems (OAS-CAHPS) survey, the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) survey, and the Patient-Reported Outcomes Measurement Information System (PROMIS) Global Health Outcomes Scale 1.2. Hospital patient experience scores for colorectal and hip/knee replacement surgeries displayed minimal change from pre-implementation to post-implementation of the ISCR intervention. The ISCR intervention may have slightly improved patient abilities to return to normal activities. For example, hospital patient experience scores with participating colorectal patients reported on average pre-implementation (44%), that they were completely able to return to normal activities within the past seven days pre-implementation compared with post-implementation (47%). For hip/knee surgery replacement patients, hospital patient experience scores only increased one percentage point, where on average patients were completely able to return everyday activities within the past 7 days at pre-implementation (35 percent) compared to post-implementation (36%). There are larger changes for hip fracture surgery and gynecologic surgery hospitals pre and post implementation. However, the number of hospitals participating was very small for hip fracture surgery (n=7) and gynecologic surgery (n=15) hospitals. Therefore, variability in results for hip fracture surgery and gynecologic procedures may reflect the fact that results in one or two hospitals could dramatically affect the scores. The gynecologic surgery service line was only introduced in cohorts 3A and 3B and therefore had the least amount of time for inclusion in the program.

Implementation Evaluation

Overall, sites reported moderate to high levels of readiness at the beginning of the program. However, there was wide variation across sites, with a small proportion of facilities reporting low (i.e., below the scale mid-point) readiness levels on a subscale of the Organizational Readiness for Change Assessment, a previously validated instrument. Similarly, there were wide differences in the use of CUSP principles during implementation. We assessed multidisciplinary teamwork, leadership engagement and process and outcome data sharing with the frontline. Most sites did not achieve high quality implementation across all of these factors.

Clear patterns emerged about project barriers. Workload, time constraints, and competing priorities dominated sites' experiences with barriers, until cohorts 3 and 4 where COVID-19 emerged as the dominant concern. The NPT engaged in creative problem solving to reduce the demands of program participation. Strategies included continued streamlining of communication and outreach processes, offering office hours for one-on-one support, review and harmonization of program materials (e.g., increasing the clarity and consistency of pathway documents), and discussion of guidance to sites for efficient data abstraction. A series of in-person and virtual site visits provided insight into the implementation, sustainment, and unique challenges of the emergency general surgery service line. Core themes of these analyses emphasize the social and technical complexity of pathway implementation, and the critical role of the electronic health record as an enabling tool.

Conclusion

Each cohort of the AHRQ ISCR program built on the achievements and lessons of previous program cohorts and continued to advance the safety and quality of perioperative surgical care received by patients at participating hospitals. This is reflected in the recruitment, program participation metrics, implementation evaluation findings, and most importantly the observed statistically significant increases in some clinical process adherence, and reductions in some adverse outcome rates. For colorectal surgical procedures, six of the seven process measures demonstrated significant improvement in adherence over the project duration: preoperative mechanical bowel prep, preoperative oral antibiotics, use of multimodal pain management, the first postoperative intake of liquids, first postoperative intake of solids, and indwelling urinary catheter duration. Only adherence to the first postoperative mobilization process measure did not significantly improve. Five of the nine outcome measures demonstrated significant improvements. The risk of experiencing an extended length of stay decreased by 9.83 percent. The risk of experiencing ileus decreased by 20.16 percent, and the risk of experiencing either ileus or an extended length of stay decreased by 14.69 percent. There was a 5 percent reduction in the duration until return of bowel function, and 4% reduction in the duration of length of stay. Risk of experience VTE, UTI, SSI, or a composite of all three of these outcomes was not significantly changed during the project. For Hip Fracture procedures, none of the eight process or outcome measures demonstrated significant improvement over the project duration. For hip/knee replacement procedures, none of the six process measures demonstrated significant improvement. Two of the eight outcome measures demonstrated significant changes, with a 12 percent decrease in the duration of length of stay, and an 88.4 percent increase in risk of experiencing a transfusion. As detailed in the report, this finding for transfusion was unexpected. It is difficult to know if this represents increased perioperative blood loss or increased attention to perioperative optimization of patient risk factors (e.g., low hemoglobin). For gynecologic surgery procedures, two of the seven

process measures demonstrated significant change over the project duration: with patient-controlled analgesia significantly decreasing, and local wound analgesia significantly increasing. Two of the six outcome measures demonstrated significant improvement over time with the risk of experiencing a prolonged length of stay decreasing by 41.4 percent and a 20 percent reduction in the duration of length of stay. For the EGS appendectomy and cholecystectomy procedures, two of the seven process measures demonstrated significant improvement over the project duration with adherence to patient education and use of multimodal pain management increasing. None of the nine outcome measures demonstrated significant change over the project duration. For the EGS major abdominal procedures, four of the nine process measures demonstrated significant improvement over the project duration. Adherence to advanced care planning, patient education, Foley catheter removal, and first postoperative VTE prophylaxis dose after surgery all increased significantly. However, none of the nine outcome measures demonstrated significant improvement.

The AHRQ ISCR program was a complex project, from the nature of the interventions, to the breadth of stakeholders involved in implementing required changes within a hospital, and to the sophistication of the data abstraction and analysis processes. The COVID-19 pandemic disrupted hospital operations at different points across the country, affecting staffing and resource allocation, case volume, and the ability for teams to meet. Additionally, the pandemic impacted different cohorts based on timing, with the end of cohort 3 and the totality of cohort 4 being impacted. The ISCR NPT worked with program participants to understand the challenges of implementation during the COVID-19 pandemic and to provide the support and program modifications needed to streamline resources and support hospital success. For example, national leader webinars and coaching calls were developed to focus on technical and adaptive content that was requested by participants, such as guidance on multimodal pain management. The standard 90-day timeframe for completing data entry on procedures was lifted, giving participating hospitals more flexibility and time if abstractors were reassigned to support patient care. We are heartened by the passion and dedication of participating sites who continued to work to improve perioperative care even during a global pandemic presenting unimaginable challenges.

Introduction and Program Description

Program Rationale and Objectives

The Agency for Healthcare Research and Quality (AHRQ) Safety Program for Improving Surgical Care and Recovery (ISCR) was developed to provide technical assistance to hospitals to help them implement evidence-based practices to improve outcomes and prevent complications among patients who undergo surgery. The approach used the Comprehensive Unit-based Safety Program (CUSP) framework, a combination of clinical and cultural (i.e., technical and adaptive) intervention components. The technical components of enhanced recovery pathways are a constellation of preoperative, intraoperative, and postoperative practices designed to decrease complications and to accelerate recovery.

As a result, AHRQ contracted with the Johns Hopkins University Armstrong Institute for Patient Safety and Quality and its partners, including the American College of Surgeons (ACS), the University of California San Francisco, Westat, and the Johns Hopkins Applied Physics Lab to implement and evaluate a national quality improvement collaborative. In order to facilitate broader adoption of these evidence-based practices among U.S. hospitals, the national project team (NPT) adapted CUSP, which has been demonstrated to be an effective approach to reducing other patient harms, to enhanced recovery of surgical patients. The adaptive elements include promoting leadership and frontline staff engagement; facilitating close teamwork among surgeons, anesthesia providers, and nurses; and enhancing patient communication and engagement.

Program objectives:

1. Identify evidence-based components of enhanced recovery for surgical patients and relevant measures.
2. Adapt the CUSP model to enhanced recovery and develop an intervention and toolkit to facilitate implementation. The intervention targeted clinical and cultural (i.e., technical and adaptive) aspects of change.
3. Recruit and provide technical assistance to hospitals to implement enhanced recovery practices.
4. Meaningfully improve patient outcomes across participating hospitals.
5. Understand facilitators and barriers to effective implementation across participating hospitals and assess adoption of the program.

The NPT used a multipronged approach to evaluate progress and impact. Participating hospitals used an ACS-based registry adapted for the ISCR program (referred to as the ISCR registry in this report) for data entry, allowing them to track their progress on outcome and process measures and to share their data with the NPT. Hospitals participating in all but the final option period of the project were also encouraged to participate in pre- and post-implementation patient experience surveys. Additionally, to support implementation and understand how the program was being used at the hospital level, a web-based implementation assessment was administered at regular intervals over the course of each 18-month cohort.

This report summarizes lessons learned and results from the base period and the three option periods, and details work conducted under the contract's third option period to prepare, kick off, and support the colorectal surgery, hip and knee replacement surgery, hip fracture surgery, gynecologic surgery, and emergency general surgery service lines.

Chapter 1. Development of the ISCR Program

The Improving Surgical Care and Recovery (ISCR) Program spanned more than 6 years and was divided into a base period and three option periods. The base period, which began September 30, 2016, developed and launched the colorectal surgery pathway for cohort 1. option period 1 began October 1, 2017, and added comprehensive hip and knee replacement, and hip fracture surgery to the ISCR Program for cohort 2 hospitals. Option period 2 began February 1, 2019, adding gynecologic surgery to the ISCR program for cohort 3 hospitals. Cohort 3 consisted of two 18-month cohorts: cohort 3A running from March 2019 to August 2020, and cohort 3B running from September 2019 to February 2021. Cohort 3B was introduced to allow hospitals interested in participating but unable to complete the enrollment process in time for the start of cohort 3A. Option period 3 of the AHRQ ISCR Program began September 30, 2019, adding the emergency general surgery pathway for cohort 4. Option period 3 was originally scheduled to end on March 31, 2022, but a 9-month no-cost extension was executed in January 2020, extending the option period through December 21, 2022. This extension was intended to allow the NPT to run two 18-month cohorts, 4A (March 2020 through August 2021) and 4B (September 2020 through February 2022). However, in response to resource constraints at participating hospitals resulting from COVID-19 (e.g., staff reallocation, COVID-19 patient surges, etc.), the NPT shifted the start of cohort 4A to align with the start with cohort 4B, giving hospitals more time to resume surgcial procedures that had been postponed due to COVID-19; for staff to return to their normal duties; and for ISCR teams to regroup. Table 1 provides an overview of the ISCR program's periods of performance, the cohorts, the surgical lines available to participating hospitals for implementation, and the duration and timeframe for cohort activities.

Table 1. Overview of Periods, Cohorts, and ISCR Pathways

Period	Cohort	Service Line	Duration and Timeframe
Base Period Start date: September 30, 2016	Cohort 1	Colorectal	18 months 07/01/2017–12/31/2018
Option Period 1 Start date: October 1, 2017	Cohort 2	Colorectal, Orthopedic	18 months 03/01/2018–08/31/2019
Option Period 2 Start date: February 1, 2019	Cohort 3A Cohort 3B	Colorectal, Orthopedic, Gynecologic	18 months 03/01/2019–08/31/2020 18 months 09/01/2019–02/28/2021
Option Period 3 Start date: September 30, 2019	Cohort 4	Colorectal, Orthopedic, Gynecologic, Emergency General	18 months 09/01/2020–02/28/2022

Much of each period was devoted to development of the new enhanced recovery pathway and the supporting toolkit materials; recruitment of hospitals; and engagement through coaching calls and national leader webinars. For participating hospitals, the first 3 months of the cohort were pre-ISCR pathway implementation work, and the remaining 15 months were implementation, optimization, and sustainability efforts. Information about the development of the clinical pathways and the adaptive components of the ISCR program that were designed to provide education and support to participating hospitals, is detailed in sections I through IX of this report.

Section I. Clinical Pathway Development

Before each cohort started, the National Project Team (NPT) reviewed the literature and consulted with subject matter experts in the field to develop an updated prototype enhanced recovery pathway for the service line that was introduced for that cohort. The NPT and consultants assimilated appropriate evidence-based surgical and anesthesia protocols for each type of surgery and submitted them for peer review and publication. These evidence reviews were included among program resources available to participating hospitals (Tables 2–6). From there, the NPT finalized measures to evaluate pathway implementation and effectiveness and built them into the ISCR data collection registry. Finally, the NPT developed resources to aid hospital data abstractors with data collection into the ISCR registry. Figure 1 provides an overview of the clinical pathway development and implementation toolkit resources.

Figure 1. Overview of Clinical Pathway and Implementation Toolkit Resources

Section II. Implementation Toolkit

In parallel with clinical pathway development, the NPT continued to iteratively refine an implementation toolkit that included resources for both technical and adaptive aspects of system improvement, and it offered hospitals a unique approach to implementation and sustainability of their AHRQ ISCR programs, using the CUSP framework. Technical components of the program focused on changing procedural aspects of care. Technical work interventions in the program included evidence for the ISCR pathways and supporting pathway documents. Adaptive components of the program targeted attitudes, beliefs, and behaviors of the people who deliver care. Adaptive work is a key driver of efforts to implement new technical changes. Thus, an evidence-based pathway (technical work) will only impact outcomes if staff understand, value, and prioritize use of the pathway (adaptive work).

Finally, the NPT created a program curriculum of monthly coaching calls, national leader webinars, and in-person training events. Additional support efforts included weekly email updates from the NPT, one-on-one nurse consultations, and data collection support via email and telephone.

Below is a more detailed description of resources and support available to hospitals.

Resources Available on the AHRQ ISCR Program Website

From documents created by the NPT to documents shared by hospitals (see sharing library resources in Appendix A), a wealth of resources was available to support implementation efforts (Tables 2–6). Hospitals were encouraged not to reinvent the wheel but adapt materials available in the AHRQ ISCR program website resource library to their local setting.

The AHRQ ISCR program website was the main portal for all program resources. Through this platform, participating hospitals could find upcoming events (on the home page), review recordings and slides of past webinars and coaching calls, and access program tools, evidence reviews, templates, data registry trainings, and more. Resources listed below were used in the project and were developed to assist teams with implementation and data collection specific to the ACS registry and measures. Resources to be found on the AHRQ website after the December 2022 completion of the project have been revised to reflect experience gained over the course of the project. Material related to data collection of process and outcome measures is more generic, allowing future users to more easily adapt the material to their current definitions and data collection methods.

Table 2. Summary of Emergency General Surgery Resources

Emergency General Surgery Pathway	Resource
EGS Pathway and Evidence Review	▪ Sample Major Abdominal ISCR Pathway Checklist ▪ Sample Appendectomy/Cholecystectomy ISCR Pathway Checklist ▪ Sample Major Abdominal ISCR Pathway Grid for Staff Education ▪ Sample Appendectomy/Cholecystectomy ISCR Pathway Grid for Staff Education ▪ ISCR EGS Appendectomy and Cholecystectomy Pathway Worksheet ▪ ISCR EGS Major Abdominal Pathway Worksheet ▪ Surgical Technical Evidence Review for Acute Appendectomy Conducted for the Agency for Healthcare Research and Quality Safety Program for Improving Surgical Care and Recovery https://doi.org/10.1016/j.jamcollsurg.2018.09.024 ▪ Surgical Technical Evidence Review for Acute Cholecystectomy Conducted for the AHRQ Safety Program for Improving Surgical Care and Recovery https://doi.org/10.1016/j.jamcollsurg.2019.11.014 ▪ Technical Evidence Review for Emergency Major Abdominal Operation Conducted for the Agency for Healthcare Research and Quality Safety Program for Improving Surgical Care and Recovery https://doi.org/10.1016/j.jamcollsurg.2020.08.772
EGS Gap Analysis and Goal Setting	▪ ISCR EGS Gap Analysis and Goal Setting Form ▪ ISCR EGS Current Procedural Terminology (CPT) Codes

Emergency General Surgery Pathway	Resource
EGS Data and Registry Training	▪ ISCR EGS Worksheet ▪ How to: ISCR Operation Reports ▪ Engaging Frontline Staff with EGS ISCR Process and Outcome Data ▪ ISCR EGS Case Inclusion Guide ▪ ISCR EGS Data Collection Process ▪ 8-Day Cycle Schedule for Case Inclusion 2022 ▪ ISCR EGS Variables and Definitions ▪ Data Download Report Training Video ▪ ISCR Quick Guide - Registry Reports ▪ Data Entry Overview ▪ Related Tool: Data Entry Overview Document ▪ Navigating the ISCR Registry and Resource Portal (e-learning module) ▪ ISCR Registry Data Download Report Instructions
EGS Sample Patient Education Booklet	▪ Emergency Appendectomy Patient Education Booklet ▪ Emergency Appendectomy Patient Education Booklet (Spanish) ▪ Emergency Cholecystectomy Patient Education Booklet ▪ Emergency Cholecystectomy Patient Education Booklet (Spanish) ▪ Emergency Laparotomy Patient Education Booklet ▪ Emergency Laparotomy Patient Education Booklet (Spanish)

Abbreviations: AHRQ=Agency for Healthcare Research and Quality; EGS=Emergency General Surgery; ISCR=AHRQ Safety Program for Improving Surgical Care and Recovery

Table 3. Summary of Gynecologic Surgery Resources

Gynecologic Surgery Pathway	Resource
Gynecologic Pathway and Evidence Review	▪ ISCR Gynecologic Pathway ▪ Surgical Technical Evidence Review for Gynecologic Surgery Conducted for the Agency for Healthcare Research and Quality Safety Program for Improving Surgical Care and Recovery https://doi.org/10.1016/j.ajog.2018.07.014 ▪ Evidence review conducted for the AHRQ Safety Program for Improving Surgical Care and Recovery: focus on Anesthesiology for Gynecologic Surgery https://doi.org/10.1136/rapm-2018-100071
Gynecologic Gap Analysis and Goal Setting	▪ ISCR Gynecologic ICD-10 Procedure Codes for Gap Analysis and Goal Setting Form ▪ ISCR Gynecologic Gap Analysis and Goal Setting Form

Gynecologic Data and Registry Training	▪ How to: ISCR Operation Reports ▪ Gynecologic ISCR Variables and Definitions ▪ ISCR Gynecologic Data Collection Process ▪ Data Download Report Training Video ▪ ISCR Quick Guide - Registry Reports ▪ Data Entry Overview ▪ Related Tool: Data Entry Overview Document ▪ ISCR Registry Data Download Report Instructions ▪ Navigating the ISCR Registry and Resource Portal (e-learning module) ▪ ISCR Postop Occurrences (e-learning video)
Gynecologic Sample Patient Education Booklet	▪ Gynecologic Sample Patient Education Booklet ▪ Gynecologic Sample Patient Education Booklet (Spanish)

Abbreviations: AHRQ=Agency for Healthcare Research and Quality; ICD=International Classification of Diseases; ISCR=Safety Program for Improving Surgical Care and Recovery

Table 4. Summary of Orthopedic Surgery Resources

Orthopedic Surgery Pathway	Resources
Orthopedic Pathway and Evidence Review	**Total Knee and Total Hip Arthroplasty** ▪ ISCR Pathway worksheet for THA/TKA ▪ Sample ISCR Pathway Checklist for THA/TKA ▪ Evidence Review Conducted for the Agency for Healthcare Research and Quality Safety Program for Improving Surgical Care and Recovery: Focus on Anesthesiology for Total Hip Arthroplasty https://doi.org/10.1213/ANE.0000000000003663 ▪ Evidence Review Conducted for the Agency for Healthcare Research and Quality Safety Program for Improving Surgical Care and Recovery: Focus on Anesthesiology for Total Knee Arthroplasty https://doi.org/10.1213/ANE.0000000000003564 ▪ Surgical Technical Evidence Review for Elective Total Joint Replacement Conducted for the AHRQ Safety Program for Improving Surgical Care and Recovery https://doi.org/10.1177%2F2151458518754451 **Hip Fracture Surgery** ▪ ISCR Pathway worksheet for Hip Fracture Surgery ▪ Sample ISCR Pathway Checklist for Hip Fracture Surgery ▪ Evidence Review Conducted for the Agency for Healthcare Research and Quality Safety Program for Improving Surgical Care and Recovery: Focus on Anesthesiology for Hip Fracture Surgery https://doi.org/10.1213/ANE.0000000000003925 ▪ Surgical Technical Evidence Review of Hip Fracture Surgery Conducted for the AHRQ Safety Program for Improving Surgical Care and Recovery https://doi.org/10.1177/2151459318769215

Orthopedic Surgery Pathway	Resources
Orthopedic Gap Analysis and Goal Setting	▪ THA/TKA Gap Analysis and Goal Setting Form ▪ THA/TKA ICD-10 Procedure Codes for Gap Analysis and Goal Setting Form ▪ Hip Fracture Gap Analysis and Goal Setting Form (optional) ▪ Hip Fracture CPT Codes ▪ Hip Fracture ICD 10
Orthopedic Data and Registry Training	▪ ISCR Orthopedic Variables and Definitions ▪ ISCR Orthopedic Data Collection Process ▪ ISCR 2020 Variable Updates Webinar and: Presentation Slides ▪ How to: Measures Report ▪ How to: Summary Report ▪ Data Download Report Training Video ▪ ISCR Quick Guide – Registry Reports ▪ Data Entry Overview. *Related Tool:* Data Entry Overview Document ▪ Navigating the ISCR Registry and Resource Portal (e-learning module) ▪ ISCR Orthopedic – Engaging Frontline Staff with Process and Outcome Data ▪ ISCR Orthopedics Variables (e-learning video) ▪ ISCR Postop Occurrences (e-learning video)
Orthopedic Sample Patient Education Booklet	▪ Sample ISCR Hip Fracture Surgery Patient Recovery Guide ▪ Sample ISCR Hip Fracture Surgery Patient Recovery Guide (Spanish) ▪ Sample ISCR THA/TKA Patient Education Booklet ▪ Sample ISCR THA/TKA Patient Education Booklet (Spanish)
General Resources: ISCR Short Videos (Narrated Presentations)	▪ ISCR Short Video on Regional Analgesia and Anesthesia for Joint Replacement ▪ Venous Thromboembolic Prophylaxis and Orthopedics: Making Sense of the Recommendations

Abbreviations: AHRQ=Agency for Healthcare Research and Quality; CPT=Current Procedural Terminology; ICD=International Classification of Diseases; ISCR=Safety Program for Improving Surgical Care and Recovery; THA/TKA=Total Hip Arthroplasty/Total Knee Arthroplasty

Table 5. Summary of Colorectal Surgery Resources

Colorectal Surgery Pathway	Resources
Colorectal Pathway and Evidence Review	▪ ISCR Colorectal Pathway ▪ Sample Colorectal ISCR Pathway Checklist ▪ Sample Colorectal ISCR Pathway Grid for Staff Education ▪ Surgical Technical Evidence Review for Colorectal Surgery Conducted for the AHRQ Safety Program for Improving Surgical Care and Recovery http://dx.doi.org/10.1016/j.jamcollsurg.2017.06.017 ▪ Evidence Review Conducted for the Agency for Healthcare Research and Quality Safety Program for Improving Surgical Care and Recovery: Focus on Anesthesiology for Colorectal Surgery https://doi.org/10.1213/ANE.0000000000003366

Colorectal Gap Analysis and Goal Setting	▪ ISCR Colorectal Gap Analysis and Goal Setting Form NSQIP ▪ ISCR Colorectal Gap Analysis and Goal Setting Form non NSQIP ▪ ISCR Colorectal CPT Codes for Gap Analysis and Goal Setting Form ▪ ISCR Colon and Rectal ICD-10 Procedure Codes for Gap Analysis and Goal Setting Form
Colorectal Data and Registry Training	▪ Colorectal ISCR Variables and Definitions ▪ Colorectal ISCR Data Collection Process ▪ ISCR 2020 Variable Updates Webinar and: Presentation Slides ▪ How to: Measures Report ▪ How to: Summary Report ▪ Data Download Report Training Video ▪ ISCR Quick Guide – Registry Reports ▪ Data Entry Overview. *Related Tool:* Data Entry Overview Document ▪ Navigating the ISCR Registry and Resource Portal (e-learning module) ▪ Engaging Frontline Staff with Colorectal ISCR Process and Outcome Data ▪ ISCR Colorectal Variables (e-learning video) ▪ ISCR Postop Occurrences (e-learning video) ▪ ISCR Registry Data Download Report Instructions
Colorectal Sample Patient Education Booklet	▪ Sample 1 ISCR Colorectal Surgery Patient Education Booklet ▪ Sample 2 ISCR Colorectal Surgery Patient Education Booklet ▪ Sample 2 ISCR Colorectal Surgery Patient Education Booklet (Spanish) ▪ Emergency Colorectal Surgery Patient Education Handout ▪ Emergency Colorectal Surgery Patient Education Handout (Spanish)
General Resources: ISCR Short Videos (Narrated Presentations)	▪ The Bowel Prep and Enhanced Recovery: What's the RIGHT Thing ▪ Venous Thromboembolic Prophylaxis and Colorectal Surgery: What's the Role of Extended Prophylaxis

Abbreviations: AHRQ=Agency for Healthcare Research and Quality; CPT=Current Procedural Terminology; ICD=International Classification of Diseases; ISCR=Safety Program for Improving Surgical Care and Recovery; NSQIP=National Surgical Quality Improvement Program

Table 6. Summary of General Resources

All Pathways	Resource
Program Implementation and Staff Training	▪ ISCR Getting Started Guide ▪ ISCR Implementation Phaseline ▪ ISCR Implementation Guide ▪ Barriers to and Facilitators of Implementing Enhanced Recovery Pathways Using an Implementation Framework A Systematic Review http://jamanetwork.com/article.aspx?doi=10.1001/jamasurg.2017.5565 ▪ Red Light, Green Light: An Overview of Common Implementation Barriers and Facilitators ▪ Sample ISCR Presentation for Senior Executives ▪ Hospital ISCR Poster ▪ ISCR Frontline Provider Education ▪ Chief Executive Officer Senior Leader Checklist ▪ CUSP Tool: Staff Safety Assessment ▪ CUSP Tool: Staff Safety Assessment Results ▪ Safety Issues Worksheet for Senior Executive Partnership
Data and Registry Training	▪ Berian Adherence to ER Protocols in NSQIP and Association with Colectomy Outcomes (Berian et al., 2017)
ISCR Patient Experience Survey	**ISCR Patient Experience Survey** ▪ ISCR Patient Experience Survey
ISCR Short Narrated Presentations	**ISCR Teamwork and Communication** ▪ Identifying Stakeholders in Improving Surgical Care and Recovery: How to do a Stakeholder Analysis ▪ *Related Tool:* Identifying ISCR Stakeholders: A Stakeholder Analysis Tool ▪ Engaging Stakeholders in Improving Surgical Care and Recovery: Developing a Vision for your ISCR program ▪ *Related Tool:* ISCR Engaging Stakeholders: Creating an Elevator Speech Tool **Guide to Leading Perioperative Teams** ▪ Set Stretch Goals ▪ Give Them a Voice ▪ Structured Learning **ISCR General Clinical (for all surgical lines)** ▪ Multimodal Analgesia Tips and Tricks
Opioid Toolkit	▪ ISCR Opioid Patient Toolkit ▪ ISCR Opioid Provider Toolkit ▪ ISCR Opioid References

Abbreviations: AHRQ=Agency for Healthcare Research and Quality; CUSP=Comprehensive Unit-based Safety Program; ER=Emergency Room; ISCR=Safety Program for Improving Surgical Care and Recovery; NSQIP=National Surgical Quality Improvement Program

Supporting the ISCR Patient Experience: Patient Education Booklets

As part of the AHRQ ISCR toolkit, patient education booklets were developed for all service lines and for some specific types of surgery within some service lines (e.g., emergency appendectomy). The NPT identified an independent contractor with 15 years of experience in science and health communication, with a focus on patient education. For consistency, the NPT worked with the same independent contractor to develop all of the booklets. The contractor aligned the content of the booklets with the pathway under the guidance of several experienced clinicians. She then conducted one-on-one interviews with more than 80 surgery patients and family caregivers of varying demographics and education levels at two different phases of booklet development, using an updated version of the booklet each time. A think-aloud approach was used, in which the interviewee reviewed the patient booklet and commented on the information. Not only did interviewees provide feedback, they also reviewed language and art options for specific sections and indicated which were preferred/clearer. It is often challenging to figure out what concepts confuse patients, how to clarify them, and how to address emotional components. The one-on-one interviews using the think-aloud method helped to identify points of confusion and important insights as edits were made to the booklets. This process allowed the contractor to develop the booklets in a way that highlighted enhanced recovery concepts that were new or different for patients, such as reduced fasting and multimodal pain management.

The learnings from the one-on-one interviews were incredibly insightful and further emphasized the importance of educating patients and their families about their surgical procedures. It also identified surprising information that many clinicians would not think to clarify with a patient before surgery. A summary of these findings is below:

Summary of Findings From the Interviews Conducted With Patients and Family Caregivers

When talking with patients, use medical terms judiciously. Medical terms add cognitive load.[15] Health literacy issues are pervasive across all educational levels. Most people prefer plain language (familiar terms) when under stress. People have a difficult time integrating new information and new terms.

- In many cases, people recognized new terms and information as new. For example, many women who reviewed the gynecologic booklet were interested to learn that urine didn't come out of their vagina but from another opening (urethra) they were not familiar with.

- However, sometimes people would confuse a known term (like uterus) with a new term (like urethra). They would see a word that started with "u" and read it as "uterus."

When a patient resource proactively addresses concerns, embarrassing questions, or social and emotional issues, this demonstrates it understands the patient experience. People then trust the resource more because it's human centered. A human centered approach can help to reassure patients that their feelings and questions are normal.

- For example, when discussing any mood issues after hysterectomy, it was essential not just to refer to feeling very sad or alone, but also refer to a sense of loss women often feel. This also helps people realize they're not outliers but are going through a common experience.

- Although it's not essential to understand before a hysterectomy, women often want to know what happens to the space in their body where their uterus was. Explaining this put many women's minds to rest and helped some of their physical experiences click.

Candor is essential for engaging people on challenging topics.

- People appreciated candor and addressing challenging topics in a way that normalized them. People were not upset or thrown off by a discussion of advance directives when it was presented in a matter-of-fact way, as something everyone should do as part of any procedure.

- They also appreciated discussions about topics like sexual function and depression after surgery. People said they would feel less awkward asking questions about things like sex after seeing that it was a common enough topic that it was included in standardized patient materials.

Discussing opioids and pain medications pose challenges on both ends of the spectrum: fear of any opioids or fear any pain won't be well controlled.

- Some people worry they'll get any opioids and suffer from constipation or become addicted, while others (especially if they had poor pain management in the past or come from a community where opioids are withheld for conditions like sickle cell anemia) worry they won't get strong enough medication to manage their pain.

- It is difficult to address these opposing concerns. The language around pain management includes both a clear explanation for why opioids are used judiciously and reassurance that pain will be managed through various approaches. The resources emphasize the importance of individuals communicating their concerns to their team about pain medication and any issues with addiction in their family.

- Throughout all the review groups, all participants except one man were aware of the opioid crisis and were not offended by the language around potential worries for family with addiction issues.

Postoperative depression often goes unaddressed. It needs to be normalized or it can have a serious impact on recovery.

- People knew recovery would be physically painful and somewhat challenging, but they were looking forward to a new hip or knee joint, or to having issues like serious uterine bleeding addressed. After their surgery, they were taken aback when the event they were anticipating alleviating their issues caused them to be sad, isolated, or depressed.

- There are cultural challenges when discussing postoperative depression. Depression is stigmatized in certain communities and cultures, and even though it's often easier to access mental health services within some primary care settings, it has often remained something people covertly get treated for and don't discuss. To this end, investigators found they needed to avoid using the term "depression" itself and instead tested many iterations of language to convey the seriousness of it and to normalize it as a common part of the recovery process so that people would feel comfortable discussing their feelings.

When newer instructions contradict past instructions, experienced patients and family caregivers may feel unsafe. Explaining the updated logic, repeating the information, and reassuring people is essential.

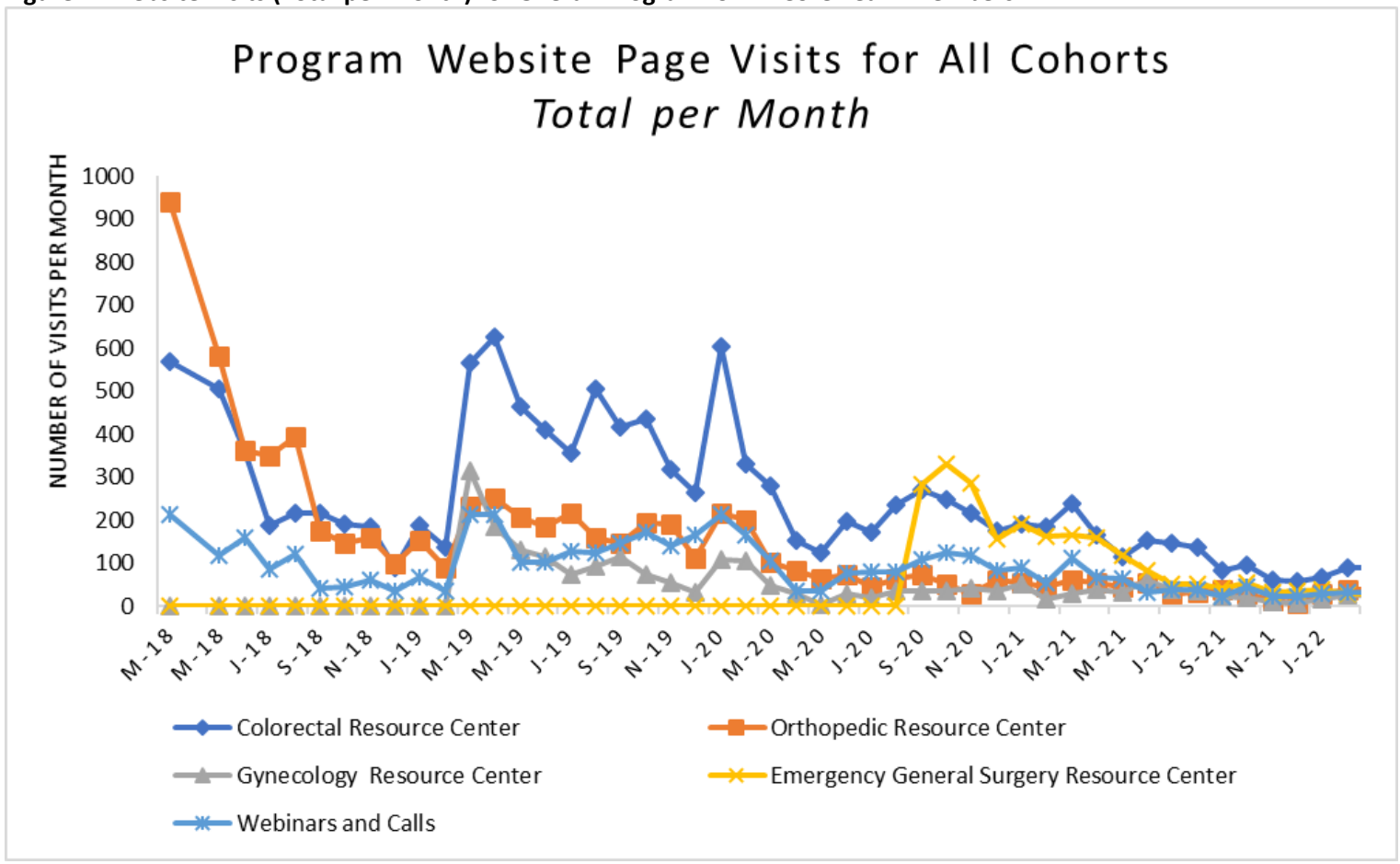
- For example, years of warning people not to eat or drink for many hours before or after surgery can confound and even cause resistance to newer instructions about shorter intervals and instructions to drink juice or a sports drink carb load the morning of surgery. Patients and family caregivers who are looking out for their loved one's safety experience anxiety. One family caregiver even told the investigator, "I think they better change it back to how it was before. That's not safe!"

- Repeating this information helps reinforce that changes like this are not a mistake. Instead, explicitly call out that this is new, updated information. Additional time and explanation were needed to reassure patients that these updated instructions are based on research and describe how they can actually help people get through and recover better after surgery.

Section III. Website Engagement

Capturing of website traffic for all cohorts began in March 2018. The highest activity occurred between February 2019 and October 2020 (Figure 2). The colorectal surgery resource center received the most visits throughout the program.

Figure 2. Website Visits (Total per Month) for Overall Program for All Core Team Members



Section IV. National Leader Webinars

National leader webinars (NLWs), roughly 45–60 minutes, aimed to connect ISCR participants with nationally recognized content experts in a variety of practice areas relating to enhanced recovery (e.g., SSI prevention, preoperative [preop] optimization, multimodal analgesia). With the NLWs, the ISCR NPT hoped to provide participants with a didactic forum to learn the most up-to-date practices from various leaders in their fields. Figure 3 shows national leader webinar topics that had the highest recorded number of participants.

Figure 3. Sample of National Leader Webinar Topics

Date	Topic	Date	Topic
Oct. 2017	Surgical Clinical Reviewers and Decreasing Perioperative Opioid Usage	**Nov. 2019**	SSI Prevention for Colectomy Bowel Prep – Yes or No? and What About Oral Antibiotics? And Is There a "Best" Intravenous Antibiotic?
Dec. 2017	Surgical site infection (SSI) Prevention for Colectomy	**Dec. 2019**	Perioperative Surgical Home: From Concept to Implementation to Scaling Up
Feb. 2018	Evidence-Based Preoperative Optimization of a Surgical Patient Undergoing Colorectal Surgery	**Jan. 2020**	Prevention of Surgical Infections: Current Guidelines
Apr. 2018	Preventing Surgical Site Infections: 2018	**May 2020**	Four Things We Can Do To Improve How Surgeons Communicate With Patients
May 2018	Venous Thromboembolism (VTE) Prophylaxis in Orthopedics and Colorectal Surgery	**Aug. 2020**	Implementing an Enhanced Recovery Program in Emergency General Surgery
Jul. 2018	The Roel of Acute Care Prescribing in the Opioid Epidemic	**Oct. 2020**	Opportunities for Evidence-Based Enhanced Recovery Pathways in Emergency General Surgery
Mar. 2019	Importance of Sustainability and Enhanced Recovery After Surgery	**Oct. 2020**	Opioid Toolkit Kickoff
Mar. 2019	SSI Prevention Best Practices/Antibiotic Prophylaxis	**Nov. 2020**	Bundles of Care in Emergency General Surgery: VTE Prophylaxis and Early Ambulation
Apr. 2019	VTE Prevention, Treatment, Prophylaxis, and Related Topics	**Jan. 2021**	Perioperative Medicine: How Did We Get Here and Where to Next?
May 2019	Catheter-associated Urinary Tract Infection Prevention: Technical and Socio-adaptive Aspects	**Feb. 2021**	How Do We Reduce SSI Risk in Emergency General Surgery
Jun. 2019	Opioid Prescription Practices: A Patient Perspective	**Mar. 2021**	Antimicrobial Stewardship Programs in Special Surgical Populations
Aug. 2019	Perioperative Diabetes Management & Glucose Control	**Jan. 2021**	State of the Project

NLWs were attended by a variety of team members at participating hospitals, including project leads, data abstractors, senior leadership, surgeons, anesthesia providers, quality improvement, infection prevention, enhanced recovery navigators, pharmacists, and health information technology. Participants' team roles were identified through a polling question at the beginning of each NLW that asked attendees to select their role from a set of ten different options.

NLWs were typically offered once or twice a month, depending on the speaker's availability, until January 2022, when the NPT decided to adjust the NLW schedule to bimonthly. Participation in NLWs was open and encouraged for all hospitals participating in ISCR, regardless of specific cohorts they joined. NLW topics were chosen based on relevance and interest to program participants. The NPT also used feedback received from participants in implementation check-in surveys, support phone calls, as well as their own clinical expertise on enhanced recovery to help identify topics for NLWs.

The average number of participants from cohort 1, cohort 2, cohorts 3A/3B, and cohort 4 was 117 participants (Table 7). Participant numbers (Figure 4) for each NLW were obtained via the participant tab function in Zoom. Attendance from specific hospitals was not tracked, as doing so would impose additional barriers to accessing the calls (i.e., registration or logins).

Figure 4. National Leader Webinar Attendance Across All Cohorts

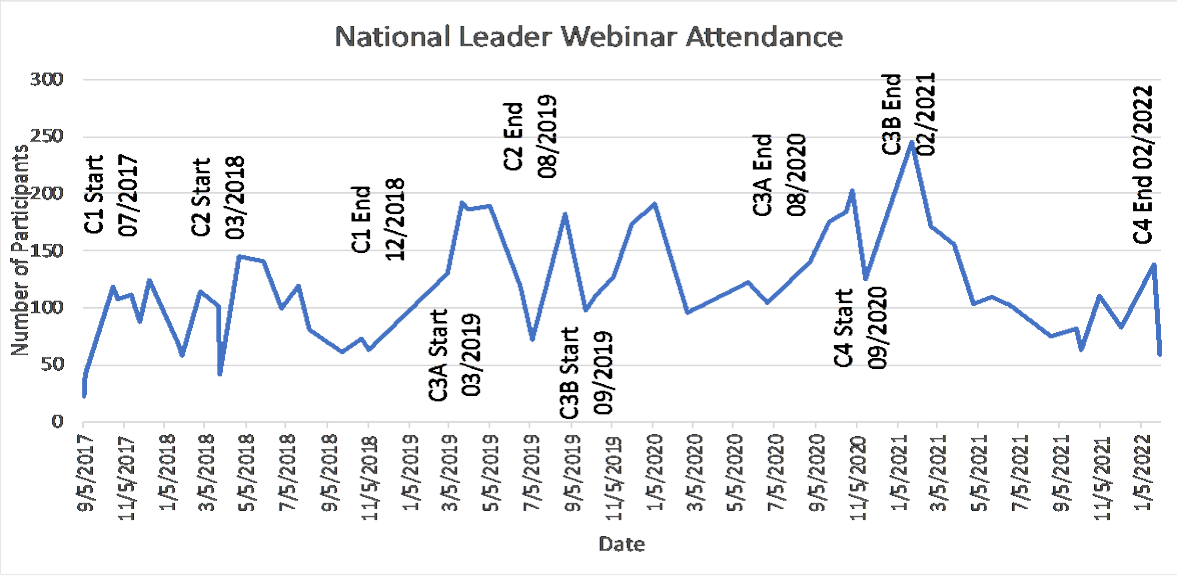


Table 7 shows the overall total and average number of participants for NLWs during each cohort, the highest and lowest number of attendees for NLWs during each cohort, and the number of NLWs held during each cohort.

Table 7. National Leader Webinar Participation by Cohort

Metric	Cohort 1	Cohort 2	Cohort 3A/3B	Cohort 4
Total	852	1,194	3,334	1,980
Average	85	117	152	124
Lowest	23	41	72	59
Highest	124	192	245	245
# of Call	10	17	22	17

Section V. Coaching Calls

Coaching calls aimed to create a community of hospitals working to implement ISCR and facilitate peer learning. To accomplish this goal, the ISCR NPT's nurse and physician consultants facilitated coaching calls and engaged participants in discussion around each month's topic, giving attendees an opportunity to share and learn from each other (Figure 5). Additionally, ISCR hospitals often presented on their work relating to the call's topic and gave overviews of their implementation journeys. Figure 6 show coaching call topics that had the highest recorded number of participants.

Figure 5. Sample Coaching Call Topics

Date	Topic	Date	Topic
Mar. 2019	Surgical site infection (SSI) prevention: An Improving Surgical Care and Recovery (ISCR) hospital talked about their colorectal SSI bundle	**Jul. 2020**	Prehabilitation: An ISCR hospital shared provided an overview on an app they are developing to streamline their prehabilitation process
Apr. 2019	Venous thromboembolism (VTE) prevention: The national project team (NPT) discussed VTE prophylaxis, risk assessment, and dosing strategies	**Aug. 2020**	Enhanced recovery literature update & using perioperative data: ISCR NPT facilitators provided a brief overview of some the newer literature relating to enhanced recovery
Jun. 2019	Multi-modal analgesia: An ISCR hospital presented on process specifics including goal-directed fluid and use of multi-modal medications (Tylenol, Celebrex, Neurontin)	**Sep. 2020**	Driving ISCR and improvement as Surgical Clinical Reviewers (SCRs): Two ISCR SCRs & project leads shared how they've been able successfully to drive the ISCR initiative at their hospitals
Aug. 2019	Perioperative glucose control: Two ISCR hospitals presented on their efforts and work related to perioperative glucose control	**Oct. 2020**	Driving improvement at the system level & implementing a hip fracture pathway: Groups from two different ISCR hospitals/health systems presented
Sep. 2019	Delirium: An ISCR hospital detailed the work they've been doing with delirium prevention and elderly patients	**Apr. 2021**	Antibiotic stewardship: The NPT led a conversation with participants on various hot topics related to antibiotic stewardship
Nov. 2019	Postoperative urinary retention: A non-ISCR shared their nurse driven protocol for bladder management and prevention of urinary retention postoperatively	**Jun. 2021**	Advanced care planning & geriatric patients: The discussion started with an overview of ISCR patient outcomes stratified by age and postoperative delirium status
Dec. 2019	Preoperative optimization: The NPT provided an overview of some of the evidence surrounding preoperative optimization	**Feb. 2021**	Preoperative optimization: An ISCR hospital presented on their colorectal preoperative optimization and patient counseling work

The chat-box function allowed hospitals to ask presenters and each other questions, providing an additional outlet for peer-to-peer learning. Coaching call topics were typically selected in a way that aligned the calls with the most recent NLW. For example, the coaching calls following an NLW on SSI prevention centered on what ISCR hospitals were currently doing in that area and how they could improve. The NPT felt this process allowed teams to immerse themselves in a specific practice area and think thoughtfully about it over the course of a few

webinars. Along with the presenting ISCR hospital, during coaching calls ISCR NPT would discuss and review data received from recently completed implementation check-in surveys, as well as a "Tip and Trick" segment that would provide ISCR sites with access to new resources, program updates, assistance with frequently asked questions about data entry, registry, implementation and pathways.

From cohort 1 to cohort 3B, coaching calls were typically offered twice a month, with either similar content or with one call focusing on the colorectal and gynecology service lines and the other call focusing on the orthopedic service lines. With the addition of the emergency general surgery (EGS) service line for cohort 4 the NPT decided to offer a monthly general coaching call focusing on general ISCR topics for all service lines, as well as providing a bimonthly coaching call focusing on EGS service lines. Participation in both coaching calls was open and encouraged for all hospitals participating in ISCR, regardless of the specific cohorts they joined. Coaching call attendees occupied similar roles to those described for NLWs. The same polling question that was described in the NLW section was used to identify participants' roles on coaching calls.

The average number of participants from cohort 1, cohort 2, cohorts 3A/3B, and cohort 4 was 83 participants (Table 8). Participant numbers for each coaching call were obtained via the participant tab function in Zoom. Figure 6 represents the coaching call attendance throughout the ISCR program. Attendance from specific hospitals was not tracked. Between September 2020 and August 2021, the average number of attendees per coaching call remained consistent with previous months, but after August 2021 the NPT noticed a decline in attendees for each coaching call. With the decline in attendance and cohort 4 nearing its end, during January 2022 the NPT team decided to readjust the coaching call schedule to become a singular monthly general coaching call for all ISCR service lines.

Figure 6. Coaching Call Attendance

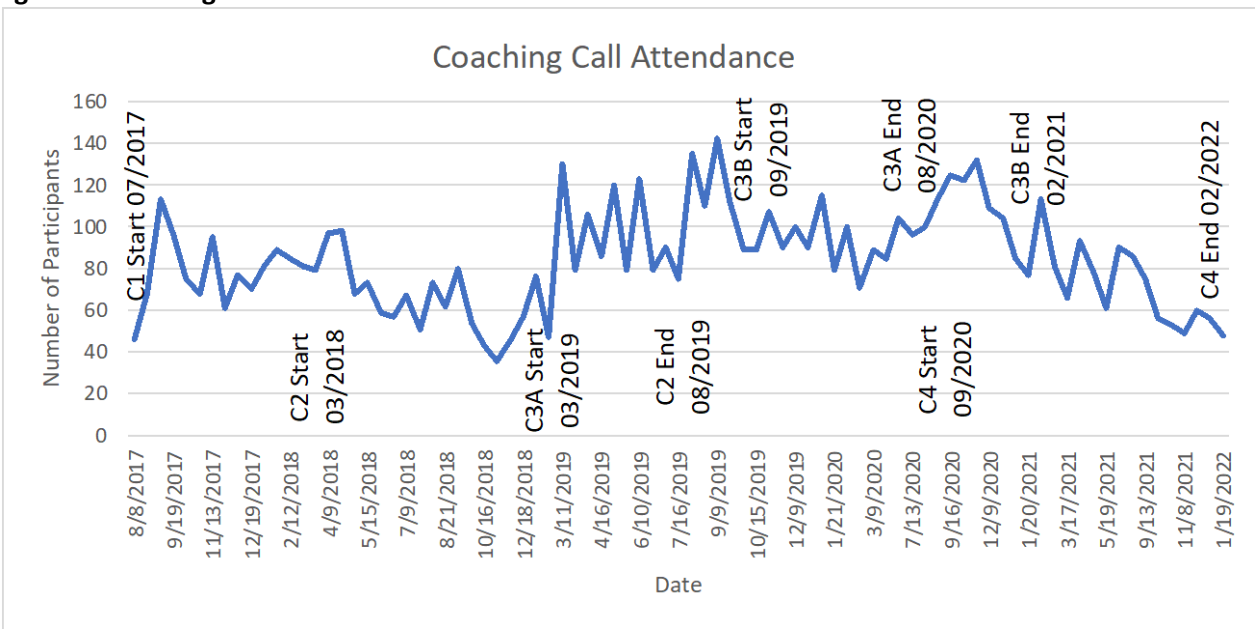


Table 8 shows the overall total and average number of participants for coaching calls during each cohort, the highest and lowest number of attendees for coaching calls during each cohort, and the number of coaching calls held during each cohort.

Table 8. Coaching Call Participation by Cohort

Metric	Cohort 1	Cohort 2	Cohort 3A/3B	Cohort 4
Total	2,205	2,435	3,850	1,932
Average	71	79	101	84
Lowest	36	39	71	48
Highest	113	135	142	132
# of Calls	31	31	38	23

Highlights From Program Webinars and Calls

- Overall 53 NLWs that averaged 117 participants
- Overall 85 coaching calls that averaged 83 participants
- More than 80 coaching calls and 50 NLWs throughout entire ISCR Program

Section VI. In-Person Educational Events

In-person educational events were open to ISCR participants from all cohorts as well as prospective hospitals interested in joining ISCR for a future cohort. These sessions aimed to provide participants with the following:

- Overview of AHRQ ISCR program components, pathway elements, evidence reviews, and program progress to date
- Discussion on ISCR patient and family engagement (including an overview of ISCR patient experience survey results)
- Experience with a virtual change management simulation to test different AHRQ ISCR implementation strategies
- Presentations and panel discussions with experienced ISCR hospitals and enhanced recovery experts
- Overview of AHRQ ISCR data and registry practices
- Networking opportunities

Attendees included surgeons, anesthesiologists, nurses, data abstractors, quality improvement specialists, senior executives, and clinical administration staff. Participant roles were obtained during the registration process. Table 9 describes event locations and a summary of attendance.

Table 9. In-Person Educational Event Attendance Summary for Cohorts 1–3

Training Site/Date	Number of Attendees
New York City, NY/July 20, 2017	108 attendees, 65 hospitals
Nashville, TN/Aug. 17, 2017	37 attendees, 12 hospitals
Des Moines, IA/April 13, 2018	23 attendees, 10 hospitals
Nashville, TN/April 19, 2018	37 attendees, 15 hospitals
St. Paul, MN/April 27, 2018	46 attendees, 20 hospitals
Baltimore, MD/April 30, 2018	17 attendees, 8 hospitals
Orlando, FL/July 20, 2018	104 attendees, 64 hospitals
Washington, DC/July 18, 2019	168 attendees, 111 hospitals
Naperville, IL/Nov. 11, 2019	33 attendees (16 in-person; 17 virtual), 18 hospitals (12 in-person; 9 virtual)

No in-person educational events were held during cohort 4 due to COVID-19. However, ISCR participants were encouraged to attend virtually (2020 and 2021) and in-person (2022) American College of Surgeons (ACS) Quality and Safety Conferences, which did feature sessions on enhanced recovery practices (see section IX. Additional Outreach Support for more information about the ACS conference). The Hawaii hospitals participating in the ISCR program, working with their coordinating entity, Hawaii Safer Care, were able to hold a regional wrapup meeting in August 2022 to share their experience and discuss their plans for the future.

Section VII. Implementation Support

Nurse Consult Calls

Upon program enrollment, each hospital was strongly encouraged by the NPT to schedule a call with the ISCR nurse consultant as part of their onboarding activities for each cohort. This was the case even if the hospital had participated in a previous cohort and was familiar with the program. The majority of program leads working at hospitals participating in the program welcomed the opportunity to meet one on one or gather team members to meet with the ISCR nurse consultant. During these calls, the nurse consultant provided hospitals with guidance and recommendations around implementation startup procedures at the local level, including creation and engagement of the core team; confirmed access to the ISCR website and tools; provided tips to gain support and buy-in from both frontline and senior leader stakeholders; addressed specific concerns with evidence supporting the pathway elements; and ensured they were aware of and had received invitations to program webinars. For hospitals that participated in previous cohorts, the nurse consultant reviewed their current implementation status and progress to date; discussed concerns related to stakeholder buy-in and data entry, abstraction, and sharing of data with both frontline and leadership; and connected hospital stakeholders with subject matter experts from the national program, if requested. As part of program refinement beginning with cohort 2, all hospitals were asked to complete a brief preconsult check-in form before the call. The check-in form asked about the current pathway elements hospitals had in place and if there were any specific questions they wanted to discuss, to aid the nurse consultant in providing hospitals with a focused dialogue during the call.

The consultant calls ranged from 10 to 50 minutes in duration, depending on the experience of the hospital with both enhanced recovery pathway implementation and previous participation in the ISCR program. Most hospitals elected to hold the call with the project lead and the data abstractor, but quite a few hospitals also invited their surgeon and quality improvement champions to participate and ask questions. The most common concerns mentioned by hospital teams focused on reducing variability to standardize pathway elements and on gaining buy-in.

In cohort 1, 96 percent of hospitals (109 out of 113) completed a consult call during the first 6 months of the program. Of hospitals enrolled in cohort 2, 90 percent (103 out of 115) completed a consult call by the end of the third cohort month, with 95 percent of calls (110 out of 115) completed within the first 6 months. Of hospitals enrolled in cohort 3A, 66 percent (61 out of 93) completed a consult call by the end of the third cohort month, with 87 percent of calls (93 out of 107) completed within the first 6 months. Of hospitals enrolled in cohort 3B, 86 percent (24 out of 28) completed a consult call by the end of the third cohort month, with 99 percent of calls (28 out of 31) completed within the first 6 months. Due to hospital attrition, these numbers do not reflect the total number of hospitals that continued to participate in the program.

The consult calls for cohort 4 were spread over a longer period of time due to the impact of COVID-19 and the adjusted start date for cohort 4. A few hospitals began their enrollment process for cohort 4A in January 2020 and completed their consult calls prior to being impacted by COVID-19. The NPT remained in regular contact with hospitals that had signed up for cohort 4A, and they were shifted to the later start date of September 2020. Other hospitals needed more time to reengage with the program following their first and second waves of COVID-19 patient surges. These hospitals were able to schedule their consult calls whenever they were able,

with some scheduling their calls as late as April 2021, 8 months after the cohort start date. In total, 84 percent of hospitals participating in cohort 4 (107 out of 128) completed their nurse consult call.

Office Hours

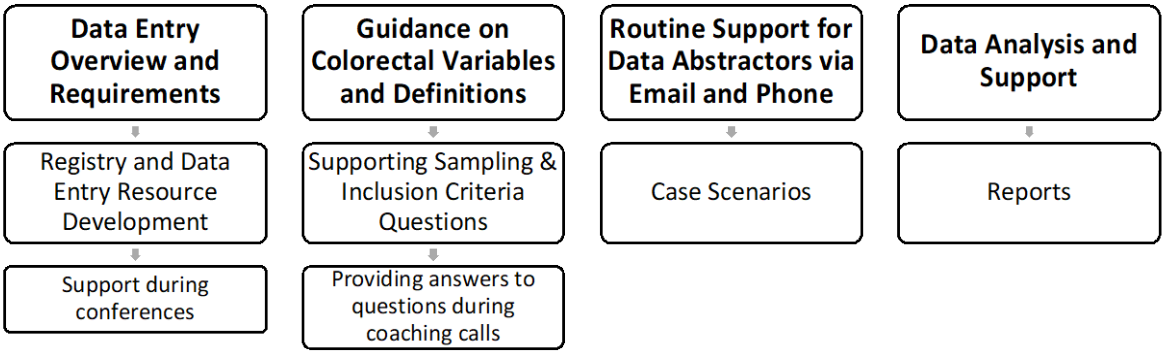
In option period 3, the NPT created an "office hours" program designed to make implementation support more accessible. Participating sites were provided a web link to sign up for office hours via weekly update emails, and in coaching call slides and national leader webinar slides, and teams were encouraged to schedule a time to meet with the ISCR nurse consultant for guidance on implementation issues. Six timeslots were offered each week, some early in the morning, some at midday, and some in the evening, giving project teams a variety of options from which to choose. During the 2½ years when office hours were offered, 65 project teams met with the nurse consultant to discuss getting started with implementation, creating order sets, addressing data abstraction concerns and questions, determining tactics for success, and many more topics.

Many teams utilized this addition to the program, but the majority of project leads, particularly those who had been participating in the program since the first and second cohorts, emailed the Nurse Consultant directly. To facilitate access to timely assistance for teams, ISCR specific email addresses were created for the Nurse Consultant, data registry support, onboarding and general enrollment questions, and general support. These email addresses were shared with participating hospitals in every weekly update and in presentations.

Section VIII. Clinical Support

As part of the NPT, the clinical support service (assistance with registry, data definition, and data entry) helped ISCR data abstractors via phone calls, emails, coaching calls, and several in-person events. On average the ACS Clinical Support team fielded 15 questions per day throughout the cohort. See Figure 7 below for additional details related to the offerings provided by the clinical support team.

Figure 7. Overview of Clinical Support Activities



Additional details will be provided related to support type, volume of support requested, methods, and support categories. Individual support was consistently offered throughout the cohort to assist with ISCR report access and interpretation. A video walkthrough of accessing and using ISCR reports was developed and made available on the AHRQ ISCR program website to provide additional education to all participating hospitals.

ISCR Registry Data Collection

To improve overall data collection efforts within the ISCR registry, the NPT worked to have all registry components for the subsequent cohorts ready well in advance of the cohort start date. Additionally, entering sample cases into the ISCR registry was built into the onboarding process and became a required step that all hospitals must complete prior to being fully enrolled. This guaranteed hospitals had access to the registry and that identified ISCR data abstractors understood how to enter data into the registry.

The following initiatives were also in place to assist participants with data collection efforts:

- Data Collection Outreach-Quality Improvement Project
    - Monthly monitoring of hospital data entry was completed to provide consistent targeted outreach. This ensured sites continued routine data entry practices for the ISCR program. Those participating hospitals that were not entering data for the month were contacted to inquire if further education was needed, data entry resources were not available, or case volumes were unavailable that month.
- Resources
    - Data entry resources were kept current on the ISCR program website to assist hospitals. This included written material, video walkthroughs, and self-paced e-learning modules.
- Webinars
    - ISCR data entry updates and frequently asked questions were verbally presented on monthly coaching calls and national leader webinars.

- Mentor Program
    - Program participants were offered the opportunity to pair up a mentor for data entry assistance. Matches were made based on experience and electronic health record use. The program was designed to improve data entry rates and was voluntary to participate.
- Clinical Registry
    - The ACS data platform was kept current including entry options, report logic, and the addition of an opioid dashboard on a semiannual basis or as needed. ISCR reports were made more meaningful through this routine maintenance and enhancement.

Section IX. Additional Outreach Support

To ensure that hospitals remained up to date on program happenings, the NPT emailed weekly ISCR updates to ISCR participants. The goal of the weekly emails was to inform participants of program updates, including new tools that were available, upcoming coaching call and NLW dates and topics, new available resources, and tools, ISCR registry and variable updates, enrollment and onboarding reminders, relevant conference information, general tasks hospitals should be working on each month and a tip of the week. The tip of the week was also featured on the ISCR homepage and Resource Center to highlight various quality improvement implementation techniques and best practices, or recap discussions on previous webinars. Outreach support continued to assist ISCR participants with specific project needs. The NPT streamlined hospital inquiries to best assist participants based on their implementation, clinical support, and general program questions. Contact information for the NPT was on the ISCR website, weekly update emails, and various program resources and documents.

Sportfire reports (internal ACS report that displays frequency of report access within the ACS data platform by report type) for registry use were monitored each month to provide best support and resources for the most utilized ISCR reports. Throughout the program, the ISCR Measures Colorectal Report was the most frequently viewed report.

Chapter 2. Recruitment

The following tools/methods were developed to help hospitals decide if participation in the Improving Surgical Care and Recovery (ISCR) Program was appropriate for them:

- ISCR Recruitment Webinar
- ISCR Program Fact Sheet
- Enrollment FAQ Sheet
- Building Your Core Team
- ISCR Email to Stakeholders
- ISCR Implementation and Sustainability Overview
- Comparison Pathway Worksheets
- ISCR One-Pager

In addition to phone outreach, the National Project Team (NPT) used email communications and e-newsletters to reach interested hospitals. Communications via e-newsletters went to the following: the American College of Surgeons listserv, the Armstrong Institute listserv, the AHRQ listserv, and many national collaboratives and medical societies and associations. The NPT also attended the 2018 and 2019 ACS Quality and Safety Conference, and the 2018 and 2019 ACS Clinical Congress to promote the ISCR program through the sharing of a program overview and enrollment steps in-person with conference attendees.

Additionally, the NPT hosted recruitment webinars to share information about the AHRQ Safety Program for Improving Surgical Care and Recovery (ISCR). Information shared included a program overview and enrollment steps via Zoom or GoToWebinar with attendee questions being answered in real time through a virtual platform.

While recruitment efforts reached interested hospitals throughout the country, the most inquiries for participation came from the following States:

All Program Cohorts

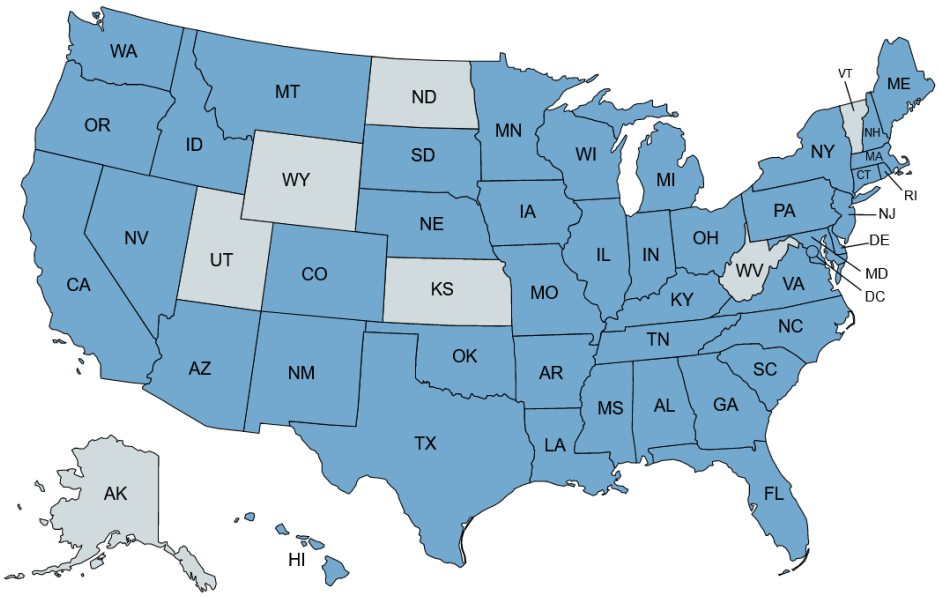
- Illinois: 57
- New York: 37
- Pennsylvania: 37
- California: 34

Requests for additional information and enrollment were received from a wide variety of individuals, including hospital executives, clinicians, and nonclinician administrative personnel.

Chapter 3. Program Enrollment and Retention

The program overall consisted of 342 hospitals collectively participating in the AHRQ Safety Program for Improving Surgical Care and Recovery (ISCR), in which 196 hospitals were American College of Surgeons (ACS) National Surgical Quality Improvement Program (ACS NSQIP®) participants and 146 were not NSQIP participants. Enrollment spread by State, for the program overall, is shown in Figure 8 below.

Figure 8. Overall Enrollment Spread



As illustrated on the map, hospitals from 44 of the 50 U.S. states and Washington, DC (shaded blue) participated in one or more cohorts of the ISCR Program. (No hospitals participated in Alaska, Kansas, North Dakota, Utah, Vermont, West Virginia, and Wyoming.)

ACS NSQIP is a nationally validated, risk-adjusted, outcomes-based program to measure and improve the quality of surgical care. It employs a prospective, peer-controlled, validated database to quantify 30-day, risk-adjusted surgical outcomes, which provide a valid comparison of outcomes among all hospitals in the program. There is an annual fee of between $10,000 to $29,000 for sites participating in ACS NSQIP, which has been active for more than 25 years. The ISCR Program was a great companion program for ACS NSQIP participants, and due to the funding from AHRQ, there was no fee for participation in the ISCR Program. Thus, many sites participated in ACS NSQIP in addition to the ISCR Program.

Of the total 342 overall program participants, approximately 57 percent also participated in NSQIP. Nearly 43 percent of program participants did not participate in NSQIP. There were more NSQIP participants than NSQIP nonparticipants in the program overall. Table 10 provides a breakdown of NSQIP and NSQIP nonparticipating sites for the program overall.

Table 10. Program Overall

Total	No. of Hospitals
Hospitals Participating in the National Surgical Quality Improvement Program	196
Hospitals not Participating in the National Surgical Quality Improvement Program	146

Hospital participation in the program overall spanned the spectrum from small, rural, and/or critical access hospitals to academic and community medical centers with bed sizes ranging from 25 to 500+ beds (Table 11).

Table 11. Bed Size, Program Overall

Bed Size	No. of Hospitals
< 50	21
50–99	21
100–199	65
200–299	56
300–399	48
400–499	35
> 500	96
TOTAL	**342**

When asked during the coaching calls and on enrollment forms why hospitals joined the program, most responses fell under these themes:

- To partner with the Johns Hopkins University (JHU) Armstrong Institute, American College of Surgeons (ACS), and the Agency for Healthcare Research and Quality (AHRQ)
- To implement an enhanced recovery pathway
- To gain access to a centralized place for data entry
- To work on a quality improvement program that spans all phases of care
- To collaborate and learn from other hospitals

Overall Program Participation Withdrawals

In total, 213 unique hospitals withdrew from the program overall. This total accounts for 33 sites that withdrew from cohort 1, 105 sites that withdrew from cohort 2, 25 sites that withdrew from cohort 3, 23 sites that withdrew from cohort 3B, and 43 sites that withdrew from cohort 4. Overall, there were 291 withdrawn service lines, with 137 sites opting out of colorectal surgery, 96 sites opting out of orthopedic surgery, 26 sites opting out of gynecologic surgery, and 32 sites opting out of emergency general surgery.

Reasons for withdrawal from the program overall included the following: budget constraints, limited resources, staff turnover, low case volumes, electronic health record transitions, and/or an inability to meet program requirements.

Chapter 4. Program Impact

Section I. Impact on Pathway Process and Outcome Measures

Methods

Data collection is an essential component of this program, both to allow hospitals to monitor process and outcome data and track their progress, and to allow the National Project Team (NPT) to determine the overall impact of various aspects of the program. The American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP®) registry was used as the data platform on which the Improving Surgical Care and Recovery (ISCR) registry was developed. The ISCR data registry is available to both NSQIP and non-NSQIP hospitals. Non-NSQIP hospitals were advised on sampling methodology, which was dependent on their hospital case volume in the same way as NSQIP hospitals. Significant data collection support was available to all ISCR participants, regardless of NSQIP participation. Table 12 details the timeline of data collection and implementation for cohorts 1, 2, 3A, 3B, and 4 ISCR participants. As detailed in Chapter 1, variables for all four surgery lines—colorectal, orthopedic, gynecologic, and emergency general—were selected for registry inclusion based on existing enhanced recovery literature and input from national technical experts and project leaders. The registry variables and definitions representing process and outcome measures for colorectal, orthopedic, gynecologic, and emergency general surgery service lines are included in Tables 13a-h.

Table 12. Cohort 1, 2, 3A, and 3B Data Collection and Implementation Periods

Cohort	Service Line	Pre-Implementation	Implementation	Sustain
Cohort 1	Colorectal	3 months 07/01/2017 – 09/30/2017	9 months 10/01/2018-06/30/2018	6 months 07/01/2018-12/31/2018
Cohort 2	Colorectal, Orthopedic	3 months 03/01/2018 – 05/31/2018	9 months 06/01/2018-02/28/2019	6 months 03/01/2019-08/31/2019
Cohort 3A	Colorectal, Orthopedic, Gynecologic	3 months 03/01/2019 – 05/31/2019	9 months 06/01/2019-02/29/2020	6 months 03/01/2020-08/31/2020
Cohort 3B	Colorectal, Orthopedic, Gynecologic	3 months 09/01/2019 – 11/30/2019	9 months 12/01/2019-08/31/2020	6 months 09/01/2020-02/28/2021
Cohort 4	Colorectal, Orthopedic, Gynecologic, Emergency General Surgery	3 months 09/01/2020-11/30/2020	9 months 12/01/2020-08/31/2021	6 months 09/01/2021-02/28/2022

Table 13a-h. Process and Outcome Measures with Definitions

Table 13a. Seven Colorectal Surgery Process Measures

Variable	Definition
1. Preoperative Mechanical Bowel Preparation	% of patients who underwent a complete mechanical bowel preparation
2. Preoperative Oral Antibiotics	% of patients who received preoperative oral antibiotics within 24 hours prior to surgery
3. Multimodal Pain	% of patients who had two or more non-opioid analgesics in the postoperative period within 48 hours of surgery end
4. First Postoperative Mobilization	% of patients who ambulated on postoperative day 0
5. First Postoperative Intake of Liquids	% of patients who consumed liquids on postoperative day 0
6. First Postoperative Intake of Solids	% of patients who consumed solids by postoperative day 1
7. Foley Catheter Duration	% of patients who had Foley catheter removed within 48 hours of surgery end, documented reason for prolonged Foley, or no Foley placed

Table 13b. Eight Colorectal Surgery Outcome Measures

Variable	Definition
1. Venous Thromboembolism (VTE)	% of patients experiencing a VTE event (pulmonary embolism or vein thrombosis requiring therapy) within 30 days of surgery end
2. Urinary Tract Infection (UTI)	% of patients experiencing a UTI within 30 days of surgery end
3. Surgical Site Infection (SSI)	% of patients experiencing an SSI within 30 days of surgery end
4. Ileus	% of patients experiencing Return of Bowel Function (ROBF) > 3 days after surgery end time
5. VUS (Composite Outcome Comprising VTE, UTI, or SSI)	% of patients experiencing binary composite outcome comprising VTE, UTI, or SSI
6. Length of Stay (LOS)	Continuous, mean number of hospital days
7. Return of Bowel Function (ROBF)	Continuous, mean number days until bowel function returned
8. Acute Hospital Discharge Date	% of patients with postoperative length of stay greater than 7 days

Table 13c. Eight Orthopedic Surgery Process Measures

Variable	Definition
1. Use of Multi-Modal Pain Management	% of patients who had two or more non-opioid analgesics in the postoperative period within 48 hours of surgery end
2. First Postoperative Mobilization	% of patients who ambulated on postoperative day 0
3. Foley Duration	% of patients who had Foley removed within 24 hours of surgery end or had no Foley placed
4. Tranexamic Acid Use	% of patients who received tranexamic acid (TXA) perioperatively

Variable	Definition
5. Medical deep vein thrombosis (DVT) prophylaxis continued 28 days Postop	% of patients who received prescription of prophylactic measures/ therapeutic medication to prevent DVT or pulmonary embolism after orthopedic surgery for 28 days post-op
6. Weight Bearing as Tolerated on Postoperative Day 1	% of patients who tolerated weight bearing on the first postoperative day or sooner
7. Evidence of Advanced Care Planning (Hip Fracture Surgery Only)	% of patients who has documentation of a healthcare proxy, living will or advanced directives prior to the operation
8. Operative Timing (incision within 24 Hours of Emergency Room Registration) (Hip Fracture Only	% of patients with surgery start (incision) time within 24 hours within emergency room registration

Table 13d. Seven Orthopedic Surgery Outcome Measures

Variable	Definition
1. Venous Thromboembolism (VTE)	% of patients experiencing a VTE event (pulmonary embolism or vein thrombosis requiring therapy) within 30 days of surgery end
2. Urinary Tract Infection (UTI)	% of patients experiencing a UTI within 30 days of surgery end
3. Surgical Site Infection (SSI)	% of patients experiencing an SSI within 30 days of surgery end
4. Length of Stay (LOS)	Continuous, number of hospital days
5. Acute Hospital Discharge Date	% of patients with postoperative length of stay greater than 75th percentile: 2 days (hip/knee replacement surgery) or 5 days (hip fracture surgery)
6. Transfusion Intra/Postoperative Blood Products Within 72 Hours	% of patients for whom it was deemed to be in the patient's best interest to transfuse blood products (specifically red blood cell and whole blood products) or reinfuse autologous red blood cell or cell-saver products, during the principal operative procedure and up to 72 hours postoperatively
7. 30-day Unplanned Return to Operative Room	% of patients who had an unplanned return to the operating room within 30 days of surgery end

Table 13e. Eight Gynecologic Surgery Process Measures

Variable	Definition
1. Postoperative Venous Thromboembolism (VTE) Chemoprophylaxis	% of patients who received postoperative VTE prophylaxis within 24 hours after surgery end
2. Multimodal Pain	% of patients who had two or more non-opioid analgesics in the postoperative period within 48 hours of surgery end
3. First Postoperative Mobilization	% of patients who ambulated on postoperative day 0

Variable	Definition
4. First Postoperative Intake of Liquids	% of patients who consumed liquids on postoperative day 0
5. First Postoperative Intake of Solids	% of patients who consumed solids by postoperative day 1
6. Foley Duration	% of patients who had Foley removed within 48 hours of surgery end, documented reason for prolonged Foley, or no Foley placed
7. Patient Controlled Analgesia	% of patients who were administered patient-controlled analgesia
8. Local Wound Analgesia	% of patients who were administered local wound analgesia

Table 13f. Six Gynecologic Surgery Outcome Measures

Variable	Definition
1. Venous Thromboembolism (VTE)	% of patients experiencing a VTE event (pulmonary embolism or vein thrombosis requiring therapy) within 30 days of surgery end
2. Urinary Tract Infection (UTI)	% of patients experiencing a UTI within 30 days of surgery end
3. Surgical Site Infection (SSI)	% of patients experiencing an SSI within 30 days of surgery end
4. VUS (Composite Outcome Comprising VTE, UTI, or SSI)	% of patients experiencing binary composite outcome comprising VTE, UTI, or SSI
5. Length of Stay (LOS)	Continuous, mean number of hospital days
6. Acute Hospital Discharge Date	% of patients with postoperative length of stay greater than 7 days

Table 13g. Ten Emergency General Surgery Process Measures

Variable	Definition
1. Patient Education	% of patients educated about details of postoperative expectations, prior to or immediately after surgery
2. Surgical Approach	% of patients who had a minimally invasive (laparoscopic or robotic) surgical approach
3. Preoperative Venous Thromboembolism (VTE) Chemoprophylaxis	% of patients who received postoperative VTE prophylaxis within 12 hours before incision or intraoperatively (major abdominal procedures only)
4. Postoperative VTE Chemoprophylaxis	% of patients who received postoperative VTE prophylaxis within 24 hours after surgery end (major abdominal procedures only)
5. Multimodal Pain Management	% of patients who had two or more non-opioid analgesics in the postoperative period within 48 hours of surgery end
6. First Postoperative Mobilization	% of patients who ambulated on postoperative day 0
7. First Postoperative Intake of Liquids	% of patients who consumed liquids on postoperative day 0
8. Foley Duration	% of patients who had Foley removed within 48 hours of surgery end, documented reason for prolonged Foley, or no Foley placed
9. Evidence of Advanced Care Plan	% of patients with documentation of a healthcare proxy, living will, or advanced care directives prior to surgery

Variable	Definition
10. Postop Opioid Prescription (Rx)	% of opioid-naïve (not taking outpatient opioids within 10 days prior to surgery) patients prescribed an opioid analgesic in the discharge orders/instructions

Table 13h. Seven Emergency General Surgery Outcome Measures

Variable	Definition
1. Venous Thromboembolism (VTE)	% of patients experiencing a VTE event (pulmonary embolism or vein thrombosis requiring therapy) within 30 days of surgery end
2. Urinary Tract Infection (UTI)	% of patients experiencing a UTI within 30 days of surgery end
3. Surgical Site Infection (SSI)	% of patients experiencing an SSI within 30 days of surgery end
4. Ileus	% of patients experiencing Return of Bowel Function (ROBF) > 3 days after surgery end time
5. VUS (Composite Outcome Comprising VTE, UTI, or SSI)	% of patients experiencing binary composite outcome comprising VTE, UTI, or SSI
6. Length of Stay (LOS)	Continuous, mean number of hospital days
7. Acute Hospital Discharge Date	% of patients with postoperative length of stay greater than 2 days (appendectomy/cholecystectomy) or 5 days (major abdominal surgeries)

Hospitals included in the analysis were those that entered data for surgery cases done during the official 12-month cohort period, beginning in the first or second month of their respective cohort and continuing through at least month 11/12. Although enrollment (and therefore determination of hospital inclusion eligibility) was based on a single orthopedic service line, hip fracture surgery cases and knee/hip replacement surgery cases are typically analyzed separately from each other since the joint replacement procedures and populations tend to differ greatly. In a similar manner, although emergency general surgery (EGS) was a single service line for enrollment and for the sake of determining hospital inclusion eligibility, EGS (urgent and emergent) appendectomies and cholecystectomies were analyzed separately from the other EGS (urgent and emergent) procedures (hernia or ulcer repair, intestinal procedures, exploratory laparotomies) since the latter group (henceforth referred to as "EGS-major abdominal procedures") tend to be much more complex than the former group (henceforth referred to as EGS-appendectomy/cholecystectomy").

There were many valid reasons for interruption of a hospital's case entry operational performance, including, but not limited to loss, or transition of data abstractors. Therefore, hospitals were not excluded from analysis for failure to enter cases for each month during their participation window. Although early cohorts were officially 12 months long, the analyses included 18 months' worth of case data to allow hospitals additional time to improve.

Primary Predictor Variable

The primary predictor variable for the analysis was time, which was defined as month number of operation date from the first month of the cohort (i.e., month 1=July 2017 for cohort 1, March 2018 for cohort 2, March 2019 for cohort 3A, September 2019 for cohort 3B, September 2020 for cohort 4; Month 2=August 2017 for cohort 1, April 2018 for cohort 2, April 2019 for cohort 3A, October 2019 for cohort 3B, October 2020 for cohort 4). Additional details on analyses, including full model reports for each outcome measure, can be found in Appendix B.

Risk Adjustment Variables

The risk adjustment variables for colorectal outcomes were: age category (<65, 65-74, 75-84, 85+), gender (female, male), race (White, Black/African-American, other, unknown), Hispanic ethnicity (yes, no, unknown), pre-operative sepsis (none, sepsis, septic shock, systemic inflammatory response syndrome), emergency surgery (no, yes), American Society of Anesthesiologists class (1–-2, 3, 4–5), CPT linear risk (a linearized risk score for procedure complexity), cohort number (1, 2, 3, 3B, 4), and operation month for the time construct. Orthopedic outcomes additionally utilized preoperative albumin value and low (<36) versus normal preoperative hematocrit level. Surgical site infection, intra/postoperative transfusion, length of stay, and VUS (composite) models also included preoperative transfusion (No, Yes) as a risk adjustment variable. Gynecologic surgery models had a variable indicating "major" cases (concurrent colorectal resection and/or cytoreduction for advanced malignancy). Emergency general surgery had a variable indicating the surgical approach (laparoscopic, robotic, open, minimally invasive surgery [MIS] converted to open, laparoscopic, and robotic were considered MIS; open and MIS converted to open were considered open) and another indicating if the patient was ventilator dependent within 48 hours prior to surgery (no, yes). Prior to modeling, missing values for race and Hispanic ethnicity were set to the "unknown" category. Current procedural terminology (CPT) code and operation month had no missing values. Missing values for other predictor values were imputed using maximum likelihood estimation. Additionally, analyses accounted for hospital-level differences by using hospital as a clustering variable.

Primary Statistical Analysis

Multivariable models were constructed for each outcome measure and process measure using patient-level data with hospital as a clustering variable. For binary outcome measure and process measures, multivariable logistic regression models were constructed to determine the odds ratio (OR) for the primary predictor variable, time. For continuous outcome measures, multivariable negative binomial regression models were constructed to determine the model parameter for time. An OR with confidence interval (CI) that did not include 1.0 or a model parameter value with a significant *p*-value (<0.05) indicated a significant change with respect to time. Odds ratios < 1.0 or negative parameter values indicated decreasing rates or durations over time, while OR > 1.0 or positive parameter values indicated increasing rates or durations over time.

Secondary Statistical Analyses

Hospital-Level Differences in Improvement

To assess if there were any hospital-level differences in process measure improvement throughout the duration of a cohort, a three-step process was undertaken: each case was assigned an "overall compliance rate"—for example, if a case was compliant for six of eight process measures, the "overall compliance" would be 0.75; then, overall compliance rates were regressed against time, with time as a random effect (by hospital) and with random intercept by hospital; finally individual hospital slopes were extracted and regressed against select hospital factors (electronic health record [EHR]) maturity, readiness to change score, American Hospital Association bed size category, residency program status, and hospital setting [rural, metropolitan, micropolitan]). Hospital factors with a p-value less than 0.05 are significant. (Positive model parameter values indicate a higher, faster rate of improvement when compared to the referent category).

A similar approach was taken to determine hospital-level differences in outcome improvement. However, instead of using an "overall outcome" rate, the VUS composite seen in the primary analyses was used as the response for a logistically regressed first step; additionally, the first step included common outcome risk adjustment variables (age, sex, etc.) used in other outcome models in this report, as well as CPT code in order to adjust for the procedure-specific risk. In this case, hospital-level log odds ratios were extracted instead of simple slopes, and these log odds ratios were linearly regressed against the same hospital factors as listed above. In this case, faster improvement would be by a significantly negative slope in the final regression step.

Patient-Level Subgroups

To assess if there were any differences in how different patient subgroups experienced the ISCR program, different methods were used for process measures than for outcomes. Age group, sex, race, and Hispanic ethnicity are already risk adjustment variables within the primary outcome measure models, so the odds ratios of the different groups compared to baseline were simply examined from the full model report. Subsets with the entire 95% confidence interval higher than 1 experienced the outcome significantly more than the referent group, and subsets with the entire 95% confidence interval less than 1 experienced the outcome significantly less than the referent group.

For process measures, a series of pairwise chi-square tests of independence were conducted, using the same reference group as in the outcomes (for example, Hispanic vs. Non-Hispanic and Unknown vs. Non-Hispanic). After the p-value was extracted from each pairwise test, Bonferroni corrections were done to compensate for the familywise error. Groups with corrected p values less than 0.05 were significant, and inference about direction was made by comparing raw rates of the process measure in the comparison group versus the referent group.

Cross-Service Line Analysis

For the cross-service line analysis, the process measures and outcomes that were collected for multiple service lines were selected, and logistic regressions were performed the same way they were in the primary analysis—except with cases from all service lines and cohorts combined into the same model (using "service line" as an extra risk adjustment variable in process measure variables, and CPT code instead of CPT linear risk in outcome models. There was also a cohort risk adjustment variable in each model.) As with the primary analyses, the

primary predictor of interest is time; in these cross-service line analyses a significant odds ratio greater than 1 indicates increased odds over time, across service lines and cohorts, and a significant odds ratio less than 1 indicates decreased odds over time, across service lines and cohorts.

Impact of ISCR Process Measures on Surgical Outcomes

Although many analyses were already completed on process measures separately from outcomes, this analysis removes the time component from the models, and introduces process measures as predictors for each ISCR outcome. Because the time component was removed, this analysis includes additional cases, from hospitals that had case start month too late or case end month too early for eligibility in the primary analyses. Process measures with odds ratios statistically significantly greater than 1 increase the odds of the outcome occurring, and those with odds ratios statistically significantly less than 1 decrease the odds of the outcome occurring.

Impact of ISCR Program on 30-Day Readmission and 30-Day Mortality

This analysis utilized NSQIP data from NSQIP-participating ISCR hospitals. After identifying which ISCR cohort and service line combination(s) these hospitals participated in (to an extent that made them eligible for the primary analysis described above), NSQIP data for the corresponding hospitals and service lines was pulled for the 12 months prior to cohort start date ("pre" period) and 12 months following cohort start date ("post" period). Logistic models were performed using readmission and mortality as the outcomes, with a "pre/post" variable replacing the time variable as the principal predictor: significant odds ratio greater than 1 indicating that participation in ISCR increased odds of the outcome, and significant odds ratio less than 1 indicating that participation in ISCR decreased odds of the outcome. Risk adjustment variables for these models included the top 10 predictors from the corresponding models in the most recent NSQIP Semi-Annual Report (SAR), and because EGS does not currently have corresponding models in the SAR, the same predictors used in the colorectal readmission and mortality models were used for the purposes of the EGS readmission and mortality models for this analysis. To mirror the SAR, hip fracture surgery and hip/knee replacement surgery were combined into a single orthopedic model for each outcome, and the two EGS subgroups were also kept in a single model for each outcome.

Results

The following sections present the registry data entry by calendar month, event rates for binary outcomes, unadjusted trends of binary and continuous outcomes by month, and the risk-adjusted analysis of process and outcome measures. Data for each service line are presented in aggregate (all cohorts together); data for the orthopedic hip fracture surgery population is presented separately from data for the orthopedic knee/hip replacement surgery population, and the emergency general surgery appendectomy and cholecystectomy population is presented separately from data for the emergency general surgery major abdominal procedures population, since appendectomies and cholecystectomies are generally less complex than the hernia, ulcer, small bowel, colon, and exploratory laparotomy procedures. Results start with the colorectal service line in which Tables 14a–c summarize monthly registry data entry, while Tables 15a–d and Figures 9–16 illustrate unadjusted binary and continuous outcomes by month. Note that the event rate is the proportion of the number of analysis-eligible cases abstracted with the reported outcome relative to the total number of analysis-eligible cases abstracted for that service line. Figure 17 reports process measure compliance over time.

COLORECTAL SURGERY, COHORTS 1–4

Unadjusted Data Trends

Table 14a. Colorectal Surgery Registry Data Entry Summary, by Month—Process Measure

Month	# Hosp	# Cases
1	158	1379
2	171	1577
3	163	1684
4	162	1638
5	154	1672
6	153	1625
7	155	1732
8	157	1693
9	157	1673
10	157	1762
11	161	1944
12	157	1829
13	150	1644
14	150	1499
15	150	1630
16	144	1581
17	144	1653
18	147	1571
Total	*n/a*	*29786*

Abbreviations: n/a= not applicable

Table 14b. Colorectal Surgery Registry Data Entry Summary, by Month—Outcome Measure

Month	# Hosp	# Cases
1	174	1512
2	186	1745
3	176	1805
4	176	1801
5	171	1831
6	168	1774
7	169	1920
8	172	1851
9	174	1888
10	173	1909
11	175	2071
12	172	1982
13	165	1812
14	167	1670
15	165	1765
16	160	1762
17	160	1817
18	163	1712
Total	*n/a*	*32627*

Abbreviations: n/a= not applicable

Table 14c. Colorectal Surgery Registry Data Entry Summary, by Month—NSQIP Outcome

Month	# Hosp	# Cases
1	219	2073
2	231	2410
3	221	2368
4	221	2420
5	215	2513
6	213	2426
7	216	2682
8	219	2549
9	208	2202
10	212	2481
11	217	2596
12	214	2514
13	207	2301
14	207	2235
15	203	2245
16	199	2317
17	199	2335
18	201	2206
Total	*n/a*	*42873*

Abbreviations: n/a= not applicable; NSQIP = National Surgical Quality Improvement Program

Table 15a. Colorectal Surgery Event Rates of Binary Outcome Measures by Month–Venous Thromboembolism

Month	(n)	Cases	Rate (%)
1	49	1817	2.36
2	43	2141	1.78
3	48	2144	2.03
4	56	2149	2.31
5	49	2304	1.95
6	57	2198	2.35
7	52	2434	1.94
8	53	2337	2.08
9	43	1985	1.95
10	40	2260	1.61
11	49	2348	1.89
12	38	2288	1.51
13	42	2092	1.83
14	34	2031	1.52
15	50	2023	2.23
16	45	2123	1.94
17	50	2133	2.14
18	48	1998	2.18
Total	*846*	*40667*	*n/a*

Abbreviations: n/a= not applicable

Table 15b. Colorectal Surgery Event Rates of Binary Outcome Measures by Month– Urinary Tract Infection

Month	(n)	Cases	Rate (%)
1	47	2073	2.27
2	44	2410	1.83
3	48	2368	2.03
4	47	2420	1.94
5	49	2513	1.95
6	42	2426	1.73
7	49	2682	1.83
8	43	2549	1.69
9	40	2202	1.82
10	37	2481	1.49
11	36	2596	1.39
12	50	2514	1.99
13	36	2301	1.56
14	43	2235	1.92
15	45	2245	2.00
16	41	2317	1.77
17	52	2335	2.23
18	46	2206	2.09
Total	795	42873	*n/a*

Abbreviations: n/a= not applicable

Table 15c. Colorectal Surgery Event Rates of Binary Outcome Measures by Month–Surgical Site Infection

Month	(n)	Cases	Rate (%)
1	199	2073	9.60
2	221	2410	9.17
3	196	2368	8.28
4	224	2420	9.26
5	233	2513	9.27
6	215	2426	8.86
7	255	2682	9.51
8	203	2549	7.96
9	178	2202	8.08
10	206	2481	8.30
11	247	2596	9.51
12	214	2514	8.51
13	225	2301	9.78
14	190	2235	8.50
15	207	2245	9.22
16	208	2317	8.98
17	227	2335	9.72
18	219	2206	9.93
Total	3867	42873	*n/a*

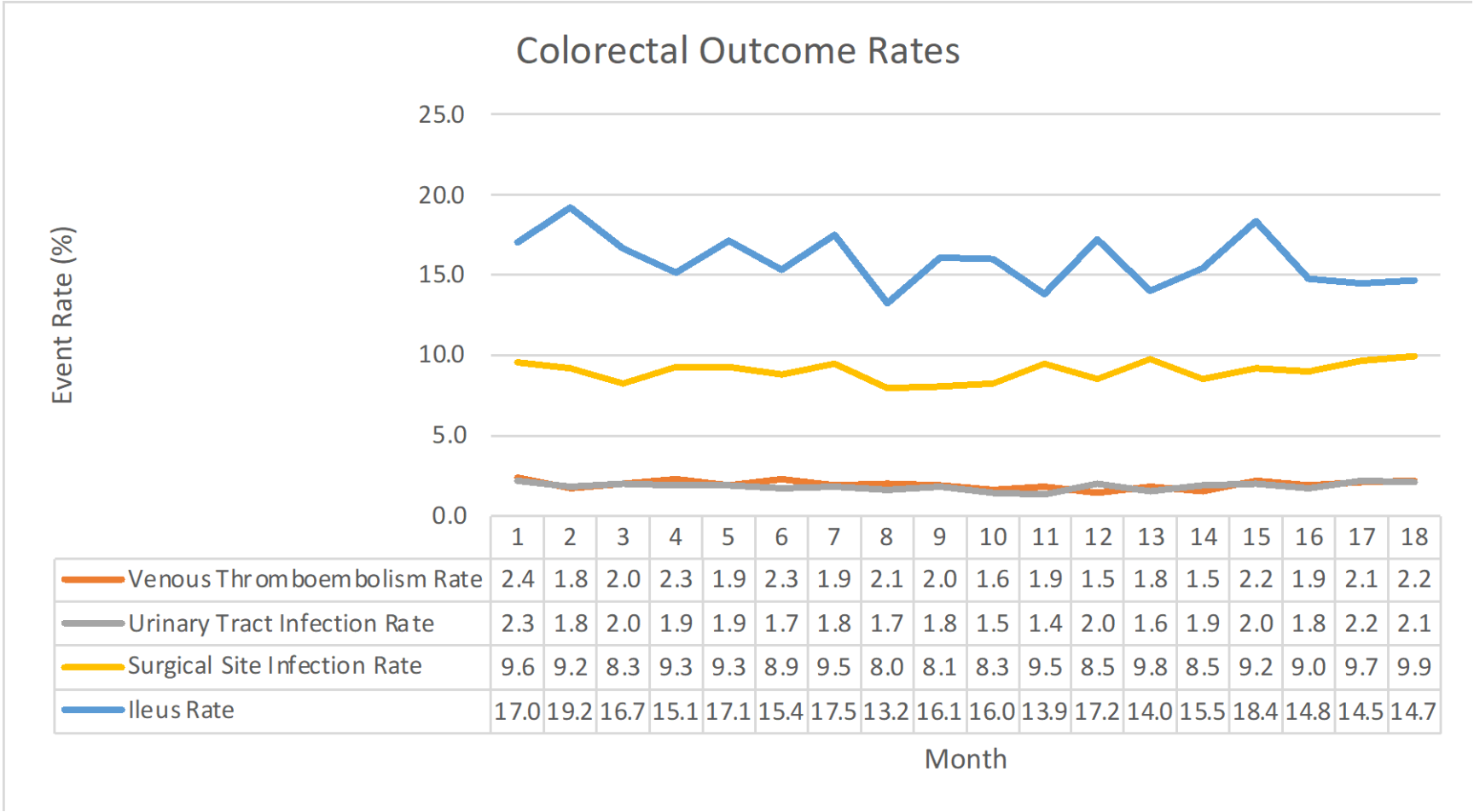
Abbreviations: n/a= not applicable

Table 15d. Colorectal Surgery Event Rates of Binary Outcome Measures by Month–Ileus

Month	(n)	Cases	Rate (%)
1	235	1381	17.02
2	311	1617	19.23
3	275	1646	16.71
4	248	1641	15.11
5	289	1686	17.14
6	253	1648	15.35
7	313	1789	17.50
8	231	1744	13.25
9	278	1726	16.11
10	275	1722	15.97
11	260	1876	13.86
12	309	1794	17.22
13	232	1659	13.98
14	229	1481	15.46
15	292	1591	18.35
16	230	1559	14.75
17	238	1637	14.54
18	232	1578	14.70
Total	4730	29775	*n/a*

Abbreviations: n/a= not applicable

Figure 9. Colorectal Surgery Unadjusted Event Rates of Binary Outcome Measures by Month



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Venous Thromboembolism Rate	2.4	1.8	2.0	2.3	1.9	2.3	1.9	2.1	2.0	1.6	1.9	1.5	1.8	1.5	2.2	1.9	2.1	2.2
Urinary Tract Infection Rate	2.3	1.8	2.0	1.9	1.9	1.7	1.8	1.7	1.8	1.5	1.4	2.0	1.6	1.9	2.0	1.8	2.2	2.1
Surgical Site Infection Rate	9.6	9.2	8.3	9.3	9.3	8.9	9.5	8.0	8.1	8.3	9.5	8.5	9.8	8.5	9.2	9.0	9.7	9.9
Ileus Rate	17.0	19.2	16.7	15.1	17.1	15.4	17.5	13.2	16.1	16.0	13.9	17.2	14.0	15.5	18.4	14.8	14.5	14.7

Figure 10. Colorectal Surgery Venous Thromboembolism Event Rates of Binary Outcome Measures by Month

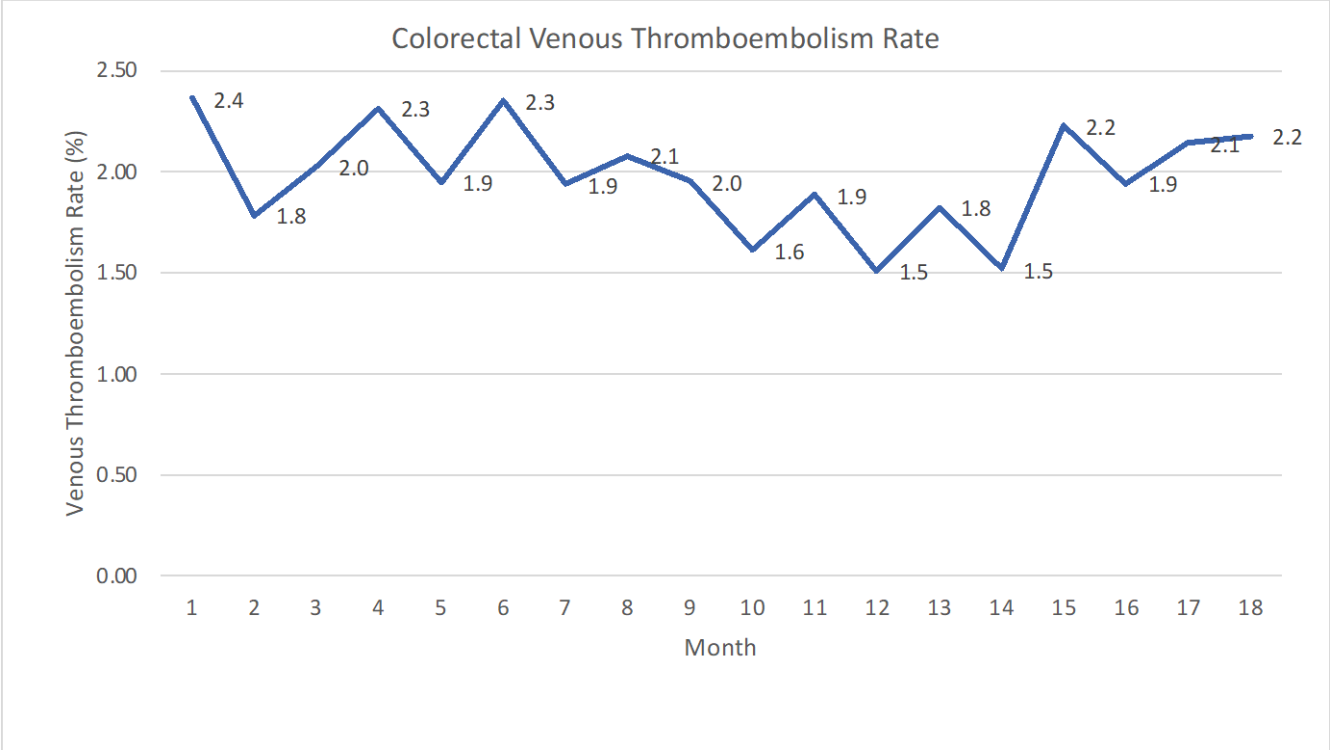


Figure 11. Colorectal Surgery Urinary Tract Infection Event Rates of Binary Outcome Measures by Month

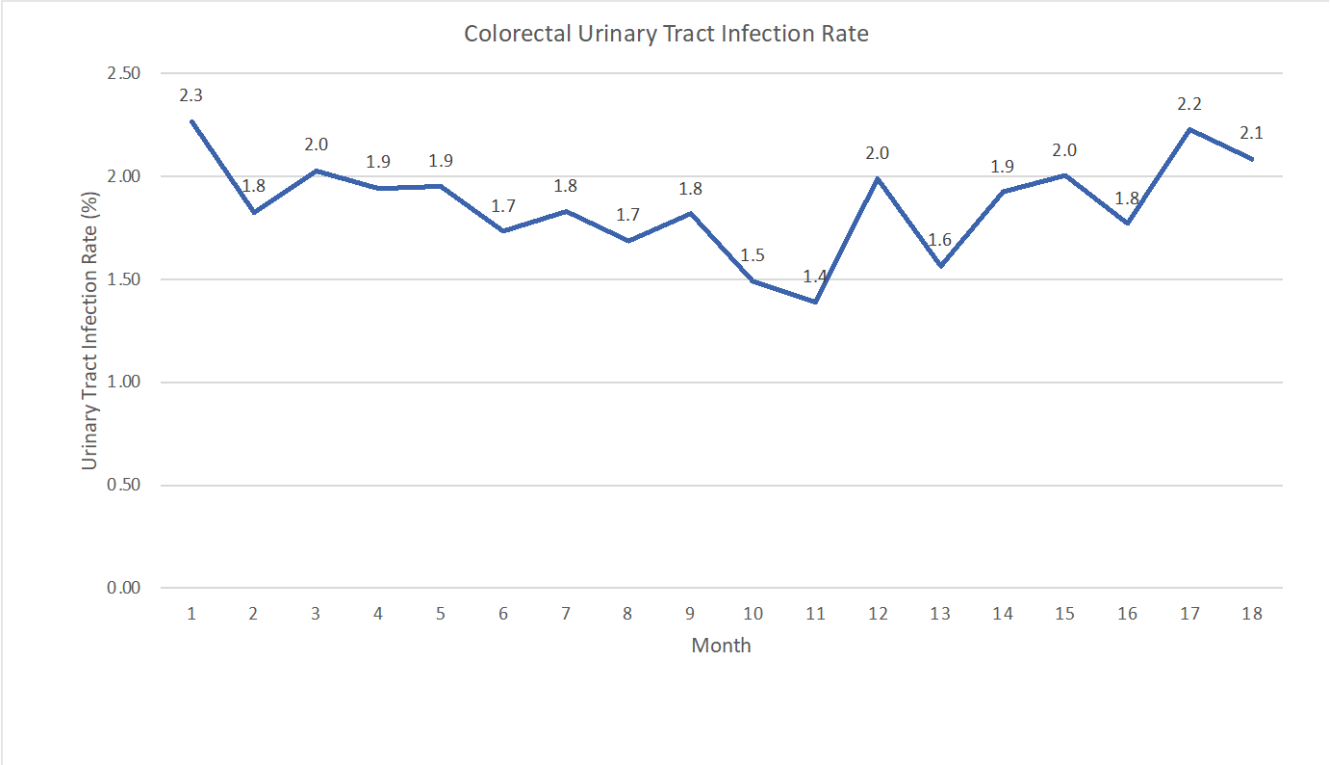


Figure 12. Colorectal Surgery Surgical Site Infection (SSI) Event Rates of Binary Outcome Measures by Month

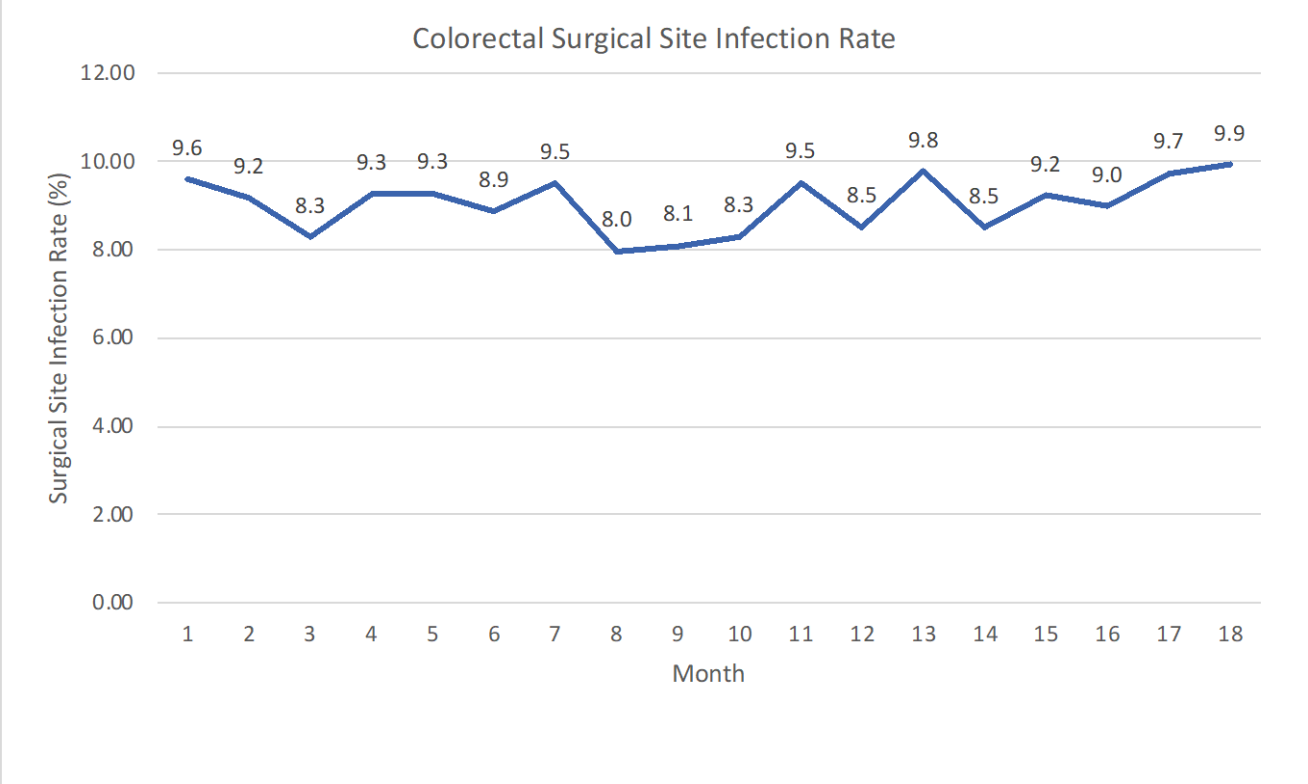


Figure 13. Colorectal Surgery Ileus Event Rates of Binary Outcome Measures by Month

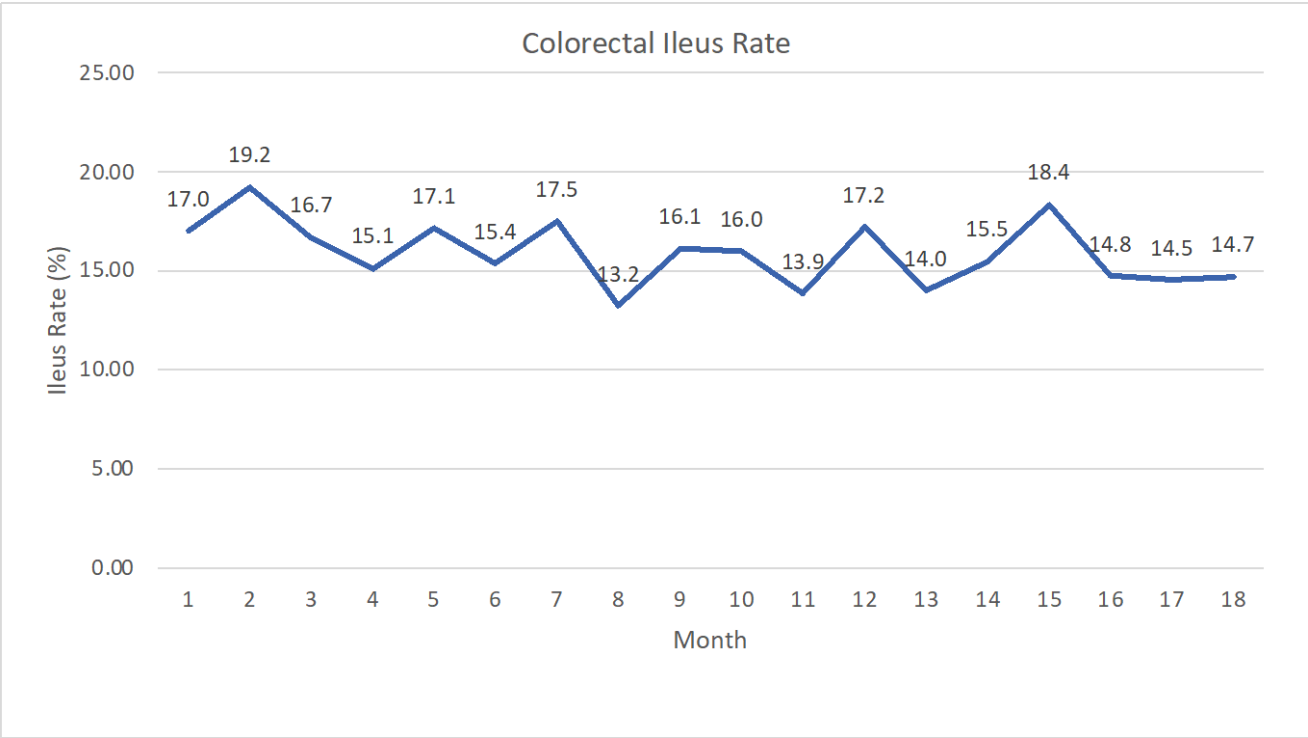


Figure 14. Colorectal Surgery Prolonged Length of Stay (>75th percentile) Binary Outcome Measures by Month

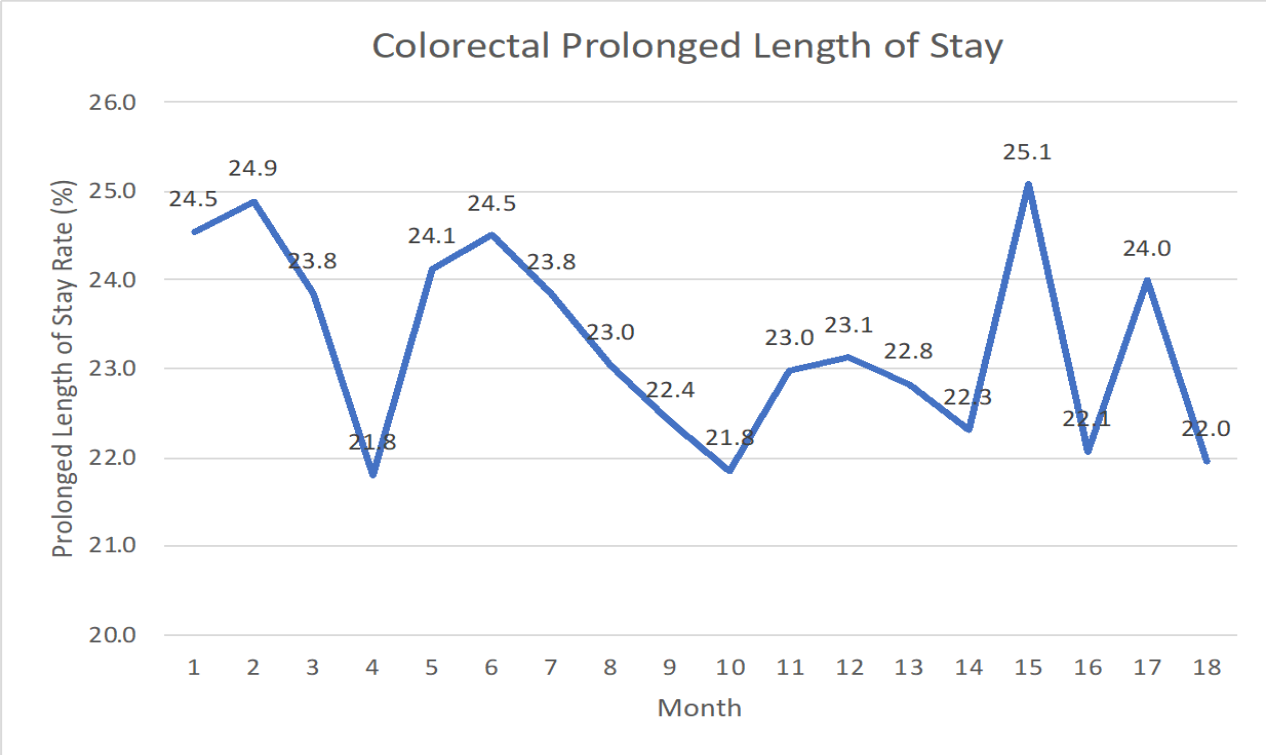


Figure 15. Colorectal Surgery Mean Days of Return of Bowel Function by Month

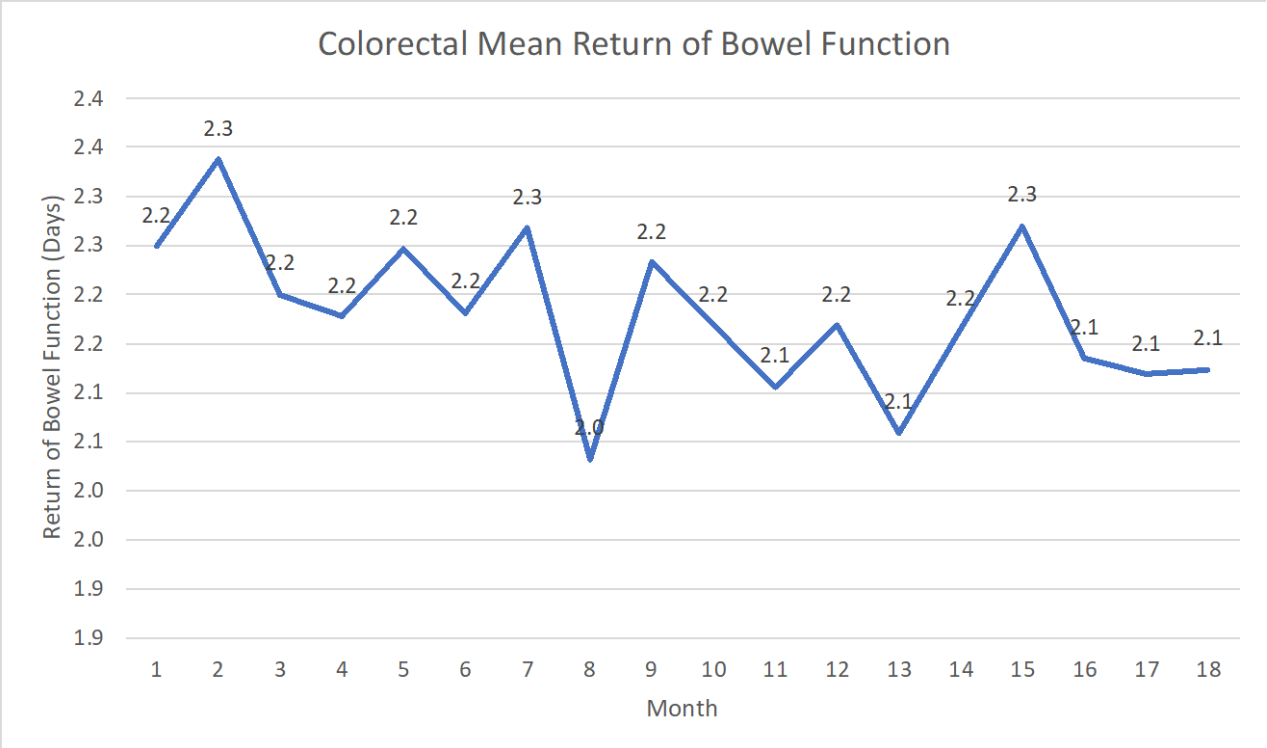


Figure 16. Colorectal Surgery Mean Days of Length of Stay by Month

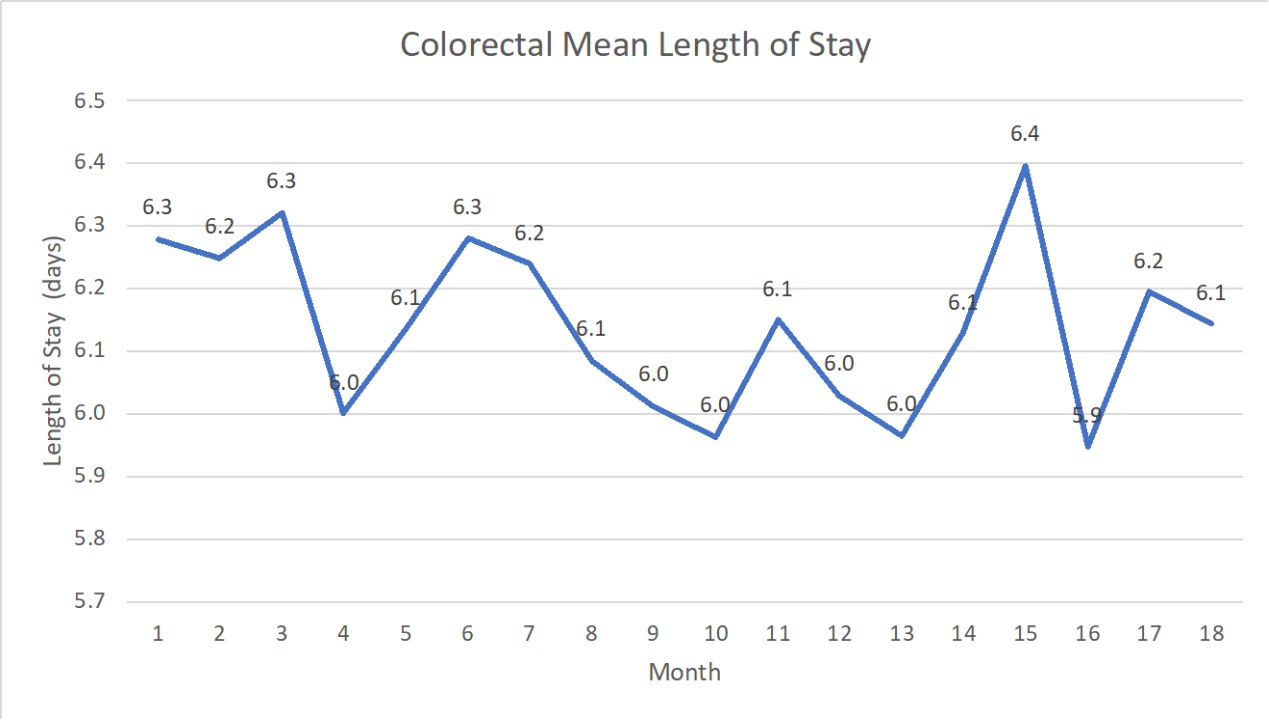
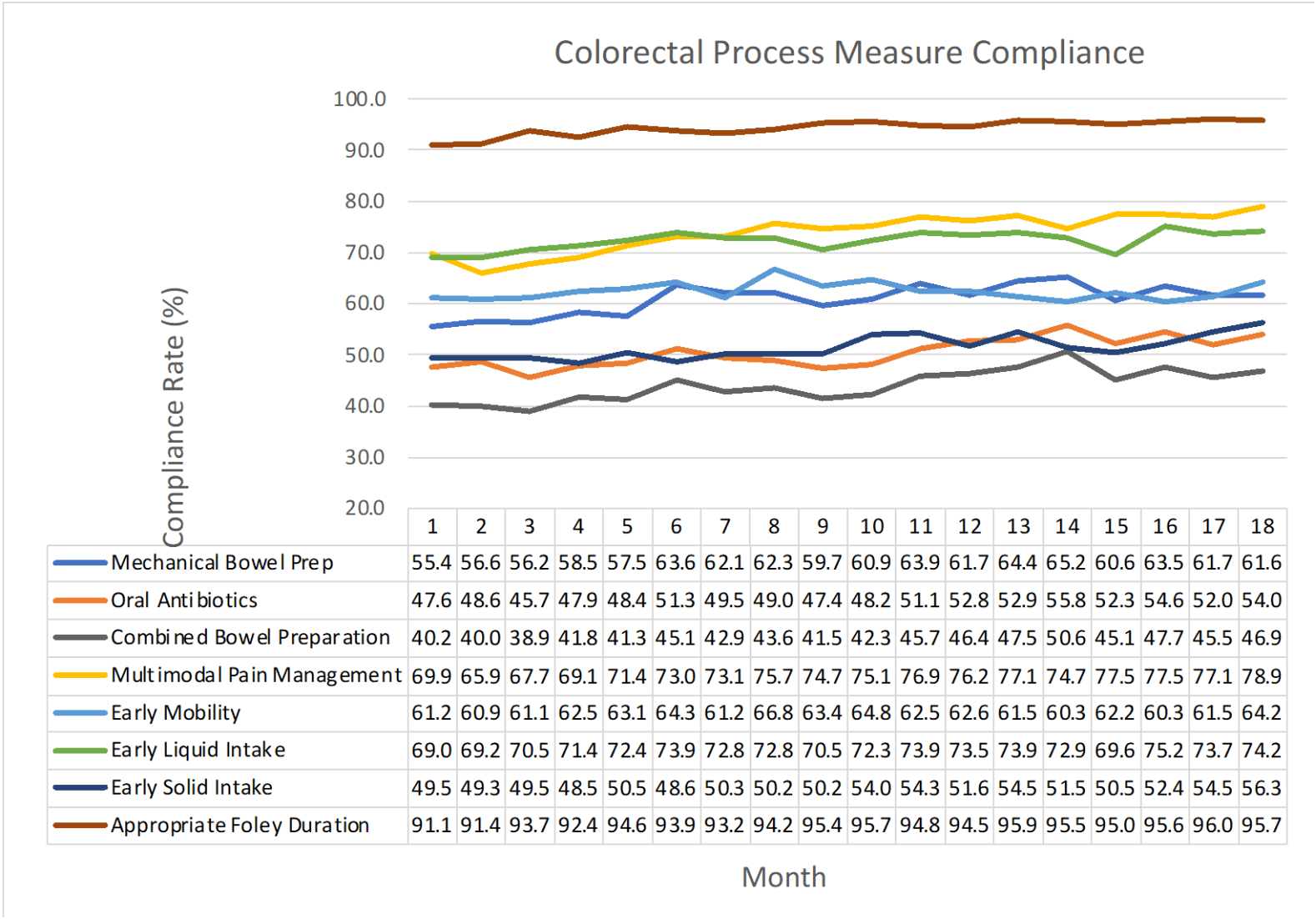


Figure 17. Colorectal Surgery Core Process Measure Compliance by Month



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Mechanical Bowel Prep	55.4	56.6	56.2	58.5	57.5	63.6	62.1	62.3	59.7	60.9	63.9	61.7	64.4	65.2	60.6	63.5	61.7	61.6
Oral Antibiotics	47.6	48.6	45.7	47.9	48.4	51.3	49.5	49.0	47.4	48.2	51.1	52.8	52.9	55.8	52.3	54.6	52.0	54.0
Combined Bowel Preparation	40.2	40.0	38.9	41.8	41.3	45.1	42.9	43.6	41.5	42.3	45.7	46.4	47.5	50.6	45.1	47.7	45.5	46.9
Multimodal Pain Management	69.9	65.9	67.7	69.1	71.4	73.0	73.1	75.7	74.7	75.1	76.9	76.2	77.1	74.7	77.5	77.5	77.1	78.9
Early Mobility	61.2	60.9	61.1	62.5	63.1	64.3	61.2	66.8	63.4	64.8	62.5	62.6	61.5	60.3	62.2	60.3	61.5	64.2
Early Liquid Intake	69.0	69.2	70.5	71.4	72.4	73.9	72.8	72.8	70.5	72.3	73.9	73.5	73.9	72.9	69.6	75.2	73.7	74.2
Early Solid Intake	49.5	49.3	49.5	48.5	50.5	48.6	50.3	50.2	50.2	54.0	54.3	51.6	54.5	51.5	50.5	52.4	54.5	56.3
Appropriate Foley Duration	91.1	91.4	93.7	92.4	94.6	93.9	93.2	94.2	95.4	95.7	94.8	94.5	95.9	95.5	95.0	95.6	96.0	95.7

Risk-Adjusted Analysis for Colorectal Surgery

The OR of process measure compliance over 1-month increments and OR over the 18-month total cohort time period are reported in Table 16, along with the overall compliance rate (presented as a decimal rather than a percentage, e.g., 0.609 instead of 60.9%). The odds of process measure compliance significantly increased with time for preoperative mechanical bowel prep, preoperative oral antibiotics, the combination of both of these bowel prep variables, use of multimodal pain control, intake of liquids after surgery, intake of solids after surgery, and indwelling urinary catheter duration (Table 16). No significant increase was found in compliance to first postoperative mobilization (Table 16).

Table 17 provides a summary of outcome measure modeling. Venous thromboembolism (VTE), urinary tract infection (UTI), surgical site infection (SSI), VUS, prolonged length of stay (i.e., >75th percentile of all cases in the service line), prolonged postoperative ileus, and ILOS (ileus and/or length of stay >75th percentile) are presented as odds ratios associated with one month increments of time and for 18 months. The continuous outcomes, LOS and return of bowel function (ROBF) are presented as model parameters (beta values) with *p*-values of significance. Significantly decreased odds of event occurrence over time was observed for length of stay >75th percentile, ileus, and the composite of these two measures (Table 17). Decreased LOS and ROBF also had a significant association over time when analyzed as continuous variables. VTE, UTI, SSI, and the composite of these three outcomes were not found to be significant.

Estimated risk reductions for binary outcome measures are represented in Table 18. Baseline rates were estimated from a single month of risk-adjusted ISCR colorectal data from the first month of each cohort. Relative change in risk is an estimation of the magnitude of effect due to the AHRQ ISCR program. Baseline durations for continuous outcomes were estimated from the expected values from the first month of each cohort. There were significantly decreased odds of prolonged length of stay by the end of the 18-month period, OR 0.874 (95% CI = 0.787 to 0.971), with a relative reduction of risk of 9.83 percent from baseline. Ileus also had decreased odds of occurrence, OR 0.767 (95% CI = 0.638 to 0.922) after 18 months, with a 20.16 percent relative reduction in risk from baseline. Table 19 indicates the estimated parameter values for continuous outcomes. ROBF demonstrated a 5 percent decrease in mean duration over time, and LOS demonstrated a 4 percent decrease over time.

Table 16. Association of Colorectal Surgery Process Measure Compliance With Time

Process Measure	Overall Compliance Rate	OR (95% CI) for 1 Month Increment	OR (95% CI) for 18 Months
Preop Mechanical Bowel Prep	0.609	1.016 (1.003, 1.029)*	1.336 (1.063, 1.679)*
Preop Oral Antibiotics	0.505	1.018 (1.003, 1.033)*	1.374 (1.060, 1.781)*
Both Preop Preparations	0.440	1.020 (1.006, 1.034)*	1.431 (1.118, 1.831)*
Use of Multi-Modal Pain Management	0.740	1.034 (1.017, 1.051)*	1.832 (1.366, 2.459)*
First Postop Mobilization	0.625	1.000 (0.990, 1.009)	0.997 (0.838, 1.185)
First Postop Intake of Liquids	0.724	1.011 (1.000, 1.021)*	1.209 (1.008, 1.449)*
First Postop Intake of Solids	0.515	1.014 (1.005, 1.023)*	1.280 (1.092, 1.501)*
Foley Duration	0.944	1.046 (1.020, 1.073)*	2.251 (1.431, 3.541)*

**Indicates significant odds ratio*

Table 17. Summary of Colorectal Surgery Outcome Measure Model Results

Outcome	OR (95% CI) for 1 Month Increment	OR (95% CI) for 18 Months
VTE	0.993 (0.979, 1.007)	0.882 (0.684, 1.137)
UTI	0.998 (0.982, 1.014)	0.961 (0.720, 1.215)
SSI	1.001 (0.993, 1.009)	1.013 (0.874, 1.174)
VUS	1.000 (0.993, 1.007)	0.997 (0.881, 1.128)
Length of Stay >75th Percentile	0.993 (0.987, 0.998)*	0.874 (0.787, 0.971)*
Ileus	0.985 (0.975, 0.996)*	0.767 (0.638, 0.922)*
ILOS	0.988 (0.980, 0.995)*	0.800 (0.698, 0.917)*
Length of Stay (LOS) †	-0.0025 (<.0001)*	n/a
Return of Bowel Function (ROBF) †	-0.0031 (0.0002)*	n/a

Abbreviations: ILOS = ileus and/or length of stay >75th percentile; n/a= not applicable; SSI = surgical site infection; UTI = urinary tract infection; VTE = venous thromboembolism; VUS = composite measure of VTE, SSI, UTI

**Indicates significant value*

†Indicates continuous outcome variable; data are negative binomial model parameters, or beta values, with (p-value) of significance rather than odds ratio

Table 18. Estimated Risk Reductions and Relative Change in Risk for Colorectal Surgery Binary Outcome Measures Over Time

Outcome	Odds Ratio by Month (95% CI)	Odds Ratio (95% CI) for 18-Month Cumulative	Risk at Baseline (%)	Risk at Month 18 (%)	Absolute Change in Risk (%)	Relative Change in Risk (%)
VTE	0.993 (0.979, 1.007)	0.882 (0.684, 1.137)	2.08	1.84	-0.24	-11.61%
UTI	0.998 (0.982, 1.014)	0.961 (0.720, 1.215)	1.84	1.77	-0.07	-3.88%
SSI	1.001 (0.993, 1.009)	1.013 (0.874, 1.174)	8.92	9.03	0.11	1.19%
VUS	1.000 (0.993, 1.007)	0.997 (0.881, 1.128)	11.75	11.72	-0.03	-0.24%
Prolonged LOS†	0.993 (0.987, 0.998)*	0.874 (0.787, 0.971)*	24.16	21.79	-2.37	-9.83%
Ileus	0.985 (0.975, 0.996)*	0.767 (0.638, 0.922)*	17.29	13.80	-3.48	-20.16%
ILOS	0.988 (0.980, 0.995)*	0.800 (0.698, 0.917)*	31.16	26.58	-4.58	-14.69%

Abbreviations: ILOS = ileus and length of stay >75th percentile; LOS = length of stay; SSI = surgical site infection; UTI = urinary tract infection; VTE = venous thromboembolism; VUS = composite measure of VTE, SSI, UTI.
**Indicates significant value*
†prolonged LOS = length of stay >75th percentile for all cases included in model for that service line

Table 19. Estimated Parameters and Change in Duration for Colorectal Surgery Continuous Outcome Measures

Outcome	Beta Value Parameter (p value) by Month	Beta Value Parameter (p value) for 18-month Cumulative	Duration at Baseline (Days)	Duration Month 18 (Days)	Change in Duration (Days)	Change in Duration (%)
ROBF	-0.0031 (0.0002)*	-0.0559 (0.0002)*	2.2309	2.11	-0.12	-5%
LOS	-0.0025 (<.0001)*	-0.0456 (<0.0001)*	6.1758	5.90	-0.27	-4%

Abbreviations: LOS = length of stay; ROBF = return of bowel function
**Indicates significant value*

Results for the hip fracture surgery service line start with Table 20, which summarizes monthly registry data entry, while Tables 21a–e and Figures 18–25 illustrate unadjusted binary and continuous outcomes by month. Figure 26 reports process measure compliance over time.

HIP FRACTURE SURGERY, COHORTS 2–4

Unadjusted Data Trends

Table 20. Hip Fracture Surgery Registry Data Entry Summary, by Calendar Month

Month	# Hosp	# Cases
1	30	177
2	42	230
3	44	221
4	43	285
5	45	284
6	41	262
7	41	249
8	45	245
9	42	263
10	45	269
11	43	309
12	42	248
13	40	293
14	37	262
15	40	269
16	41	246
17	36	280
18	35	243
Total	*n/a*	*4635*

Abbreviations: n/a= not applicable

Table 21a. Hip Fracture Surgery Unadjusted Rates of Binary Outcomes–Venous Thromboembolism

Month	(n)	Cases	Rate (%)
1	7	177	3.95
2	6	230	2.61
3	1	221	0.45
4	4	285	1.40
5	5	284	1.76
6	7	262	2.67
7	3	249	1.20
8	8	245	3.27
9	5	263	1.90
10	2	269	0.74
11	8	309	2.59
12	5	248	2.02
13	7	293	2.39
14	9	262	3.44
15	5	269	1.86
16	7	246	2.85
17	7	280	2.50
18	4	243	1.65
Total	*100*	*4635*	*n/a*

Abbreviations: n/a= not applicable

Table 21b. Hip Fracture Surgery Unadjusted Rates of Binary Outcomes– Urinary Tract Infection

Month	(n)	Cases	Rate (%)
1	6	177	3.39
2	7	230	3.04
3	7	221	3.17
4	10	285	3.51
5	6	284	2.11
6	8	262	3.05
7	6	249	2.41
8	7	245	2.86
9	10	263	3.80
10	7	269	2.60
11	11	309	3.56
12	7	248	2.82
13	8	293	2.73
14	6	262	2.29
15	9	269	3.35
16	10	246	4.07
17	5	280	1.79
18	4	243	1.65
Total	*134*	*4635*	*n/a*

Abbreviations: n/a= not applicable

Table 21c. Hip Fracture Surgery Unadjusted Rates of Binary Outcomes–Surgical Site Infection

Month	(n)	Cases	Rate (%)
1	0	177	0.00
2	3	230	1.30
3	0	221	0.00
4	4	285	1.40
5	3	284	1.06
6	2	262	0.76
7	3	249	1.20
8	1	245	0.41
9	3	263	1.14
10	2	269	0.74
11	2	309	0.65
12	6	248	2.42
13	2	293	0.68
14	2	262	0.76
15	2	269	0.74
16	5	246	2.03
17	1	280	0.36
18	4	243	1.65
Total	*45*	*4635*	*n/a*

Abbreviations: n/a= not applicable

Table 21d. Hip Fracture Surgery Unadjusted Rates of Binary Outcomes–Transfusion

Month	(n)	Cases	Rate (%)
1	31	177	17.51
2	39	230	16.96
3	35	221	15.84
4	50	285	17.54
5	57	284	20.07
6	42	262	16.03
7	58	249	23.29
8	52	245	21.22
9	45	263	17.11
10	63	269	23.42
11	56	309	18.12
12	54	248	21.77
13	51	293	17.41
14	56	262	21.37
15	63	269	23.42
16	34	246	13.82
17	65	280	23.21
18	50	243	20.58
Total	*901*	*4635*	*n/a*

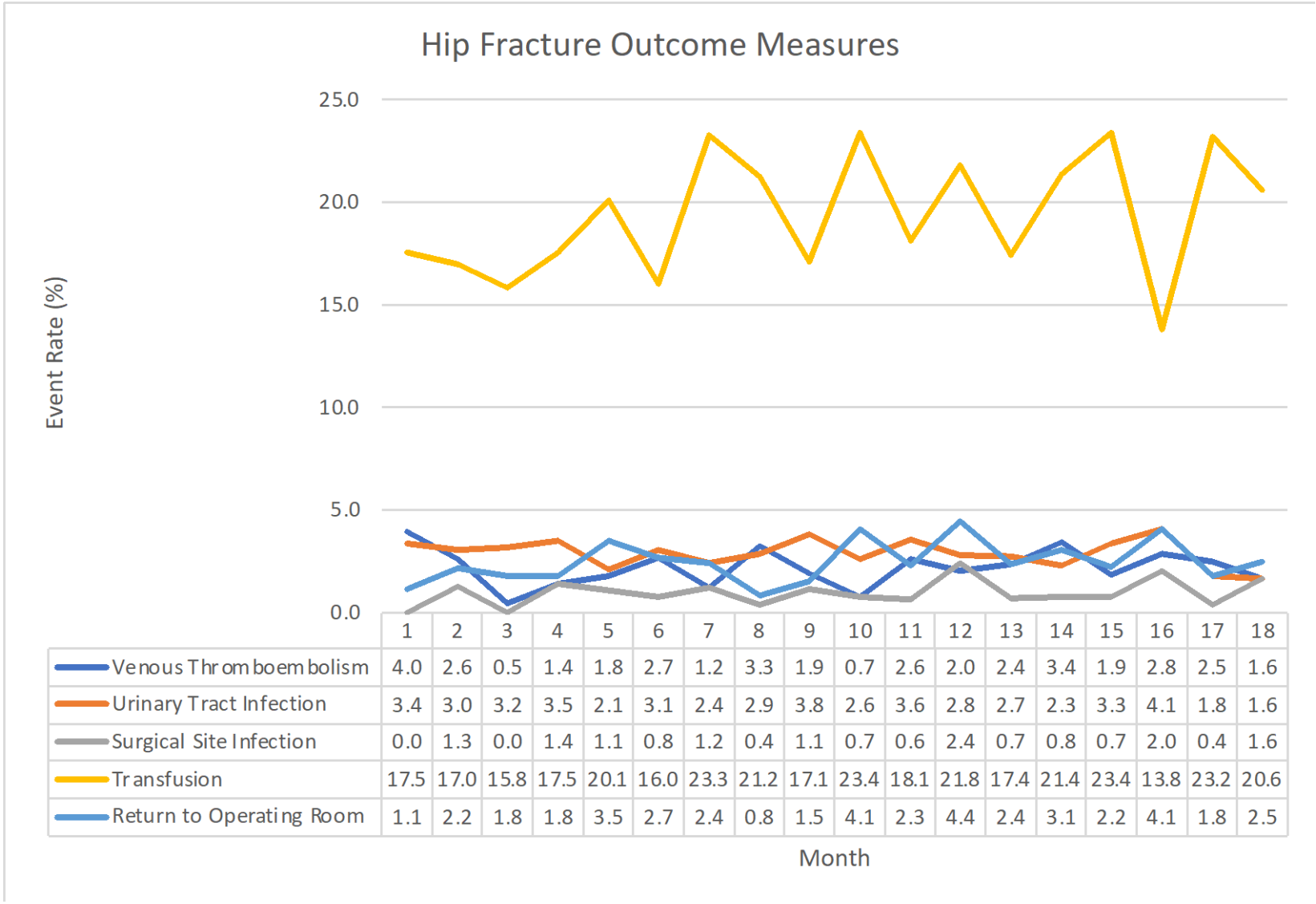
Abbreviations: n/a= not applicable

Table 21e. Hip Fracture Surgery Unadjusted Rates of Binary Outcomes–Return to Operating Room

Month	(n)	Cases	Rate (%)
1	2	177	1.13%
2	5	230	2.17%
3	4	221	1.81%
4	5	285	1.75%
5	10	284	3.52%
6	7	262	2.67%
7	6	249	2.41%
8	2	245	0.82%
9	4	263	1.52%
10	11	269	4.09%
11	7	309	2.27%
12	11	248	4.44%
13	7	293	2.39%
14	8	262	3.05%
15	6	269	2.23%
16	10	246	4.07%
17	5	280	1.79%
18	6	243	2.47%
Total	*116*	*4635*	*n/a*

Abbreviations: n/a= not applicable

Figure 18. Unadjusted Hip Fracture Surgery Binary Outcome Rates by Month



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Venous Thromboembolism	4.0	2.6	0.5	1.4	1.8	2.7	1.2	3.3	1.9	0.7	2.6	2.0	2.4	3.4	1.9	2.8	2.5	1.6
Urinary Tract Infection	3.4	3.0	3.2	3.5	2.1	3.1	2.4	2.9	3.8	2.6	3.6	2.8	2.7	2.3	3.3	4.1	1.8	1.6
Surgical Site Infection	0.0	1.3	0.0	1.4	1.1	0.8	1.2	0.4	1.1	0.7	0.6	2.4	0.7	0.8	0.7	2.0	0.4	1.6
Transfusion	17.5	17.0	15.8	17.5	20.1	16.0	23.3	21.2	17.1	23.4	18.1	21.8	17.4	21.4	23.4	13.8	23.2	20.6
Return to Operating Room	1.1	2.2	1.8	1.8	3.5	2.7	2.4	0.8	1.5	4.1	2.3	4.4	2.4	3.1	2.2	4.1	1.8	2.5

Figure 19. Hip Fracture Surgery Venous Thromboembolism Event Rates by Month

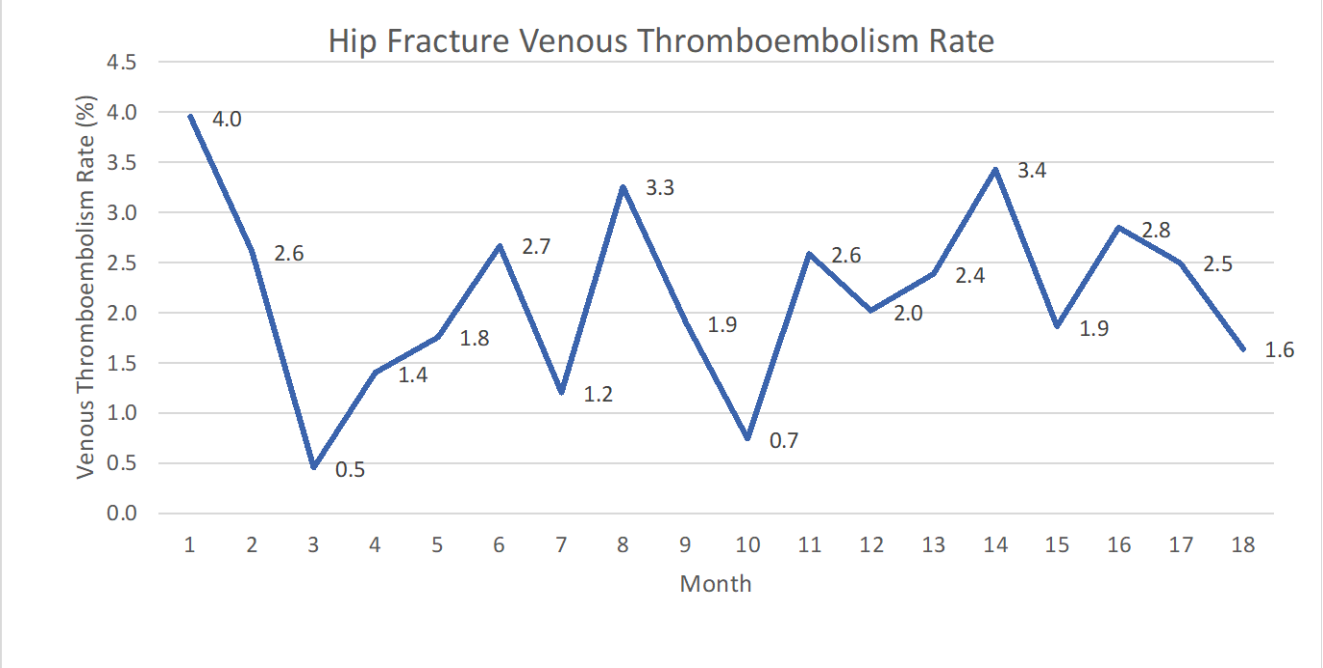


Figure 20. Hip Fracture Surgery Urinary Tract Infection Event Rates by Month

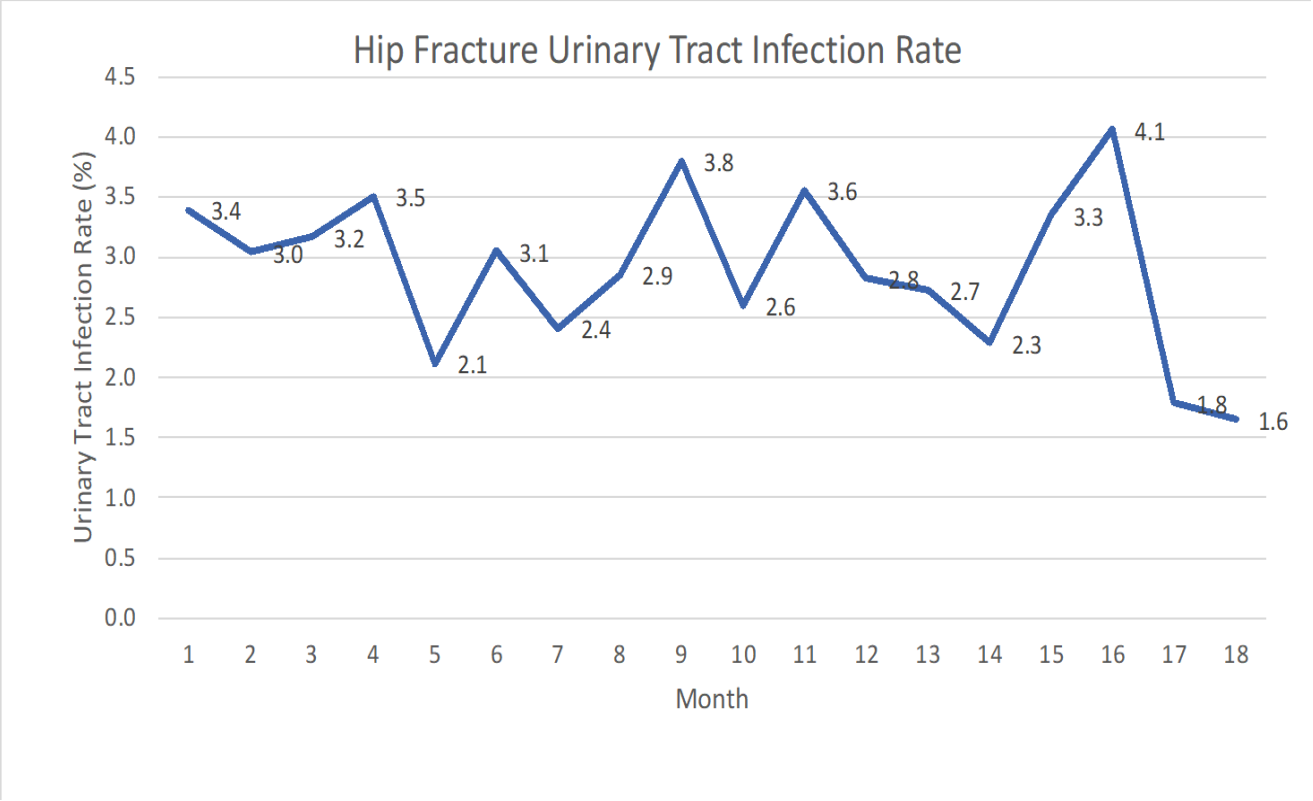


Figure 21. Hip Fracture Surgery Surgical Site Infection Event Rates by Month

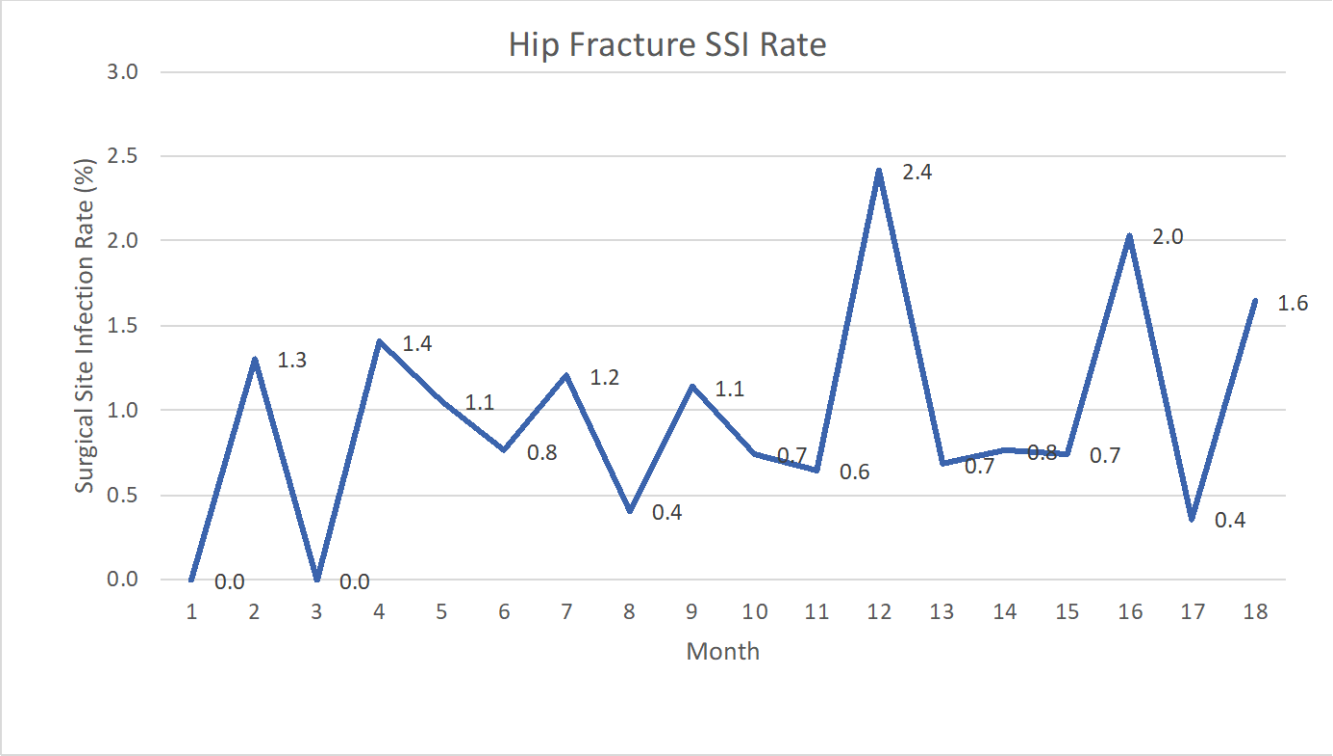


Figure 22. Hip Fracture Surgery Intra/Postoperative Transfusion Event Rates by Month (red blood cell and whole blood products)

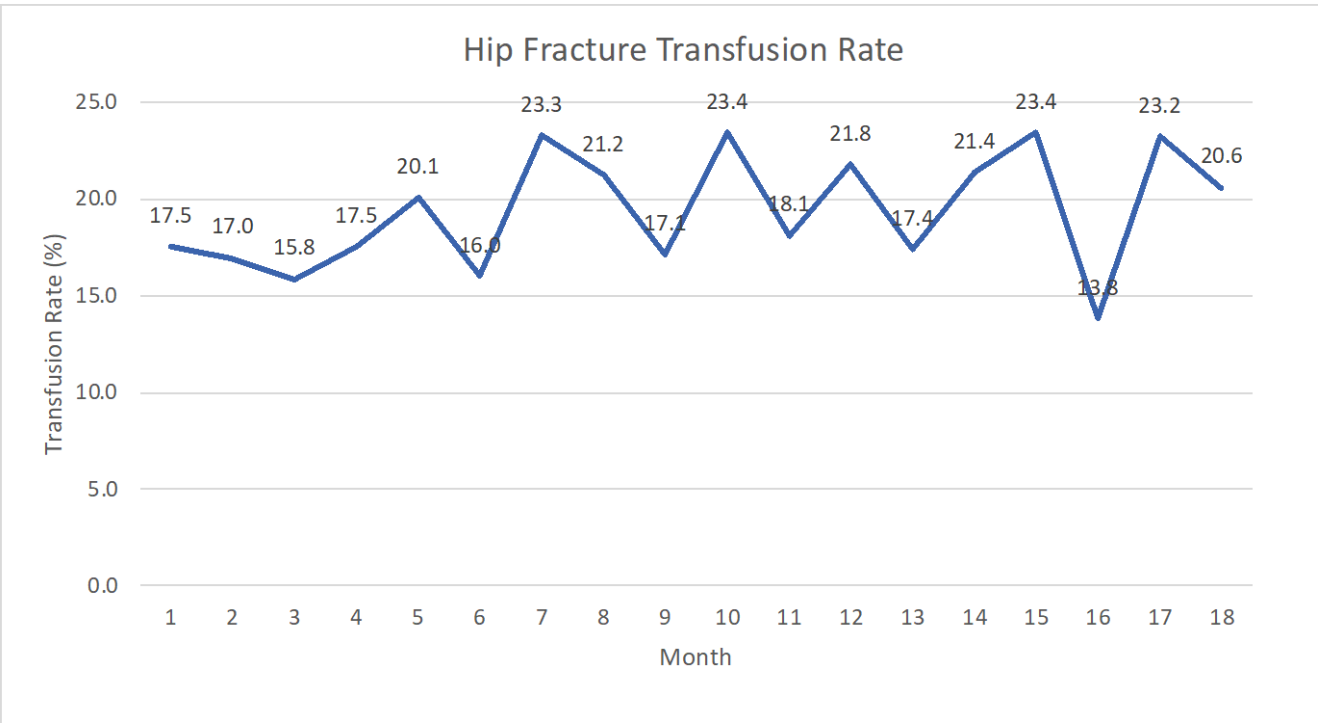


Figure 23. Hip Fracture Surgery Return to Operating Room Event Rates by Month

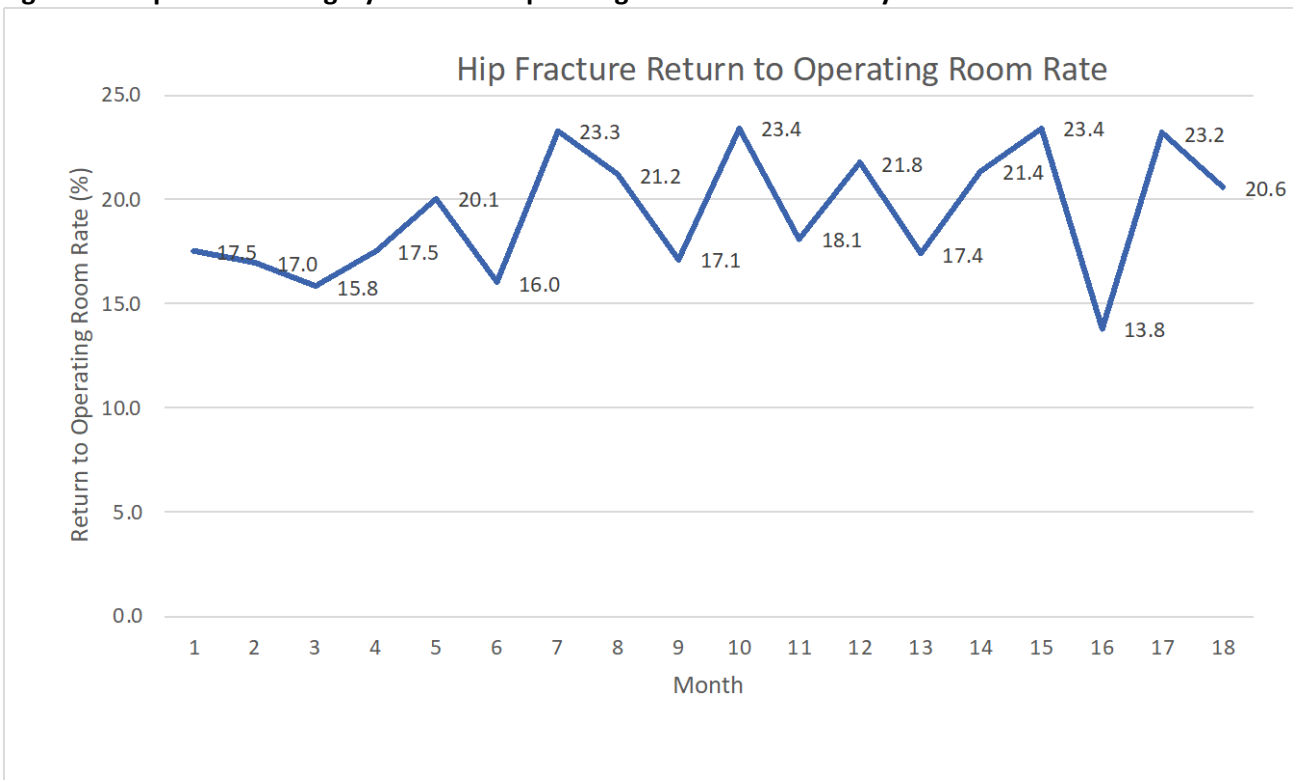


Figure 24. Hip Fracture Surgery Prolonged Length of Stay (>75th percentile) Binary Outcome Measures by Month

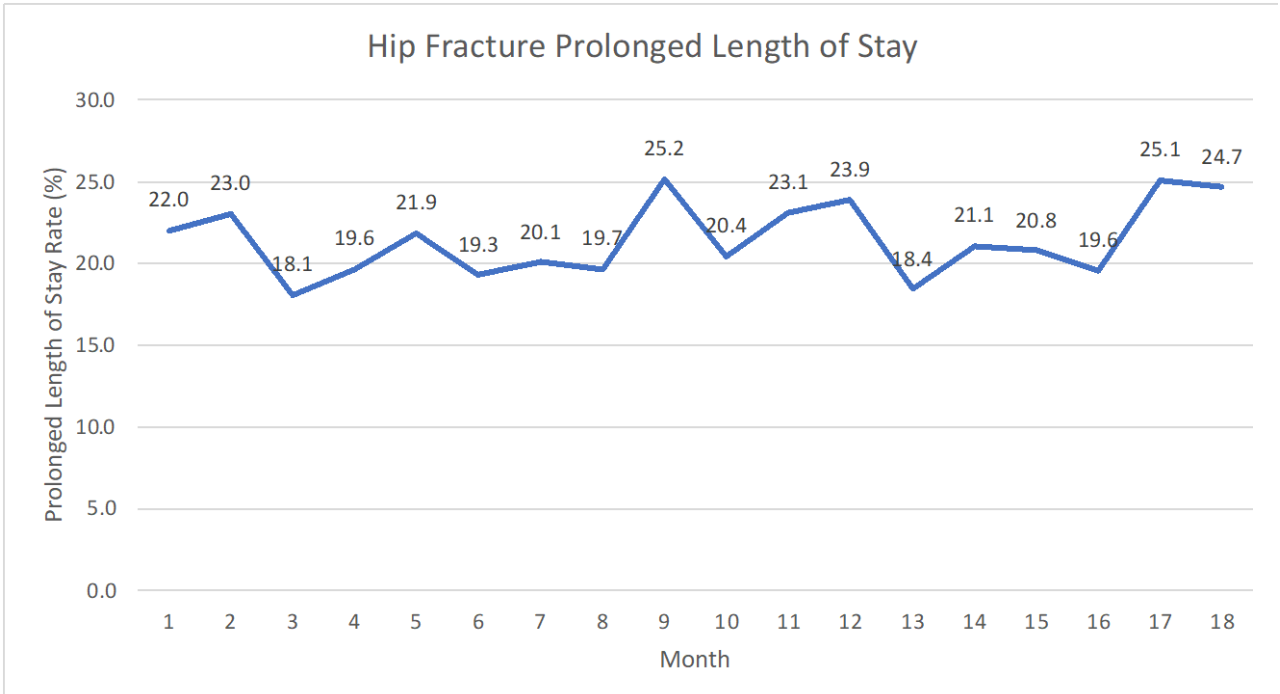


Figure 25. Hip Fracture Surgery Mean Length of Stay by Month

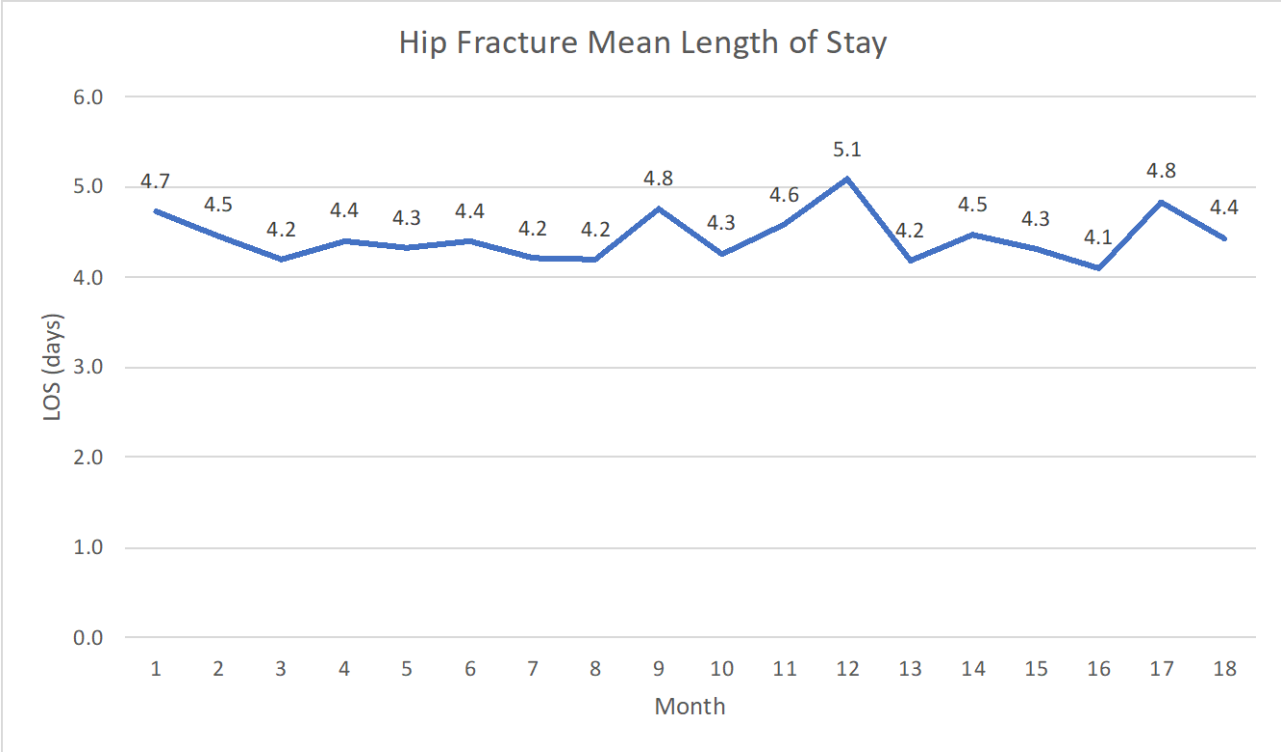
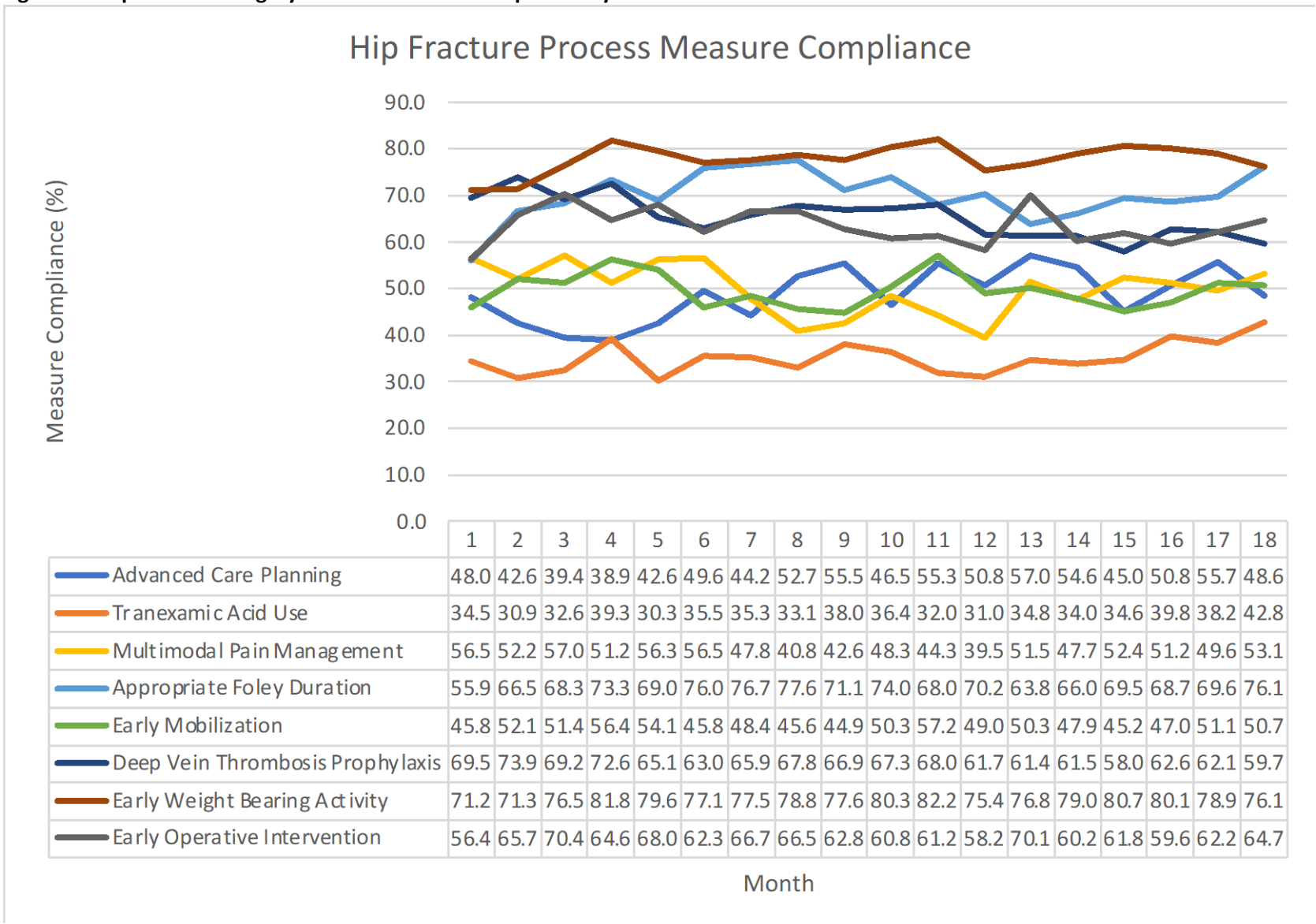


Figure 26. Hip Fracture Surgery Process Measure Compliance by Month



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Advanced Care Planning	48.0	42.6	39.4	38.9	42.6	49.6	44.2	52.7	55.5	46.5	55.3	50.8	57.0	54.6	45.0	50.8	55.7	48.6
Tranexamic Acid Use	34.5	30.9	32.6	39.3	30.3	35.5	35.3	33.1	38.0	36.4	32.0	31.0	34.8	34.0	34.6	39.8	38.2	42.8
Multimodal Pain Management	56.5	52.2	57.0	51.2	56.3	56.5	47.8	40.8	42.6	48.3	44.3	39.5	51.5	47.7	52.4	51.2	49.6	53.1
Appropriate Foley Duration	55.9	66.5	68.3	73.3	69.0	76.0	76.7	77.6	71.1	74.0	68.0	70.2	63.8	66.0	69.5	68.7	69.6	76.1
Early Mobilization	45.8	52.1	51.4	56.4	54.1	45.8	48.4	45.6	44.9	50.3	57.2	49.0	50.3	47.9	45.2	47.0	51.1	50.7
Deep Vein Thrombosis Prophylaxis	69.5	73.9	69.2	72.6	65.1	63.0	65.9	67.8	66.9	67.3	68.0	61.7	61.4	61.5	58.0	62.6	62.1	59.7
Early Weight Bearing Activity	71.2	71.3	76.5	81.8	79.6	77.1	77.5	78.8	77.6	80.3	82.2	75.4	76.8	79.0	80.7	80.1	78.9	76.1
Early Operative Intervention	56.4	65.7	70.4	64.6	68.0	62.3	66.7	66.5	62.8	60.8	61.2	58.2	70.1	60.2	61.8	59.6	62.2	64.7

Risk-Adjusted Analysis for Hip Fracture Surgery

The odds ratio of process measure compliance over one-month increments and odds ratio for the 18-month total cohort time period are reported in Table 22. No significant increase was found in compliance to any of the process measures.

Table 23 summarizes outcome measure modeling. No significant difference was observed in odds of occurrence over time for VTE, UTI, SSI, LOS, transfusion, or return to operating room.

Estimated risk reductions and relative risk reductions for binary outcome measures are reported in Table 24. Baseline rates were estimated from a single month of risk-adjusted ISCR hip fracture surgery data from the first month of the cohort. Relative change in risk is an estimation of the magnitude of effect due to the AHRQ ISCR program. Again, none of the models were shown to have a significant change over time. Table 25 reports a 3% increase in length of stay following hip fracture surgery from baseline to 18 months.

Table 22. Association of Hip Fracture Surgery Process Measure Compliance With Time

Process Measure	Overall Compliance Rate	OR (95% CI) for 1 Month Increments	OR (95% CI) for 18 Months
Evidence of Advanced Care Plan	0.490	1.027 (0.989, 1.067)	1.627 (0.817, 3.240)
Use of Preoperative TXA	0.352	1.013 (0.989, 1.038)	1.266 (0.820, 1.953)
Use of Multi-Modal Pain Management	0.498	0.989 (0.950, 1.029)	0.817 (0.400, 1.672)
Foley Duration	0.702	1.004 (0.983, 1.026)	1.081 (0.735, 1.590)
First Postop Mobilization	0.498	0.995 (0.970, 1.020)	0.914 (0.580, 1.439)
Continued DVT PPX 28 Days Postop	0.652	0.970 (0.932, 1.010)	0.582 (0.281, 1.205)
Weight Bearing as Tolerated Within 1 Day	0.781	1.011 (0.976, 1.048)	1.227 (0.644, 2.337)
Operative Intervention within 24 hrs of Emergency Room Registration	0.635	0.991 (0.969, 1.013)	0.853 (0.572, 1.273)

Abbreviations: DVT = deep vein thrombosis; PPX = prophylaxis; TXA = tranexamic acid

Table 23. Summary of Hip Fracture Surgery Outcome Measure Model Results

Outcome	OR (95% CI)	OR (95% CI) for 18 Months
VTE	1.010 (0.974, 1.048)	1.197 (0.618, 2.318)
UTI	0.985 (0.945, 1.027)	0.767 (0.363, 1.621)
SSI	1.029 (0.967, 1.096)	1.677 (0.544, 5.168)
VUS	1.001 (0.973, 1.030)	1.018 (0.609, 1.700)
Length of Stay >75th Percentile	1.015 (0.995, 1.036)	1.311 (0.912, 1.884)
Length of Stay (LOS)*	0.0015 (0.4248)	n/a
Transfusion	1.019 (0.996, 1.042)	1.398 (0.926, 2.108)
30- day Unplanned Return to OR	1.020 (0.976, 1.066)	1.430 (0.648, 3.154)

Abbreviations: LOS = length of stay; n/a= not applicable; SSI = surgical site infection; UTI = urinary tract infection; VTE = venous thromboembolism; VUS = composite measure of VTE, SSI, UTI

**Indicates continuous outcome variable; result is negative binomial model parameter, or beta value, with (p-value) of significance rather than odds ratio*

Table 24. Estimated Risk Reductions and Relative Risk Change for Hip Fracture Surgery Binary Outcome Measures Over Time

Outcome	Odds Ratio by Month (95% CI)	Odds Ratio (18-Month Cumulative)	Risk at Baseline (%)	Risk at Month 18 (%)	Absolute Change in Risk (%)	Relative Change in Risk (%)
VTE	1.010 (0.974, 1.048)	1.197 (0.618, 2.318)	2.16	2.57	0.41	19.19%
UTI	0.985 (0.945, 1.027)	0.767 (0.363, 1.621)	3.38	2.62	-0.77	-22.64
SSI	1.029 (0.967, 1.096)	1.677 (0.544, 5.168)	0.82	1.37	0.55	66.71%
VUS	1.001 (0.973, 1.030)	1.018 (0.609, 1.700)	5.32	5.41	0.09	1.67%
Prolonged LOS*	1.015 (0.995, 1.036)	1.311 (0.912, 1.884)	21.36	26.24	4.88	22.86%
Transfusion	1.019 (0.996, 1.042)	1.398 (0.926, 2.108)	17.81	23.24	5.44	30.52%
30- day Unplanned Return to OR	1.020 (0.976, 1.066)	1.430 (0.648, 3.154)	2.22	3.14	0.92	41.72%

Abbreviations: LOS = length of stay; SSI = surgical site infection; UTI = urinary tract infection; VTE = venous thromboembolism; VUS = composite measure of VTE, SSI, UTI;

**Prolonged LOS= length of stay >75th percentile for all cases included in model, for this service line*

Table 25. Estimated Parameters and Change in Duration for Hip Fracture Surgery Continuous Outcome Measures

Outcome	Beta Value Parameter (p value)by Month	Beta Value Parameter (p value) for18-Month Cumulative	Duration at Baseline (Days)	Duration Month 18 (Days)	Change in Duration (Days)	Change in Duration(%)
LOS	0.0015 (0.4248)	0.0274 (0. 4248)	4.3274	4.45	0.12	3%

Abbreviations: LOS = length of stay

Results for the hip/knee replacement surgery service line starts with Table 26, which summarizes monthly registry data entry, while Tables 27a–e and Figures 27–34 illustrate unadjusted binary and continuous outcomes by month. Figure 35 reports process measure compliance over time.

HIP/KNEE REPLACEMENT SURGERY, COHORTS 2–4

Unadjusted Analysis

Table 26. Hip/Knee Replacement Surgery Registry Data Entry Summary, by Calendar Month

Month	# Hosp	# Cases
1	42	751
2	52	945
3	54	1099
4	52	1258
5	51	1078
6	56	1068
7	53	994
8	49	1340
9	52	1269
10	54	1129
11	59	1412
12	54	1226
13	46	844
14	35	668
15	42	850
16	44	978
17	41	897
18	42	847
Total	*n/a*	*18364*

Abbreviations: n/a= not applicable

Table 27a. Rates of Binary Hip/Knee Replacement Surgery Outcome Measures–Venous Thromboembolism

Month	(n)	Cases	Rate (%)
1	9	751	1.20
2	9	945	0.95
3	7	1099	0.64
4	9	1258	0.72
5	6	1078	0.56
6	7	1068	0.66
7	10	994	1.01
8	10	1340	0.75
9	6	1269	0.47
10	4	1129	0.35
11	13	1412	0.92
12	7	1226	0.57
13	6	844	0.71
14	3	668	0.45
15	8	850	0.94
16	7	978	0.72
17	9	897	1.00
18	10	847	1.18
Total	*140*	*18653*	*n/a*

Abbreviations: n/a= not applicable;

Table 27b. Rates of Binary Hip/Knee Replacement Surgery Outcome Measures–Urinary Tract Infection

Month	(n)	Cases	Rate (%)
1	2	751	0.27
2	9	945	0.95
3	7	1099	0.64
4	8	1258	0.64
5	9	1078	0.83
6	11	1068	1.03
7	7	994	0.70
8	8	1340	0.60
9	13	1269	1.02
10	8	1129	0.71
11	9	1412	0.64
12	9	1226	0.73
13	5	844	0.59
14	6	668	0.90
15	3	850	0.35
16	9	978	0.92
17	3	897	0.33
18	7	847	0.83
Total	*133*	*18653*	*n/a*

Abbreviations: n/a= not applicable

Table 27c. Rates of Binary Hip/Knee Replacement Surgery Outcome Measures–Surgical Site Infection

Month	(n)	Cases	Rate (%)
1	10	751	1.33
2	12	945	1.27
3	14	1099	1.27
4	11	1258	0.87
5	14	1078	1.30
6	11	1068	1.03
7	12	994	1.21
8	14	1340	1.04
9	18	1269	1.42
10	7	1129	0.62
11	15	1412	1.06
12	16	1226	1.31
13	9	844	1.07
14	9	668	1.35
15	10	850	1.18
16	19	978	1.94
17	18	897	2.01
18	9	847	1.06
Total	228	18653	*n/a*

Abbreviations: n/a= not applicable

Table 27d. Rates of Binary Hip/Knee Replacement Surgery Outcome Measures–Transfusion

Month	(n)	Cases	Rate (%)
1	14	751	1.86
2	22	945	2.33
3	26	1099	2.37
4	30	1258	2.38
5	22	1078	2.04
6	27	1068	2.53
7	21	994	2.11
8	26	1340	1.94
9	28	1269	2.21
10	28	1129	2.48
11	44	1412	3.12
12	35	1226	2.85
13	32	844	3.79
14	17	668	2.54
15	19	850	2.24
16	33	978	3.37
17	28	897	3.12
18	26	847	3.07
Total	478	18653	*n/a*

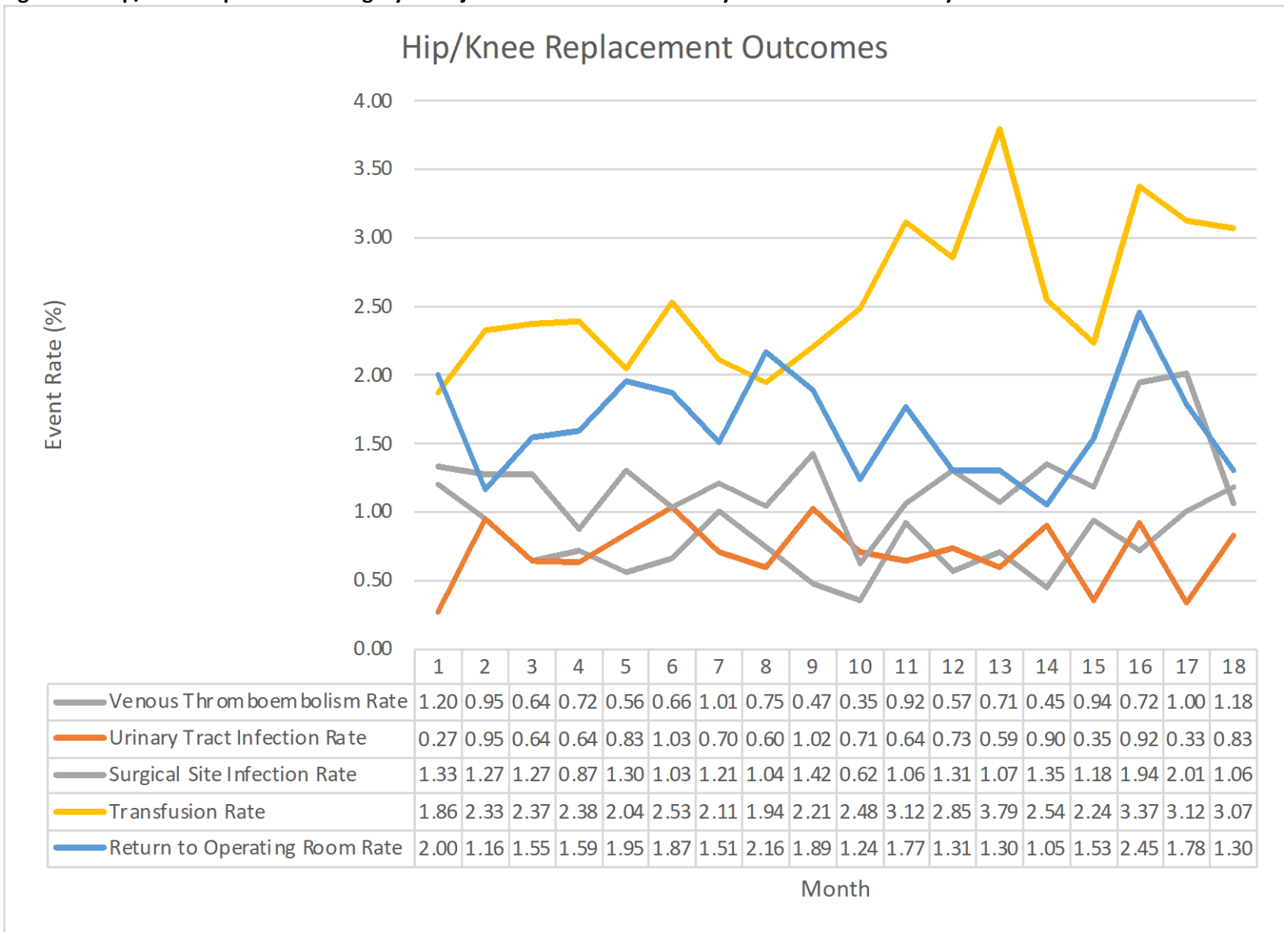
Abbreviations: n/a= not applicable

Table 27e. Rates of Binary Hip/Knee Replacement Surgery Outcome Measures–Return to Operating Room

Month	(n)	Cases	Rate (%)
1	15	751	2.00
2	11	945	1.16
3	17	1099	1.55
4	20	1258	1.59
5	21	1078	1.95
6	20	1068	1.87
7	15	994	1.51
8	29	1340	2.16
9	24	1269	1.89
10	14	1129	1.24
11	25	1412	1.77
12	16	1226	1.31
13	11	844	1.30
14	7	668	1.05
15	13	850	1.53
16	24	978	2.45
17	16	897	1.78
18	11	847	1.30
Total	309	18653	*n/a*

Abbreviations: n/a= not applicable

Figure 27. Hip/Knee Replacement Surgery Unadjusted Event Rates of Binary Outcome Measures by Month



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Venous Thromboembolism Rate	1.20	0.95	0.64	0.72	0.56	0.66	1.01	0.75	0.47	0.35	0.92	0.57	0.71	0.45	0.94	0.72	1.00	1.18
Urinary Tract Infection Rate	0.27	0.95	0.64	0.64	0.83	1.03	0.70	0.60	1.02	0.71	0.64	0.73	0.59	0.90	0.35	0.92	0.33	0.83
Surgical Site Infection Rate	1.33	1.27	1.27	0.87	1.30	1.03	1.21	1.04	1.42	0.62	1.06	1.31	1.07	1.35	1.18	1.94	2.01	1.06
Transfusion Rate	1.86	2.33	2.37	2.38	2.04	2.53	2.11	1.94	2.21	2.48	3.12	2.85	3.79	2.54	2.24	3.37	3.12	3.07
Return to Operating Room Rate	2.00	1.16	1.55	1.59	1.95	1.87	1.51	2.16	1.89	1.24	1.77	1.31	1.30	1.05	1.53	2.45	1.78	1.30

Figure 28. Hip/Knee Replacement Surgery Unadjusted Venous Thromboembolism Event Rates by Month

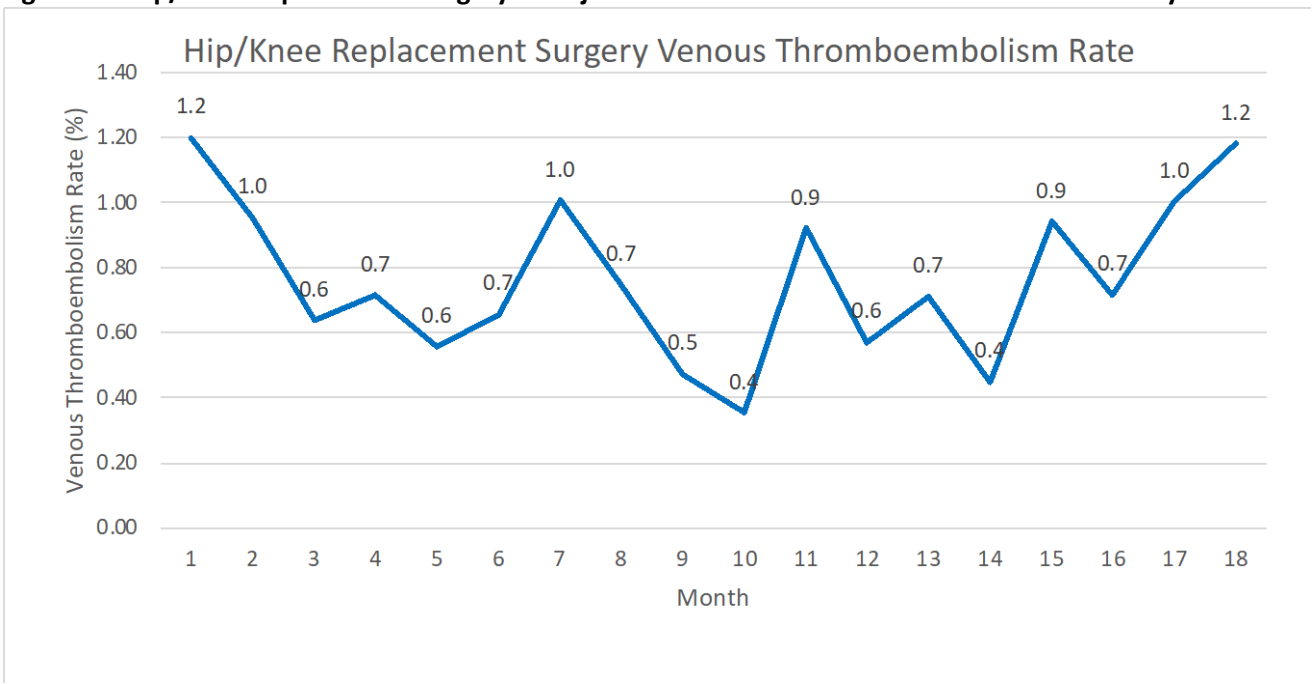


Figure 29. Hip/Knee Replacement Surgery Unadjusted Urinary Tract Infection Event Rates by Month

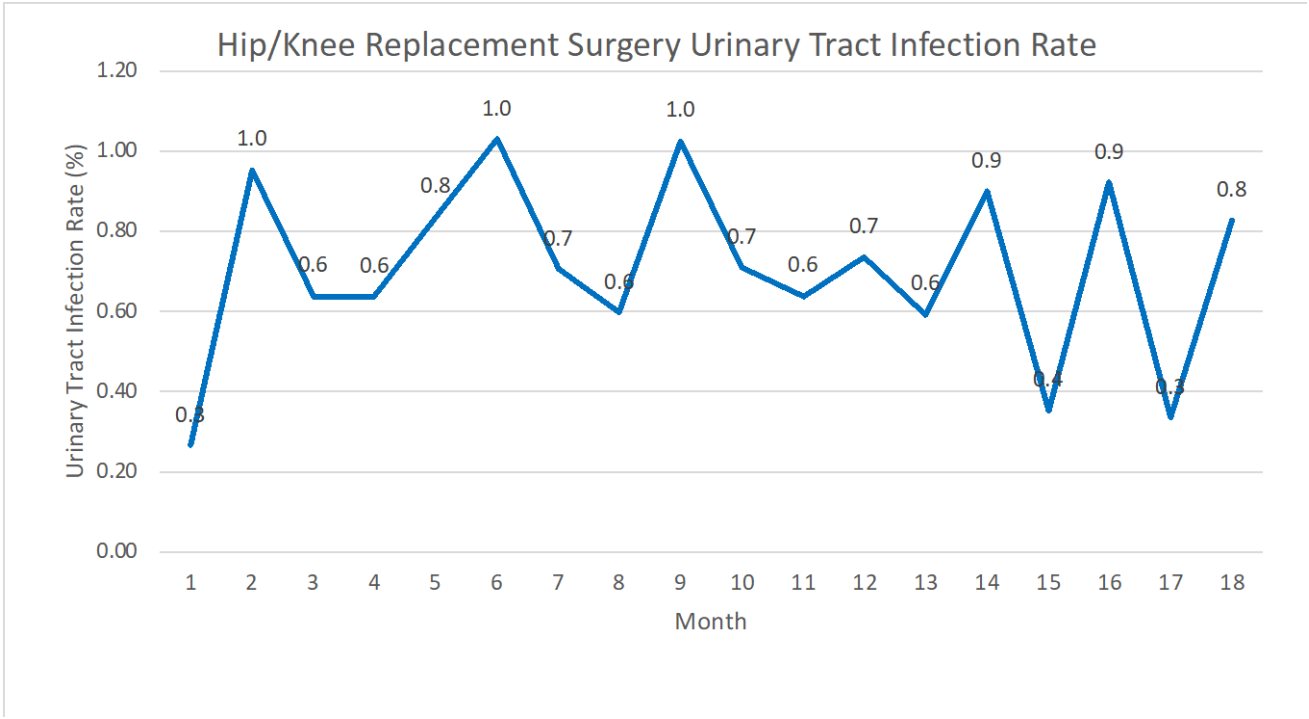


Figure 30. Hip/Knee Replacement Surgery Unadjusted Surgical Site Infection Event Rates by Month

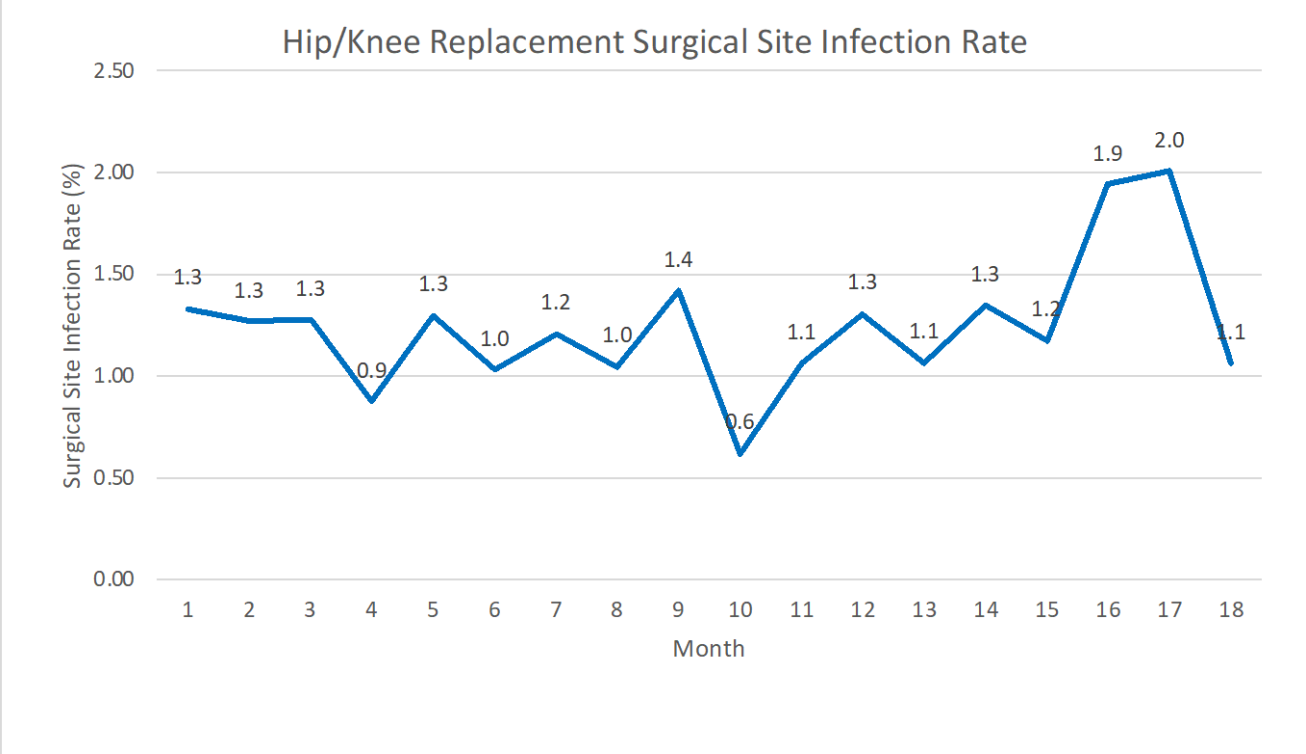


Figure 31. Hip/Knee Replacement Surgery Unadjusted Transfusion Rates by Month

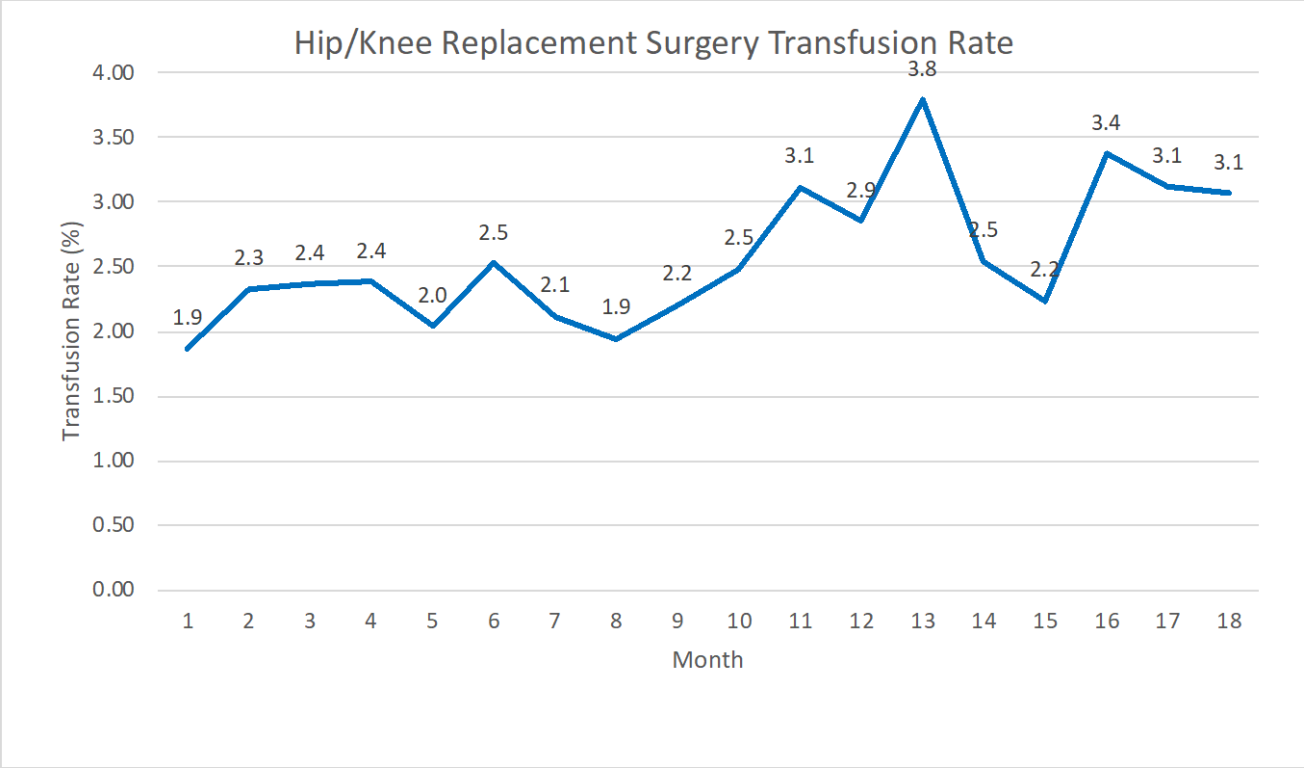


Figure 32. Hip/Knee Replacement Surgery Unadjusted Return to Operating Room by Month

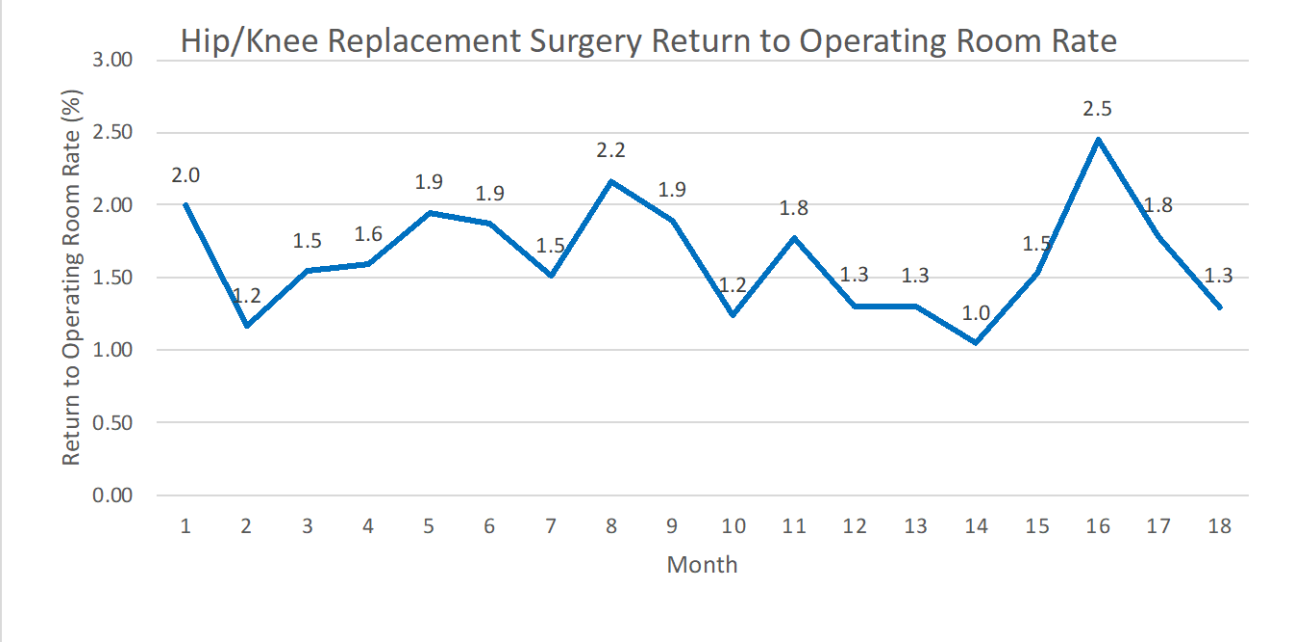


Figure 33. Hip/Knee Replacement Surgery Prolonged Length of Stay (>75th percentile) Binary Outcome Measures by Month

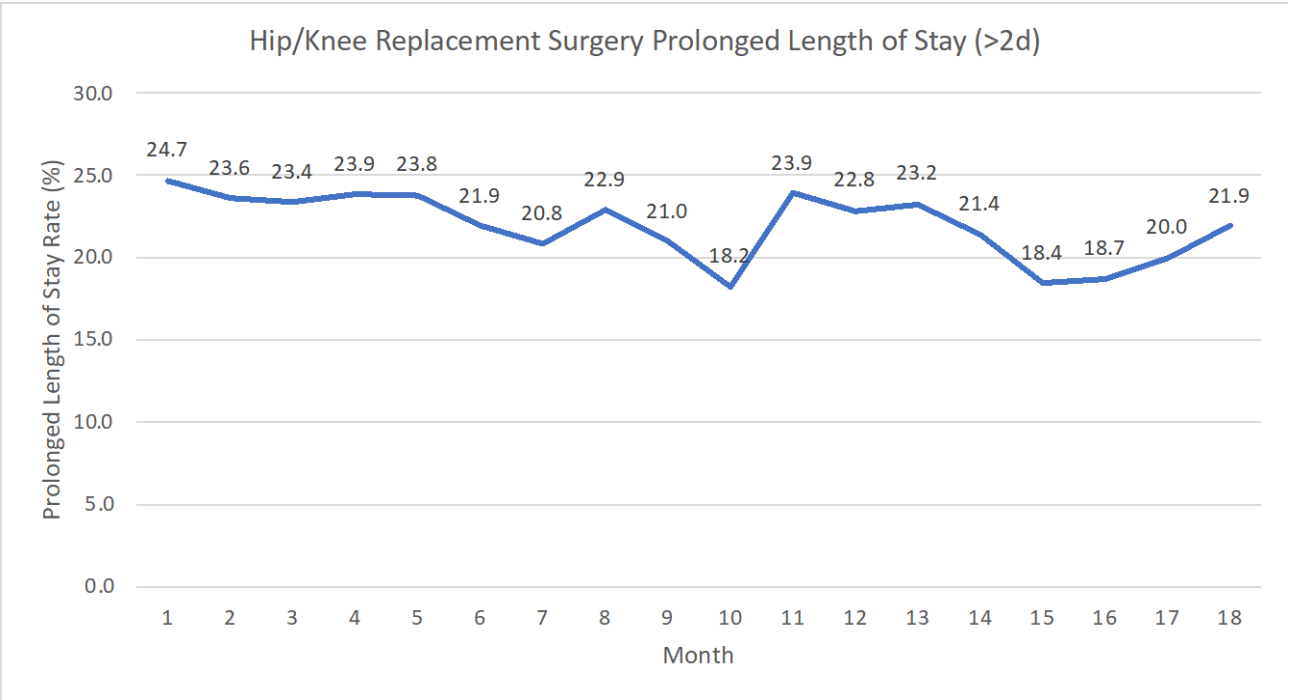


Figure 34. Hip/Knee Replacement Surgery Mean Length of Stay by Month

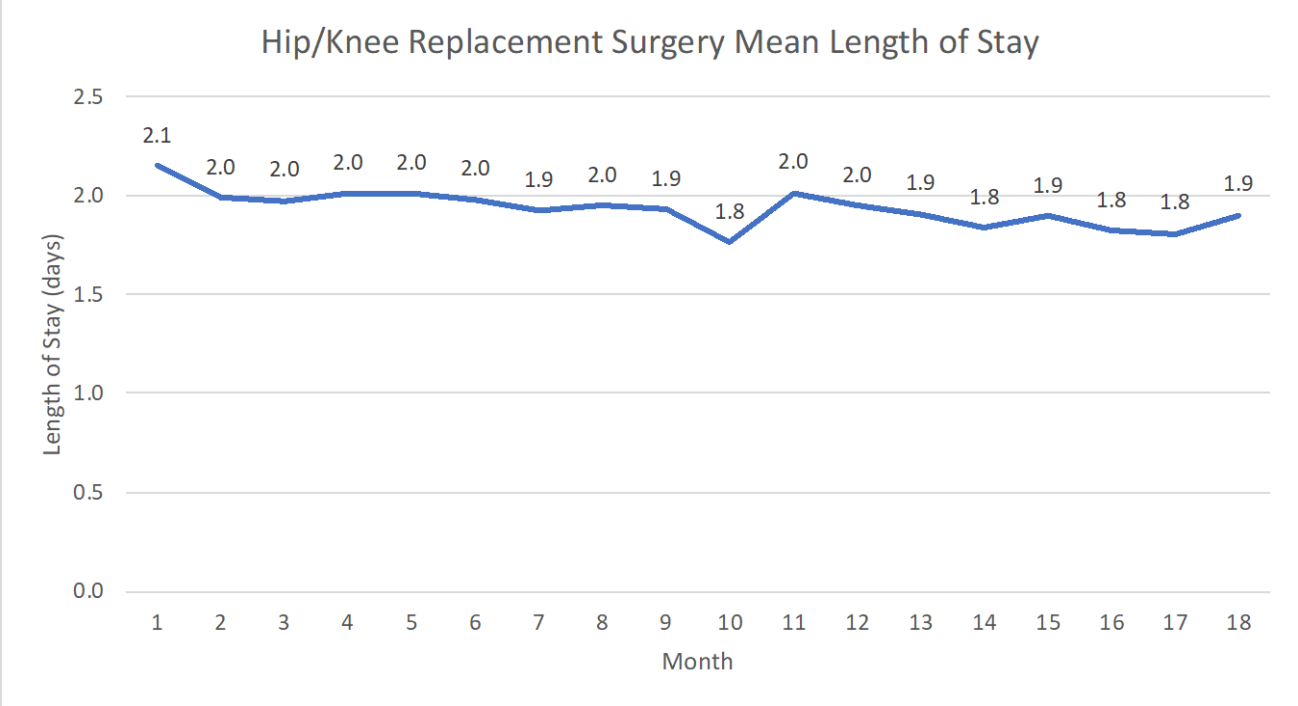
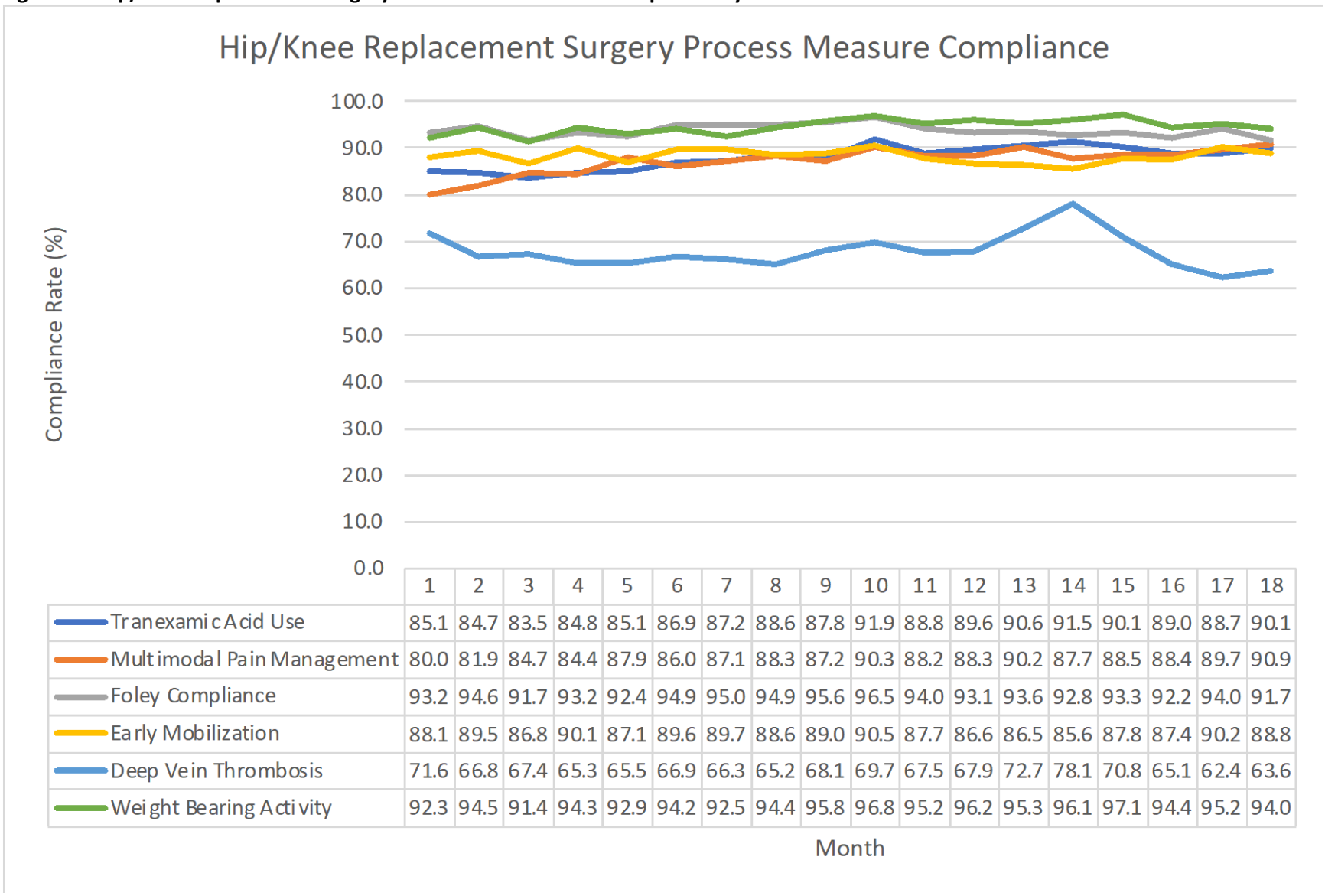


Figure 35. Hip/Knee Replacement Surgery Core Process Measure Compliance by Month



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Tranexamic Acid Use	85.1	84.7	83.5	84.8	85.1	86.9	87.2	88.6	87.8	91.9	88.8	89.6	90.6	91.5	90.1	89.0	88.7	90.1
Multimodal Pain Management	80.0	81.9	84.7	84.4	87.9	86.0	87.1	88.3	87.2	90.3	88.2	88.3	90.2	87.7	88.5	88.4	89.7	90.9
Foley Compliance	93.2	94.6	91.7	93.2	92.4	94.9	95.0	94.9	95.6	96.5	94.0	93.1	93.6	92.8	93.3	92.2	94.0	91.7
Early Mobilization	88.1	89.5	86.8	90.1	87.1	89.6	89.7	88.6	89.0	90.5	87.7	86.6	86.5	85.6	87.8	87.4	90.2	88.8
Deep Vein Thrombosis	71.6	66.8	67.4	65.3	65.5	66.9	66.3	65.2	68.1	69.7	67.5	67.9	72.7	78.1	70.8	65.1	62.4	63.6
Weight Bearing Activity	92.3	94.5	91.4	94.3	92.9	94.2	92.5	94.4	95.8	96.8	95.2	96.2	95.3	96.1	97.1	94.4	95.2	94.0

Risk-Adjusted Analysis for Hip/Knee Replacement Surgery

The odds of process measure compliance over 1-month increments and odds over the 18-month total cohort time period are reported in Table 28. No significant increase was found in compliance to any of the process measures.

Table 29 summarizes the outcome measure modeling. No outcomes had a significantly increased or decreased odds of occurrence over time, except for continuous LOS, which showed a significant reduction over time.

Table 30 reports odds and relative risk changes over time for binary outcome measures. Baseline rates were estimated from a single month of risk-adjusted ISCR hip/knee replacement surgery data from the first month of the cohort. Relative change in risk is an estimation of the magnitude of effect due to the AHRQ ISCR program. There was no significant reduction in risk for VTE, UTI, SSI, VUS, transfusion, or return to operating room; however, LOS was associated with a 12 percent decrease over time (model parameter -.0072, p <0.0001). Transfusion had a significantly increased odds at 18 months (OR 1.921, 95% CI = 1.199 to 3.078) with a relative increase in risk of 88.40 percent from baseline. Table 31 reports a 9 percent decrease in length of stay following hip/knee replacement surgery from baseline to 18 months.

Table 28. Association of Hip/Knee Replacement Surgery Process Measure Compliance With Time

Process Measure	Overall Compliance Rate	OR (95% CI) for 1-Month Increments	OR (95% CI) for 18 Months
Use of Preoperative TXA	0.879	1.038 (0.994, 1.085)	1.973 (0.896, 4.344)
Use of Multi-Modal Pain Management	0.873	1.040 (0.994, 1.089)	2.039 (0.896, 4.638)
Foley Duration	0.938	0.994 (0.950, 1.040)	0.898 (0.396, 2.033)
First Postop Mobilization	0.884	0.995 (0.967, 1.024)	0.915 (0.547, 1.531)
Continued DVT PPX 2D Days Postop	0.675	1.000 (0.958, 1.045)	1.005 (0.458, 2.208)
Weight Bearing as Tolerated Within 1 Day	0.946	1.035 (0.977, 1.097)	1.861 (0.654, 5.297)

Abbreviations: DVT = deep vein thrombosis; PPX = prophylaxis; TXA = tranexamic acid

Table 29. Summary of Hip/Knee Replacement Surgery Outcome Measure Model Results

Outcome	OR (95% CI)	OR (95% CI) for 18 Months
VTE	1.011 (0.974, 1.049)	1.218 (0.626, 2.368)
UTI	1.002 (0.965, 1.040)	1.037 (0.529, 2.032)
SSI	1.018 (0.984, 1.054)	1.388 (0.744, 2.591)
VUS	1.012 (0.989, 1.036)	1.246 (0.822, 1.890)
Length of Stay >75th Percentile	0.985 (0.968, 1.001)	0.758 (0.560, 1.025)
Length of Stay†	-0.0072 (<.0001)*	n/a
Transfusion	1.037 (1.010, 1.064)*	1.921 (1.199, 3.078)*
Return to OR	0.996 (0.973, 1.019)	0.926 (0.611, 1.401)

Abbreviations: n/a= not applicable; SSI = surgical site infection; UTI = urinary tract infection; VTE = venous thromboembolism; VUS = composite measure of VTE, SSI, UTI

**indicates a significant value*

†Indicates continuous outcome variable, result is negative binomial model beta value parameter with (p-value) of significance rather than odds ratio

Table 30. Estimated Odds Ratios and Relative Risk Change for Hip/Knee Replacement Surgery Binary Outcome Measures Over Time

Outcome	Odds Ratio by Month (95% CI)	Odds Ratio (18-Month Cumulative)	Risk at Baseline (%)	Risk at Month 18 (%)	Absolute Change in Risk (%)	Relative Change in Risk (%)
VTE	1.011 (0.974, 1.049)	1.218 (0.626, 2.368)	0.70	0.85	0.15	21.71%
UTI	1.002 (0.965, 1.040)	1.037 (0.529, 2.032)	0.74	0.77	0.03	3.64%
SSI	1.018 (0.984, 1.054)	1.388 (0.744, 2.591)	1.11	1.53	0.42	38.17%
VUS	1.012 (0.989, 1.036)	1.246 (0.822, 1.890)	2.25	2.78	0.54	23.87%
Prolonged LOS†	0.985 (0.968, 1.001)	0.758 (0.560, 1.025)	23.93	19.25	-4.68	-19.55
Transfusion	1.037 (1.010, 1.064)*	1.921 (1.199, 3.078)*	2.19	4.13	1.94	88.40%
Return to OR	0.996 (0.973, 1.019)	0.926 (0.611, 1.401)	1.78	1.65	-0.13	-7.33

Abbreviations: LOS = length of stay; SSI = surgical site infection; UTI = urinary tract infection; VTE = venous thromboembolism; VUS = composite measure of VTE, SSI, UTI;

**Indicates significant value*

†prolonged LOS= length of stay >75th percentile for all cases included in model

Table 31. Estimated Parameters and Change in Duration for Hip/Knee Replacement Surgery Continuous Outcome Measures

Outcome	Beta Value Parameter (p value)by Month	Beta Value Parameter(p value) for 18-Month Cumulative	Duration at Baseline (Days)	Duration Month 18 (Days)	Change in Duration (Days)	Change in Duration(%)
LOS	-0.0072 (<.0001)*	-0.1304 (<.0001)*	2.1402	1.88	-0.26	-12%

Abbreviations: LOS = length of stay
**Indicates significant value*

Results for the gynecologic surgery service line start with Table 32, which summarizes monthly registry data entry, while Tables 33a–c and Figures 36–41 illustrate unadjusted binary and continuous outcomes by month. Figure 42 reports process measure compliance over time.

GYNECOLOGIC SURGERY, COHORTS 3–4

Unadjusted Data Trends

Table 32. Gynecologic Surgery Registry Data Entry Summary, by Calendar Month

Month	# Hosp	# Cases
1	45	941
2	42	1030
3	43	1002
4	41	987
5	44	1098
6	42	1017
7	41	995
8	40	1036
9	43	903
10	41	1014
11	43	1105
12	40	1098
13	40	744
14	35	444
15	43	803
16	43	1024
17	39	917
18	36	823
Total	*n/a*	*16981*

Abbreviations: n/a= not applicable

Table 33a. Gynecologic Surgery Event Rates of Binary Outcomes Measures by Month–Venous Thromboembolism

Month	(n)	Cases	Rate (%)
1	1	941	0.11
2	6	1030	0.58
3	3	1002	0.30
4	5	987	0.51
5	11	1098	1.00
6	7	1017	0.69
7	2	995	0.20
8	3	1036	0.29
9	2	903	0.22
10	5	1014	0.49
11	3	1105	0.27
12	8	1098	0.73
13	2	744	0.27
14	4	444	0.90
15	1	803	0.12
16	5	1024	0.49
17	1	917	0.11
18	5	823	0.61
Total	74	16981	*n/a*

Abbreviations: n/a= not applicable

Table 33b. Gynecologic Surgery Event Rates of Binary Outcomes Measures by Month–Urinary Tract Infection

Month	(n)	Cases	Rate (%)
1	14	941	1.49%
2	26	1030	2.52%
3	18	1002	1.80%
4	25	987	2.53%
5	15	1098	1.37%
6	28	1017	2.75%
7	26	995	2.61%
8	20	1036	1.93%
9	25	903	2.77%
10	32	1014	3.16%
11	32	1105	2.90%
12	29	1098	2.64%
13	12	744	1.61%
14	4	444	0.90%
15	7	803	0.87%
16	27	1024	2.64%
17	22	917	2.40%
18	27	823	3.28%
Total	389	16981	*n/a*

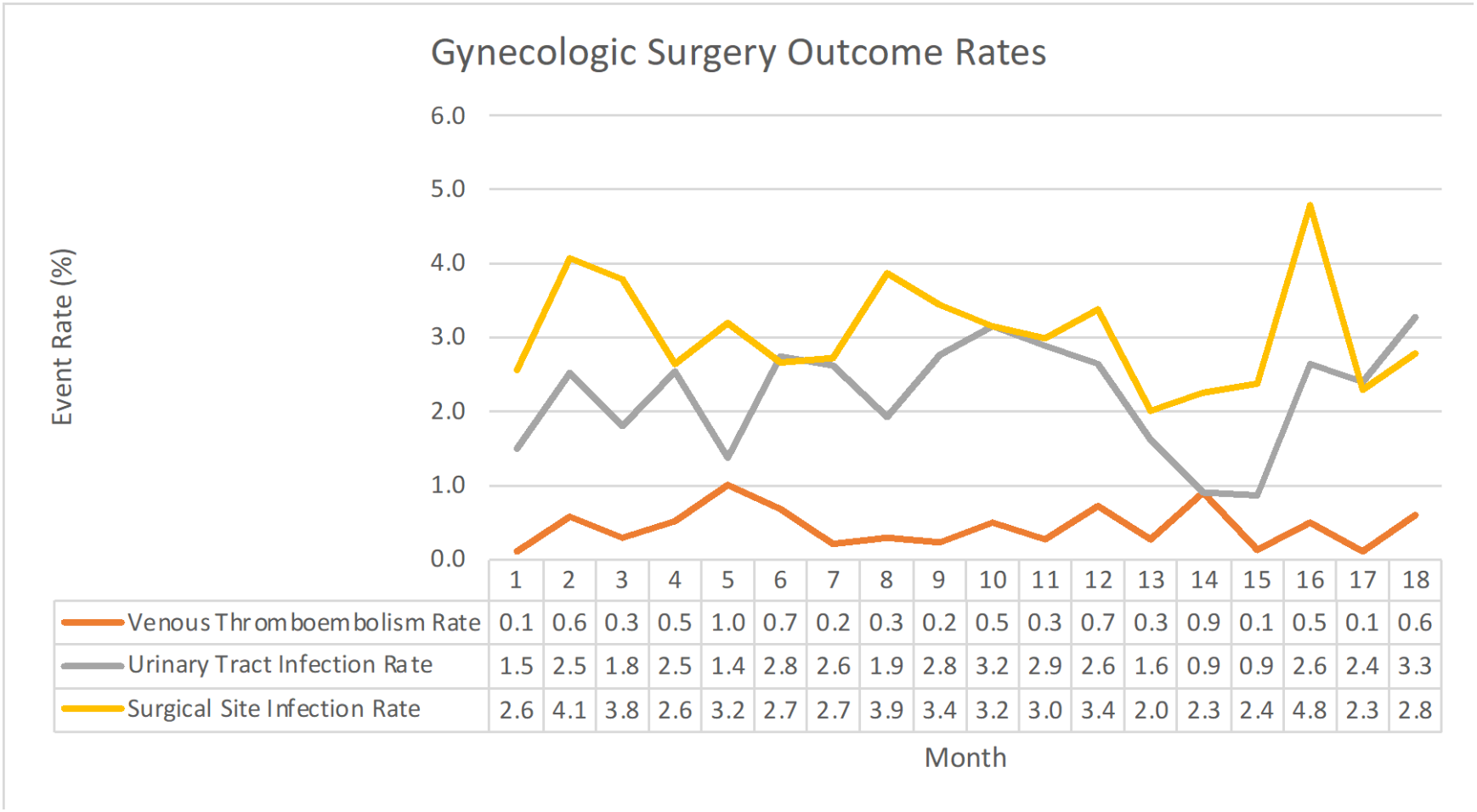
Abbreviations: n/a= not applicable

Table 33c. Gynecologic Surgery Event Rates of Binary Outcomes Measures by Month–Surgical Site Infection

Month	(n)	Cases	Rate (%)
1	24	941	2.55%
2	42	1030	4.08%
3	38	1002	3.79%
4	26	987	2.63%
5	35	1098	3.19%
6	27	1017	2.65%
7	27	995	2.71%
8	40	1036	3.86%
9	31	903	3.43%
10	32	1014	3.16%
11	33	1105	2.99%
12	37	1098	3.37%
13	15	744	2.02%
14	10	444	2.25%
15	19	803	2.37%
16	49	1024	4.79%
17	21	917	2.29%
18	23	823	2.79%
Total	529	16981	*n/a*

Abbreviations: n/a= not applicable

Figure 36. Gynecologic Surgery Unadjusted Event Rates of Binary Outcome Measures by Month



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Venous Thromboembolism Rate	0.1	0.6	0.3	0.5	1.0	0.7	0.2	0.3	0.2	0.5	0.3	0.7	0.3	0.9	0.1	0.5	0.1	0.6
Urinary Tract Infection Rate	1.5	2.5	1.8	2.5	1.4	2.8	2.6	1.9	2.8	3.2	2.9	2.6	1.6	0.9	0.9	2.6	2.4	3.3
Surgical Site Infection Rate	2.6	4.1	3.8	2.6	3.2	2.7	2.7	3.9	3.4	3.2	3.0	3.4	2.0	2.3	2.4	4.8	2.3	2.8

Figure 37. Gynecologic Surgery Venous Thromboembolism Event Rates of Binary Outcome Measures by Month

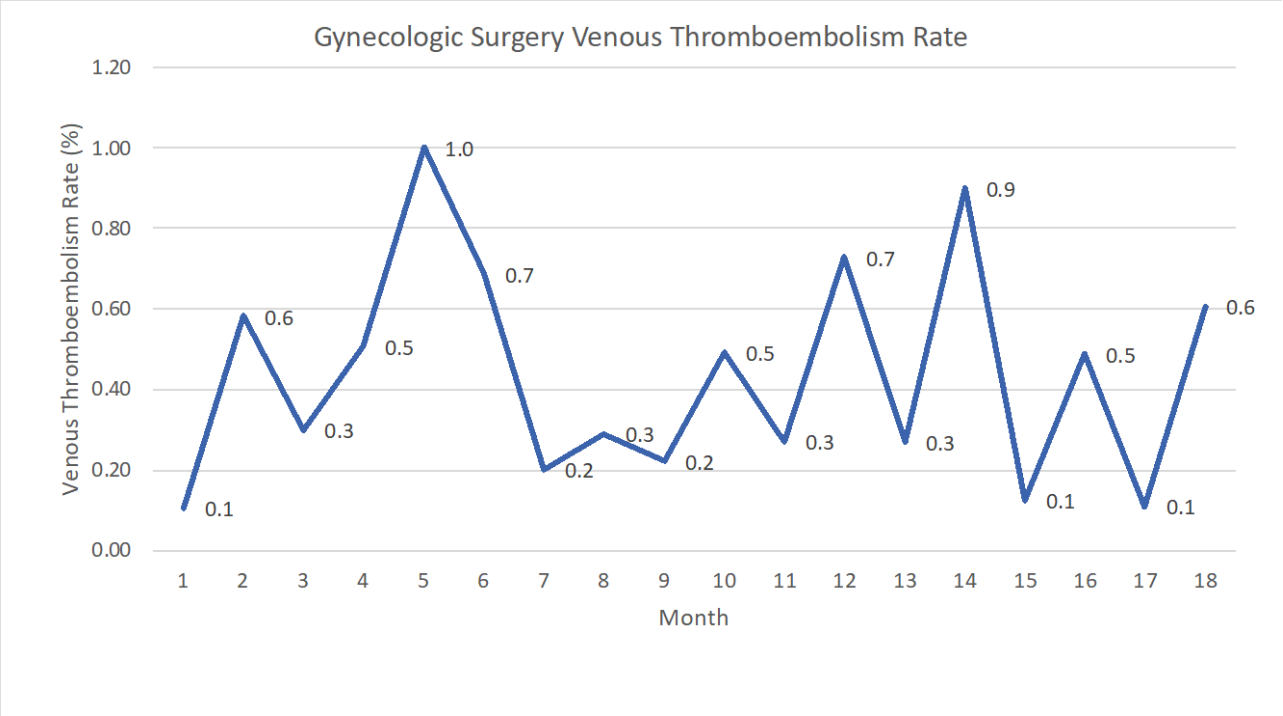


Figure 38. Gynecologic Surgery Urinary Tract Infection Event Rates of Binary Outcome Measures by Month

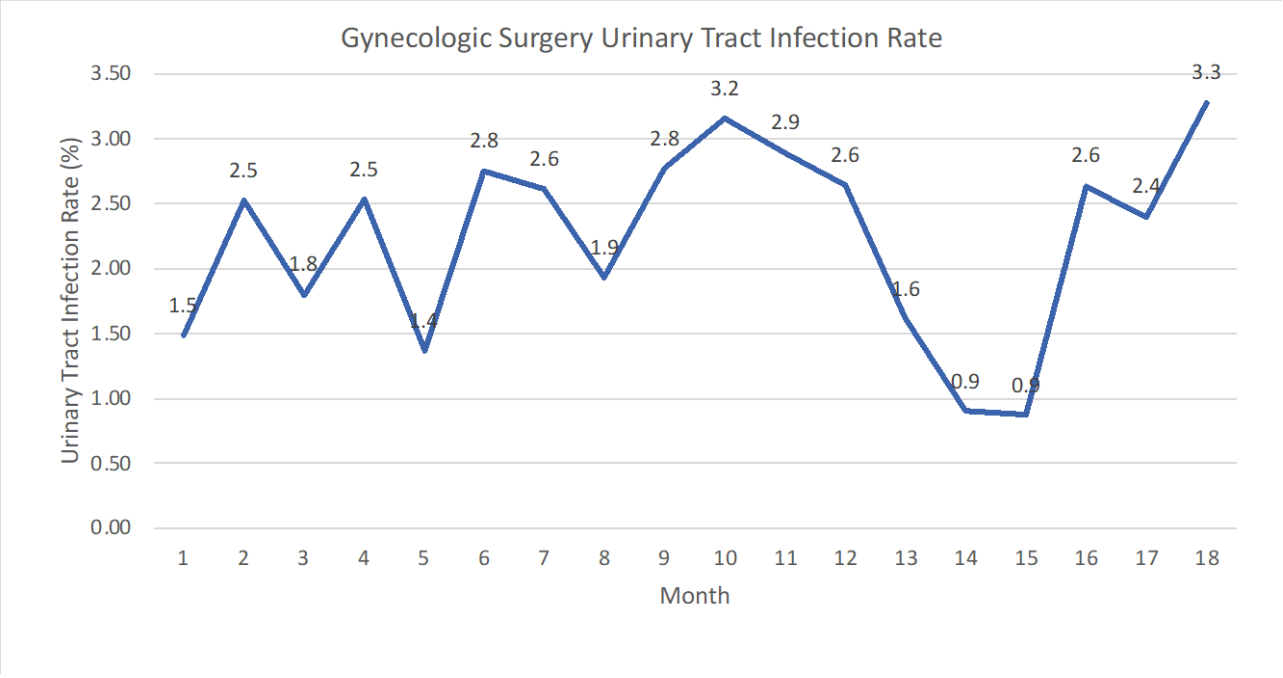


Figure 39. Gynecologic Surgery Surgical Site Infection Event Rates of Binary Outcome Measures by Month

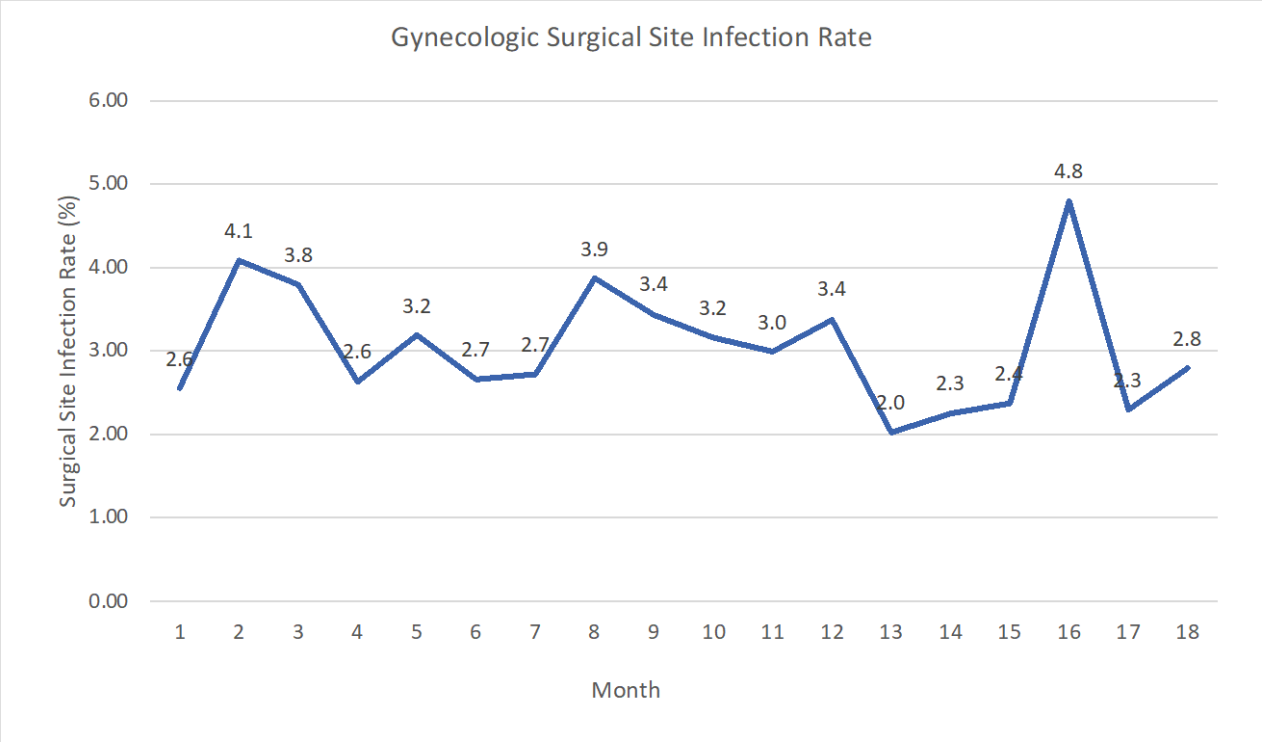


Figure 40. Gynecologic Surgery Prolonged Length of Stay (>75th percentile) Binary Outcome Measures by Month

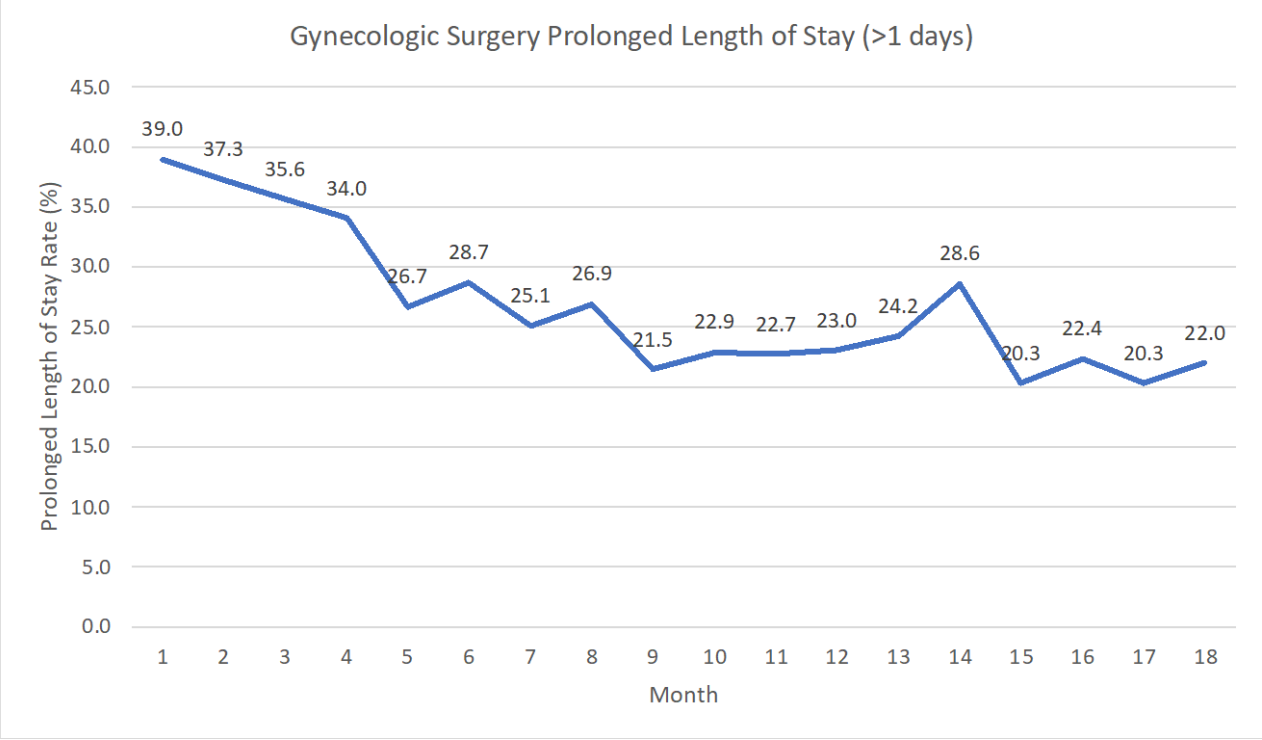


Figure 41. Gynecologic Surgery Mean Days of Length of Stay by Month

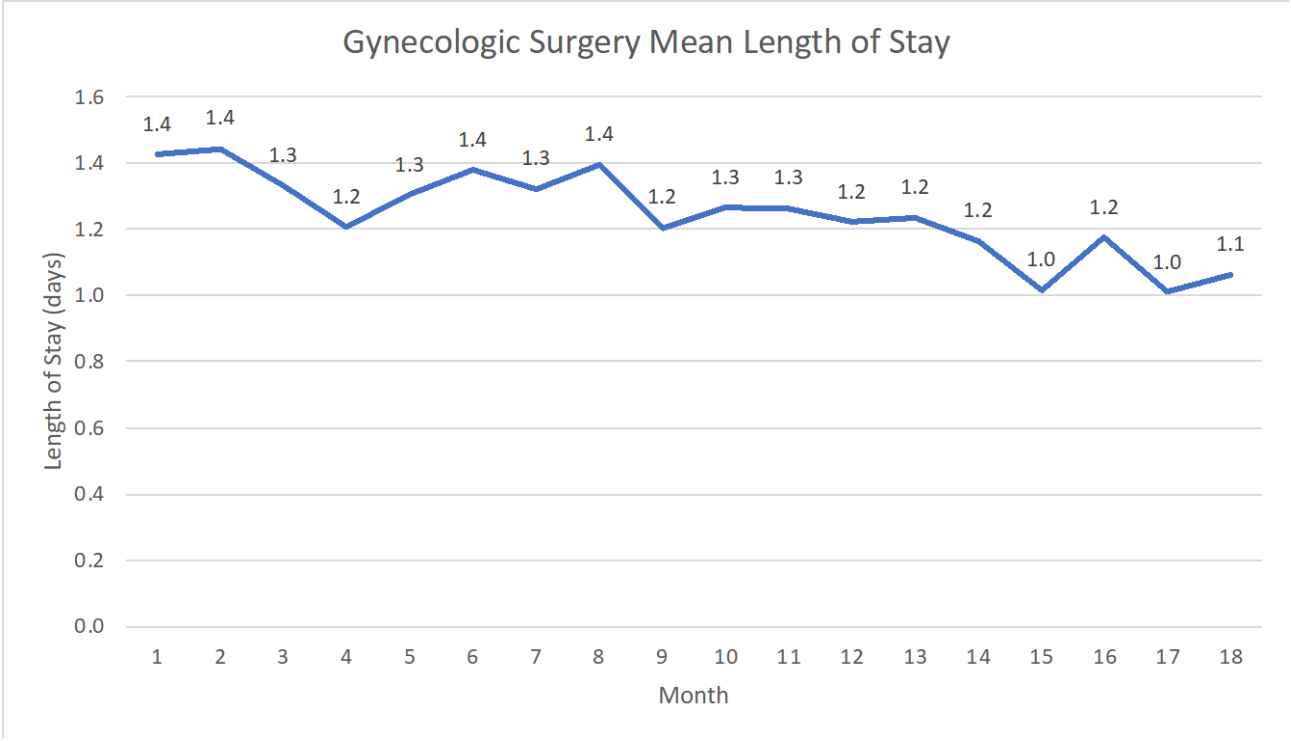
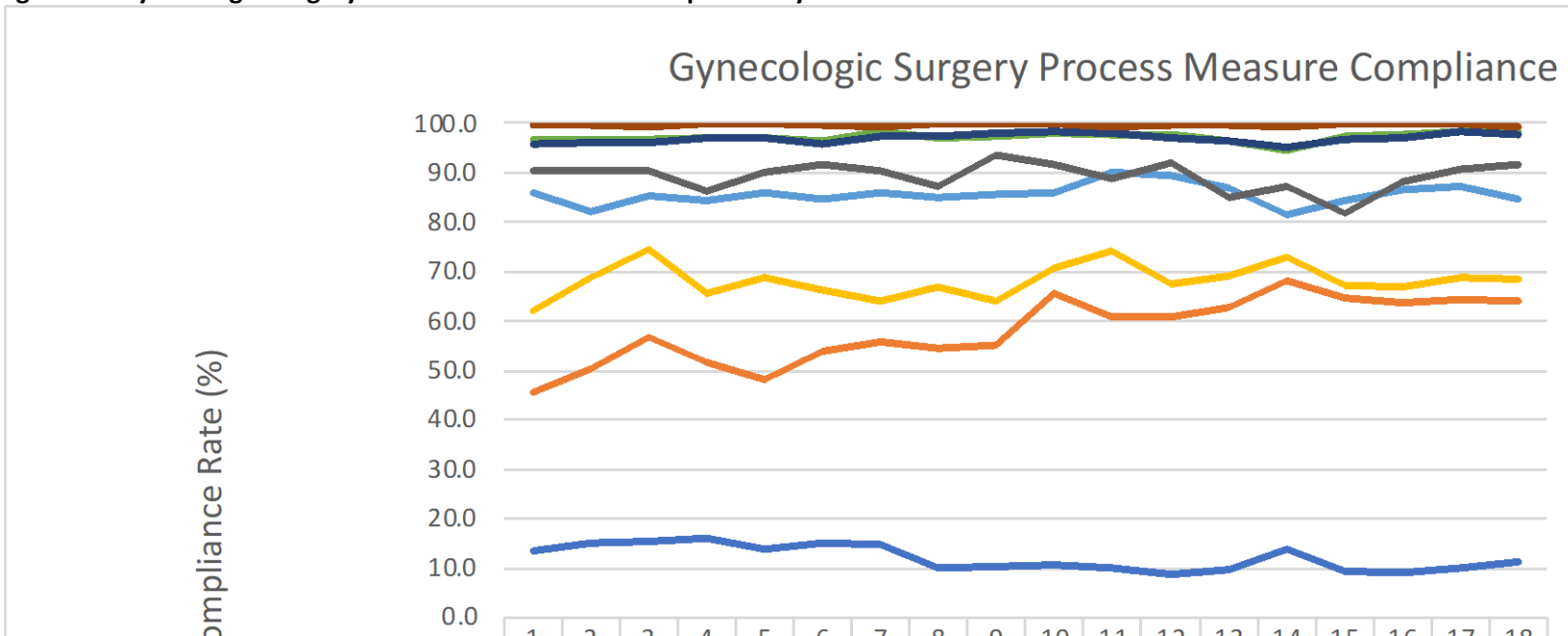


Figure 42. Gynecologic Surgery Core Process Measure Compliance by Month



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Patient Controlled Analgesia	13.6	15.0	15.5	16.1	13.7	15.2	14.8	10.0	10.4	10.8	10.2	8.7	9.7	13.9	9.4	9.2	10.1	11.3
Local Wound Analgesia	45.7	50.4	56.6	51.5	48.2	53.9	55.7	54.4	55.3	65.7	61.0	60.9	62.8	68.3	64.6	63.6	64.5	64.2
Multimodal Pain Management	62.2	68.7	74.3	65.6	68.8	66.4	64.1	66.9	64.0	70.5	74.0	67.5	69.1	72.8	67.3	66.7	68.7	68.4
Early Mobility	85.8	82.0	85.3	84.4	85.9	84.6	85.8	85.1	85.7	86.1	90.0	89.3	86.8	81.6	84.4	86.7	87.3	84.7
Early Liquid Intake	96.7	96.8	96.6	97.0	97.2	96.5	98.4	97.0	97.5	98.0	97.7	97.8	96.3	94.6	97.2	97.6	98.4	98.5
Early Solid Intake	95.8	96.0	96.0	97.1	97.0	95.9	97.5	97.5	98.0	98.3	97.9	96.9	96.4	95.1	96.6	97.0	98.4	97.6
Early Foley Removal	99.5	99.5	99.4	99.9	100.0	99.7	99.3	99.8	99.9	100.0	99.3	99.6	99.6	99.2	99.9	99.8	99.9	99.4
Postoperative VTE* Prophylaxis	90.4	90.5	90.3	86.3	90.2	91.7	90.4	87.3	93.6	91.6	88.7	91.9	85.0	87.2	81.9	88.2	90.6	91.7

**VTE=Venous Thromboembolism*

Risk-Adjusted Analysis for Gynecologic Surgery

The odds of process measure compliance over 1-month increments and odds over the 18-month total cohort time period are reported in Table 34. The odds of process measure compliance significantly increased over time for local wound analgesia, while the odds of patient-controlled analgesia being administered significantly decreased over time. ORs for compliance did not significantly change over time for use of multimodal pain management, first postoperative mobilization, first postoperative intake of solids, first postoperative intake of liquids, or Foley catheter duration.

Table 35 summarizes outcome measures modeling. Significantly decreased odds of event occurrence was observed for LOS >75th percentile, and continuous LOS over time. ORs over time were not significant for VTE, UTI, SSI, or for their binary composite (VUS).

Table 36 reports odds and estimated relative risk changes over time for binary outcome measures. Baseline rates were estimated from a single month of risk-adjusted ISCR gynecologic surgery data from the first month of each cohort. Relative change in risk is an estimation of the magnitude of effect due to the AHRQ ISCR program. Baseline durations for continuous outcomes were estimated from the expected values from the first month of each cohort. There were significantly decreased odds of prolonged length of stay at 18 months, OR 0.496 (95% CI = 0.382 to 0.644), with a relative reduction of risk of 41.39 percent from baseline. Table 37 indicates the estimated parameter values for continuous outcomes; length of stay demonstrated a 20 percent decrease over time.

Table 34. Association of Gynecologic Surgery Process Measure Compliance With Time

Process Measure	Overall Compliance Rate	OR (95% CI) for 1-Month Increment	OR (95% CI) for 18 Months
Patient Controlled Analgesia	0.118	0.965 (0.942, 0.989)*	0.529 (0.341, 0.821)*
Local Wound Analgesia	0.581	1.044 (1.019, 1.071)*	2.186 (1.400, 3.414)*
Use of Multimodal Pain Management	0.695	1.003 (0.962, 1.047)	1.065 (0.495, 2.290)
First Postop Mobilization	0.856	1.012 (0.991, 1.034)	1.244 (0.854, 1.811)
First Postop Intake of Liquids	0.973	1.023 (0.999, 1.049)	1.517 (0.980, 2.348)
First Postop Intake of Solids	0.970	1.027 (0.998, 1.056)	1.604 (0.956, 2.689)
Foley Catheter Duration	0.997	1.007 (0.967, 1.049)	1.140 (0.546, 2.376)

Abbreviations: CI = confidence interval; OR = odds ratio
**Indicates significant odds ratio*

Table 35. Summary of Gynecologic Surgery Outcome Measure Model Results

Outcome	OR (95% CI) for 1-Month Increment	OR (95% CI) for 18 Months
VTE	0.988 (0.947, 1.032)	0.811 (0.377, 1.748)
UTI	1.010 (0.988, 1.034)	1.206 (0.804, 1.810)
SSI	0.995 (0.971, 1.019)	0.908 (0.584, 1.412)
VUS	0.999 (0.980, 1.018)	0.984 (0.701, 1.382)
Length of Stay >75th Percentile	0.962 (0.948, 0.976)*	0.496 (0.382, 0.644)*
Length of Stay†	-0.0122 (<.0001)*	n/a

Abbreviations: CI = confidence interval; n/a= not applicable; OR = odds ratio; ILOS = ileus and length of stay >75th percentile; SSI = surgical site infection; UTI = urinary tract infection; VTE = venous thromboembolism; VUS = composite measure of VTE, SSI, UTI

**Indicates significant value*

†Indicates continuous outcome variable, result is negative binomial model beta value parameter with (p-value) of significance rather than odds ratio

Table 36. Estimated Odds Ratios and Relative Risk Change for Gynecologic Surgery Binary Outcome Measures Over Time

Outcome	Odds Ratio by Month (95% CI)	Odds Ratio (95% CI) for 18-month Cumulative	Risk at Baseline (%)	Risk at Month 18 (%)	Absolute Change in Risk (%)	Relative Change in Risk (%)
VTE	0.988 (0.947, 1.032)	0.811 (0.377, 1.748)	0.48	0.39	-0.09	-18.77%
UTI	1.010 (0.988, 1.034)	1.206 (0. .804, 1.810)	2.07	2.48	0.41	20.08%
SSI	0.995 (0.971, 1.019)	0.908 (0.584, 1.412)	3.26	2.97	-0.29	-8.89%
VUS	0.999 (0.980, 1.018)	0.984 (0.701, 1.382)	5.43	5.35	-0.08	-1.50%
Prolonged LOS†	0.962 (0.948, 0.976)*	0.496 (0.382, 0.644)*	30.62	17.95	-12.67	-41.39%

Abbreviations: LOS = length of stay; SSI = surgical site infection; UTI = urinary tract infection; VTE = venous thromboembolism; VUS = composite measure of VTE, SSI, UTI

**Indicates significant value*

†Prolonged LOS= length of stay >75th percentile for all cases included in model, for this service line

Table 37. Estimated Parameters and Change in Duration for Gynecologic Surgery Continuous Outcome Measures

Outcome	Beta Value Parameter (p value)by Month	Beta Value Parameter(p value) for 18-Month Cumulative	Duration at Baseline (Days)	Duration Month 18 (Days)	Change in Duration (Days)	Change in Duration(%)
LOS	-0.0122 (<.0001)*	-0.2198 (<.0001)*	1.4111	1.13	-0.28	-20%

Abbreviations: LOS = length of stay; ROBF = return of bowel function
**Indicates significant value*

Results for the emergency general surgery-appendectomy/cholecystectomy service line start with Table 38, which summarizes monthly registry data entry, while Tables 39a–e and Figures 43–51 illustrate unadjusted binary and continuous outcomes by month. Figure 52 reports process measure compliance over time.

Emergency General Surgery-Appendectomy/Cholecystectomy, Cohort 4

Unadjusted Data Trends

Table 38. Emergency General Surgery-Appendectomy/Cholecystectomy Registry Data Entry Summary, by Calendar Month

Month	# Hosp	# Cases
1	59	887
2	58	791
3	59	843
4	58	803
5	59	970
6	57	831
7	58	1043
8	57	869
9	60	942
10	57	911
11	59	927
12	57	896
13	57	775
14	57	831
15	57	890
16	54	854
17	58	829
18	55	871
Total	*n/a*	*15763*

Abbreviations: n/a= not applicable

Table 39a. Emergency General Surgery-Appendectomy/Cholecystectomy Unadjusted Rates of Binary Outcomes–Venous Thromboembolism

Month	(n)	Cases	Rate (%)
1	5	887	0.56
2	1	791	0.13
3	0	843	0.00
4	2	803	0.25
5	5	970	0.52
6	3	831	0.36
7	3	1043	0.29
8	5	869	0.58
9	3	942	0.32
10	2	911	0.22
11	2	927	0.22
12	7	896	0.78
13	4	775	0.52
14	0	831	0.00
15	2	890	0.22
16	1	854	0.12
17	4	829	0.48
18	2	871	0.23
Total	51	15763	*n/a*

Abbreviations: n/a= not applicable

Table 39b. Emergency General Surgery-Appendectomy/Cholecystectomy Unadjusted Rates of Binary Outcomes–Urinary Tract Infection

Month	(n)	Cases	Rate (%)
1	4	887	0.45
2	1	791	0.13
3	2	843	0.24
4	4	803	0.50
5	3	970	0.31
6	2	831	0.24
7	7	1043	0.67
8	2	869	0.23
9	2	942	0.21
10	3	911	0.33
11	4	927	0.43
12	3	896	0.33
13	3	775	0.39
14	3	831	0.36
15	4	890	0.45
16	6	854	0.70
17	6	829	0.72
18	4	871	0.46
Total	63	15763	*n/a*

Abbreviations: n/a= not applicable

Table 39c. Emergency General Surgery-Appendectomy/Cholecystectomy Unadjusted Rates of Binary Outcomes–Surgical Site Infection

Month	(n)	Cases	Rate (%)
1	31	887	3.49
2	16	791	2.02
3	23	843	2.73
4	26	803	3.24
5	24	970	2.47
6	34	831	4.09
7	36	1043	3.45
8	24	869	2.76
9	34	942	3.61
10	29	911	3.18
11	30	927	3.24
12	26	896	2.90
13	30	775	3.87
14	30	831	3.61
15	31	890	3.48
16	28	854	3.28
17	25	829	3.02
18	30	871	3.44
Total	*507*	*15763*	*n/a*

Abbreviations: n/a= not applicable

Table 39d. Emergency General Surgery-Appendectomy/Cholecystectomy Unadjusted Rates of Binary Outcomes–Transfusion

Month	(n)	Cases	Rate (%)
1	6	887	0.68%
2	11	791	1.39%
3	8	843	0.95%
4	6	803	0.75%
5	4	970	0.41%
6	8	831	0.96%
7	10	1043	0.96%
8	2	869	0.23%
9	6	942	0.64%
10	1	911	0.11%
11	4	927	0.43%
12	9	896	1.00%
13	6	775	0.77%
14	5	831	0.60%
15	9	890	1.01%
16	7	854	0.82%
17	6	829	0.72%
18	5	871	0.57%
Total	113	15763	*n/a*

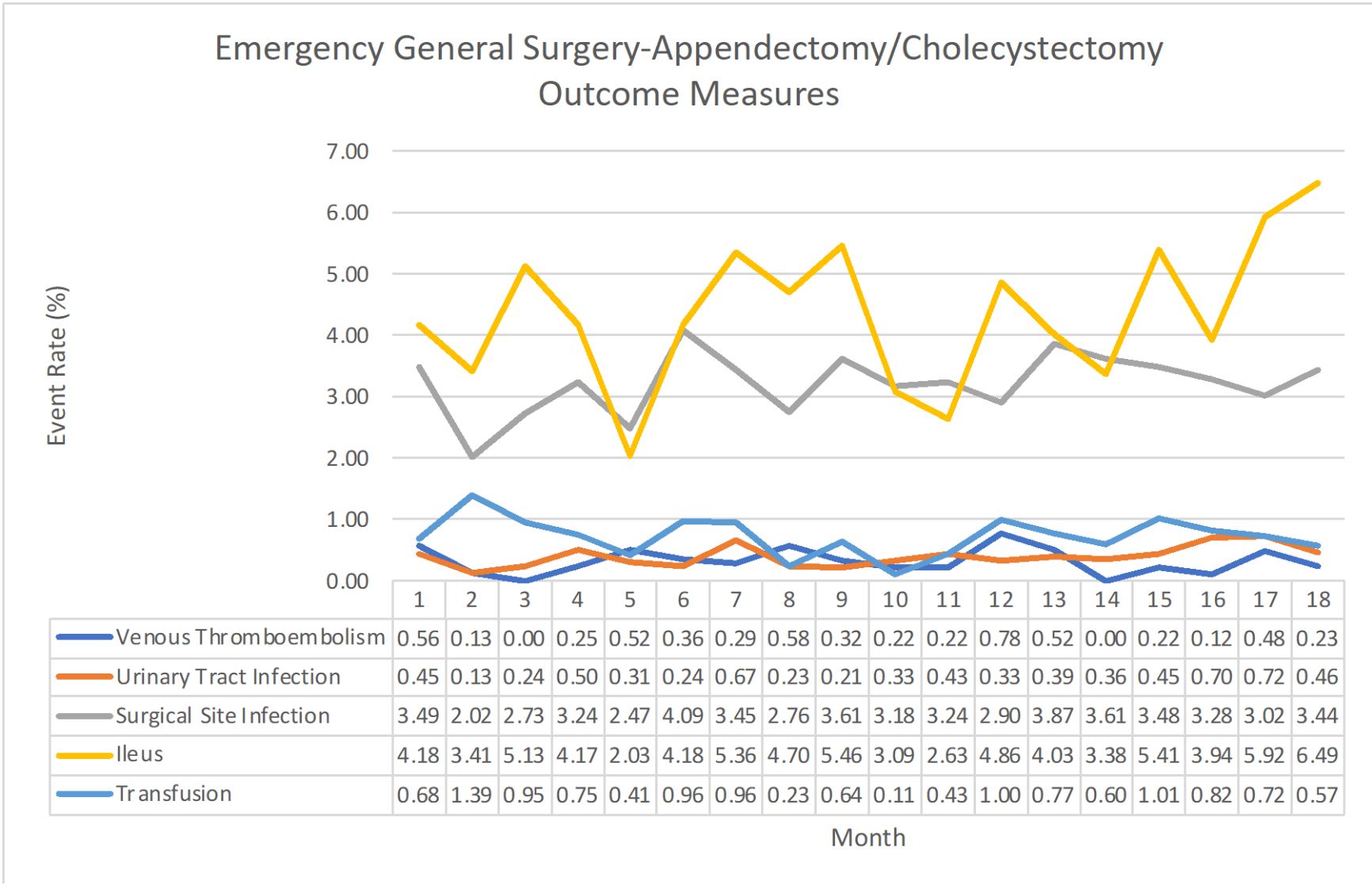
Abbreviations: n/a= not applicable

Table 39e. Emergency General Surgery-Appendectomy/Cholecystectomy Unadjusted Rates of Binary Outcomes–Ileus

Month	(n)	Cases	Rate (%)
1	16	383	4.18%
2	10	293	3.41%
3	16	312	5.13%
4	12	288	4.17%
5	7	344	2.03%
6	14	335	4.18%
7	21	392	5.36%
8	15	319	4.70%
9	19	348	5.46%
10	11	356	3.09%
11	10	380	2.63%
12	16	329	4.86%
13	11	273	4.03%
14	11	325	3.38%
15	18	333	5.41%
16	13	330	3.94%
17	18	304	5.92%
18	20	308	6.49%
Total	258	5952	*n/a*

Abbreviations: n/a= not applicable

Figure 43. Unadjusted Emergency General Surgery-Appendectomy/Cholecystectomy Binary Outcome Rates by Month



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Venous Thromboembolism	0.56	0.13	0.00	0.25	0.52	0.36	0.29	0.58	0.32	0.22	0.22	0.78	0.52	0.00	0.22	0.12	0.48	0.23
Urinary Tract Infection	0.45	0.13	0.24	0.50	0.31	0.24	0.67	0.23	0.21	0.33	0.43	0.33	0.39	0.36	0.45	0.70	0.72	0.46
Surgical Site Infection	3.49	2.02	2.73	3.24	2.47	4.09	3.45	2.76	3.61	3.18	3.24	2.90	3.87	3.61	3.48	3.28	3.02	3.44
Ileus	4.18	3.41	5.13	4.17	2.03	4.18	5.36	4.70	5.46	3.09	2.63	4.86	4.03	3.38	5.41	3.94	5.92	6.49
Transfusion	0.68	1.39	0.95	0.75	0.41	0.96	0.96	0.23	0.64	0.11	0.43	1.00	0.77	0.60	1.01	0.82	0.72	0.57

Figure 44. Emergency General Surgery-Appendectomy/Cholecystectomy Venous Thromboembolism Event Rates by Month

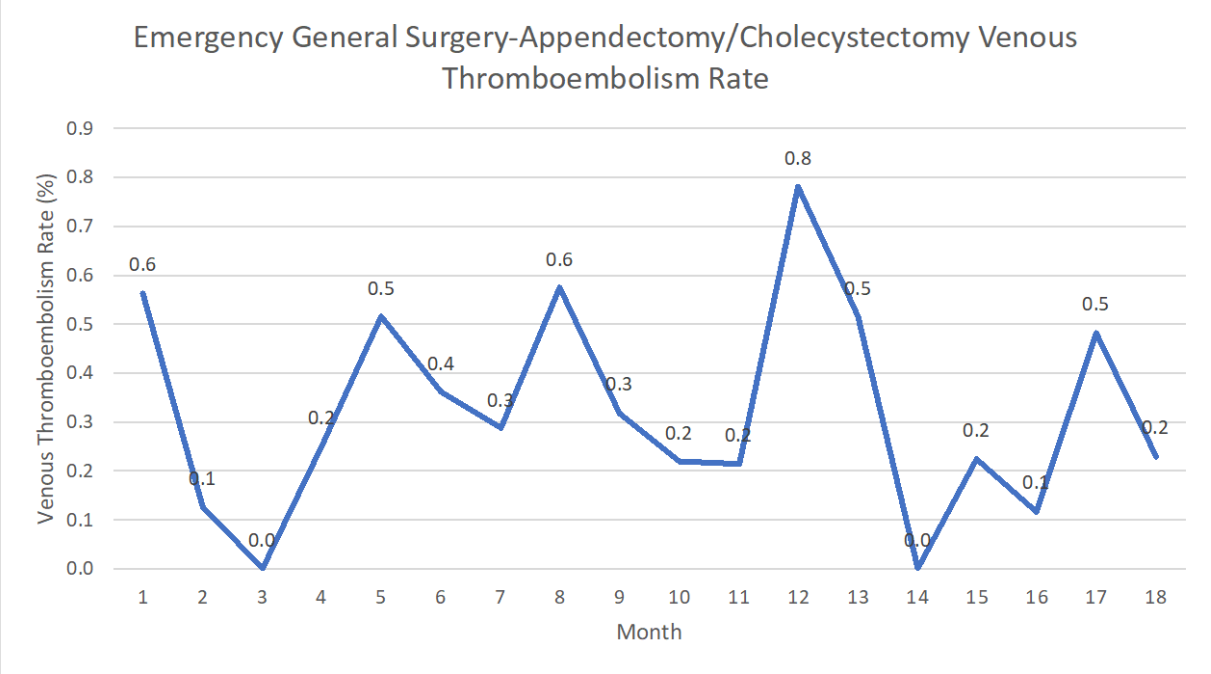


Figure 45. Emergency General Surgery-Appendectomy/Cholecystectomy Urinary Tract Infection Event Rates by Month

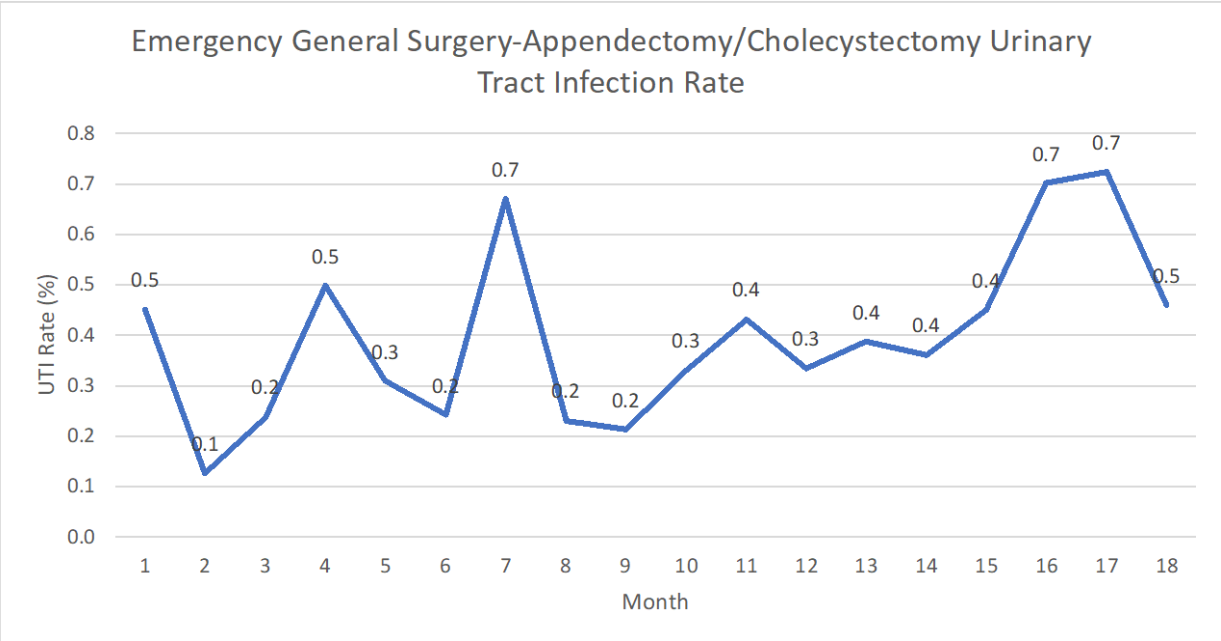


Figure 46. Emergency General Surgery-Appendectomy/Cholecystectomy Surgical Site Infection Event Rates by Month

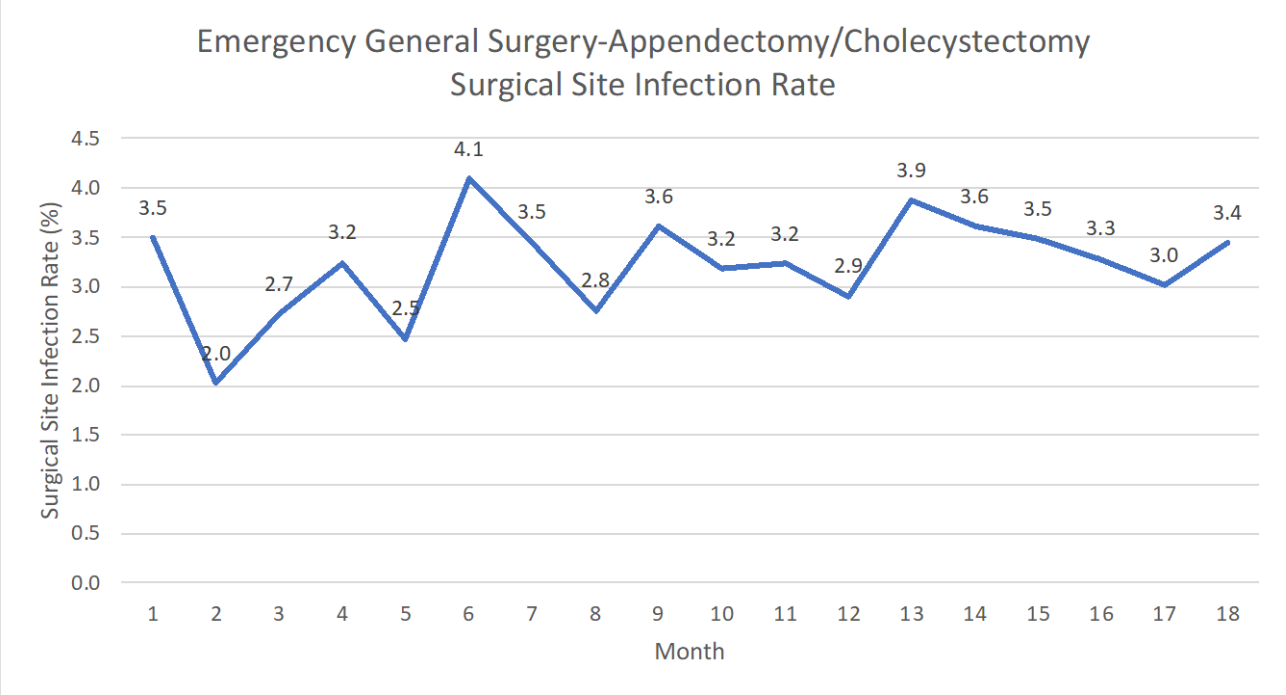


Figure 47. Emergency General Surgery-Appendectomy/Cholecystectomy Transfusion Event Rates by Month

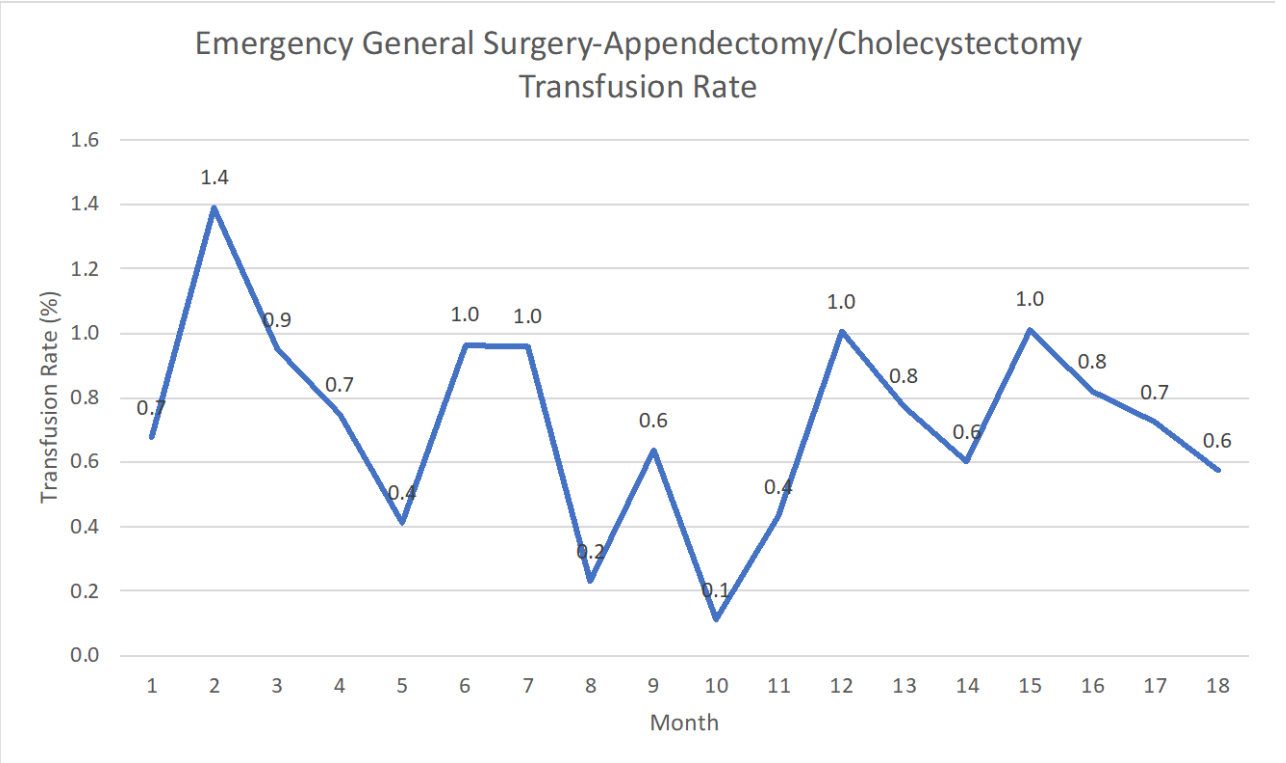


Figure 48. Emergency General Surgery-Appendectomy/Cholecystectomy Ileus Event Rates by Month

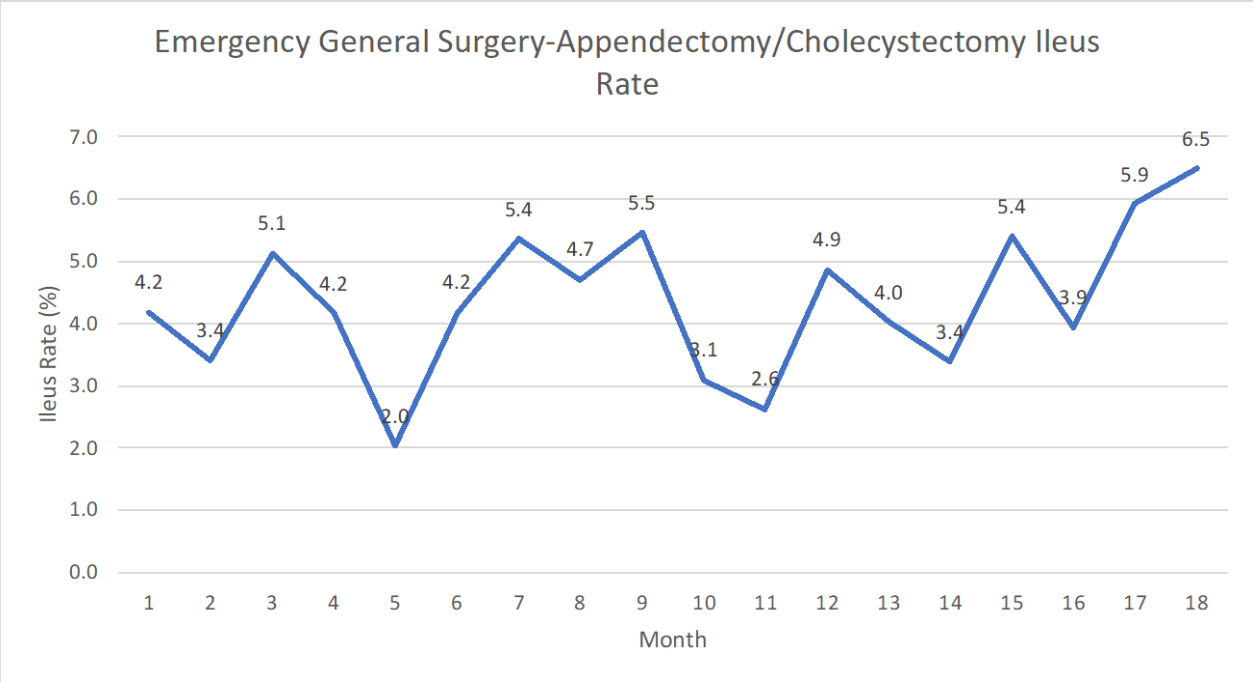


Figure 49. Emergency General Surgery-Appendectomy/Cholecystectomy Prolonged Length of Stay (>75th percentile) Binary Outcome Measures by Month

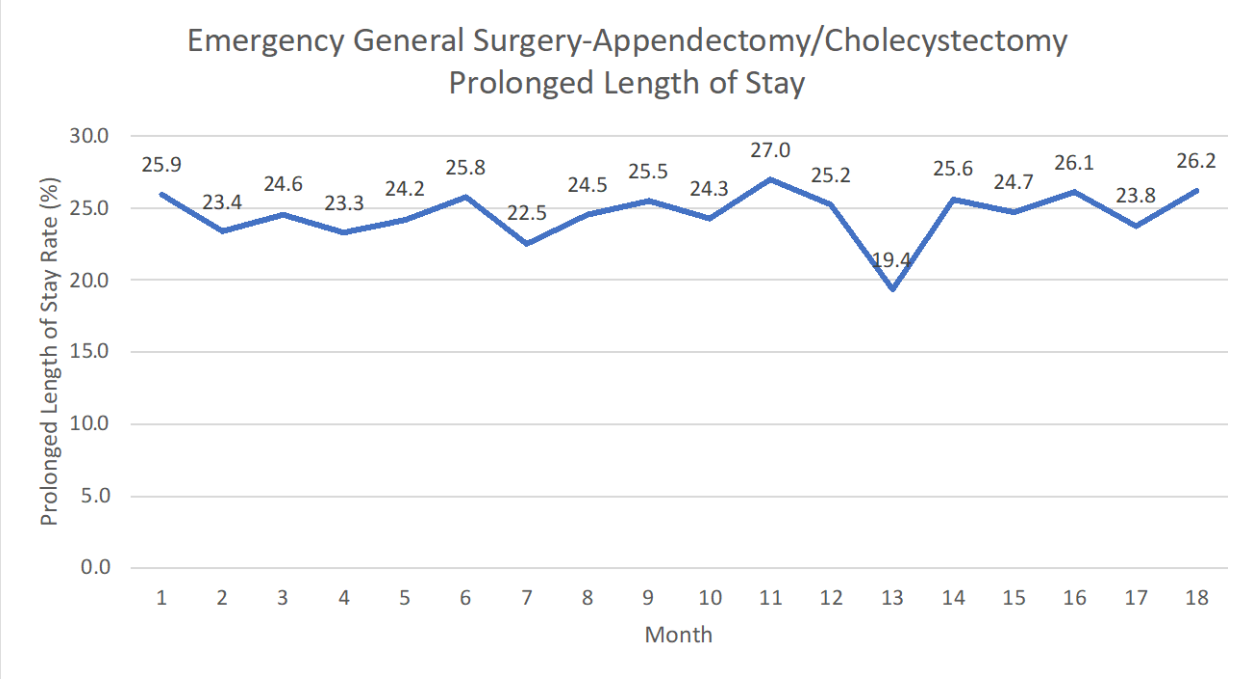


Figure 50. Emergency General Surgery-Appendectomy/Cholecystectomy Mean Days of Return of Bowel Function by Month

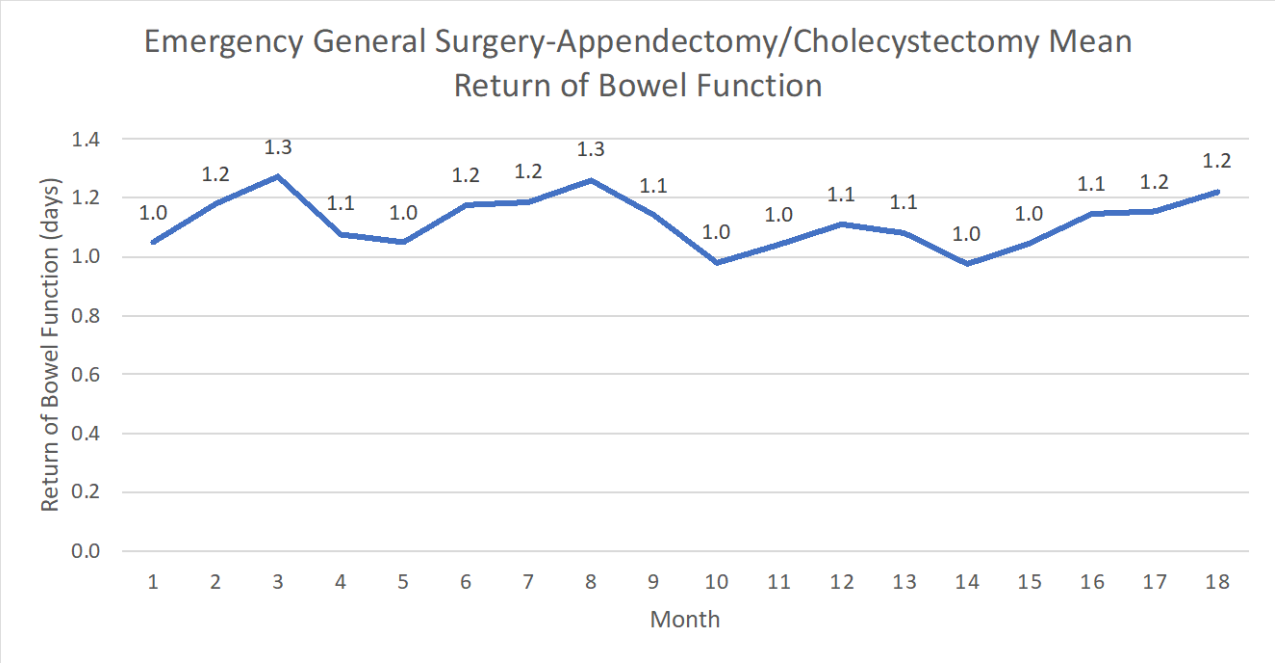


Figure 51. Emergency General Surgery-Appendectomy/Cholecystectomy Mean Length of Stay by Month

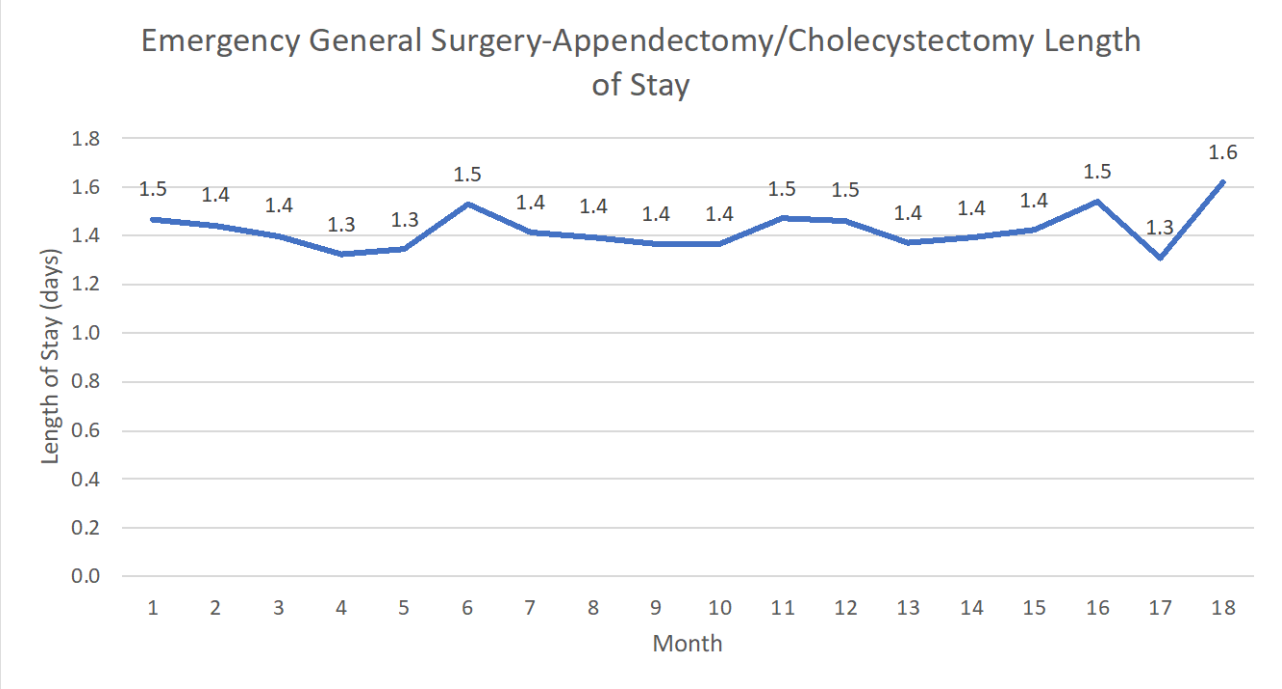
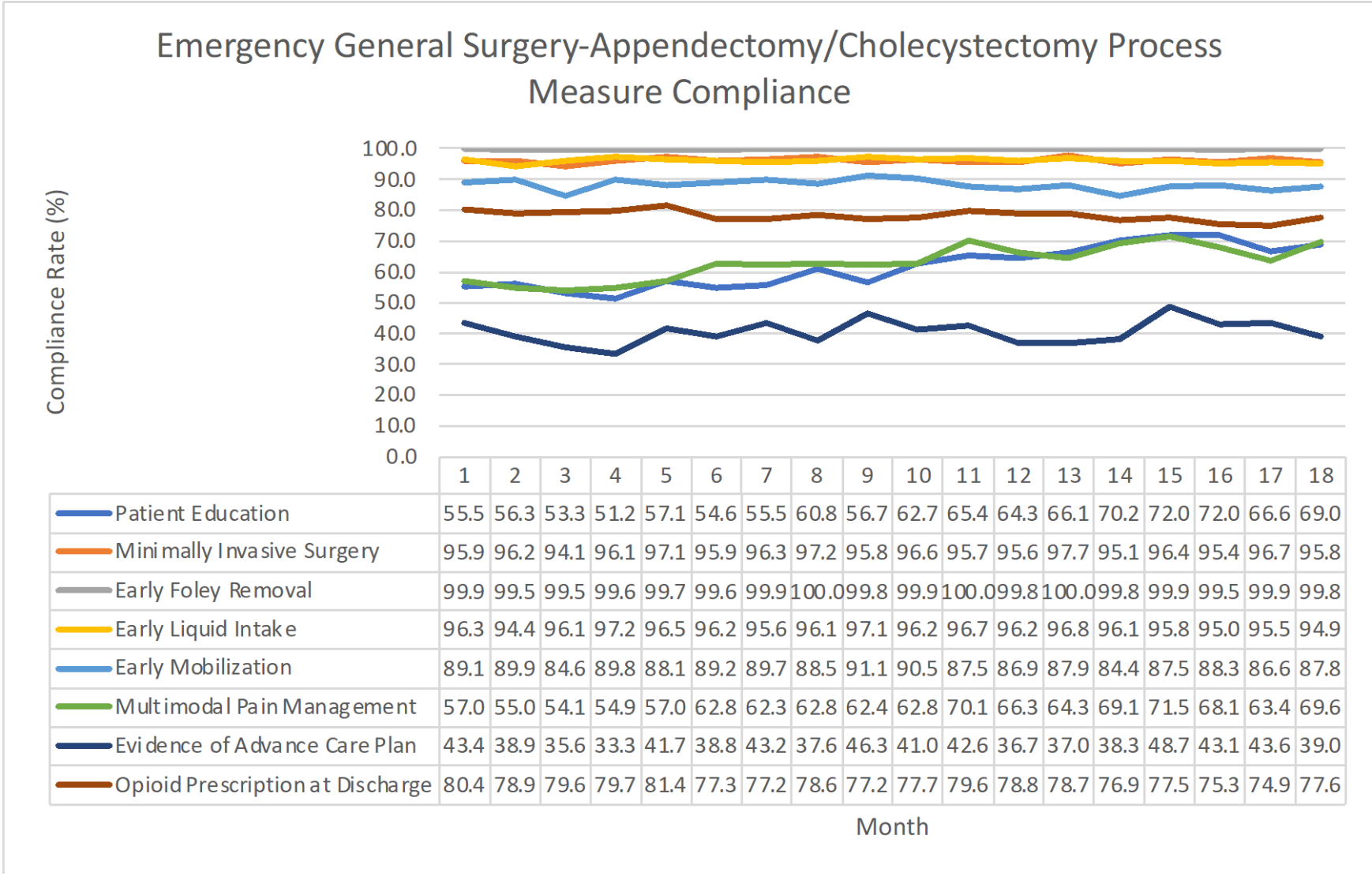


Figure 52. Emergency General Surgery-Appendectomy/Cholecystectomy Process Measure Compliance by Month



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Patient Education	55.5	56.3	53.3	51.2	57.1	54.6	55.5	60.8	56.7	62.7	65.4	64.3	66.1	70.2	72.0	72.0	66.6	69.0
Minimally Invasive Surgery	95.9	96.2	94.1	96.1	97.1	95.9	96.3	97.2	95.8	96.6	95.7	95.6	97.7	95.1	96.4	95.4	96.7	95.8
Early Foley Removal	99.9	99.5	99.5	99.6	99.7	99.6	99.9	100.0	99.8	99.9	100.0	99.8	100.0	99.8	99.9	99.5	99.9	99.8
Early Liquid Intake	96.3	94.4	96.1	97.2	96.5	96.2	95.6	96.1	97.1	96.2	96.7	96.2	96.8	96.1	95.8	95.0	95.5	94.9
Early Mobilization	89.1	89.9	84.6	89.8	88.1	89.2	89.7	88.5	91.1	90.5	87.5	86.9	87.9	84.4	87.5	88.3	86.6	87.8
Multimodal Pain Management	57.0	55.0	54.1	54.9	57.0	62.8	62.3	62.8	62.4	62.8	70.1	66.3	64.3	69.1	71.5	68.1	63.4	69.6
Evidence of Advance Care Plan	43.4	38.9	35.6	33.3	41.7	38.8	43.2	37.6	46.3	41.0	42.6	36.7	37.0	38.3	48.7	43.1	43.6	39.0
Opioid Prescription at Discharge	80.4	78.9	79.6	79.7	81.4	77.3	77.2	78.6	77.2	77.7	79.6	78.8	78.7	76.9	77.5	75.3	74.9	77.6

Risk-Adjusted Analysis for EGS-Appendectomy/Cholecystectomy

The odds ratio of process measure compliance over one-month increments and odds ratio for the 18-month total cohort time period are reported in Table 40. The odds of patient education and odds of use of multimodal pain management both had significant increases over time.

Table 41 summarizes outcome measure modeling. No significant difference was observed in odds of occurrence over time for VTE, UTI, SSI, LOS, transfusion, or ileus.

Estimated risk reductions and relative reductions in risk for binary outcome measures are reported in Table 42. Baseline rates were estimated from a single month of risk-adjusted ISCR EGS appendectomy/cholecystectomy data from the first month of the cohort. Relative change in risk is an estimation of the magnitude of effect due to the AHRQ ISCR program. Again, none of the models were shown to have a significant change over time. Table 43 reports a 2 percent decrease in length of stay following major abdominal surgery from baseline to 18 months, and a 4 percent increase in days to return of bowel function.

Table 40. Association of Emergency General Surgery-Appendectomy/Cholecystectomy Process Measure Compliance With Time

Process Measure	Overall Compliance Rate	OR (95% CI) for 1-Month Increments	OR (95% CI) for 18 Months
Evidence of Advanced Care Plan	0.406	1.008 (0.985, 1.031)	1.153 (0.764, 1.742)
Patient Education	0.616	1.051 (1.007, 1.096)*	2.435 (1.136, 5.218)*
Foley Catheter Duration	0.998	1.043 (0.980, 1.110)	2.140 (0.696, 6.574)
First Postop Intake of Liquids	0.960	0.991 (0.967, 1.014)	0.843 (0.551, 1.290)
First Postop Mobilization	0.883	0.990 (0.972, 1.007)	0.827 (0.600, 1.140)
Use of Multimodal Pain Management	0.630	1.039 (1.013, 1.066)*	2.006 (1.272, 3.164)*
Naïve Opioid Prescription at Discharge	0.782	0.988 (0.974, 1.002)	0.799 (0.621, 1.029)

Abbreviations: CI = confidence interval; OR = odds ratio

Table 41. Summary of Emergency General Surgery-Appendectomy/Cholecystectomy Outcome Measure Model Results

Outcome	OR (95% CI)	OR (95% CI) for 18 Months
VTE	0.980 (0.951, 1.011)	0.732 (0.263, 2.038)
UTI	1.037 (0.982, 1.095)	1.918 (0.716, 5.135)
SSI	1.009 (0.991, 1.027)	1.169 (0.852, 1.604)
VUS	1.007 (0.991, 1.024)	1.142 (0.854, 1.527)
LOS >75th Percentile	0.997 (0.986, 1.008)	0.941 (0.769, 1.151)
LOS †	-0.0013 (0.4784)	n/a
Transfusion	0.986 (0.945, 1.028)	0.770 (0.359, 1.653)
Ileus	1.017 (0.987, 1.049)	1.366 (0.793, 2.351)
Return of Bowel Function †	0.0021 (0.4126)	n/a

Abbreviations: LOS = length of stay; n/a= not applicable; SSI = surgical site infection; UTI = urinary tract infection; VTE = venous thromboembolism; VUS = composite measure of VTE, SSI, UTI

**Indicates significant value*

†Indicates continuous outcome variable, result is negative binomial model beta value parameter with (p-value) of significance rather than odds ratio

Table 42. Estimated Risk Reductions and Relative Risk Change for Emergency General Surgery-Appendectomy/Cholecystectomy Binary Outcome Measures Over Time

Outcome	Odds Ratio by Month (95% CI)	Odds Ratio (18-Month Cumulative)	Risk at Baseline (%)	Risk at Month 18 (%)	Absolute Change in Risk (%)	Relative Change in Risk (%)
VTE	0.980 (0.951, 1.011)	0.732 (0.263, 2.038)	0.33	0.24	-0.09	-26.69%
UTI	1.037 (0.982, 1.095)	1.918 (0.716, 5.135)	0.29	0.55	0.26	91.35%
SSI	1.009 (0.991, 1.027)	1.169 (0.852, 1.604)	2.96	3.45	0.48	16.35%
VUS	1.007 (0.991, 1.024)	1.142 (0.854, 1.527)	3.30	3.75	0.45	13.63%
Prolonged LOS*	0.997 (0.986, 1.008)	0.941 (0.769, 1.151)	24.85	23.73	-1.12	-4.51%
Transfusion	0.986 (0.945, 1.028)	0.770 (0.359, 1.653)	0.69	0.53	-0.16	-22.85%
Ileus	1.017 (0.987, 1.049)	1.366 (0.793, 2.351)	3.37	4.54	1.18	34.87%

Abbreviations: LOS = length of stay; SSI = surgical site infection; UTI = urinary tract infection; VTE = venous thromboembolism; VUS = composite measure of VTE, SSI, UTI

**Prolonged LOS= length of stay >75th percentile for all cases included in model, for this service line*

Table 43. Estimated Parameters and Change in Duration for Emergency General Surgery-Appendectomy/Cholecystectomy Continuous Outcome Measures

Outcome	Parameter (by Month)	Parameter (18-Month Cumulative)	Duration at Baseline (Days)	Duration Month 18 (Days)	Change in Duration (Days)	Change in Duration (%)
LOS	-.0013 (0.4784)	-0.0235 (0.4784)	1.4002	1.37	-0.03	-2%
ROBF	0.0021 (0.4126)	0.0378 (0.4126)	1.1107	1.15	0.04	4%

Abbreviations: LOS = length of stay, ROBF = return of bowel function

Results for the emergency general surgery-major abdominal procedures service line start with Table 44, which summarizes monthly registry data entry, while Table 45a–e and Figures 53–61 illustrate unadjusted binary and continuous outcomes by month. Figure 62 reports process measure compliance over time.

EGS-Major Abdominal Procedures

Unadjusted Data Trends

Table 44. Emergency General Surgery–Major Abdominal Procedures Registry Data Entry Summary, by Calendar Month

Month	# Hosp	# Cases
1	59	422
2	58	420
3	60	368
4	58	398
5	61	426
6	60	396
7	59	425
8	59	430
9	60	435
10	60	452
11	58	444
12	56	405
13	59	384
14	58	408
15	58	397
16	58	411
17	58	391
18	57	409
Total	*n/a*	*6999*

Abbreviations: n/a= not applicable

Table 45a. Emergency General Surgery-Major Abdominal Procedures Unadjusted Rates of Binary Outcomes– V**enous** T**hromboembolism**

Month	(n)	Cases	Rate (%)
1	21	422	4.98
2	20	420	4.76
3	16	368	4.35
4	15	398	3.77
5	20	426	4.69
6	14	396	3.54
7	14	425	3.29
8	10	430	2.33
9	16	435	3.68
10	13	452	2.88
11	14	444	3.15
12	12	405	2.96
13	5	384	1.30
14	11	408	2.70
15	16	397	4.03
16	13	411	3.16
17	17	391	4.35
18	17	409	4.16
Total	264	7421	*n/a*

Abbreviations: n/a= not applicable

Table 45b. Emergency General Surgery-Major Abdominal Procedures Unadjusted Rates of Binary Outcomes–Urinary Tract Infection

Month	(n)	Cases	Rate (%)
1	7	422	1.66
2	10	420	2.38
3	8	368	2.17
4	7	398	1.76
5	8	426	1.88
6	8	396	2.02
7	8	425	1.88
8	8	430	1.86
9	5	435	1.15
10	11	452	2.43
11	6	444	1.35
12	6	405	1.48
13	3	384	0.78
14	5	408	1.23
15	5	397	1.26
16	5	411	1.22
17	9	391	2.30
18	12	409	2.93
Total	131	7421	*n/a*

Abbreviations: n/a= not applicable;

Table 45c. Emergency General Surgery-Major Abdominal Procedures Unadjusted Rates of Binary Outcomes–Surgical Site Infection

Month	(n)	Cases	Rate (%)
1	63	422	14.93
2	74	420	17.62
3	58	368	15.76
4	58	398	14.57
5	67	426	15.73
6	51	396	12.88
7	63	425	14.82
8	59	430	13.72
9	70	435	16.09
10	63	452	13.94
11	64	444	14.41
12	49	405	12.10
13	62	384	16.15
14	60	408	14.71
15	53	397	13.35
16	56	411	13.63
17	56	391	14.32
18	58	409	14.18
Total	1084	7421	*n/a*

Abbreviations: n/a= not applicable

Table 45d. Emergency General Surgery-Major Abdominal Procedures Unadjusted Rates of Binary Outcomes–Transfusion

Month	(n)	Cases	Rate (%)
1	86	422	20.38
2	87	420	20.71
3	71	368	19.29
4	68	398	17.09
5	76	426	17.84
6	66	396	16.67
7	81	425	19.06
8	84	430	19.53
9	76	435	17.47
10	63	452	13.94
11	70	444	15.77
12	76	405	18.77
13	62	384	16.15
14	71	408	17.40
15	63	397	15.87
16	76	411	18.49
17	72	391	18.41
18	74	409	18.09
Total	1322	7421	*n/a*

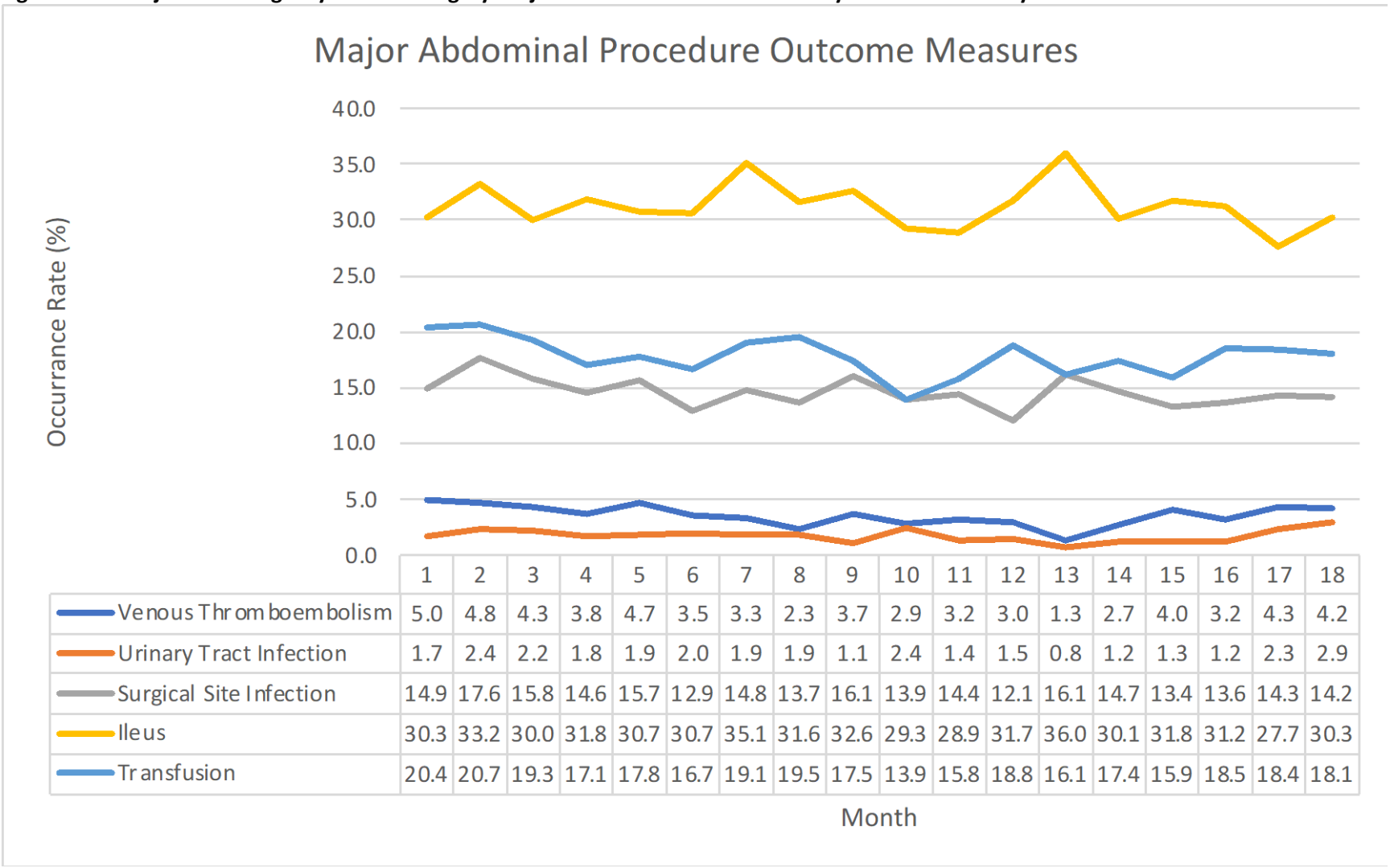
Abbreviations: n/a= not applicable

Table 45e. Emergency General Surgery-Major Abdominal Procedures Unadjusted Rates of Binary Outcomes–Ileus

Month	(n)	Cases	Rate (%)
1	110	363	30.30
2	123	370	33.24
3	92	307	29.97
4	104	327	31.80
5	113	368	30.71
6	104	339	30.68
7	130	370	35.14
8	114	361	31.58
9	121	371	32.61
10	111	379	29.29
11	109	377	28.91
12	106	334	31.74
13	121	336	36.01
14	103	342	30.12
15	107	337	31.75
16	109	349	31.23
17	88	318	27.67
18	96	317	30.28
Total	1961	6265	*n/a*

Abbreviations: n/a= not applicable

Figure 53. Unadjusted Emergency General Surgery-Major Abdominal Procedure Binary Outcome Rates by Month



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Venous Thromboembolism	5.0	4.8	4.3	3.8	4.7	3.5	3.3	2.3	3.7	2.9	3.2	3.0	1.3	2.7	4.0	3.2	4.3	4.2
Urinary Tract Infection	1.7	2.4	2.2	1.8	1.9	2.0	1.9	1.9	1.1	2.4	1.4	1.5	0.8	1.2	1.3	1.2	2.3	2.9
Surgical Site Infection	14.9	17.6	15.8	14.6	15.7	12.9	14.8	13.7	16.1	13.9	14.4	12.1	16.1	14.7	13.4	13.6	14.3	14.2
Ileus	30.3	33.2	30.0	31.8	30.7	30.7	35.1	31.6	32.6	29.3	28.9	31.7	36.0	30.1	31.8	31.2	27.7	30.3
Transfusion	20.4	20.7	19.3	17.1	17.8	16.7	19.1	19.5	17.5	13.9	15.8	18.8	16.1	17.4	15.9	18.5	18.4	18.1

Figure 54. Emergency General Surgery-Major Abdominal Procedures Venous Thromboembolism Event Rates by Month

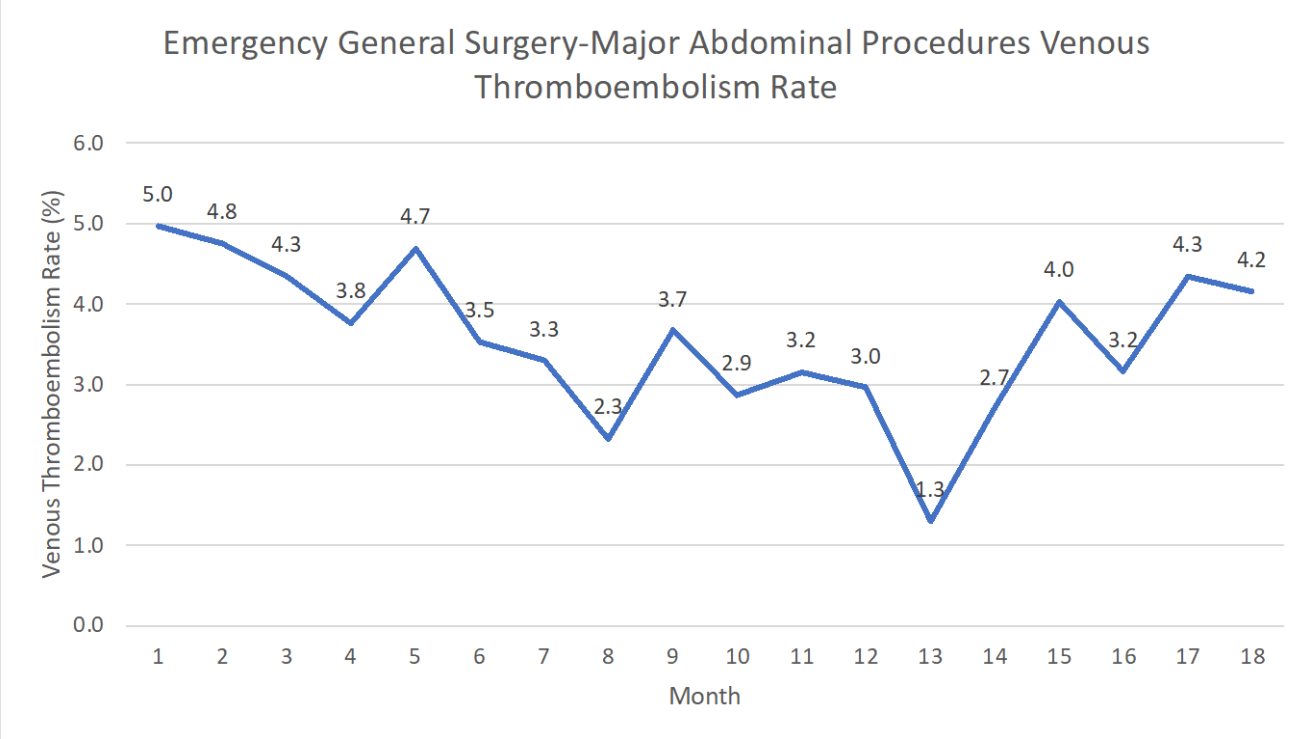


Figure 55. Emergency General Surgery-Major Abdominal Procedures Urinary Tract Infection Event Rates by Month

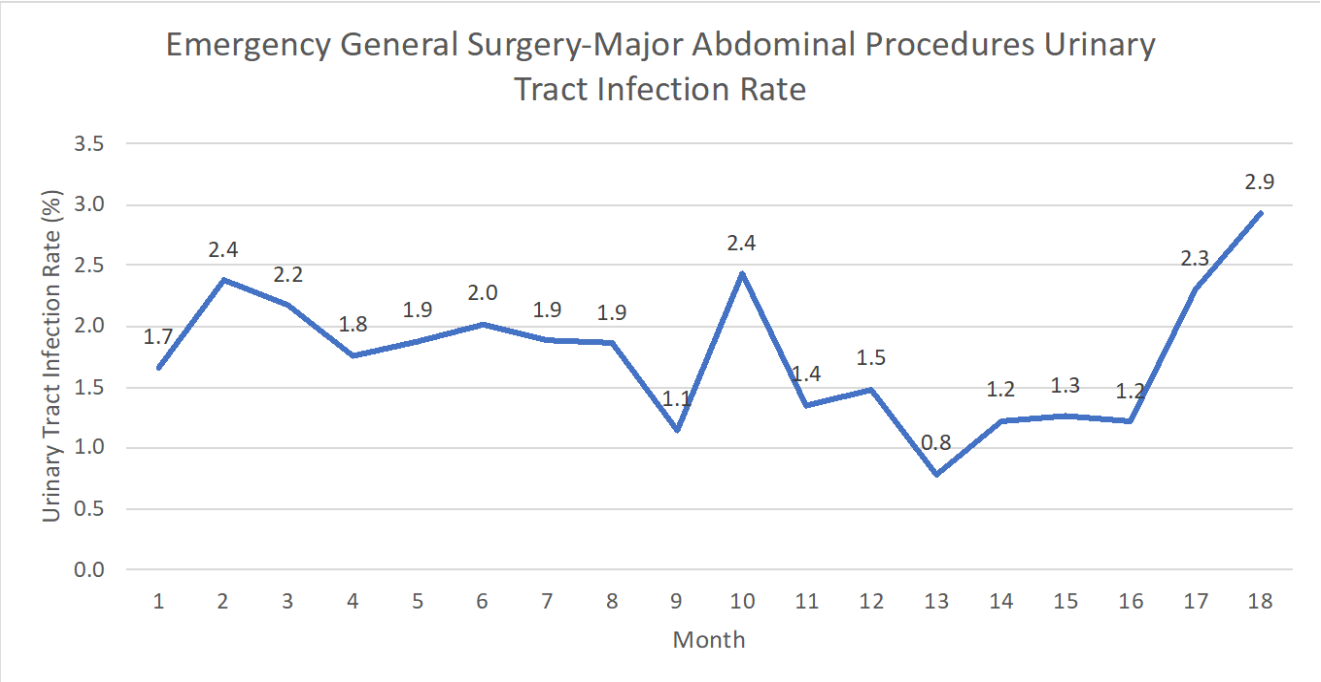


Figure 56. Emergency General Surgery-Major Abdominal Procedures Surgical Site Infection Event Rates by Month

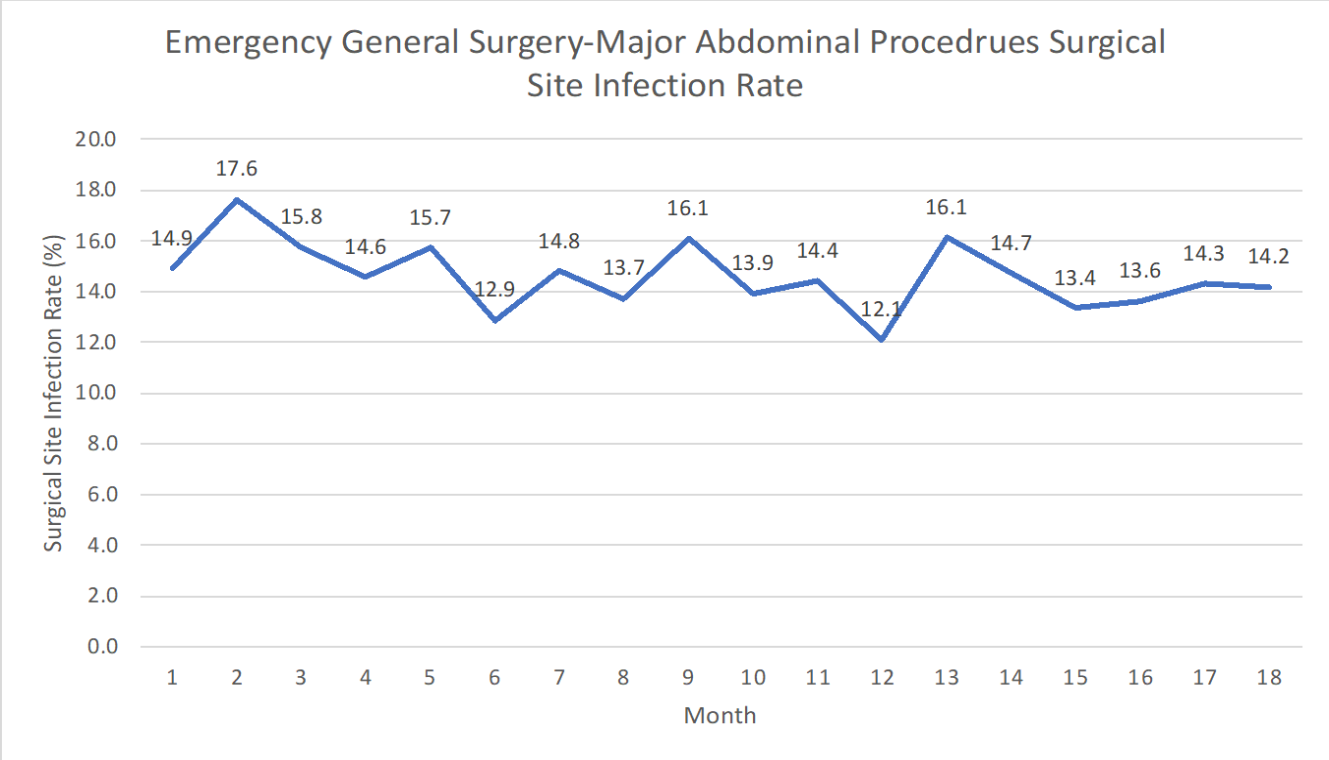


Figure 57. Emergency General Surgery-Major Abdominal Procedures Transfusion Event Rates by Month

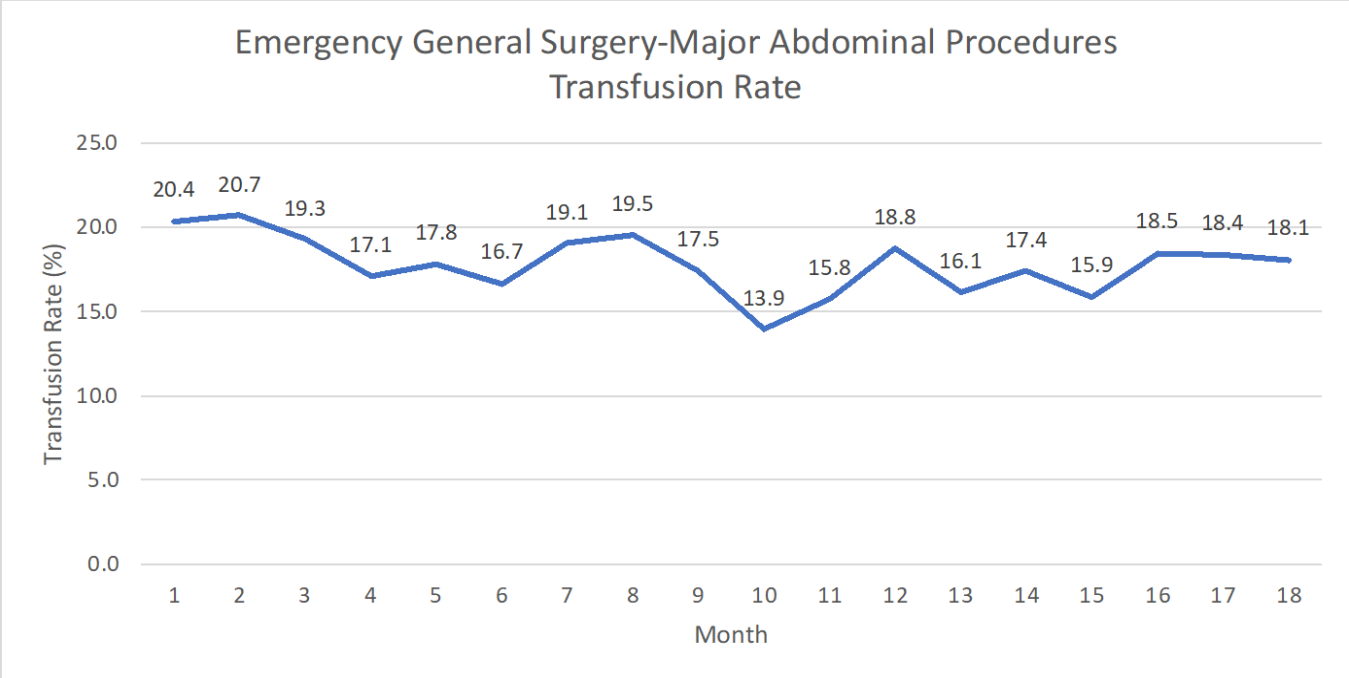


Figure 58. Emergency General Surgery-Major Abdominal Procedures Ileus Event Rates by Month

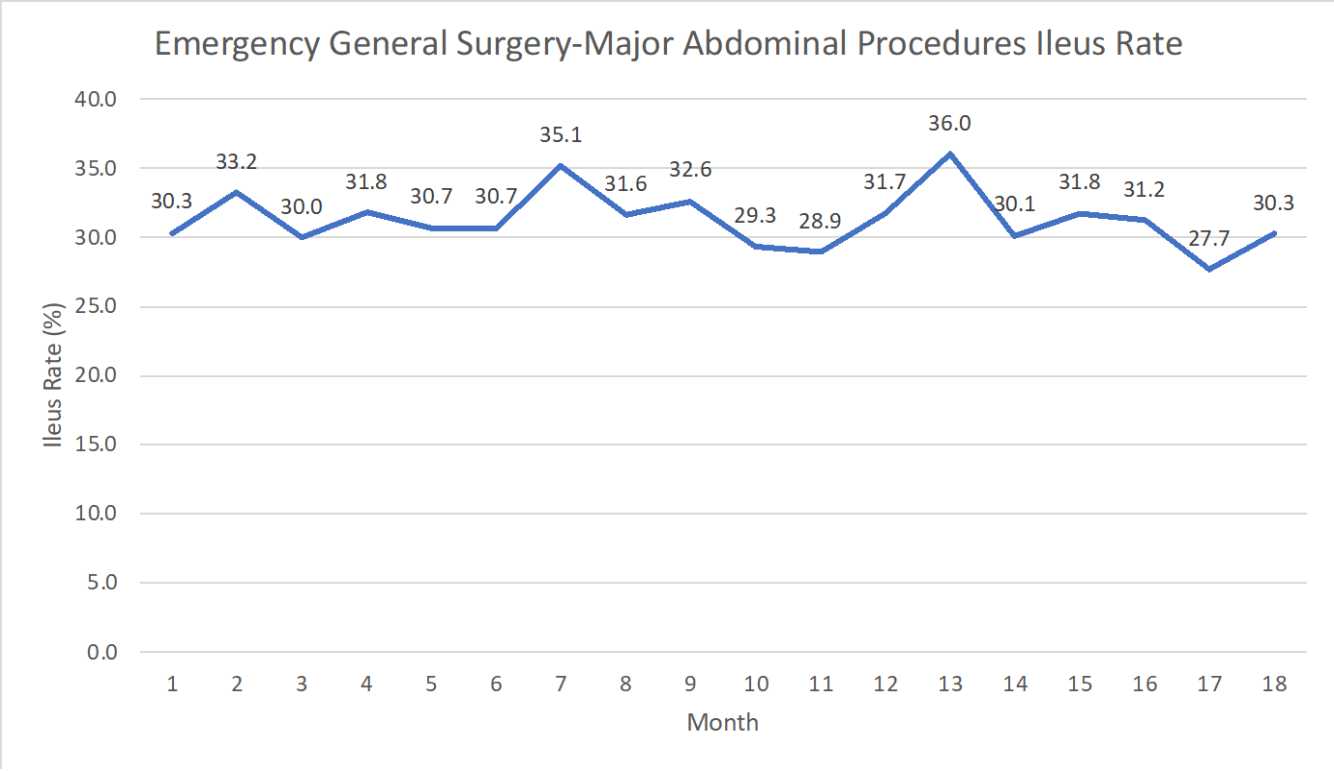


Figure 59. Emergency General Surgery-Major Abdominal Procedures Prolonged Length of Stay (>75th Percentile) Binary Outcome Measures by Month

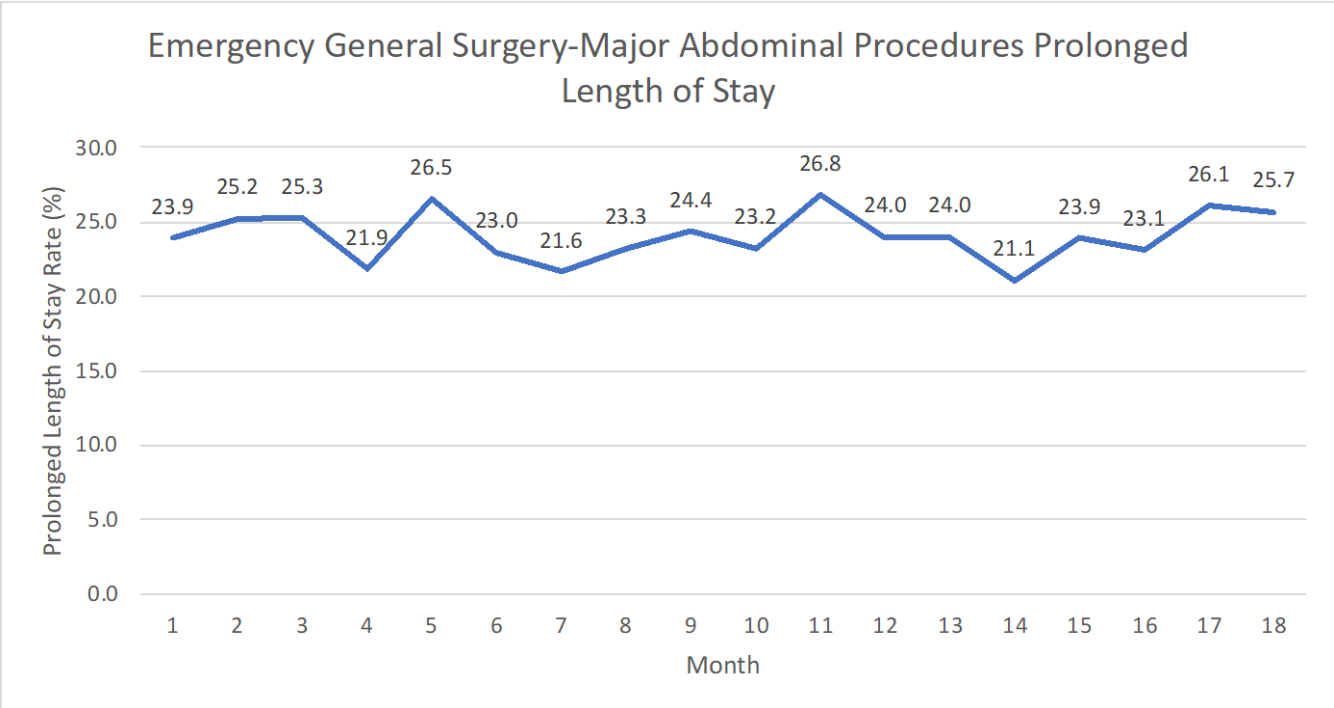


Figure 60. Emergency General Surgery-Major Abdominal Procedures Mean Days of Return of Bowel Function

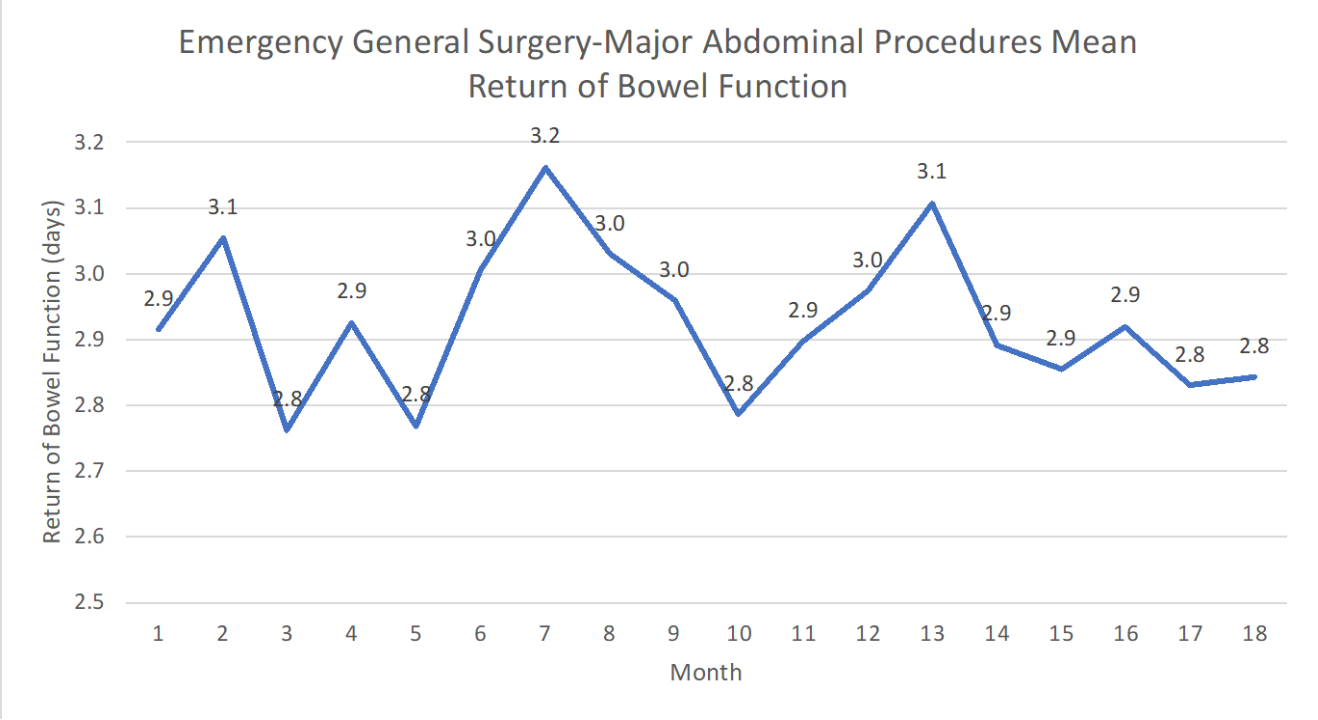


Figure 61. Emergency General Surgery-Major Abdominal Procedures Mean Length of Stay by Month

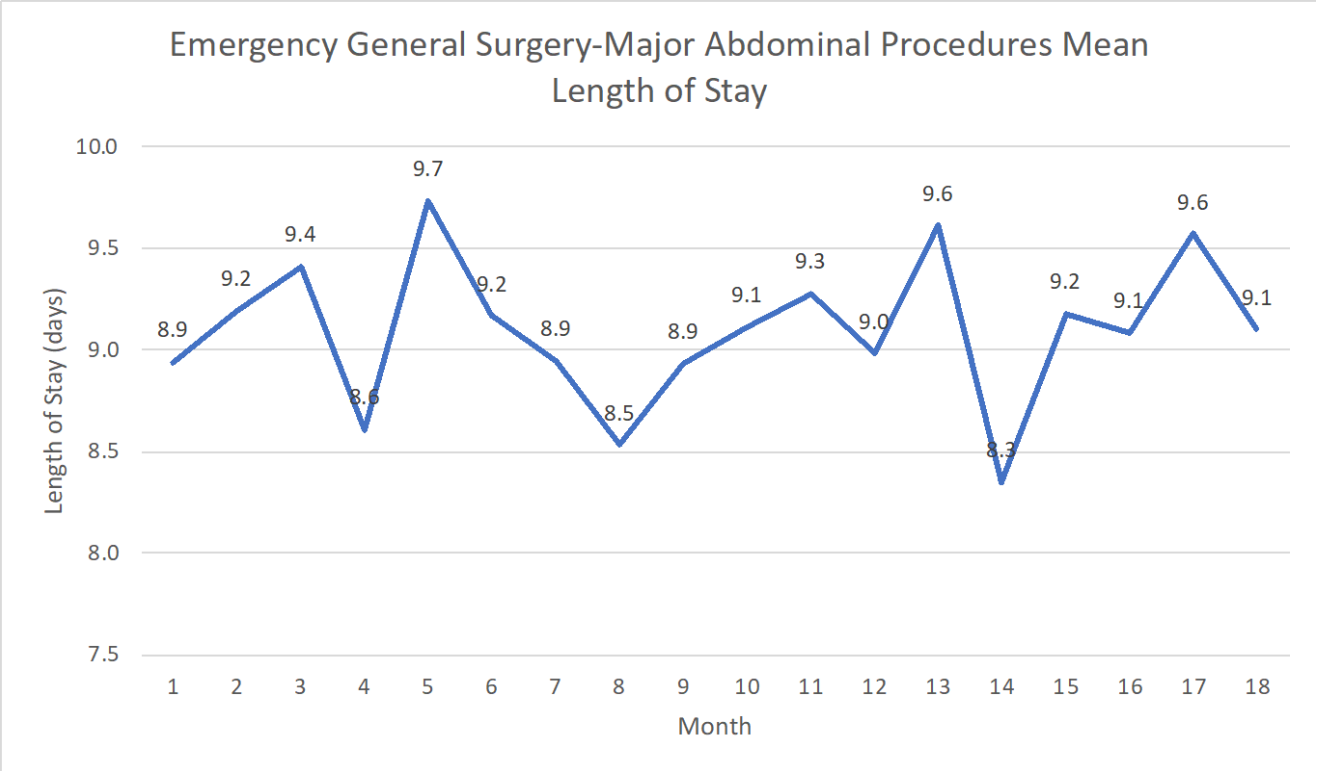
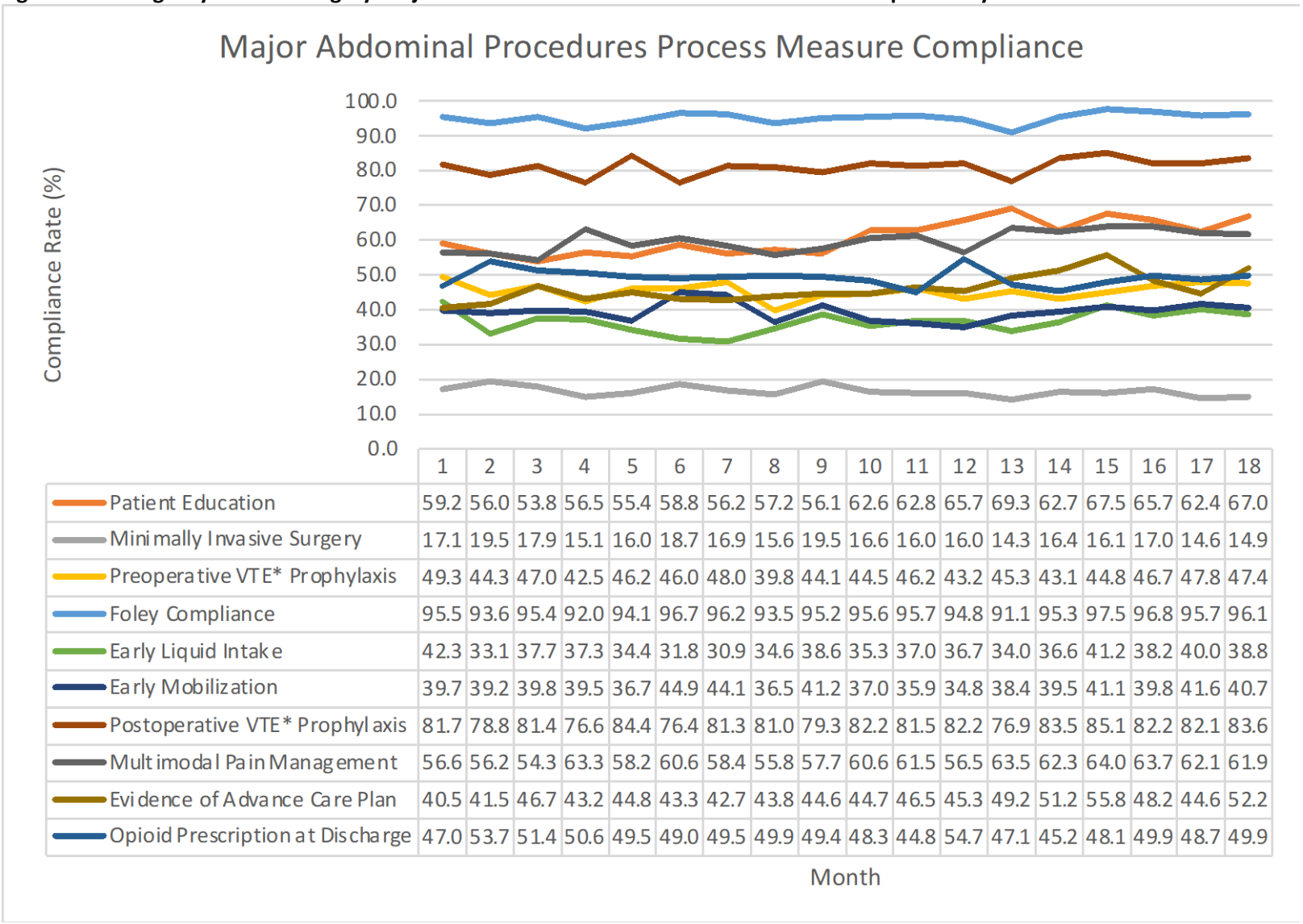


Figure 62. Emergency General Surgery-Major Abdominal Procedures Process Measure Compliance by Month



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Patient Education	59.2	56.0	53.8	56.5	55.4	58.8	56.2	57.2	56.1	62.6	62.8	65.7	69.3	62.7	67.5	65.7	62.4	67.0
Minimally Invasive Surgery	17.1	19.5	17.9	15.1	16.0	18.7	16.9	15.6	19.5	16.6	16.0	16.0	14.3	16.4	16.1	17.0	14.6	14.9
Preoperative VTE* Prophylaxis	49.3	44.3	47.0	42.5	46.2	46.0	48.0	39.8	44.1	44.5	46.2	43.2	45.3	43.1	44.8	46.7	47.8	47.4
Foley Compliance	95.5	93.6	95.4	92.0	94.1	96.7	96.2	93.5	95.2	95.6	95.7	94.8	91.1	95.3	97.5	96.8	95.7	96.1
Early Liquid Intake	42.3	33.1	37.7	37.3	34.4	31.8	30.9	34.6	38.6	35.3	37.0	36.7	34.0	36.6	41.2	38.2	40.0	38.8
Early Mobilization	39.7	39.2	39.8	39.5	36.7	44.9	44.1	36.5	41.2	37.0	35.9	34.8	38.4	39.5	41.1	39.8	41.6	40.7
Postoperative VTE* Prophylaxis	81.7	78.8	81.4	76.6	84.4	76.4	81.3	81.0	79.3	82.2	81.5	82.2	76.9	83.5	85.1	82.2	82.1	83.6
Multimodal Pain Management	56.6	56.2	54.3	63.3	58.2	60.6	58.4	55.8	57.7	60.6	61.5	56.5	63.5	62.3	64.0	63.7	62.1	61.9
Evidence of Advance Care Plan	40.5	41.5	46.7	43.2	44.8	43.3	42.7	43.8	44.6	44.7	46.5	45.3	49.2	51.2	55.8	48.2	44.6	52.2
Opioid Prescription at Discharge	47.0	53.7	51.4	50.6	49.5	49.0	49.5	49.9	49.4	48.3	44.8	54.7	47.1	45.2	48.1	49.9	48.7	49.9

**VTE=Venous Thromboembolism*

Risk-Adjusted Analysis for EGS-Major Abdominal Procedures Surgery

The odds ratio of process measure compliance over 1-month increments and odds ratio for the 18-month total cohort time period are reported in Table 46. The odds of evidence of advanced care planning, patient education, indwelling urinary catheter compliance, and first postoperative dose of VTE chemoprophylaxis compliance all significantly increased over time.

Table 47 summarizes outcome measure modeling. No significant difference was observed in odds of occurrence over time for VTE, UTI, SSI, LOS, transfusion, or ileus.

Estimated risk reductions and relative reductions in risk for binary outcome measures are reported in Table 48. Baseline rates were estimated from a single month of risk-adjusted ISCR major abdominal procedure data from the first month of the cohort. Relative change in risk is an estimation of the magnitude of effect due to the AHRQ ISCR program. Again, none of the models were shown to have a significant change over time. Table 49 reports a 1 percent decrease in length of stay following major abdominal surgery from baseline to 18 months, and a 2 percent decrease in days to return of bowel function.

Table 46. Association of Emergency General Surgery Major Abdominal Procedure Process Measure Compliance With Time

Process Measure	Overall Compliance Rate	OR (95% CI) for 1 Month Increments	OR (95% CI) for 18 Months
Evidence of Advanced Care Plan	0.460	1.022 (1.004, 1.041)*	1.490 (1.069, 2.076)*
Patient Education	0.608	1.031 (1.002, 1.061)*	1.742 (1.042, 2.912)*
Preop VTE PPX	0.387	1.001 (0.984, 1.017)	1.013 (0.754, 1.360)
Foley Catheter Removal	0.934	1.021 (1.002, 1.041)*	1.459 (1.038, 2.050)*
First Postop Intake of Liquids	0.366	1.007 (0.994, 1.021)	1.137 (0.891, 1.451)
First Postop Mobilization	0.394	1.000 (0.986, 1.014)	0.995 (0.772, 1.282)
First Postop VTE PPX dose after Surgery	0.811	1.013 (1.001, 1.025)*	1.260 (1.025, 1.548)*
Use of Multimodal Pain Management	0.598	1.016 (0.999, 1.033)	1.336 (0.987, 1.807)
Naïve Opioid Prescription at Discharge	0.492	0.995 (0.984, 1.008)	0.922 (0.742, 1.146)

Abbreviations: CI = confidence interval; OR = odds ratio; PPX = prophylaxis; VTE = venous thromboembolism
**Indicates significant value*

Table 47. Summary of Emergency General Surgery Major Abdominal Procedure Outcome Measure Model Results

Outcome	OR (95% CI)	OR (95% CI) for 18 Months
VTE	0.980 (0.951, 1.011)	0.698 (0.403, 1.210)
UTI	0.990 (0.957, 1.024)	0.838 (0.458, 1.534)
SSI	0.989 (0.976, 1.003)	0.825 (0.646, 1.053)
VUS	0.987 (0.973, 1.001)	0.786 (0.610, 1.013)
LOS >75th Percentile	1.002 (0.992, 1.011)	1.028 (0.862, 1.227)
LOS *	-0.0007 (0.6749)	n/a
Transfusion	0.993 (0.976, 1.009)	0.876 (0.651, 1.180)
Ileus	0.997 (0.986, 1.008)	0.945 (0.781, 1.145)
ILOS	0.996 (0.987, 1.005)	0.934 (0.794, 1.098)
Return of Bowel Function*	-0.0009 (0.6254)	n/a

Abbreviations: CI = confidence interval; LOS = length of stay; n/a= not applicable; OR = odds ratio; SSI = surgical site infection; UTI = urinary tract infection; VTE = venous thromboembolism; VUS = composite measure of VTE, SSI, UTI

**Indicates continuous outcome variable, result is negative binomial model beta value parameter with (p-value) of significance rather than odds ratio*

Table 48. Estimated Risk Reductions and Relative Risk Change for Emergency General Surgery Major Abdominal Procedure Binary Outcome Measures Over Time

Outcome	Odds Ratio by Month (95% CI)	Odds Ratio (18-month Cumulative)	Risk at Baseline (%)	Risk at Month 18 (%)	Absolute Change in Risk (%)	Relative Change in Risk (%)
VTE	0.980 (0.951, 1.011)	0.698 (0.403, 1.210)	3.95	2.79	-1.16	-29.39%
UTI	0.990 (0.957, 1.024)	0.838 (0.458, 1.534)	1.88	1.58	-0.30	-15.95%
SSI	0.989 (0.976, 1.003)	0.825 (0.646, 1.053)	15.42	13.07	-2.35	-15.23%
VUS	0.987 (0.973, 1.001)	0.786 (0.610, 1.013)	19.28	15.80	-3.48	-18.05%
Prolonged LOS*	1.002 (0.992, 1.011)	1.028 (0.862, 1.227)	20.88	21.34	0.46	2.23%
Transfusion	0.993 (0.976, 1.009)	0.876 (0.651, 1.180)	17.75	15.91	-1.85	-10.39%
Ileus	0.997 (0.986, 1.008)	0.945 (0.781, 1.145)	30.42	29.24	-1.18	-3.88%
ILOS	0.996 (0.987, 1.005)	0.934 (0.794, 1.098)	38.39	36.78	-1.61	-4.19%

Abbreviations: LOS = length of stay; SSI = surgical site infection; UTI = urinary tract infection; VTE = venous thromboembolism; VUS = composite measure of VTE, SSI, UTI

**Prolonged LOS = length of stay >75th percentile for all cases included in model, for this service line*

Table 49. Estimated Parameters and Change in Duration Emergency General Surgery Major Abdominal Procedure Continuous Outcome Measures

Outcome	Parameter(by Month)	Parameter(18-Month Cumulative)	Duration at Baseline (Days)	Duration Month 18 (Days)	Change in Duration (Days)	Change in Duration(%)
LOS	-.0007 (0.6749)	-0.0121 (0.6749)	8.6678	8.56	-0.10	-1%
ROBF	-.0009 (0.6254)	-0.0153 (0.6254)	2.8232	2.78	-0.04	-2%

Abbreviations: LOS = length of stay; ROBF = return of bowel function

Secondary Analyses

Due to the sheer quantity of content analyzed, the following sections include limited tables and graphs, and focus on the significant and specific takeaways from each analysis.

Hospital-Level Differences in Improvement

Out of the six process measure models (one for each service line), five (all but the model for hip/knee replacement surgery hospitals) had at least one hospital-level factor that significantly predicted rate of improvement. Hospital setting (rural, metropolitan, micropolitan) was a significant effect in the colorectal process measure model (N=88 hospitals), with an F test p value of 0.0021; specifically, rural hospitals improved at a linear rate of 0.0089 per month faster than the referent group of metropolitan hospitals, and micropolitan hospitals improved at a linear rate of 0.0061 per month faster than the metropolitan hospitals. Residency status was significant in both EGS process measure models (EGS-appendectomy/cholecystectomy: N=39 hospitals, p value 0.0007; EGS-major abdominal procedures: N=40 hospitals, p value <0.0373). In both instances, having a residency program increased the linear rate of total process measure improvement per month compared to those without residency programs (EGS-appendectomy/cholecystectomy: 0.0107; EGS-major abdominal procedures: 0.0041). Bed size was significant in the colorectal surgery (p value <0.0001), hip fracture surgery (N=31 hospitals, p-value 0.0448), gynecologic surgery (N=37 hospitals, p value 0.0270), EGS-appendectomy/cholecystectomy (p value <0.0001), and EGS-major abdominal surgery (p value 0.0002) process measure models, though there was either no or a different, single, bed size category (out of 8) that appeared to drive the effect in each of these models. The EHR maturity score was significant in the EGS-major abdominal procedures (p value 0.0285) process measure model, where each additional point in score led to a decrease in process measure improvement of 0.0060 per month. Overall observer-reported communication ability (ORCA) score was not significant in any of the process measure improvement models.

Out of the six outcome measure models (one for each service line), five (all except gynecologic surgery) had at least one hospital-level factor that significantly predicted log odds of improvement. Hospital setting was significant in hip/knee replacement surgery (p value 0.0042), with rural hospitals having log odds ratio for time (months) that is 0.0082 higher than the log odds ratio for time for metropolitan hospitals, in turn indicating higher odds for time with rural hospitals in comparison to metropolitan hospitals. Bed size was significant in colorectal surgery (p value <0.0001), hip fracture surgery (p value <0.0001), hip/knee replacement surgery (p value <0.0001), and EGS-major abdominal procedures (p value 0.0002). Again, there was no or differing, bed size

categories that appeared to drive the effect in each of these models. Overall ORCA score only had a significant estimate in the EGS-appendectomy/cholecystectomy outcome model (p value 0.0003), but the effect was so small as to be reported as a 0.0000 increase in log odds ratio for each unit increase in overall ORCA score. Residency status was not significant in any of the outcome measure reduction models.

Patient-Level Subgroups

In each colorectal process measure, age group was significantly associated with compliance, often with p-values <0.0001 for each group in comparison to the referent <65 age group; typically, the higher the age group, the lower the compliance rate. The same pattern was found in most process measures of most of the service lines; one notable exception is that advance care planning increases with age bracket in all three service lines it is collected for (hip fracture surgery and both EGS groups). Race was significant in each process measure of total joint replacement but was insignificant in indwelling urinary catheter adherence in each other service line, as well as insignificant for first postoperative mobilization in hip fracture surgery, first postoperative VTE prophylaxis dose for gynecologic surgery, and patient education for EGS-major abdominal procedures; there is no clear pattern for which racial groups have higher or lower compliance. Gender is the least frequently significant classification for process measure compliance and seems to have no directional pattern. In colorectal surgeries and total joint replacements, there are significant differences only for first postoperative mobilization and indwelling urinary catheter compliance; hip fracture surgery additionally has gender differences between rates for evidence of advance care planning and timeliness to the emergency room; appendectomies/cholecystectomies have differences in compliance rates for first postoperative liquid intake and first postoperative mobilization; major abdominal procedures have differences in compliance rates for first postoperative mobilization and patient education; process measure rates do not differ between genders for gynecologic surgery process measures. Hispanic ethnicity has significant differences in many process measures for many service lines, but no noticeable patterns.

Just as with process measures, age group has the largest quantity of significant comparisons, with ileus, UTI, and extended LOS having the most noticeable progressive increase in odds from age group to age group. While race, age group, and especially Hispanic ethnicity all have noticeably fewer outcomes than association with process measures, gender has significant association with a higher percentage of outcomes compared with process measures. Although race was significant in fewer instances, there is a clearer pattern that the Black or African American group has higher odds of negative outcomes compared to the White group.

Cross-Service Line Analysis

Out of all seven process measures that are mandatory in more than one service line, use of multimodal pain management, indwelling urinary catheter compliance, first postoperative intake of liquids, first postoperative intake of solids, and evidence of advance care plan all show significant improvement over time (Table 50).

Out of all 8 outcomes that are mandatory in more than one service line, the only ones that show significant improvement are binary length of stay (LOS>75th percentile), ileus, and the composite of those two measures (Table 51).

Table 50. Cross-Service Line Analysis: Process Measures

Process Measure	OR (CI) or Parameter (P-value) - Time	Number of Cases	Number of Events	Event Rate	Number of Hospitals
Use of Multimodal Pain Management†	1.020 (1.005, 1.035)	76816	56418	0.734	233
First Postop Mobilization	1.000 (0.992, 1.008)	62622	44854	0.716	232
Indwelling Urinary Catheter Compliance*†	1.042 (1.023, 1.061)	53529	51475	0.962	212
First Postop Intake of Liquids†	1.012 (1.004, 1.020)	47886	36254	0.757	212
First Postop VTE PPX dose after Surgery	1.005 (0.993, 1.018)	11415	9684	0.848	89
First Postop Intake of Solids†	1.016 (1.007, 1.025)	38132	25644	0.673	191
Evidence of Advance Care Plan†	1.026 (1.004, 1.048)	8241	3929	0.477	109

Abbreviations: CI = confidence interval; OR = odd ratio; PPX = Prophylaxis ; VTE = venous thromboembolism
**Only includes colorectal surgery, gynecologic surgery, and EGS service lines due to the differing definition used for the orthopedic service lines.*
†Indicates significant model (CI does not contain 1.000)

Table 51. Cross-Service Line Analysis: Outcomes

Outcome	Odds Ratio
VTE	0.992 (0.981, 1.003)
UTI	1.001 (0.989, 1.013)
SSI	0.999 (0.993, 1.005)
VUS	0.998 (0.993, 1.004)
LOS75	0.990 (0.985, 0.995)*
Transfusion	1.007 (0.993, 1.022)
Ileus	0.991 (0.983, 0.999)*
ILOS	0.992 (0.987, 0.998)*

Abbreviations: ILOS = ileus and/or length of stay >75th percentile; LOS75 = length of stay >75th percentile; SSI = surgical site infection; UTI = urinary tract infection; VTE = venous thromboembolism; VUS = composite measure of VTE, SSI, UTI
**Indicates significant model (CI does not contain 1.000)*

Impact of ISCR Process Measures on Surgical Outcomes

See Table 52 below for which process measures are of specific interest in relation to which outcomes in which service lines; asterisks indicate which of these process measures are significant in fully adjusted models.

Of particular note is that indwelling urinary catheter compliance was only significantly associated with outcomes of gynecologic surgeries; in the case where there was a documented reason for prolonged catheterization, the odds of UTI were significantly higher (OR: 3.312; 95% CI 1.033,10.616). Furthermore, patient education never had a significant effect, and for ileus, early liquid and solid intake always had a significant impact. In both EGS-appendectomy/cholecystectomy (OR 2.598; 95% CI 1.302, 5.186) and EGS-major abdominal procedures (OR 1.835; 95% CI 1.347, 2.500), an open surgical approach significantly increased the odds of prolonged length of stay compared to laparoscopic surgery. It is also notable that first postoperative mobilization was significant in every service line's 30-day VTE model.

Table 52. ISCR Outcomes and Relevant Process Measures

Service Line	Outcome	Relevant Process Measure(s) Investigated
Colorectal Surgery	SSI	Preop Mechanical Bowel Prep*, Preop Oral Antibiotics*
	UTI	Indwelling Urinary Catheter Compliance
	VTE	First Postop Mobilization*
	Ileus	First Postop Intake of Solids*, First Postop Intake of Liquids*
	LOS	Multimodal Pain Management
Orthopedic	SSI	[No Mandatory Process Measures Associated With This Outcome]
	UTI	Indwelling Urinary Catheter Compliance
	VTE	First Postop Mobilization*(Hip/Knee replacement), Medical DVT Prophylaxis Continued 28 Days Postop*(Hip/Knee replacement), Weight Bearing as Tolerated on POD#1
	LOS	Multimodal Pain Management*(Hip Fracture and Hip/Knee replacement)
	Transfusion	Tranexamic Acid Use
Gynecologic Surgery	SSI	Local Wound Analgesia
	UTI	Indwelling Urinary Catheter Compliance*
	VTE	First Postop Mobilization*, First Postop VTE Chemoprophylaxis Dose
	LOS	Multimodal Pain Management*
EGS	SSI	Patient Education, Surgical Approach*
	UTI	Patient Education, Indwelling Urinary Catheter Compliance
	VTE	Patient Education, First Postop VTE Chemoprophylaxis*, First Postop Mobilization*
	LOS	Surgical Approach*, Multimodal Pain Management
	Transfusion	[No Mandatory Process Measures Associated With This Outcome]
	Ileus	Patient Education, First Postop Intake of Liquids*

Abbreviations: LOS = length of stay; SSI = surgical site infection; UTI = urinary tract infection; VTE = venous thromboembolism
**Indicates significant effect*

Impact of ISCR Program on 30-Day Readmission and 30-Day Mortality

The pre/post variable did not have a significant odds ratio in the readmission or mortality models for any of the service lines.

Discussion

Overall, the colorectal ISCR cohorts showed improvement in pathway implementation over time. Mechanical bowel preparation, preoperative oral antibiotics, use of regional analgesia, multimodal pain management, and Foley catheter duration all had significantly increased adoption over time in the colorectal service line. Overall compliance to multimodal pain control, and to appropriate Foley catheter duration, was high (>75% by month 10). Oral antibiotics and early solid food intake showed increased compliance over time, but frequently showed monthly compliance rates less than 50 percent. Although preoperative mechanical bowel preparation and preoperative oral antibiotics are meant to work in conjunction with one another, compliance to both never reached 51 percent in any month. These may represent the time required to engage all stakeholders in the most current practice and standardization of clinical care. These findings may suggest that the implementation period required for adoption of more controversial elements may be longer than initially anticipated at the beginning of this project. The one process measure in which there was no demonstrated improvement over time was early mobility, which may represent difficulty in data documentation and collection for this registry variable. These mostly significant increases in process measure adherence largely suggest success of ISCR in Colorectal pathway adoption. We hypothesize that hospitals will continue to improve their pathway implementation with increased experience and team buy-in.

Of the colorectal outcomes measured, LOS and ROBF showed significant decreases in duration over time. No statistically significant decrease was observed in VTE, UTI, SSI, or the binary composite of these three outcomes, VUS (though, with the exception of SSI, they do suggest a nonsignificant decreasing trend). There may be several explanations for these findings. Unadjusted rates of UTI and VTE were low throughout the duration of the cohort (both approximately 2%). Additionally, compliance for indwelling urinary catheters included patients who had no indwelling urinary catheter placed, so, the UTI rate reported here was an overall UTI rate, not solely catheter-associated UTIs. The small number of UTI events seen in this population may represent unmeasured factors, such as improper insertion techniques and individual patient risk factors that may predispose a patient to UTI. Appropriate indwelling urinary catheter usage may have additional benefits to patient care outside of UTI prevention, such as decreasing risk of delirium, patient comfort, and increased ease of mobilization. VTE events, although low, may represent patients with a high baseline risk for VTE despite timely and appropriate dosing of prophylactic medications and adequate mobilization. SSI showed some evidence of an upward trend, though not statistically significant, over the life of the colorectal cohort. Possible explanations include the relatively slow adoption of consistent compliance to oral antibiotics and mechanical bowl prep. Unadjusted SSI rates in our ISCR program did not exceed 9.9 percent for the life of the cohort and averaged 9.0 percent over 18 months. Additionally, this program focused on two important process measures that contribute to SSI risk: oral antibiotics and mechanical bowel prep. However, compliance to other elements of a more comprehensive SSI reduction bundle (hair clipping, skin prep, wound protectors, glucose control, perioperative normothermia, antibiotic choice, dosing, etc.) are unknown.

Both LOS and ROBF following colorectal surgery demonstrated substantial decreases over time. These results may be feasibly associated with particular process measures. ROBF may be impacted by early intake of liquids, early mobilization, multimodal pain control, and regional analgesia. LOS is likely to be impacted in a similar way by these process measures. In addition to the parsimonious set of outcomes measured here, the increased adoption of multimodal pain control has potentially broad public health impacts on overall reduction of opioid use.

The orthopedic hip fracture surgery cohort trended upwards over time in compliance with some process measures, although no metrics reached statistical significance. The case numbers for this service line remained fairly low throughout the cohort, with the sum of the four cohorts never reaching 310 cases for any given month. It is possible that relatively low case numbers at any given hospital made consistent pathway implementation difficult. Process measure compliance may additionally reflect the particular challenges in a population that is often elderly and frail. Low compliance to process measures such as early mobilization and multimodal pain control may reflect these characteristics of the population.

Hip fracture outcomes saw no significant changes over time. Given the complicated nature of this population, there were likely unmeasured factors contributing to outcomes and length of stay, such as frailty and delirium.

Orthopedic hip/knee replacement surgery largely did not demonstrate significant changes in any process measures over time. Rates of transfusion, however, did demonstrate significant increases over time. It is difficult to interpret whether this finding represents increased perioperative blood loss or increased attention to perioperative optimization of patient risk factors (e.g., low hemoglobin). It is worthwhile to note that most process measures demonstrated high compliance over the life of the cohort despite no significant changes over time, with overall average rates of: multimodal pain management >85%, appropriate Foley catheter duration >90%, mobilization >85%, and weight-bearing activity >90%.

Apart from intra/postoperative transfusions, hip/knee replacement surgery binary outcome measures did not show significant change over time, although the continuous length of stay model did show a significant decrease in duration. Moreover, all outcome measures other than binary length of stay had unadjusted rates less than 4 percent for the lifetime of the cohort. Length of stay did demonstrate a relative decrease by 12 percent over the 18-month cohort. This may suggest that overall care standardization across total joint pathways may impact length of stay despite lack of evidence of increased compliance in any one element.

The gynecologic surgery service line saw significant improvement in the process measure, local wound analgesia, over time and a significant decline in patient-controlled analgesia over time. This seems like a natural tradeoff, given the focus on reducing opioid use; as patients receive more local wound care, there may be less need for patient-controlled intravenous opioid analgesics. The reduction in patient-controlled analgesia could also be indicative that many gynecologic procedures are being done as outpatient procedures. Once again, the only significant outcome reductions were for the length of stay models, and unadjusted rates for VTE, UTI, and SSI rarely exceeded 4 percent in any given month, leaving little room for improvement other than reduced stays. The decreasing length of stay, like the decreasing patient-controlled analgesia, could reflect an increasing trend towards outpatient procedures.

The emergency general surgery–appendectomy and cholecystectomy service line saw significant improvements in patient education and multimodal pain management over the 18-month cohort. There was a large focus on opioid use reduction in the EGS service lines, which would call for an increase in multimodal pain management as compensation and while appendectomies and cholecystectomies failed to have significant reductions in the rate of naïve opioid prescriptions at discharge, there was an insignificant decreasing trend suggestive that the two approaches to pain control may be close to compensating for each other as hoped. However, none of the outcomes for this service line had significant changes over time. For VTE, UTI, SSI, binary composite VUS, intra/postoperative transfusion, and ileus, this is unsurprising due to overall low occurrence rates (never above 6% in any given month for any of these outcomes). Similarly, because length of stay (mean length of stay never exceeding 1.6 overnights in any given month), and days until return of bowel function (mean days never exceeding 1.3 overnights) there was not much room for improvement for prolonged length of stay or ileus, respectively.

Hospital-Level Differences in Improvement

The emergency general surgery–major abdominal procedures service line had very high morbidity, but despite high event rates allowing much room for improvement, the outcomes did not improve significantly. Enhanced recovery is new to this area and given the complexity of the patients, the pandemic and the starting point, it is plausible that 18 months was not sufficient time to achieve improvement in outcomes. The cohort did show significant improvements over time in the evidence of advanced care planning, patient education, indwelling urinary catheter compliance, and timely first dose of postoperative VTE chemoprophylaxis. Since these major abdominal procedures are typically more complex, an increase in advanced care planning and patient education both represent an emphasis on preparation—first for what to expect, and then how to proceed if circumstances become dire. As with the EGS appendectomy and cholecystectomy cases, again, none of the outcomes experienced significant reductions over 18 months, although all except for extended length of stay had non-significant reductions. Although complication rates for the major abdominal procedures are higher than for the appendectomies and cholecystectomies, uncaptured pathway elements and the fact that the COVID-19 pandemic was ongoing during the entirety of the cohort, may have presented complicating factors towards event reduction.

For the hospital-level improvement models, no clear patterns emerged. Instances of rural hospitals having greater improvement compared with metropolitan hospitals, or hospitals with higher EHR maturity scores having less improvement compared with lower scoring hospitals, may simply be an artifact of starting point: if rural hospitals start from a lower overall process measure compliance rate there is more room for improvement, and if hospitals with higher EHR maturity perform better in the beginning, there is less room for improvement, and therefore the rate of process measure compliance has less room to grow and the odds for time of outcome occurrences have less room to shrink. Instances where residency program status had a positive impact may have been partially due to the fact that teaching hospitals have more new, young, doctors taking initiative in enhanced recovery endeavors. On the other hand, since few hospital-level factors were examined and some are self-reported, there may be additional unexamined latent factors (former) or response bias (latter) impacting the findings. Especially for EGS-appendectomy/cholecystectomy, the VUS rates may have been so minimal from month to month within hospitals, that in a random slope, random intercept model, the random slopes (log odds ratios for time by hospital) were so uniformly tiny as to have essentially no room for impact when regressed against the hospital level factors

Patient-Level Subgroups

It is interesting to note that there were fewer significant differences between groups in the Outcome models as compared with the chi-square compared process measures. It may be that, because the patient factors when looking at outcomes had already been adjusted for other variables, there may be unexamined factors contributing to the differences between groups for process measures; it is also possible that even the outcome models did not include enough adjustment to fully represent patient-level differences, and uncollected latent variables (such as socioeconomic status, access to care, or comorbidities) may account for some of these differences. For gender differences between process measures in gynecologic surgeries, lack of difference may simply be the result of lack of power because of a small number of male patients.

Cross-Service Line Analysis

The cross-service line time effects for process measure improvement are unsurprising. As the preponderance of cases come from the colorectal service line, five of the seven process measures are also found in the colorectal service line, and all of those except for first postoperative mobilization are significant for colorectal, it follows that the remaining four would have significant odds ratios for time. Similarly, because first postoperative mobilization is not significant in any service line (including colorectal), it is intuitive that it is also not significant across service lines. Also, although first postoperative VTE prophylaxis dose is significant in EGS-major abdominal procedures, there are far more cases in the gynecologic surgery service line, where the compliance rate appears flat across the 18 months. The same concept holds true for outcomes: in the primary analyses, most of the outcomes have insignificant odds ratios for time, with the most common exception being length of stay models. Again, since colorectal dominates the cases where ileus is collected, it is expected that ileus and the composite of ileus and prolonged length of stay (which both have significant odds ratios for time in the primary colorectal models) would also have significant odds ratios for time across service lines.

Impact of ISCR Process Measures on Surgical Outcomes

By and large, it is seen that the process measures of interest impact the intended outcomes, even when adjusted for by other predictors, including process measures; however, it appears that patient education does not appear to be significantly associated with improved outcomes. As addressed in other sections of this report, indwelling urinary catheter compliance is repeatedly and consistently high, making it understandable that compliance (or lack thereof) is unlikely to play a large role in the remaining UTI rate. Because open surgical approaches are more invasive than laparoscopic, it is intuitive that the healing time would be longer, contributing to increased odds of having a prolonged length of stay. As with other analyses, other factors (including other process measures) that are unmeasured and/or unadjusted for, may contribute to unexpected results where examined process measures do not appear to have the intended effect.

Impact of ISCR Program on 30-Day Readmission and 30-Day Mortality

It is possible that there was not sufficient time during the “post” period to experience a significant decrease in readmission or mortality after the start of the cohort, and perhaps with more time allotted for the “post” period, there may be more change. Although introduction of enhanced recovery pathways may help in the reduction of particularly high rates of specific outcomes, there is also less room for improvement in lower-occurrence outcomes such as readmission and mortality.

Limitations

The results presented here must be interpreted with consideration for some limitations. First, true baselines for hospitals are difficult to determine given that some hospitals did not have systematic data entry prior to pathway implementation. Additionally, hospitals may have begun implementing pathway elements and improving at various times prior to systematic data entry, or may not have started until much later, with these various stages of implementation at the cohort start date potentially blunting our observed impact of program participation. Second, to ease the burden of data collection on hospitals, required variables were limited to a parsimonious set with clinical expert input in the development of resources for each service line. Therefore, there may be unmeasured pathway components or outcomes on which the program had impact. Third, there was lack of data on process measures, ROBF, and ileus in some cohort one hospitals. Therefore, there were smaller samples of cases used to analyze the process measures, ROBF and ileus, which may have led to an insufficient statistical power and decreased likelihood of statistically significant improvements over time. Additionally, procedure-specific risk calculations had to be calculated from ISCR data instead of a broader sample in some models, as not all ISCR outcomes are available outside of ISCR cases. Finally, due to the COVID-19 pandemic, which struck different areas of the country at different times, and impacted later cohorts but not earlier cohorts, results could have been skewed in unknowable ways as different hospitals may have had to start case collection or stopped too soon.

Section II. Impact on Patient Experience

Methods

About the Survey

The ISCR Patient Experience Survey is based on items from the Outpatient and Ambulatory Surgery Consumer Assessment of Healthcare Providers and Systems (OAS-CAHPS) survey, the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) survey, and the Patient-Reported Outcomes Measurement Information System (PROMIS) Global Health Outcomes Scale 1.2. The ISCR Patient Experience Survey was developed through collaborative meetings with Johns Hopkins University and Westat, with approval from AHRQ. The survey was specifically designed and used on the ISCR project.

The ISCR survey includes 30 items, designed to assess the patient experience across a variety of dimensions. The survey covers the following:

- **Composite Measures:** Composite measures are sets of questions that address a specific topic. Each of the composite measures consist of two or more survey items that relate to a topic. Composite measure scores are calculated by averaging the composite-level percent scores across all trending hospitals (hospitals with at least three surveys received after data cleaning in both pre- and post-implementation phases), and separately for pre-implementation hospitals, and post-implementation hospitals. If a hospital is missing an item score from a composite measure for all respondents, the proportional score is still calculated on the remaining items, dividing by the number of items for which there are responses. See section titled *Notes: Calculations* for more information of how composite measures are calculated.

  In this survey, the three composites assess:
  1. Communications About Your Procedure (4 items)
  2. Preparation for Discharge and Recovery (4 items)
  3. Pain Management (2 items)

- **Additional Measures:** Additional assessment measures include:
  1. Single Item Measures of Care (3 items)
  2. Patient Self-Reported Postsurgical Symptoms (5 items)
  3. Global Ratings (2 items)
  4. Patient Self-Reported Health Outcomes (3 items)

- **Background Questions:** capture the respondent's self-reported characteristics (7 items)

Patient Eligibility Requirements

Patients eligible for participation in survey data collection must have undergone either colorectal surgery, total hip or knee joint replacement surgery, hip fracture surgery, or gynecologic surgery at a participating hospital with specific discharged dates. Cohort 3 data collection was broken into two sub cohorts (cohort 3A and cohort 3B). The patient experience evaluation concluded at the end of cohort 3B; no data were collected in cohort 4. Table 53 presents the eligible discharge dates for all cohorts.

Table 53. ISCR Patient Experience Survey: Eligible Discharge Dates

Cohort #	Eligible Discharge Dates	
	Pre-implementation	Post-implementation
Cohort 1 (colorectal surgery)	September 2, 2017 to February 28, 2018	March 2, 2018 to September 30, 2018
Cohort 2 (colorectal surgery, hip/knee replacement surgery, hip fracture surgery)	March 1, 2018 to August 30, 2018	December 1, 2018 to May 1, 2019
Cohort 3a (colorectal surgery, hip/knee replacement surgery, hip fracture surgery, gynecologic surgery)	March 1, 2019 to August 1, 2019	December 21, 2019 to May 21, 2020
Cohort 3b (colorectal surgery, hip/knee replacement surgery, hip fracture surgery, gynecologic surgery)	September 1, 2019 to February 1, 2020	June 1, 2020 to November 1, 2020

As described in more detail below, the patient experience survey mailing was timed to arrive at an eligible patient's residence no sooner than 51 days after patient discharge,* and no later than 90 days after patient discharge. Therefore, patients received the mailed survey at their residence no sooner than 52 days after discharge. No information was provided on whether patients went to a rehabilitation facility or other facility after discharge. Only patients 18 years of age or older at the time of their procedure were eligible to participate in the patient experience survey. Patients who were incarcerated or residing in rehabilitation or senior care facilities were included. Patients with non-U.S. addresses were excluded.

Patient File Preparation

ACS transmitted encrypted files of qualified adult colorectal patients to Westat via a secure, password protected File Transfer Protocol (FTP) site. Westat conducted automated and visual quality checks on each patient file prior to survey deployment. For example, the patient files were examined for completeness (e.g., missing names, incomplete address), city name/zip code agreement, and valid discharge date. Westat corrected minor errors in patient files, such as capitalization and punctuation and, when possible, updated the zip code to agree with the provided city. However, no additional patient-level tracing was attempted.

Data Collection

Data collection occurred on an ongoing basis, with the number of participating hospitals increasing over the course of the data collection period. Access to secure files was restricted to one information technology (IT) manager from ACS and two Westat project staff. Westat received patient files for the following:

- Cohort 1 pre-implementation weekly transfer of files began October 19, 2017, and ended on February 5, 2018. Transfer of patient files for cohort 1 for the post-implementation phase occurred weekly between May 15, 2018, and September 25, 2018. Westat received 12 total pre-implementation individual patient files (1,405 patient records) and 14 post-implementation patient data files from ACS (715 patient records).

*In effort to minimize overlap with the Centers for Medicare & Medicaid Services' hospital CAHPS survey program, the initial ISCR patient experience survey was not mailed until at least 51 days after the patient was discharged.

- Cohort 2 pre-implementation weekly transfer of files began May 15, 2018. A 6-week hiatus in operations beginning June 21, 2019, allowed the ACS to revise the patient sampling database. Transfer of patient files for Cohort 2 for the post-implementation phase occurred weekly between January 15, 2019, and July 1, 2019. Westat received 13 total pre-implementation individual patient files (2,458 patient records) and 19 post-implementation patient data files from ACS (3,398 patient records).
- Cohort 3A pre-implementation weekly transfer of files began April 14, 2019, and ended on September 15, 2019. Transfer of patient files for cohort 3A for the post-implementation phase occurred weekly between February 11, 2020, and July 14, 2020. Westat received 23 total pre-implementation individual patient files and 23 post-implementation patient data files from ACS (4577 patient records).
- Cohort 3B pre-implementation weekly transfer of files began October 15, 2019, and ended March 17, 2020. Transfer of patient files for cohort 3B for the post-implementation phase occurred weekly between July 15, 2020, and December 16, 2020. Westat received 23 total pre-implementation individual patient files and 23 post-implementation patient data files from ACS (559 patient records).

Westat mailed the initial survey packet to eligible patients via first-class U.S. mail 1 week following receipt of the patient file. For each mailing, the patient discharge date (included in the file prepared by ACS) was used to ensure the mailed survey arrived at least 51 days after patient discharge and no later than 90 days after patient discharge. The survey packet included a personalized cover letter describing the goals of the study and referenced their respective surgical procedure (e.g., colorectal) and affiliated hospital, the survey booklet of five pages only in English, and a postage-paid reply envelope. The survey booklet instructed potential participants with questions about completing the survey, to call Westat toll free at 1-855-896-6029 or email ISCR@westat.com. Information about the voluntary nature of the survey and expected burden was included. A 10-digit Unique ID and barcode comprising encoded, de-identified values for cohort, patient, surgical hospital, and type of correspondence was printed on each article of correspondence. Seven days after sending the survey packet Westat mailed a postcard thanking respondents for completing and returning their survey, and reminding nonrespondents to please complete and return their survey. A second survey packet was mailed to patients who had not responded to the first survey 1 week after mailing the thank you/reminder postcard. In addition to the questionnaire and postage-paid return envelope, the second survey packet included a revised cover letter noting their nonresponse to the first request, along with additional language encouraging a response. The interval between all mailings was 1 week. All mailed survey materials are available in Appendix C.

See Appendix C for the mailing schedule of all cohorts.

Survey Management

Westat used a proprietary MultiMode Manager (M3) Survey Management System (SMS) to manage the sample of survey participants, schedule mailings, track receipt of returned surveys and undeliverable mail, assign case dispositions, monitor and track completion status, provide data extraction tools to support data analysis, and assist in reporting. The SMS monitored data collection activities at the case level while also reporting overall survey progress by hospital.

Westat used the TeleForm software system for intelligent data capture and image processing to design the mail questionnaire, scan and extract responses, conduct validation tests, and store data. This system performed automatic image capture of the hard-copy forms using Alchemy, a product for image management and delivery. Westat employed best practices for managing paper survey administration, receipt control, scanning and verification, data cleaning, and file preparation, ensuring strict quality control in all mail and processing operations.

To support patient inquiries about the study, we employed a dedicated email box and toll-free telephone line to receive and answer questions about the study. Both the email box and toll-free phone line were active for the duration of this study's data collection. All outgoing correspondence (e.g., survey packets, reminder postcards) included this email address and toll-free number. Westat received one call during cohort 3 pre-implementation data collection concerning the return envelope, and two calls during post-implementation, both inquiring if completing the survey was optional. Westat received no other communications via the email box or toll-free phone during either phase of data collection.

Coding

Westat assigned all returned study correspondence a specific receipt or disposition status code. Questionnaires returned via the postage-paid envelope were opened and examined by hand. After examining for completeness, questionnaires were assigned one of the following receipt codes:

- Survey Response. Surveys containing at least one nondemographic question answered were coded "Survey responses received," and then optically scanned for data and image capture. Scanned surveys were securely stored in a locked, restricted access area for reference purposes.
- Blank. Any returned survey containing no responses.
- Refusal. Surveys received with a message indicating unwillingness to participate.
- Deceased. Any returned survey noting the death of the participant.
- Postal Non-Deliverable. Surveys returned to sender by the United States Postal Service due to missing or inaccurate address information.

Data Editing and Cleaning

Westat performed a variety of data editing and cleaning procedures for the patient experience survey. Generally, we ensured that there were no out-of-range responses, and erroneous responses were set to missing when a skip pattern violation occurred. Surveys in which the respondent checked that someone else "answered the questions for me" (proxy responses) were excluded from the analysis. Details about these editing and cleaning procedures are provided below.

Editing and cleaning rules applied to survey items with skip patterns:

- Q3: "*Anesthesia is something that would make you feel sleepy or go to sleep during your surgery. Were you given anesthesi*a*?*"
- Q4: "*Did your surgeon or anyone from the hospital explain the process of giving anesthesia in a way that was easy to understand?*"
- Q5: "*Did your surgeon or anyone from the hospital explain the possible side effects of the anesthesia in a way that was easy to understand?*"
  - If Q3 was = to "No," then Q4 and Q5 were coded to missing.
  - If Q3 was missing and Q4 was not missing or Q5 was not missing, then Q3 was coded to "Yes."
- Q8: "*During your hospital stay, did you need medicine for pain?*"
- Q9: "*During your hospital stay, how often was your pain well controlled?*"
- Q10: "*During your hospital stay, how often did the hospital staff do everything they could to help you with your pain?*"
  - If Q8 was = to "No," then Q9 and Q10 were coded to missing.
  - If Q8 was missing and Q9 or Q10 was not missing, then Q8 was coded to "Yes."
- Q29: "*Did someone help you complete this survey?*"

- Q30: "*How did that person help you?*"
  - If Q29 was = to "No," then Q30A-E was coded to missing.
  - If Q29 was missing and Q30A-E was not missing, then Q29 was coded to "Yes."

Rules applied for Proxy Responses:

Respondents who answered, "Answered the questions for me" to question 30, "How did that person help you?" when also answering "Yes" to question 29, "Did someone help you complete this survey?" were excluded from the analysis.

Response Rates

As part of the data collection, we calculated the number of completed, returned surveys (numerator) and the total number of surveys distributed, minus ineligibles (denominator). Ineligibles included patients in the data file received that did not meet the data collection window of 90 days from the date of patient discharge. After data cleaning, response rates were calculated as follows:

$$\textit{Response rate} = \frac{\textit{Number of surveys responses received}}{\textit{Number of surveys distributed-ineligibles}}$$

Calculation of Results

To ensure confidentiality and representativeness of hospital survey responses, only hospitals with at least three completed surveys were included in the study results. Hospitals with at least five completed surveys, after data cleaning, also received an individual hospital feedback report that compared their results to aggregate study results.

Average score calculation. The average percent score for each of the three patient experience composites were calculated by averaging the composite-level percent scores across all trending hospitals, and separately for pre-implementation hospitals, and post-implementation hospitals. Similarly, the average percent score for the 23 survey items were calculated by averaging the item-level percent scores across hospitals. Since scores are reported as an overall average, scores from each hospital were weighted equally in their contribution to the calculation of the average.

Data Collection Results

Results for All Cohort pre-implementation are labeled Table 54a and for All Cohort post-implementation are labeled Table 54b by service line. Not Eligible # included patients in the data file received that did not meet the data collection window of 90 days from the date of patient discharge. Surveys Received/Total Records % indicates the number of surveys received by the total number of patient records received from ACS.

Table 54a. Data Collection Results for All Cohorts Pre-implementation by Service Line

Pre-implementation Results by Service Line										
Service Line	**Total Records Received**	**Eligible #**	**Eligible %**	**Not Eligible #**	**1st Surveys Mailed #**	**Reminders Mailed #**	**2nd Surveys Mailed #**	**Surveys Received #**	**Surveys Received/ Total Records %**	**Surveys Received/ Total Mailed %**
Colorectal	3,861	2,382	62%	1,479	2,382	2,382	2,285	962	25%	40%
Gynecologic	1,803	1,406	78%	397	1,406	1,406	1,362	467	26%	33%
Hip Fracture	518	386	75%	132	386	386	379	132	25%	34%
Hip/Knee Replacement	4,256	2,870	67%	1,386	2,870	2,870	2,782	1,590	37%	55%

Table 54b. Data Collection Results for All Cohorts Post-implementation by Service line

Post-implementation Results by Service Line										
Service Line	**Total Records Received**	**Eligible #**	**Eligible %**	**Not Eligible #**	**1st Surveys Mailed #**	**Reminders Mailed #**	**2nd Surveys Mailed #**	**Surveys Received #**	**Surveys Received/ Total Record %**	**Surveys Received/ Total Mailed %**
Colorectal	3,420	2,514	74%	906	2,506	2,506	2,443	1,062	31%	42%
Gynecologic	1,607	1,518	94%	89	1,518	1,518	1,463	556	35%	37%
Hip Fracture	762	617	81%	145	617	617	612	216	28%	35%
Hip/Knee Replacement	3,460	2,814	81%	646	2,814	2,814	2,727	1,465	42%	52%

Results

The following sections describe data cleaning, analysis, and results of the ISCR Patient Experience Survey from hospitals that chose to survey patients. Results are based on the number of All Cohorts pre- and post-implementation colorectal surgery, hip/knee replacement surgery, hip fracture surgery, and gynecologic surgery service lines. Table 55 presents the cohorts that each service line participated in.

Table 55. ISCR Service Lines by Cohort Participation

Service Line	Cohort 1	Cohort 2	Cohort 3A	Cohort 3B
Colorectal Service line	✓	✓	✓	✓
Hip/Knee Replacement Service Line		✓	✓	✓
Hip Fracture Service Line		✓	✓	✓
Gynecologic Service Line			✓	✓

Survey Administration Characteristics

Table 56 summarizes the number of participating hospitals, completed surveys, administered surveys, and the response rate for the pre- and post-implementation phases of All Cohorts by service line. In addition, this same information is shown for hospitals that participated in both phases, which we labeled trending hospitals.

Table 56. Survey Administration Statistics after Data Cleaning for All Cohort Hospitals by Service Line

Survey Administration Statistics	Pre-implementation	Post-implementation	Trending Hospitals	
			Pre-implementation	Post-implementation
Colorectal Service Line				
Number of hospitals in All Cohort analysis	79	60	47	47
Number of surveys received (response rate numerator)	897	986	655	852
Number of surveys administered (response rate denominator)	2,424	2,548	1,742	2,131
Response rate	37%	39%	38%	40%
Hip/Knee Replacement Service Line				
Number of hospitals in All Cohort analysis	53	37	34	34
Number of surveys received (response rate numerator)	1,532	1,496	1,065	1,403
Number of surveys administered (response rate denominator)	3,234	3,295	2,153	3,040
Response rate	47%	45%	49%	46%

Note: Table is based on survey records included for analysis; post data editing and cleaning. Hospitals with at least three completed surveys in both pre- and post-implementation phases were included in "Trending Hospitals."

Table 56. Survey Administration Statistics after Data Cleaning for All Cohort Hospitals by Service Line (cont.)

Survey Administration Statistics	Pre-implementation	Post-implementation	Trending Hospitals	
			Pre-implementation	Post-implementation
Hip Fracture Service Line				
Number of hospitals in All Cohort analysis	17	19	7	7
Number of surveys received (response rate numerator)	97	179	64	105
Number of surveys administered (response rate denominator)	319	629	204	368
Response rate	30%	28%	31%	29%
Gynecologic Service Line				
Number of hospitals in All Cohort analysis	24	17	15	15
Number of surveys received (response rate numerator)	436	641	357	515
Number of surveys administered (response rate denominator)	1,756	1,492	1,390	1,223
Response rate	25%	43%	26%	42%

Note: Table is based on survey records included for analysis; post data editing and cleaning. To ensure confidentiality and representativeness of hospital survey responses, only hospitals with at least three surveys received after data cleaning in both pre- and post-implementation phases were included in "Trending Hospitals" results.

Trending Hospital Respondent Characteristics

Table 57 presents aggregate respondent characteristics from all **All Cohort colorectal surgery trending hospitals** that participated in the pre- and post-implementation phases. Respondent characteristics for pre-implementation hospitals (n= 79) and post-implementation hospitals (n= 60) are presented in Appendix C.

If a respondent stated that someone answered the questions for them that survey was considered a proxy response and was not included in the analysis. The number of proxies was very small for each service line.

Table 57. Trending Hospital Respondent Characteristics for All Cohort Colorectal Surgery Hospitals

Respondent Characteristics	Trending Hospitals			
	Pre-implementation		Post-implementation	
	Number	Percent	Number	Percent
Age				
18 to 24	3	< 1%	3	< 1%
25 to 34	5	1%	11	1%
35 to 44	18	3%	27	3%
45 to 54	72	11%	94	11%
55 to 64	160	25%	192	23%
65 to 74	204	32%	281	34%
75 to 79	84	13%	95	11%
80 to 84	50	8%	82	10%
85 or older	50	8%	53	6%
Total	646	100%	838	100%
No answer	9		14	
Overall total	655		852	
Gender				
Male	268	41%	376	45%
Female	378	59%	464	55%
Total	646	100%	840	100%
No answer	9		12	
Overall total	655		852	
Education				
Completed 8th grade or less	17	3%	18	2%
Some high school, but did not graduate	31	5%	44	5%
High school graduate or General Educational Development certificate	188	30%	260	31%
Some college or 2-year degree	212	33%	262	31%
4-year college graduate	90	14%	120	14%
More than 4-year college degree	97	15%	128	15%
Total	635	100%	832	100%
No answer	20		20	
Overall total	655		852	

Trending Hospital Respondent Characteristics (continued)

Table 57. Respondent Characteristics for All Cohort Colorectal Surgery Hospitals (cont.)

Respondent Characteristics	Trending Hospitals			
	Pre-implementation		Post-implementation	
	Number	Percent	Number	Percent
Hispanic/Latino Origin/Descent				
Yes, Hispanic or Latino	27	4%	21	3%
No, not Hispanic or Latino	587	96%	792	97%
Total	614	100%	813	100%
No answer	41		39	
Overall total	655		852	
Race				
White	561	89%	748	90%
Black or African American	38	6%	46	6%
Asian	8	1%	9	1%
Native Hawaiian or Other Pacific Islander	0	0%	3	< 1%
American Indian or Alaska Native	2	< 1%	3	< 1%
Other	19	3%	14	2%
Two or more races	4	1%	6	1%
Total	632	100%	829	100%
No answer	23		23	
Overall total	655		852	
Help in Completion of Survey				
Yes	40	6%	39	5%
No	602	94%	799	95%
Total	642	100%		100%
No answer	13		14	
Overall total	655			
Actions of the Person Helping the Respondent*				
Read the questions to me	23	59%	24	65%
Wrote down the answers I gave	29	74%	21	57%
Translated the questions into my language	6	15%	3	8%
Helped in some other way	2	5%	3	8%
No answer	616		815	
Answered the questions for me (Coded missing due to proxy response)	14		16	

*Note: Respondents could choose more than one response, and that is why the percentages do not add up to 100%. Respondents who selected "Answered the questions for me" were excluded from analyses.

Trending Hospital Respondent Characteristics (continued)

Table 58 presents aggregate respondent characteristics from **All Cohort hip/knee replacement surgery trending hospitals** that participated in the pre- and post-implementation phases. Respondent characteristics for pre-implementation hospitals (n=53) and post-implementation hospitals (n=37) are presented in Appendix C.

Table 58. Trending Hospital Respondent Characteristics for All Cohort Hip/Knee Replacement Surgery Hospitals

Respondent Characteristics	Trending Hospitals			
	Pre-implementation		Post-implementation	
	Number	Percent	Number	Percent
Age				
18 to 24	0	0%	1	< 1%
25 to 34	1	< 1%	0	0%
35 to 44	10	1%	11	1%
45 to 54	51	5%	59	4%
55 to 64	238	23%	344	25%
65 to 74	435	42%	625	45%
75 to 79	164	16%	199	14%
80 to 84	99	9%	97	7%
85 or older	48	5%	51	4%
Total	1,046	100%	1,387	100%
No answer	19		16	
Overall total	1,065		1,403	
Gender				
Male	374	36%	576	42%
Female	674	64%	810	58%
Total	1,048	100%	1,386	100%
No answer	17		17	
Overall total	1,065		1,403	
Education				
Completed 8th grade or less	16	2%	18	1%
Some high school, but did not graduate	52	5%	61	4%
High school graduate or General Educational Development certificate	398	38%	428	31%
Some college or 2-year degree	329	32%	457	33%
4-year college graduate	114	11%	177	13%
More than 4-year college degree	128	12%	231	17%
Total	1,037	100%	1,372	100%
No answer	28		31	
Overall total	1,065		1,403	

Trending Hospital Respondent Characteristics (continued)

Table 58. Respondent Characteristics for All Cohort Hip/Knee Replacement Surgery Hospitals (cont.)

Respondent Characteristics	Trending Hospitals			
	Pre-implementation		Post-implementation	
	Number	Percent	Number	Percent
Hispanic/Latino Origin/Descent				
Yes, Hispanic or Latino	36	4%	60	4%
No, not Hispanic or Latino	970	96%	1,278	96%
Total	1,006	100%	1,338	100%
No answer	59		65	
Overall total	1,065		1,403	
Race				
White	950	92%	1,219	90%
Black or African American	24	2%	63	5%
Asian	25	2%	30	2%
Native Hawaiian or Other Pacific Islander	4	< 1%	5	< 1%
American Indian or Alaska Native	1	< 1%	6	< 1%
Other	15	1%	22	2%
Two or more races	13	1%	16	1%
Total	1,032	100%	1,361	100%
No answer	33		42	
Overall total	1,065		1,403	
Help in Completion of Survey				
Yes	34	3%	45	3%
No	1,007	97%	1,335	97%
Total	1,041	100%	1,380	100%
No answer	24		23	
Overall total	1,065		1,403	
Actions of the Person Helping the Respondent*				
Read the questions to me	15	44%	21	50%
Wrote down the answers I gave	19	56%	20	48%
Translated the questions into my language	6	18%	4	10%
Helped in some other way	4	12%	5	12%
No answer	1,031		1,361	
Answered the questions for me (Coded missing due to proxy response)	15		13	

*Note: Respondents could choose more than one response, and that is why the percentages do not add up to 100%. Respondents who selected “Answered the questions for me” were excluded from analyses.

Trending Hospital Respondent Characteristics (continued)

Table 59 presents aggregate respondent characteristics from **All Cohort hip fracture surgery trending hospitals** that participated in the pre- and post-implementation phases. Respondent characteristics for pre-implementation hospitals (n=17) and post-implementation hospitals (n=19) are presented in Appendix C.

Table 59. Trending Hospital Respondent Characteristics for All Cohort Hip Fracture Surgery Hospitals

Respondent Characteristics	Trending Hospitals			
	Pre-implementation		Post-implementation	
	Number	Percent	Number	Percent
Age				
18 to 24	0	0%	0	0%
25 to 34	2	3%	1	1%
35 to 44	0	0%	2	2%
45 to 54	0	0%	0	0%
55 to 64	5	8%	1	1%
65 to 74	12	20%	21	21%
75 to 79	4	7%	17	17%
80 to 84	19	31%	22	22%
85 or older	19	31%	38	37%
Total	61	100%	102	100%
No answer	3		3	
Overall total	64		105	
Gender				
Male	19	31%	25	24%
Female	42	69%	78	76%
Total	61	100%	103	100%
No answer	3		2	
Overall total	64		105	
Education				
Completed 8th grade or less	3	5%	7	7%
Some high school, but did not graduate	7	12%	3	3%
High school graduate or General Educational Development certificate	22	37%	40	39%
Some college or 2-year degree	21	35%	28	27%
4-year college graduate	1	2%	12	12%
More than 4-year college degree	6	10%	12	12%
Total	60	100%	102	100%
No answer	4		3	
Overall total	64		105	

Trending Hospital Respondent Characteristics (continued)

Table 59. Respondent Characteristics for All Cohort Hip Fracture Surgery Hospitals (cont.)

Respondent Characteristics	Trending Hospitals			
	Pre-implementation		Post-implementation	
	Number	Percent	Number	Percent
Hispanic/Latino Origin/Descent				
Yes, Hispanic or Latino	2	3%	4	4%
No, not Hispanic or Latino	56	97%	95	96%
Total	58	100%	99	100%
No answer	6		6	
Overall total	64		105	
Race				
White	56	95%	97	95%
Black or African American	1	2%	2	2%
Asian	1	2%	1	1%
Native Hawaiian or Other Pacific Islander	0	0%	0	0%
American Indian or Alaska Native	0	0%	1	1%
Other	0	0%	0	0%
Two or more races	1	2%	1	1%
Total	59	100%	102	100%
No answer	5		3	
Overall total	64			
Help in Completion of Survey				
Yes	12	20%	18	17%
No	49	80%	85	83%
Total	61	100%	103	100%
No answer	3		2	
Overall total	64		105	
Actions of the Person Helping the Respondent*				
Read the questions to me	9	75%	9	56%
Wrote down the answers I gave	6	50%	10	63%
Translated the questions into my language	0	0%	1	6%
Helped in some other way	1	8%	0	0%
No answer	52		89	
Answered the questions for me (Coded missing due to proxy response)	8		19	

*Note: Respondents could choose more than one response, and that is why the percentages do not add up to 100%. Respondents who selected “Answered the questions for me” were excluded from analyses.

Trending Hospital Respondent Characteristics (continued)

Table 60 presents aggregate respondent characteristics from all **All Cohort gynecologic surgery trending hospitals** that participated in the pre- and post-implementation phases. Respondent characteristics for pre-implementation hospitals (n=24) and post-implementation hospitals (n=17) are presented in Appendix C.

Table 60. Trending Hospital Respondent Characteristics for All Cohort Gynecologic Surgery Hospitals

Respondent Characteristics	Trending Hospitals			
	Pre-implementation		Post-implementation	
	Number	Percent	Number	Percent
Age				
18 to 24	1	< 1%	3	1%
25 to 34	14	4%	21	4%
35 to 44	78	22%	77	15%
45 to 54	85	24%	110	21%
55 to 64	77	22%	112	22%
65 to 74	69	19%	129	25%
75 to 79	13	4%	40	8%
80 to 84	16	5%	16	3%
85 or older	2	1%	5	1%
Total	355	100%	513	100%
No answer	2		2	
Overall total	357		515	
Gender				
Male	1	< 1%	1	< 1%
Female	352	100%	511	100%
Total	353	100%	512	100%
No answer	4		3	
Overall total	357		515	
Education				
Completed 8th grade or less	7	2%	10	2%
Some high school, but did not graduate	9	3%	18	4%
High school graduate or General Educational Development certificate	82	23%	142	28%
Some college or 2-year degree	118	34%	173	34%
4-year college graduate	61	17%	91	18%
More than 4-year college degree	73	21%	77	15%
Total	350	100%	511	100%
No answer	7		4	
Overall total	357		515	

Trending Hospital Respondent Characteristics (continued)

Table 60. Respondent Characteristics for All Cohort Gynecologic Surgery Hospitals (cont.)

Respondent Characteristics	Trending Hospitals			
	Pre-implementation		Post-implementation	
	Number	Percent	Number	Percent
Hispanic/Latino Origin/Descent				
Yes, Hispanic or Latino	29	8%	47	9%
No, not Hispanic or Latino	315	92%	455	91%
Total	344	100%	502	100%
No answer	13		13	
Overall total	357		515	
Race				
White	239	68%	375	74%
Black or African American	37	11%	46	9%
Asian	42	12%	40	8%
Native Hawaiian or Other Pacific Islander	7	2%	9	2%
American Indian or Alaska Native	1	0%	2	0%
Other	12	3%	18	4%
Two or more races	11	3%	17	3%
Total	349	100%	507	100%
No answer	8		8	
Overall total	357		515	
Help in Completion of Survey				
Yes	12	3%	16	3%
No	342	97%	493	97%
Total	354	100%	509	100%
No answer	3		6	
Overall total	357		515	
Actions of the Person Helping the Respondent*				
Read the questions to me	4	33%	6	40%
Wrote down the answers I gave	4	33%	5	33%
Translated the questions into my language	6	50%	6	40%
Helped in some other way	1	8%	3	20%
No answer	345		500	
Answered the questions for me (Coded missing due to proxy response)	1		4	

*Note: Respondents could choose more than one response, and that is why the percentages do not add up to 100%. Respondents who selected “Answered the questions for me” were excluded from analyses.

Summary of Patient Experience Results

Highlights From Trending Hospitals

- We examined the average difference scores of colorectal surgery and hip/knee replacement surgery trending hospitals (Post minus Pre-implementation) for each of the composite measures below.

- For *colorectal surgery*, the average differences in composite measure scores for trending hospitals (n = 47) are:
  - Communication About Your Procedure
    - Average difference score = +1 percentage point
  - Preparation for Discharge and Recovery
    - Average difference score = -3 percentage points
  - Pain Management
    - Average difference score = <+1 percentage point

- *For hip/knee replacement surgery*, the average differences in composite measure scores for trending hospitals (n = 34) are:
  - Communication About Your Procedure
    - Average difference score = +1 percentage point
  - Preparation for Discharge and Recovery
    - Average difference score = +2 percentage points
  - Pain Management
    - Average difference score = +4 percentage points

Because the number of trending hospitals in *hip fracture surgery* (n = 7) and *gynecologic surgery* (n = 15) were so low, we did not calculate average difference scores.

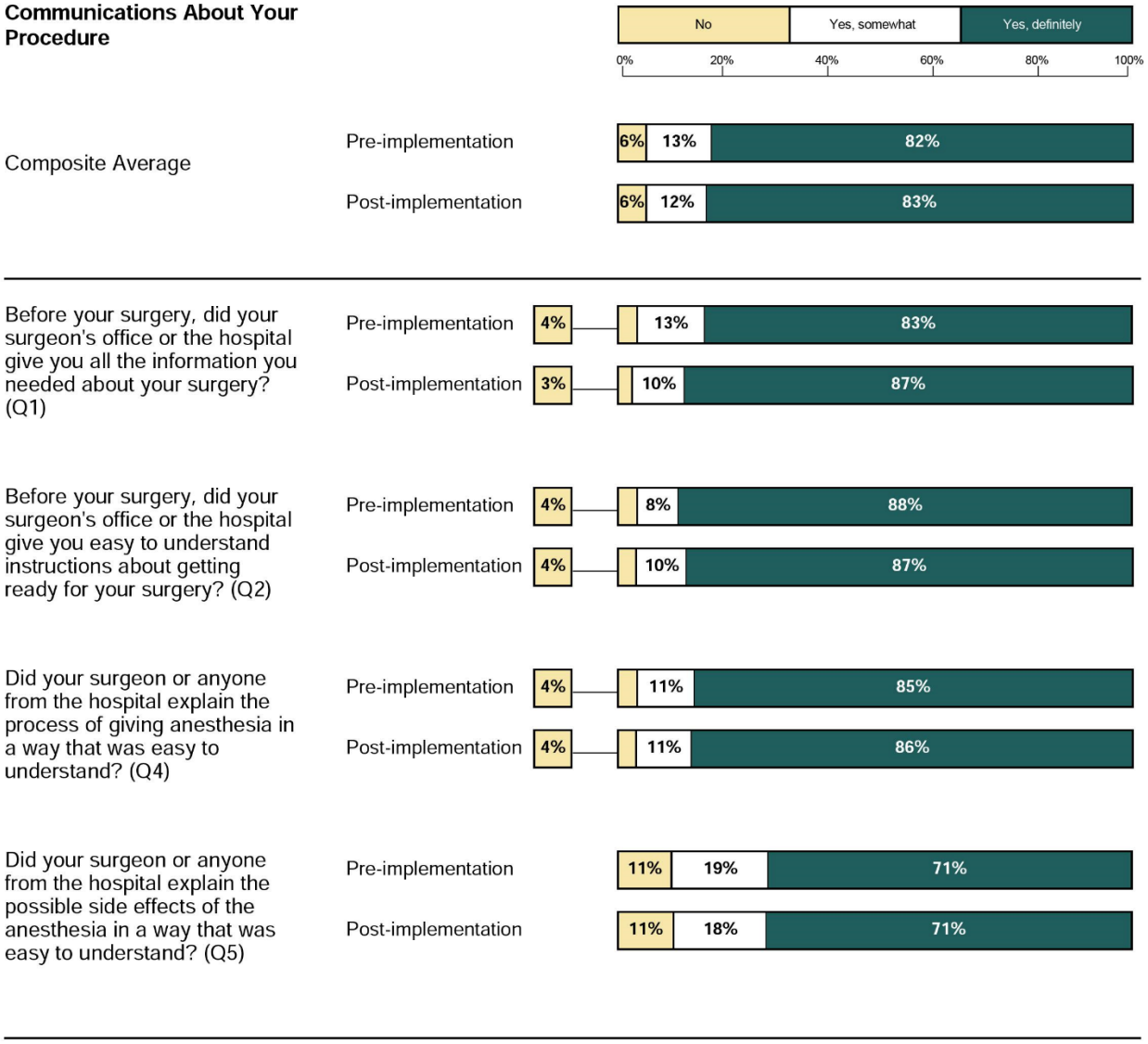
Trending Hospital Results for Colorectal Surgery – All Cohorts

Composite and Item-Level Results for Colorectal Surgery Trending Hospitals

This section provides figures to summarize the composite and item-level results by implementation status for hospitals that had sufficient patient participation in both the pre- and post-implementation phases of All Cohorts for colorectal surgery trending hospitals. The Q after the item corresponds with the question number in the survey. Aggregate nontrending results for All Cohort pre-implementation hospitals and post-implementation hospitals for colorectal surgery are available in Appendix C.

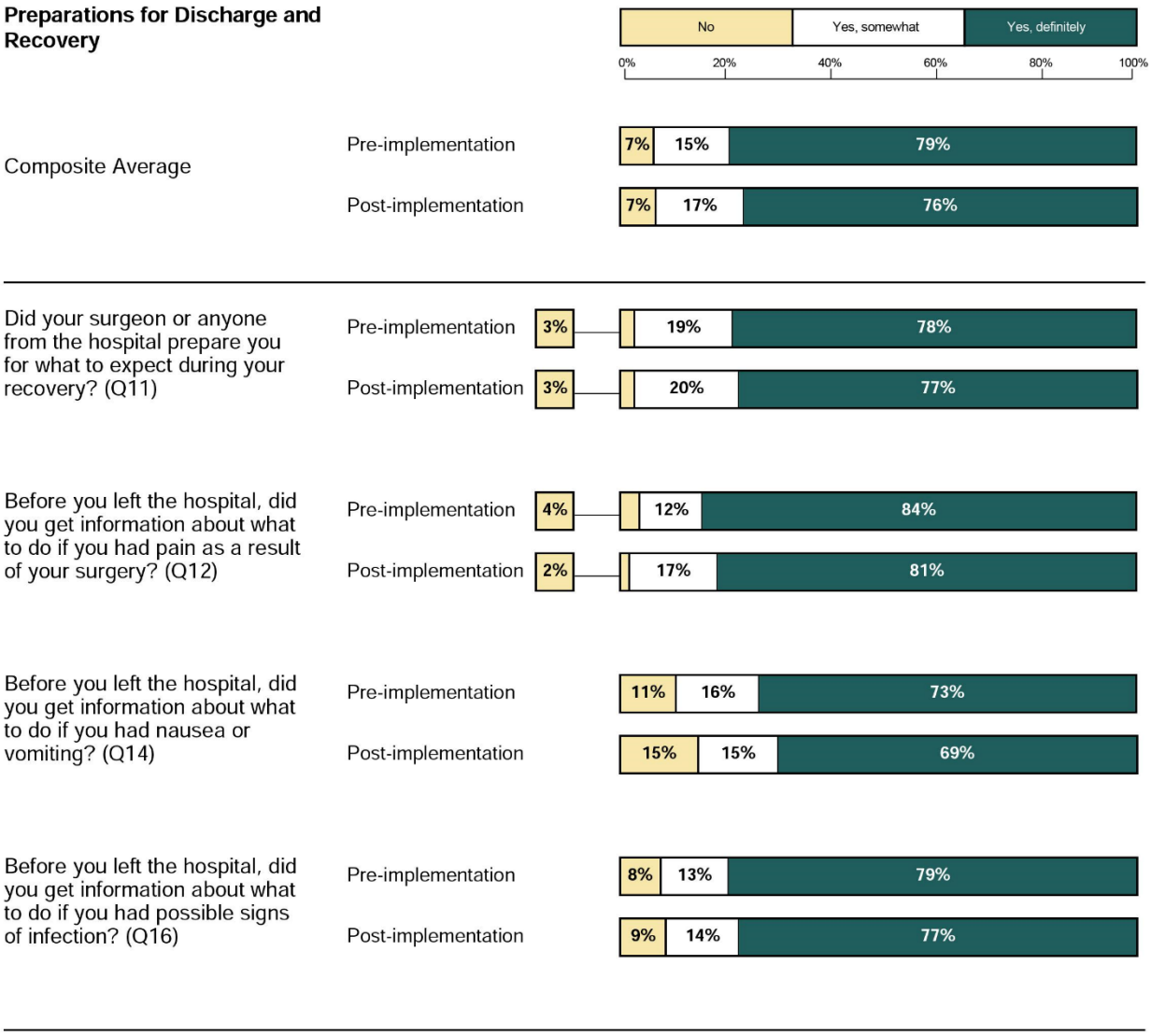
- Figure 63 shows the average percent response for each of the three *patient experience composites* and the *items* for the respective composite.
- Figure 64 shows the average percent response for the *Single Item Measures of Care*.
- Figure 65 shows the average percent responses for the *Patient Self-Reported Postsurgical Symptoms*.
- Figure 66 shows the average percent responses for the *Global Ratings*.
- Figure 67 shows the average percent responses for the *Patient Self-Reported Health Outcomes*.

Figure 63. Composite and Item Results by Implementation Status – All Colorectal Surgery Trending Hospitals (N=47) (Page 1 of 3)



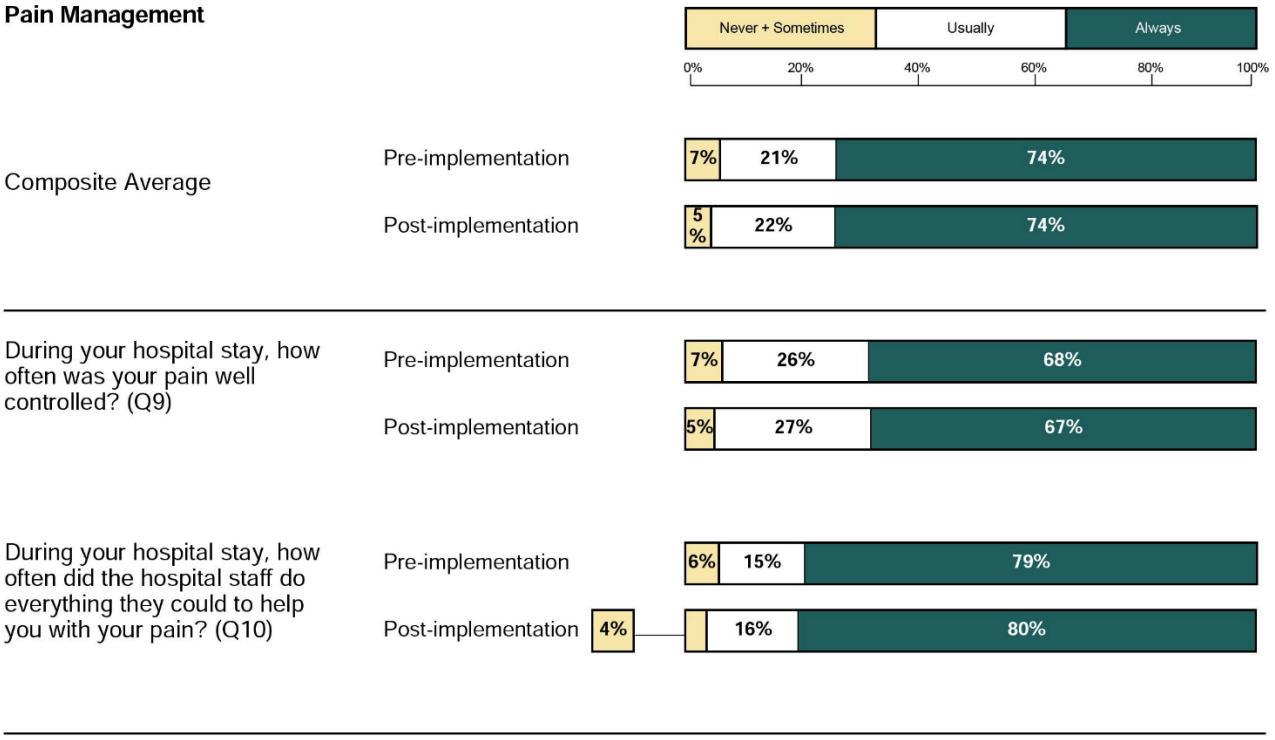
Note: Figure totals exclude missing data and may not sum to 100% due to rounding. Percentages of < 5% are shown to the left of the bar.

Figure 63. Composite and Item Results by Implementation Status – All Cohort Colorectal Surgery Trending Hospitals (N=47) (Page 2 of 3)



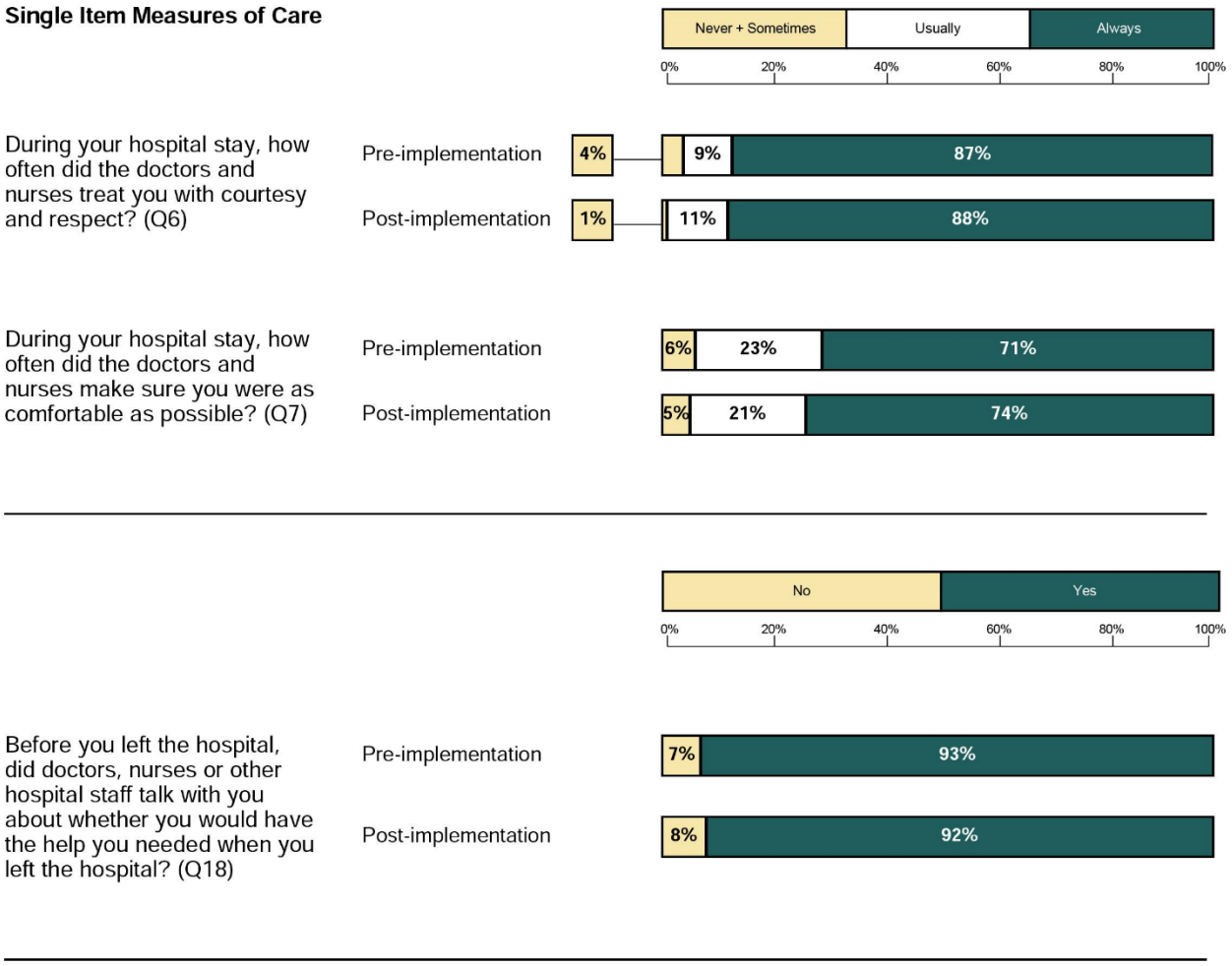
Note: Figure totals exclude missing data and may not sum to 100% due to rounding. Percentages of < 5% are shown to the left of the bar.

Figure 63. Composite and Item Results by Implementation Status – All Cohort Colorectal Surgery Trending Hospitals (N=47) (Page 3 of 3)



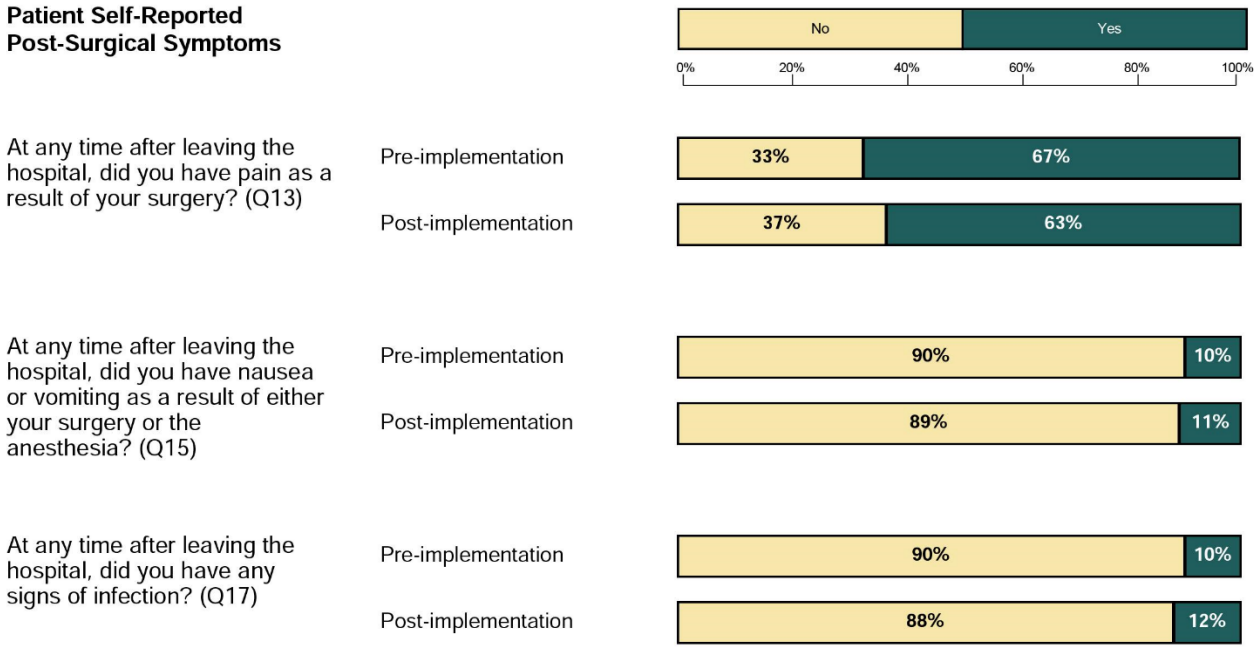
Note: Figure totals exclude missing data and may not sum to 100% due to rounding. Percentages of < 5% are shown to the left of the bar.

Figure 64. Single Item Measures of Care Results by Implementation Status – All Cohort Colorectal Surgery Trending Hospitals (N=47)



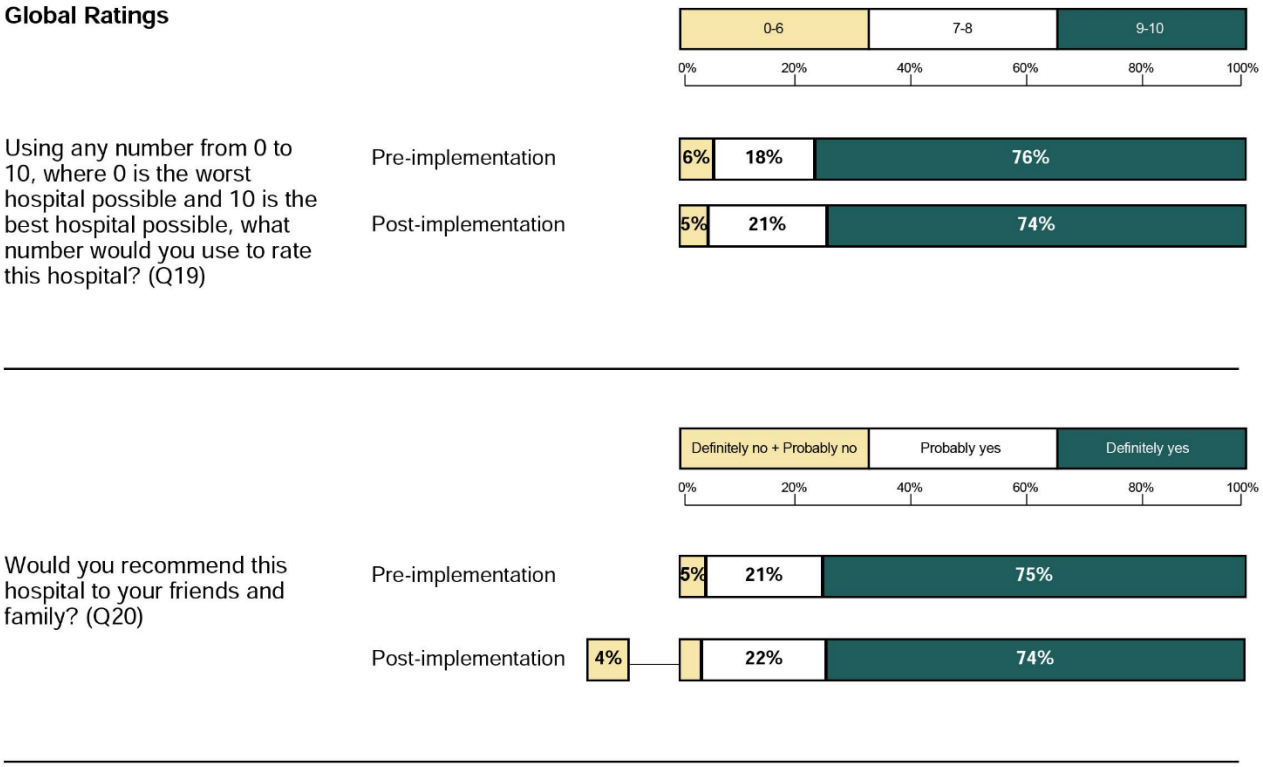
Note: Figure totals exclude missing data and may not sum to 100% due to rounding. Percentages of < 5% are shown to the left of the bar.

Figure 65. Patient Self-Reported Postsurgical Symptoms Results by Implementation Status – All Cohort Colorectal Surgery Trending Hospitals (N=47)



Note: Figure totals exclude missing data and may not sum to 100% due to rounding.

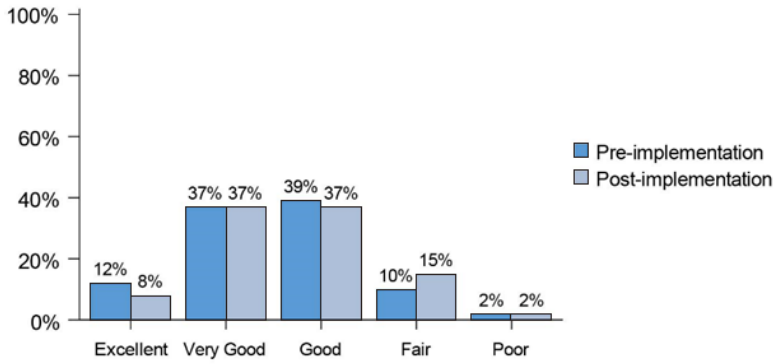
Figure 66. Global Rating Results by Implementation Status – All Cohort Colorectal Surgery Trending Hospitals (N=47)



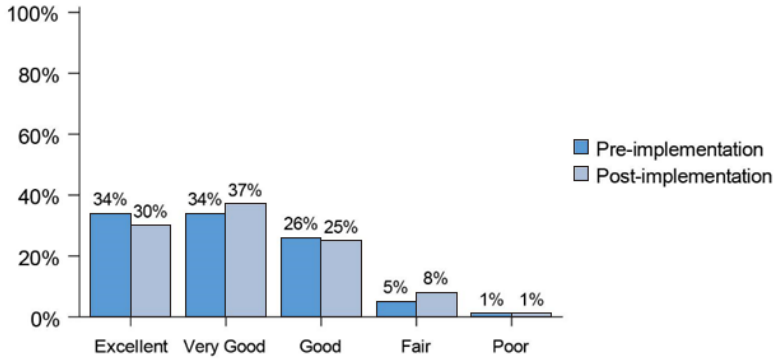
Note: Figure totals exclude missing data and may not sum to 100% due to rounding. Percentages of < 5% are shown to the left of the bar.

Figure 67. Patient Self-Reported Health Outcomes Results by Implementation Status – All Cohort Colorectal Surgery Trending Hospitals (N=47)

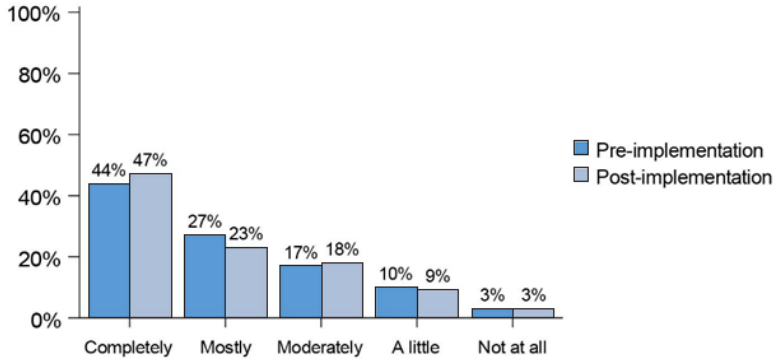
1. In general, how would you rate your overall health? (Q21)



2. In general, how would you rate your overall mental or emotional health? (Q22)



3. In the past 7 days, to what extent have you been able to return to your everyday physical activities such as walking, climbing stairs, carrying groceries, or moving a chair? (Q23)



Note: Figure totals exclude missing data and may not sum to 100% due to rounding.

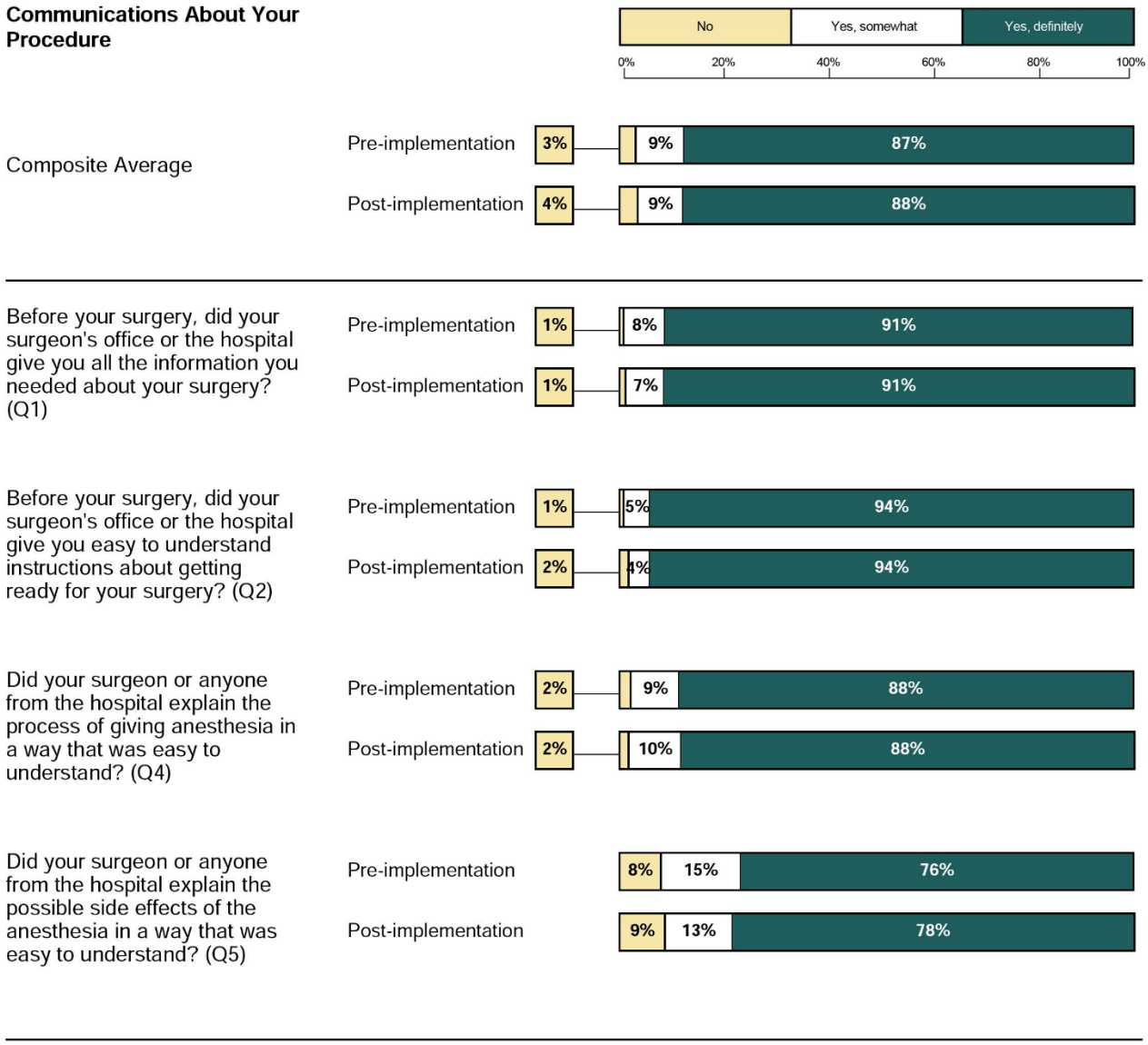
Trending Hospital Results for Hip/Knee Replacement Surgery – All Cohorts

Composite and Item-Level Results for Hip/Knee Replacement Surgery Trending Hospitals

This section provides figures to summarize the composite and item-level results by implementation status for hospitals that had sufficient patient participation in both the pre- and post-implementation phases of All Cohorts for hip/knee replacement surgery trending hospitals. The Q after the item corresponds with the question number in the survey. Aggregate non-trending results for All Cohort pre-implementation hospitals and post-Implementation hospitals for hip/knee replacement surgery are available in Appendix C.

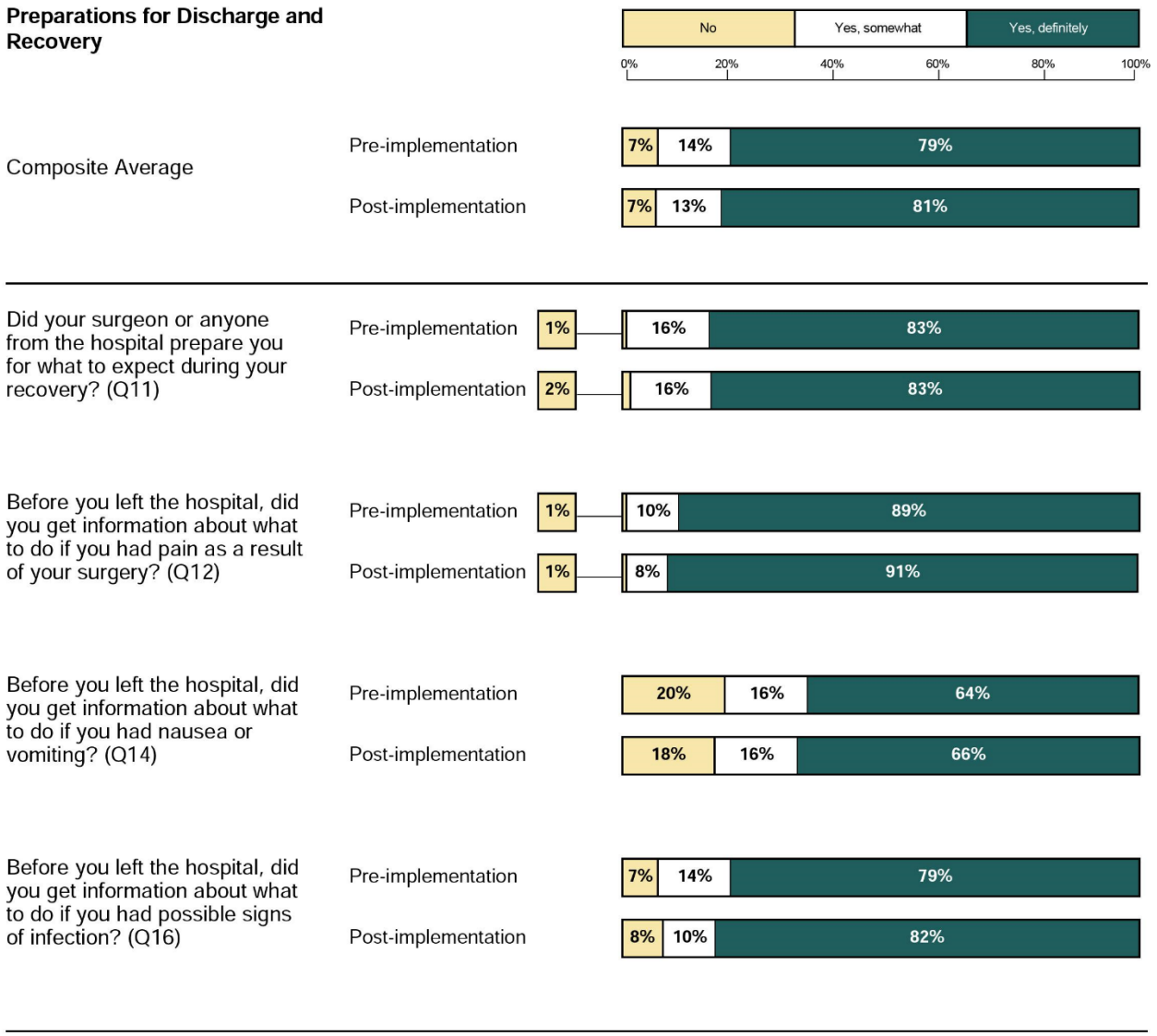
- Figure 68 shows the average percent response for each of the three *patient experience composites* and the *items* for the respective composite.
- Figure 69 shows the average percent responses for the *Single Item Measures of Care*.
- Figure 70 shows the average percent responses for the *Patient Self-Reported Postsurgical Symptoms*.
- Figure 71 shows the average percent responses for the *Global Ratings*.
- Figure 72 shows the average percent responses for the *Patient Self-Reported Health Outcomes*.

Figure 68. Composite and Item Results by Implementation Status – All Cohort Hip/Knee Replacement Surgery Trending Hospitals (N=34) (Page 1 of 3)



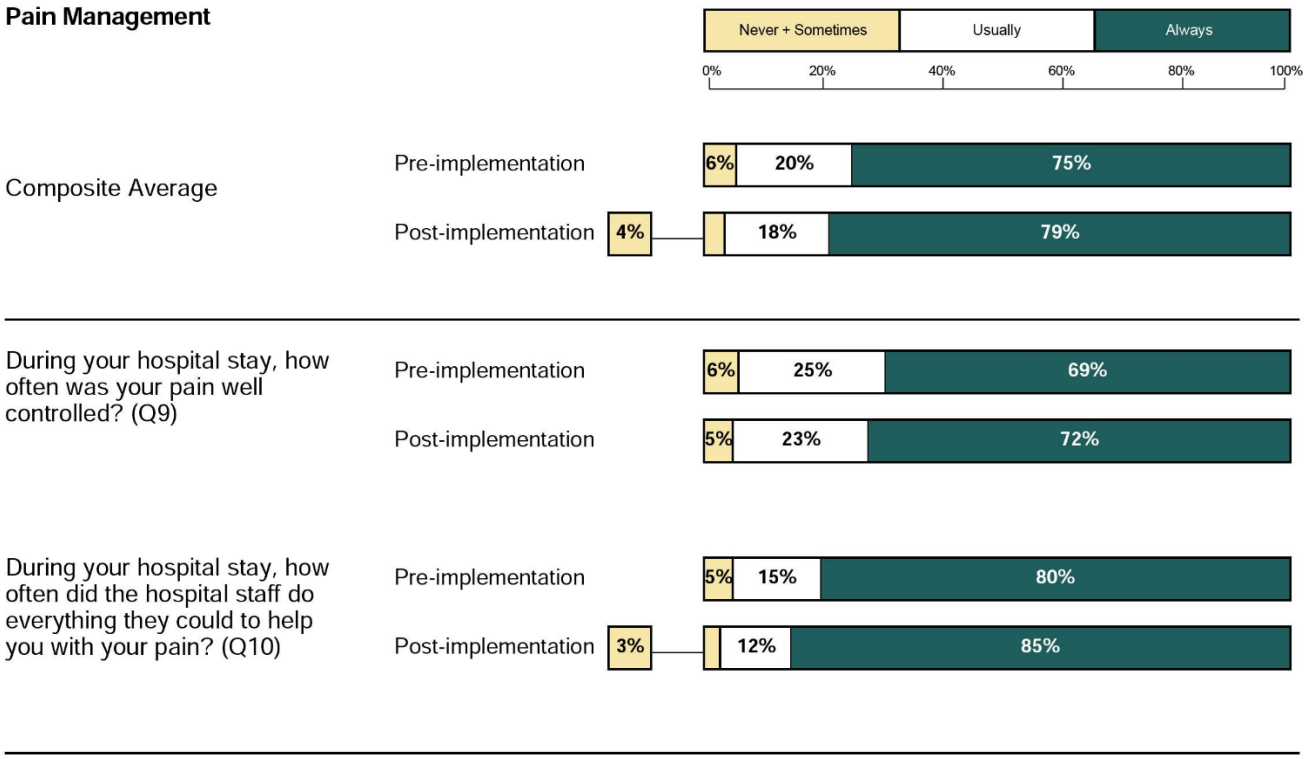
Note: Figure totals exclude missing data and may not sum to 100% due to rounding. Percentages of < 5% are shown to the left of the bar.

Figure 68. Composite and Item Results by Implementation Status – All Cohort Hip/Knee Replacement Surgery Trending Hospitals (N=34) (Page 2 of 3)



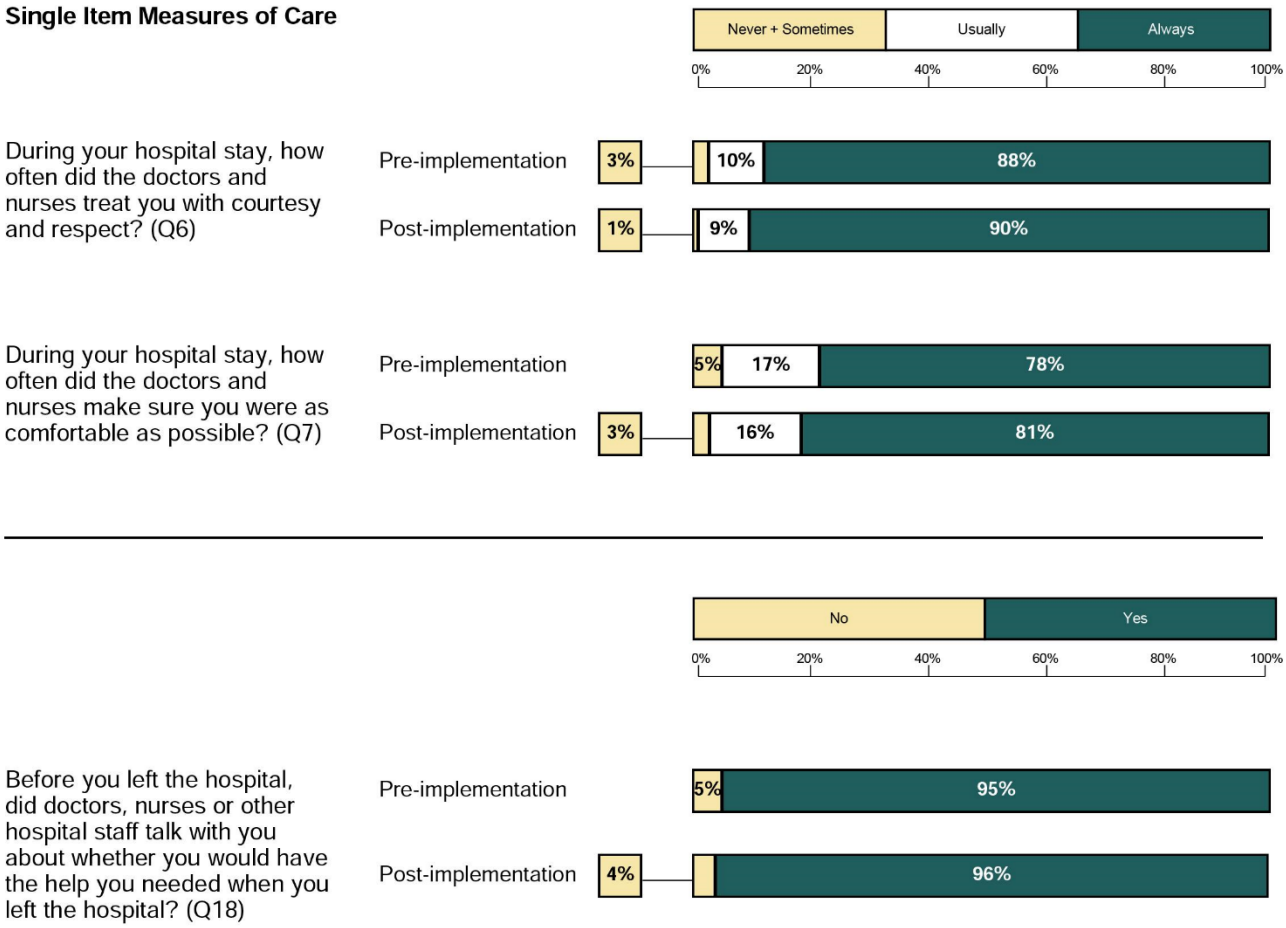
Note: Figure totals exclude missing data and may not sum to 100% due to rounding. Percentages of < 5% are shown to the left of the bar.

Figure 68. Composite and Item Results by Implementation Status – All Cohort Hip/Knee Replacement Surgery Trending Hospitals (N=34) (Page 3 of 3)



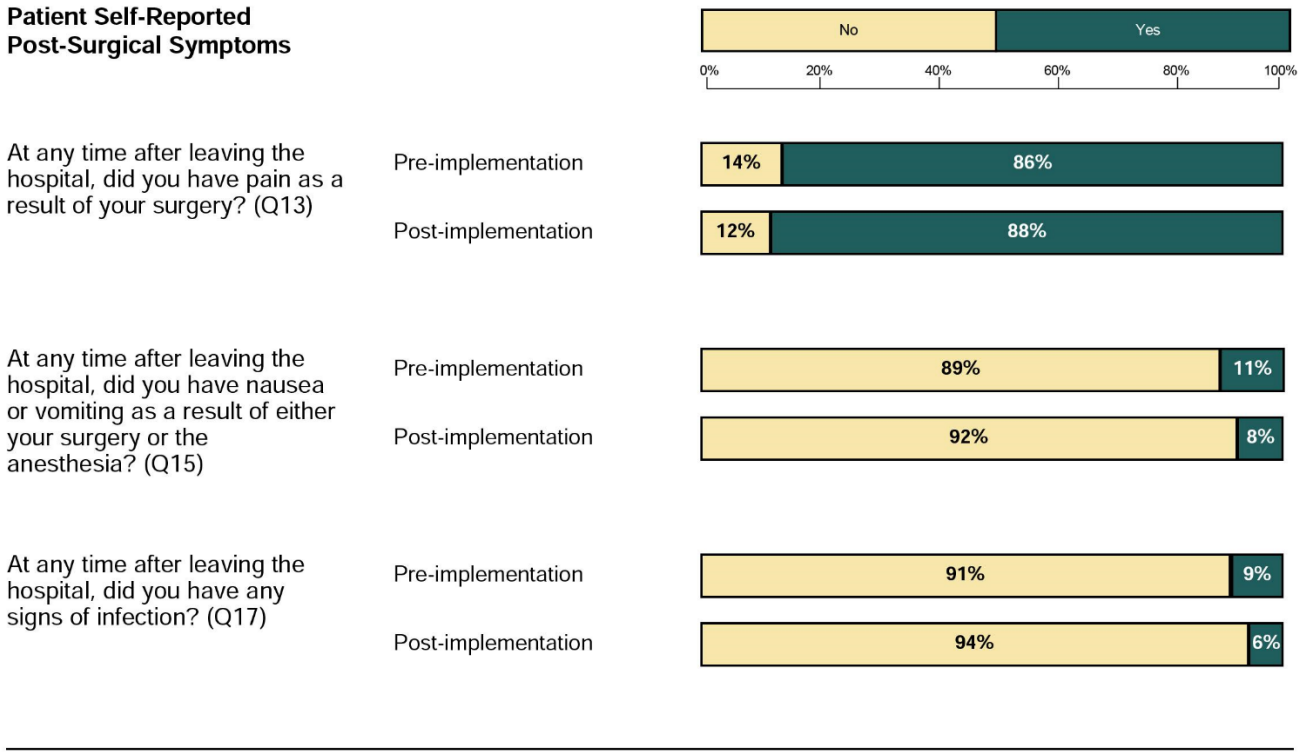
Note: Figure totals exclude missing data and may not sum to 100% due to rounding. Percentages of < 5% are shown to the left of the bar.

Figure 69. Single Item Measures of Care Results by Implementation Status – All Cohort Hip/Knee Replacement Surgery Trending Hospitals (N=34)



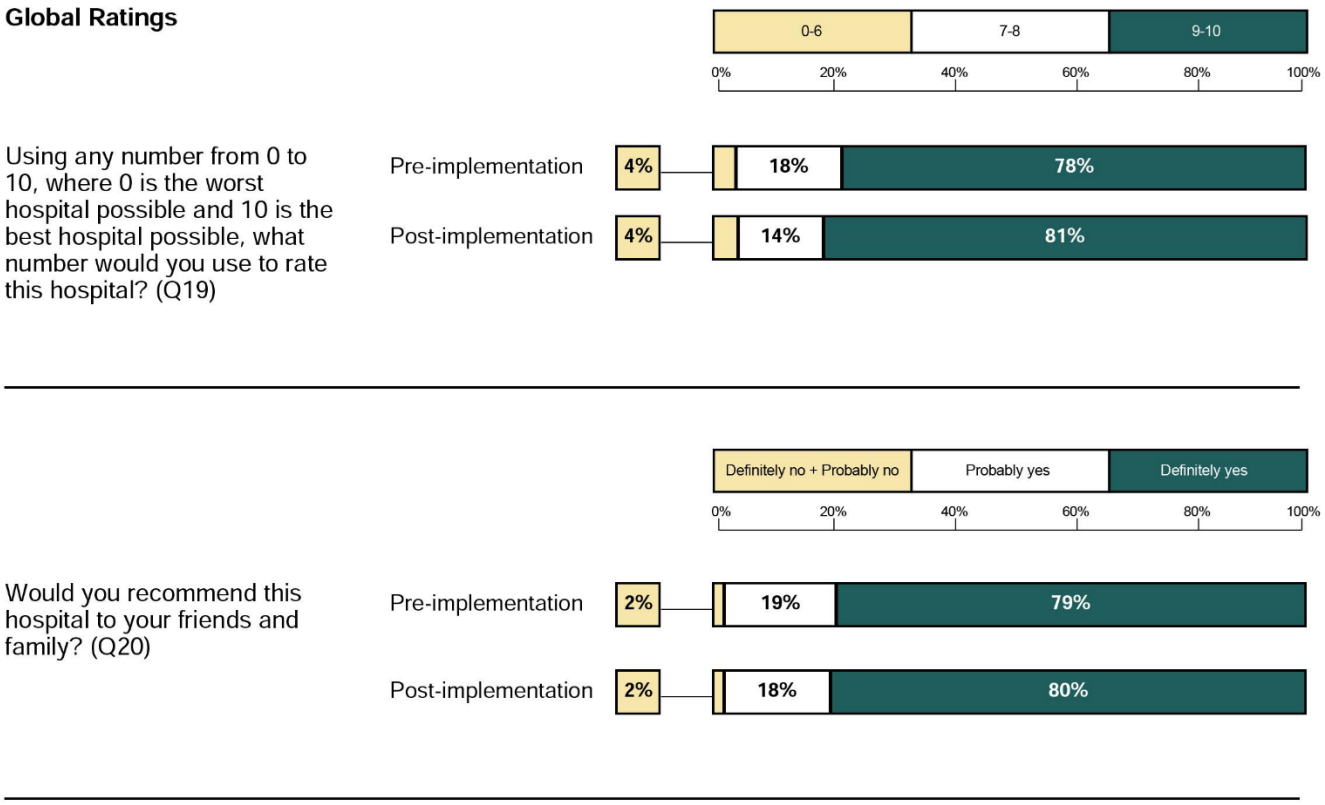
Note: Figure totals exclude missing data and may not sum to 100% due to rounding. Percentages of < 5% are shown to the left of the bar.

Figure 70. Patient Self-Reported Postsurgical Symptoms Results by Implementation Status – All Cohorts Hip/Knee Replacement Surgery Trending Hospitals (N=34)



Note: Figure totals exclude missing data and may not sum to 100% due to rounding.

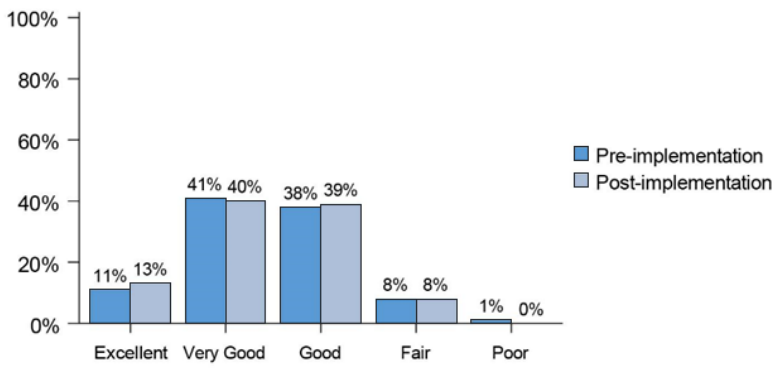
Figure 71. Global Rating Results by Implementation Status – All Cohorts Hip/Knee Replacement Surgery Trending Hospitals (N=34)



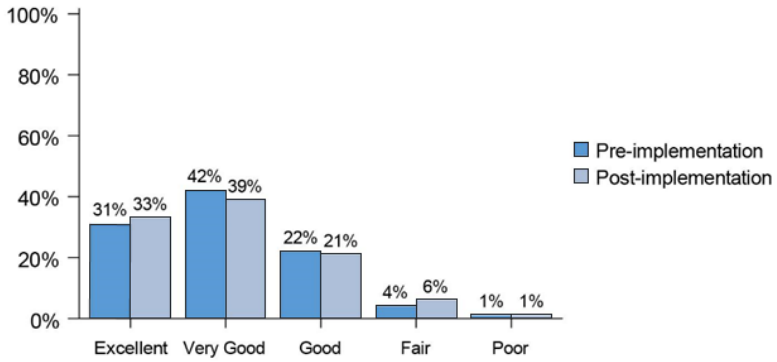
Note: Figure totals exclude missing data and may not sum to 100% due to rounding. Percentages of < 5% are shown to the left of the bar.

Figure 72. Patient Self-Reported Health Outcomes Results by Implementation Status – All Cohort Hip/Knee Replacement Surgery Trending Hospitals (N=34)

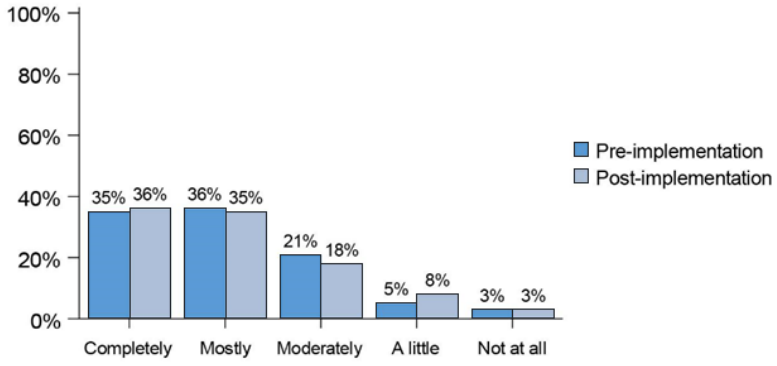
1. In general, how would you rate your overall health? (Q21)



2. In general, how would you rate your overall mental or emotional health? (Q22)



3. In the past 7 days, to what extent have you been able to return to your everyday physical activities such as walking, climbing stairs, carrying groceries, or moving a chair? (Q23)



Note: Figure totals exclude missing data and may not sum to 100% due to rounding.

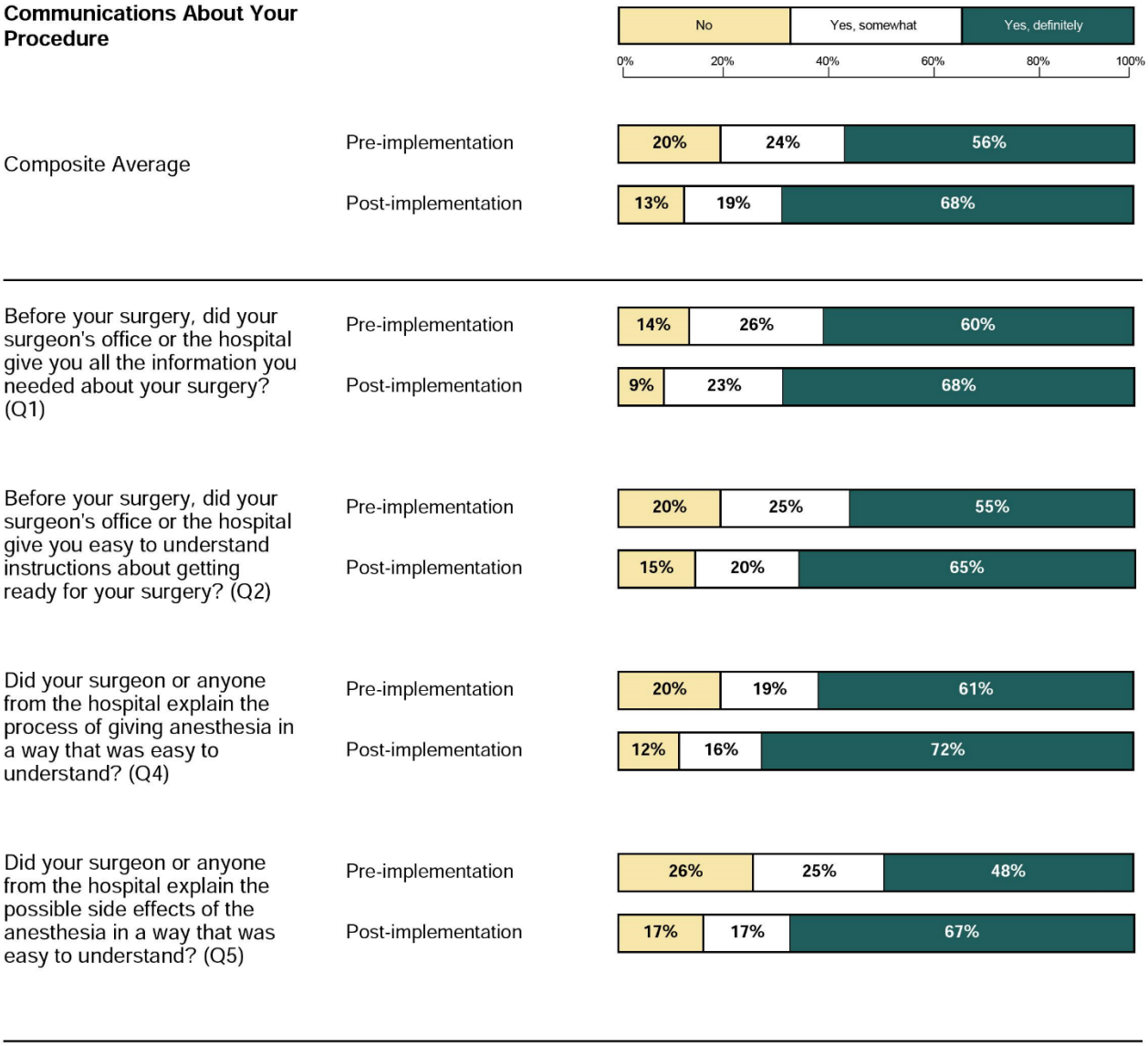
Trending Hospital Results for Hip Fracture Surgery – All Cohorts

Composite and Item-Level Results for Hip Fracture Surgery Trending Hospitals

This section provides figures to summarize the composite and item-level results by implementation status for hospitals that had sufficient patient participation in both the pre- and post-implementation phases of All Cohorts for hip fracture surgery trending hospitals. The Q after the item corresponds with the question number in the survey. Aggregate non-trending results for All Cohort pre-implementation hospitals and post-Implementation hospitals for hip fracture surgery are available in Appendix C.

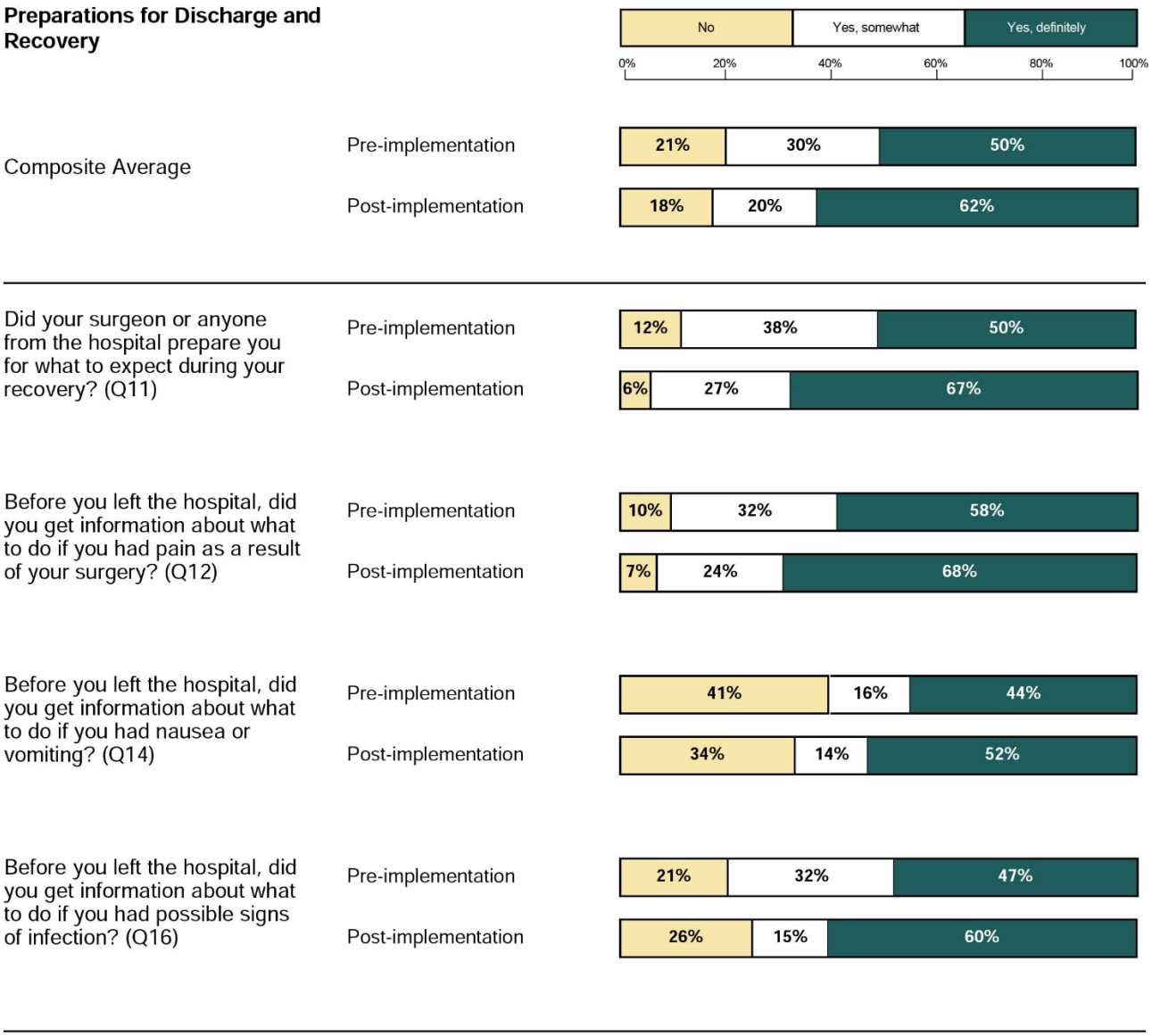
- Figure 73 shows the average percent response for each of the three *patient experience composites* and the *items* for the respective composite.
- Figure 74 shows the average percent response for the *Single Item Measures of Care*.
- Figure 75 shows the average percent responses for the *Patient Self-Reported Postsurgical Symptoms*.
- Figure 76 shows the average percent responses for the *Global Ratings*.
- Figure 77 shows the average percent responses for the *Patient Self-Reported Health Outcomes*.

Figure 73. Composite and Item Results by Implementation Status – All Cohort Hip Fracture Surgery Trending Hospitals (N=7) (Page 1 of 3)



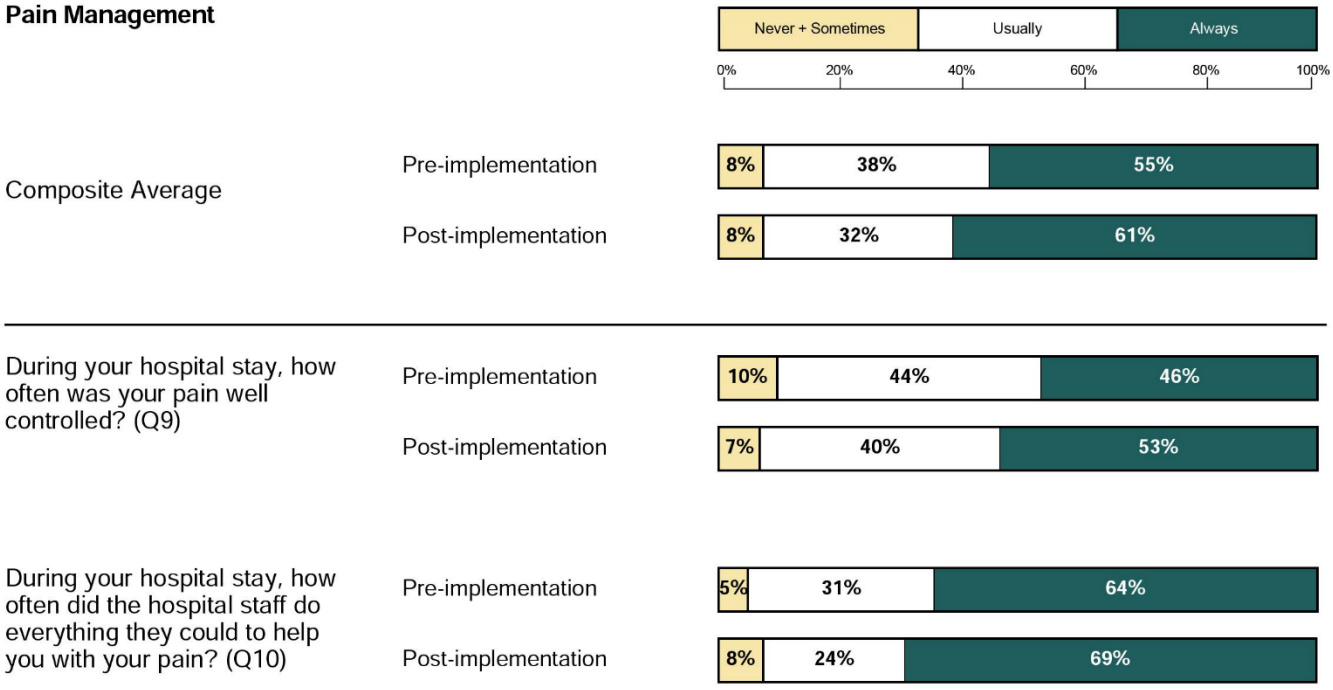
Note: Figure totals exclude missing data and may not sum to 100% due to rounding.

Figure 73. Composite and Item Results by Implementation Status – All Cohort Hip Fracture Surgery Trending Hospitals (N=7) (Page 2 of 3)



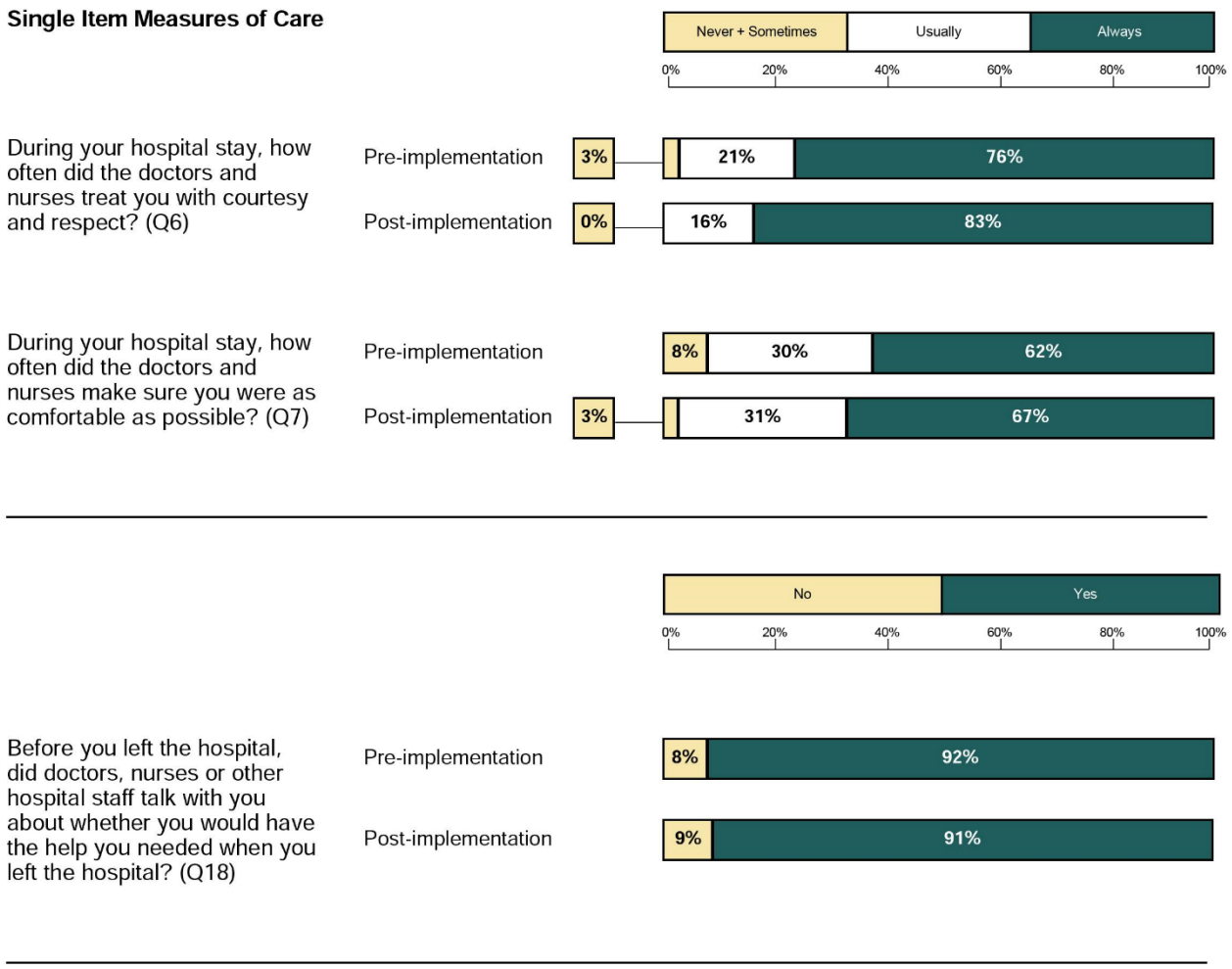
Note: Figure totals exclude missing data and may not sum to 100% due to rounding.

Figure 73. Composite and Item Results by Implementation Status – All Cohort Hip Fracture Surgery Trending Hospitals (N=7) (Page 3 of 3)



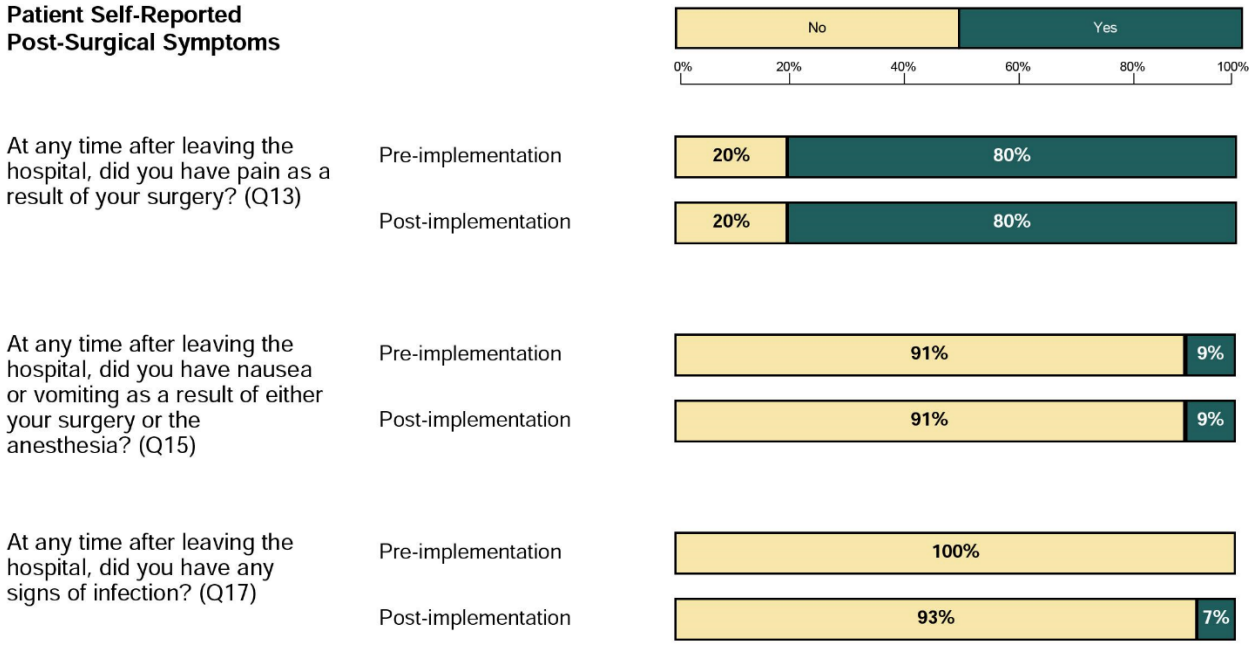
Note: Figure totals exclude missing data and may not sum to 100% due to rounding.

Figure 74. Single Item Measures of Care Results by Implementation Status – All Cohort Hip Fracture Surgery Trending Hospitals (N=7)



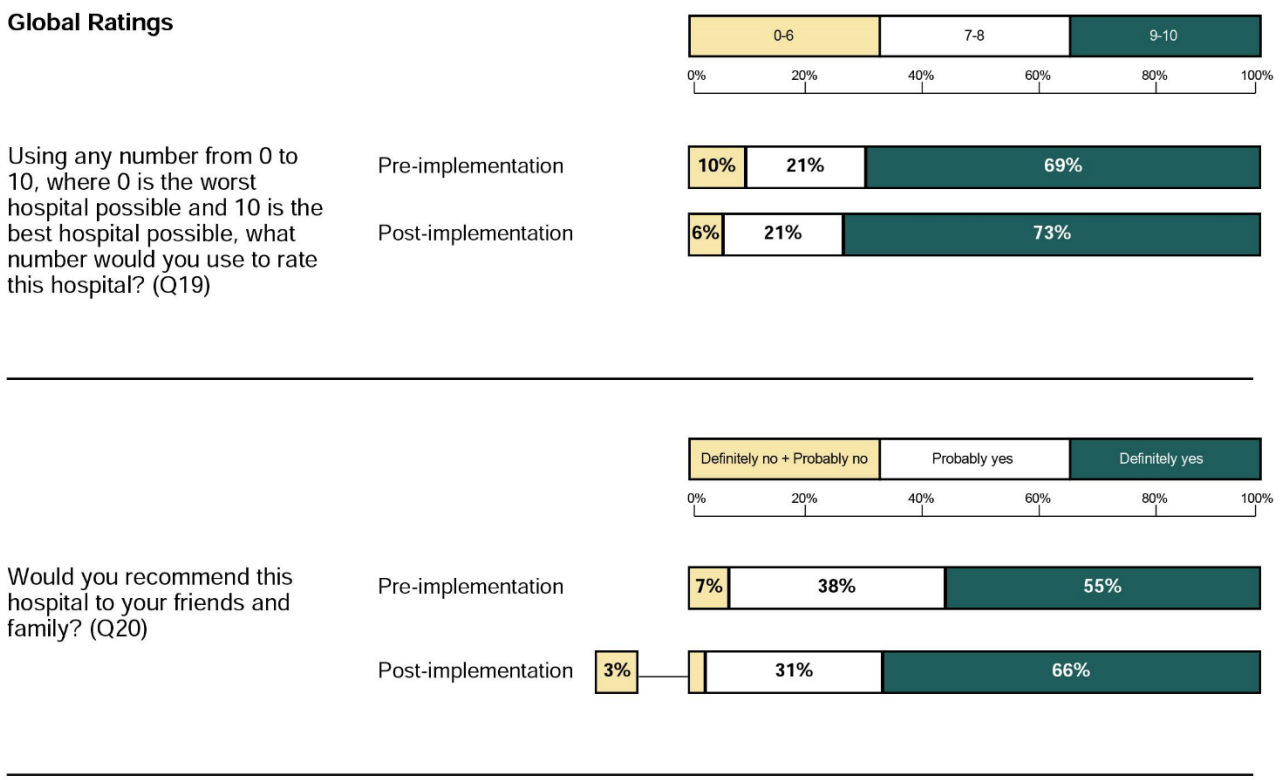
Note: Figure totals exclude missing data and may not sum to 100% due to rounding. Percentages of < 5% are shown to the left of the bar.

Figure 75. Patient Self-Reported Postsurgical Symptoms Results by Implementation Status – All Cohort Hip Fracture Surgery Trending Hospitals (N=7)



Note: Figure totals exclude missing data and may not sum to 100% due to rounding.

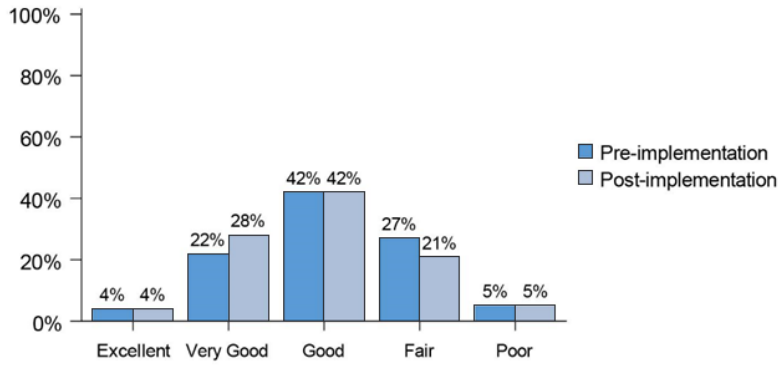
Figure 76. Global Rating Results by Implementation Status – All Cohort Hip Fracture Surgery Trending Hospitals (N=7)



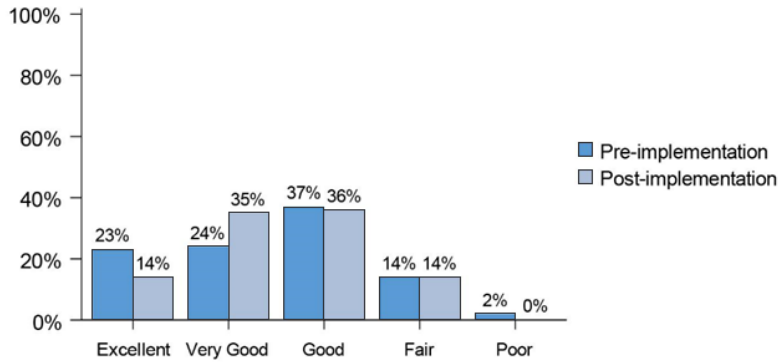
Note: Figure totals exclude missing data and may not sum to 100% due to rounding. Percentages of < 5% are shown to the left of the bar.

Figure 77. Patient Self-Reported Health Outcomes Results by Implementation Status – All Cohort Hip Fracture Surgery Trending Hospitals (N=7)

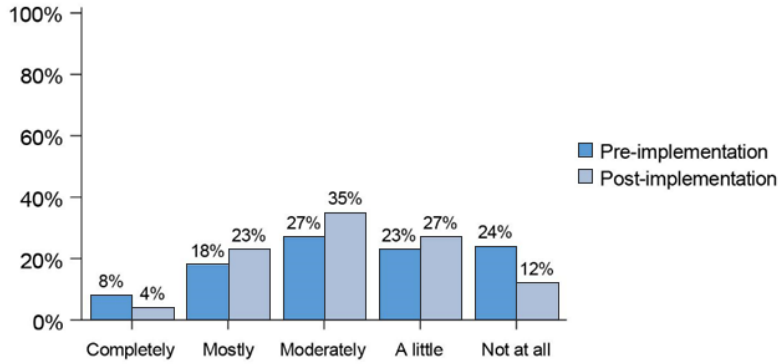
1. In general, how would you rate your overall health? (Q21)



2. In general, how would you rate your overall mental or emotional health? (Q22)



3. In the past 7 days, to what extent have you been able to return to your everyday physical activities such as walking, climbing stairs, carrying groceries, or moving a chair? (Q23)



Note: Figure totals exclude missing data and may not sum to 100% due to rounding.

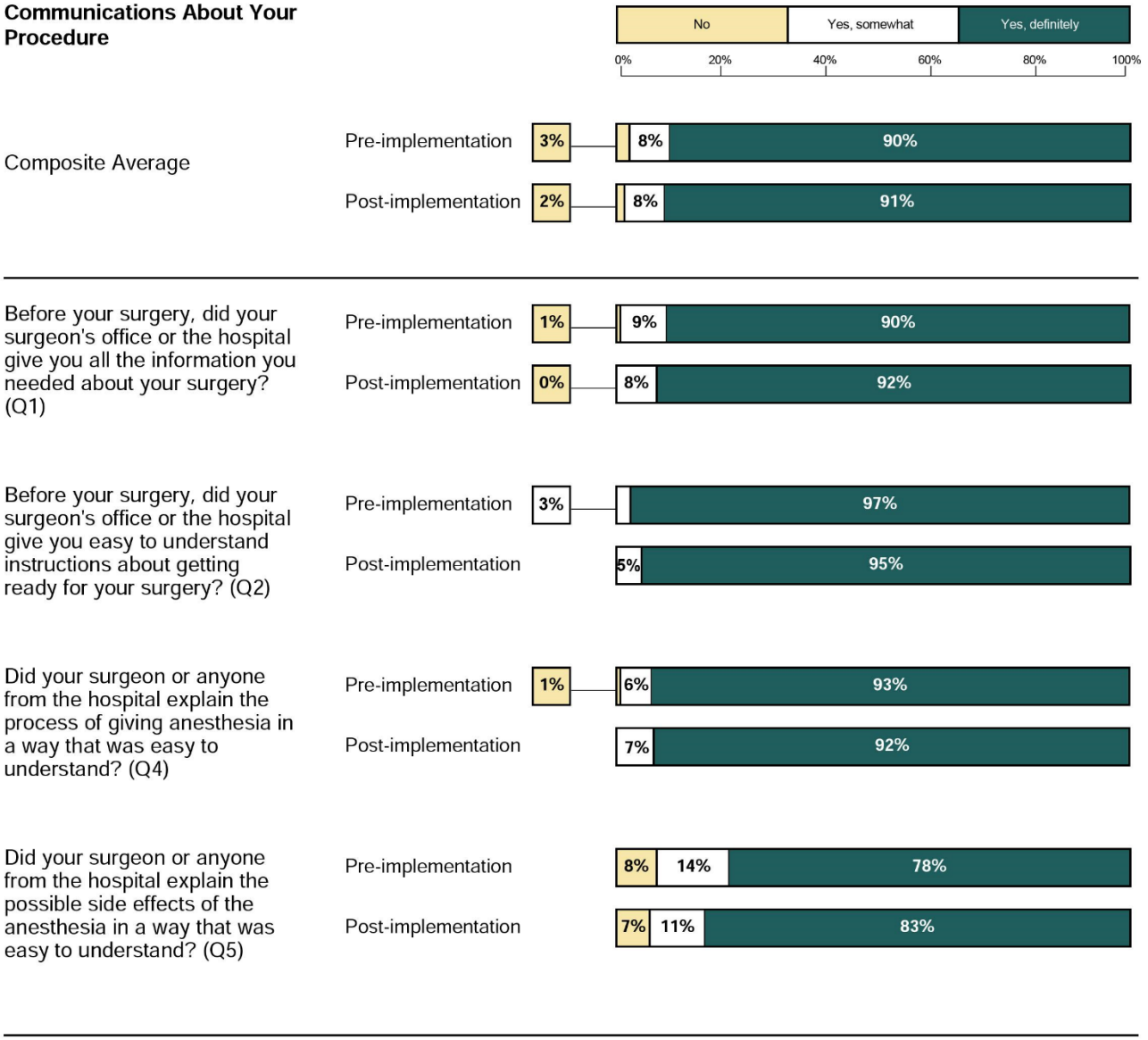
Trending Hospital Results for Gynecologic Surgery – All Cohorts

Composite and Item-Level Results for Gynecologic Surgery Trending Hospitals

This section provides figures to summarize the composite and item-level results by implementation status for hospitals that had sufficient patient participation in both the pre- and post-implementation phases of All Cohorts for gynecologic surgery trending hospitals. The Q after the item corresponds with the question number in the survey. Aggregate non-trending results for All Cohort pre-implementation hospitals and post-Implementation hospitals for gynecologic surgery are available in Appendix C.

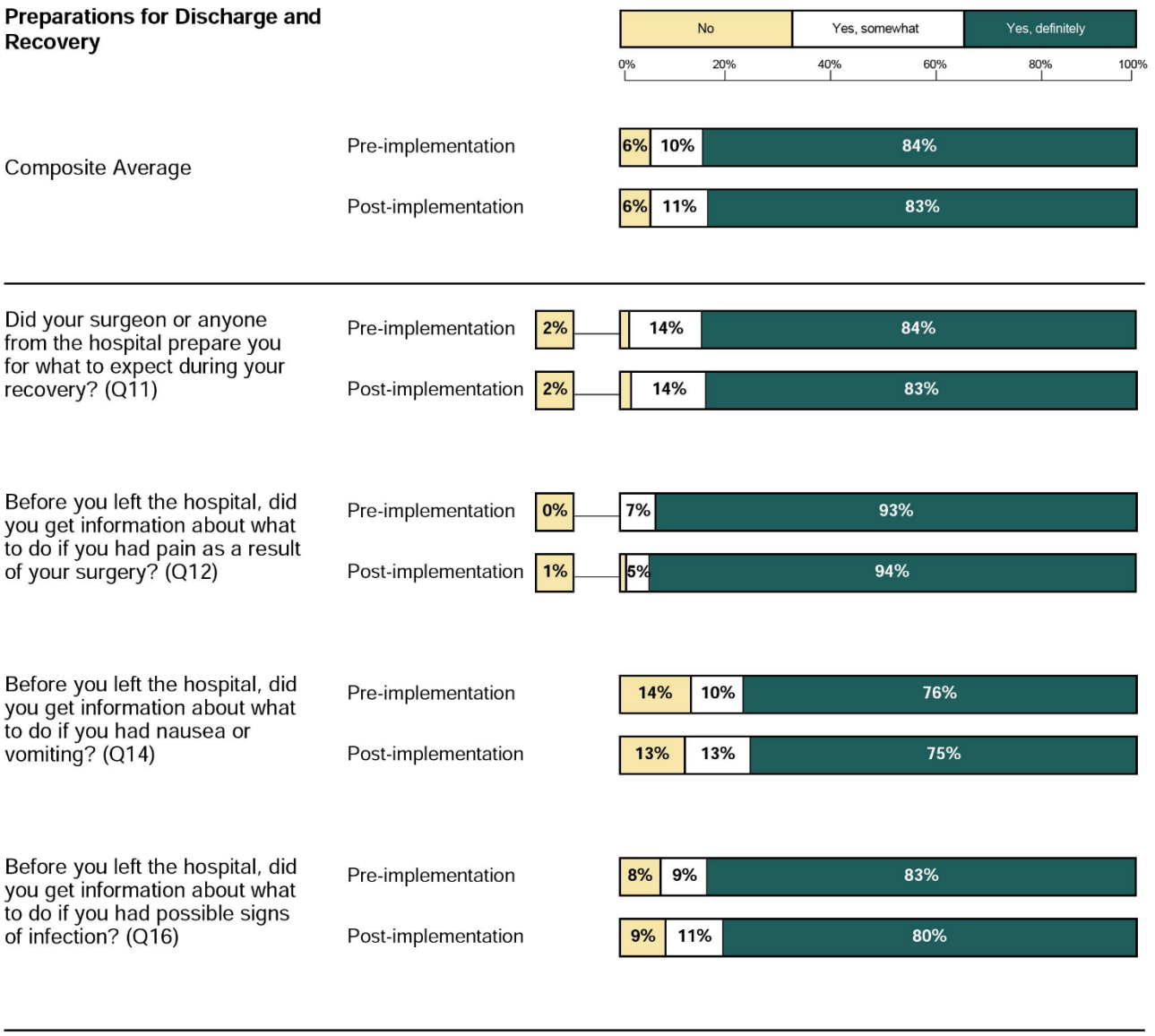
- Figure 78 shows the average percent response for each of the three *patient experience composites* and the *items* for the respective composite.
- Figure 79 shows the average percent response for the *Single Item Measures of Care*.
- Figure 80 shows the average percent responses for the *Patient Self-Reported Postsurgical Symptoms*.
- Figure 81 shows the average percent responses for the *Global Ratings*.
- Figure 82 shows the average percent responses for the *Patient Self-Reported Health Outcomes*.

Figure 78. Composite and Item Results by Implementation Status – All Cohort Gynecologic Surgery Trending Hospitals (N=15) (Page 1 of 3)



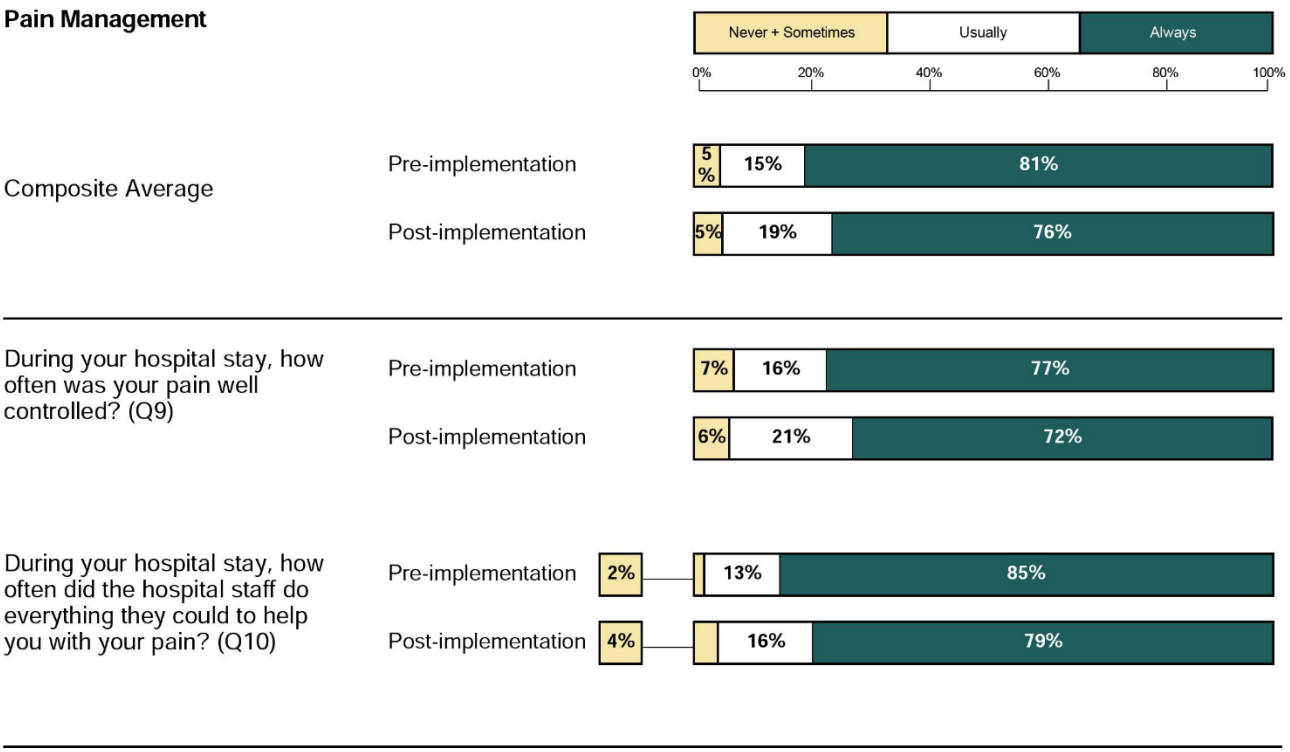
Note: Figure totals exclude missing data and may not sum to 100% due to rounding. Percentages of < 5% are shown to the left of the bar.

Figure 78. Composite and Item Results by Implementation Status – All Cohort Gynecologic Surgery Trending Hospitals (N=15) (Page 2 of 3)



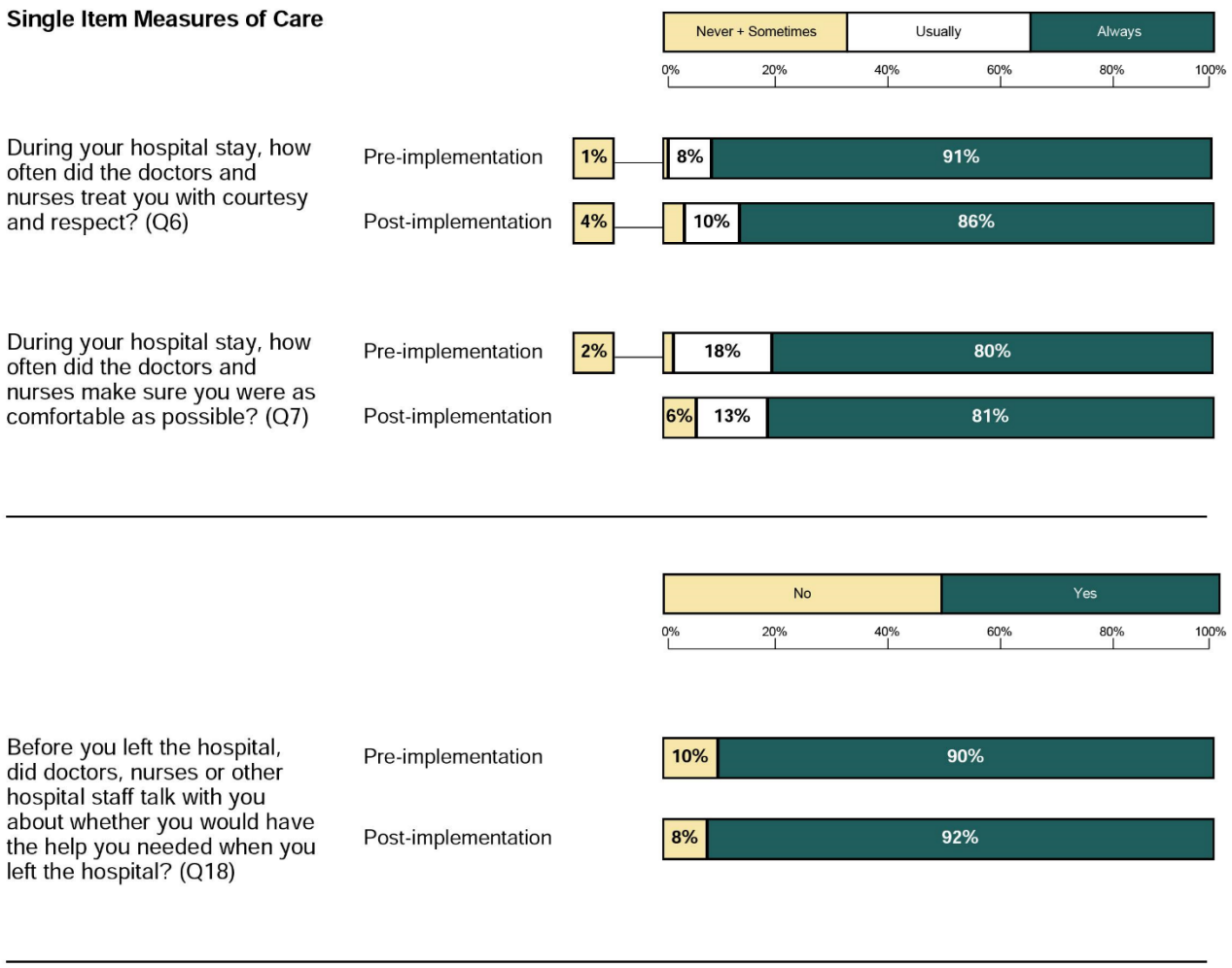
Note: Figure totals exclude missing data and may not sum to 100% due to rounding. Percentages of < 5% are shown to the left of the bar.

Figure 78. Composite and Item Results by Implementation Status – All Cohort Gynecologic Surgery Trending Hospitals (N=15) (Page 3 of 3)



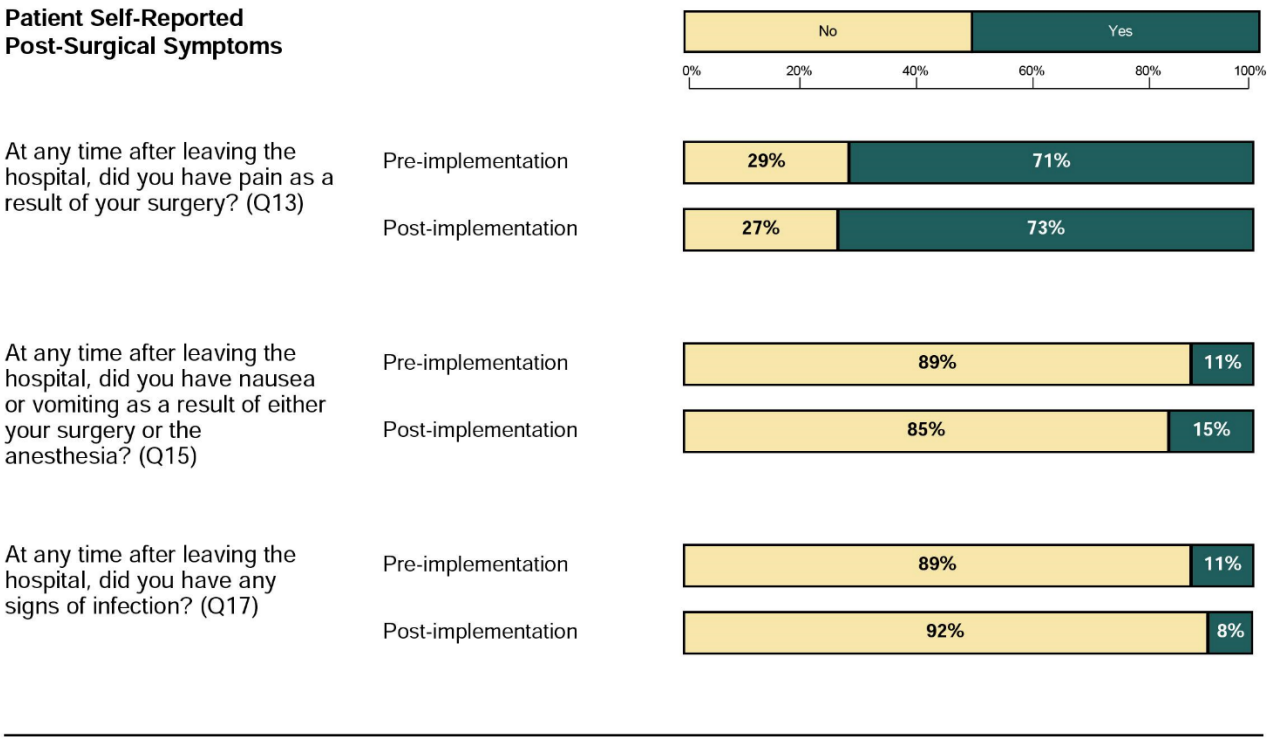
Note: Figure totals exclude missing data and may not sum to 100% due to rounding. Percentages of < 5% are shown to the left of the bar.

Figure 79. Single Item Measures of Care Results by Implementation Status – All Cohort Gynecologic Surgery Trending Hospitals (N=15)



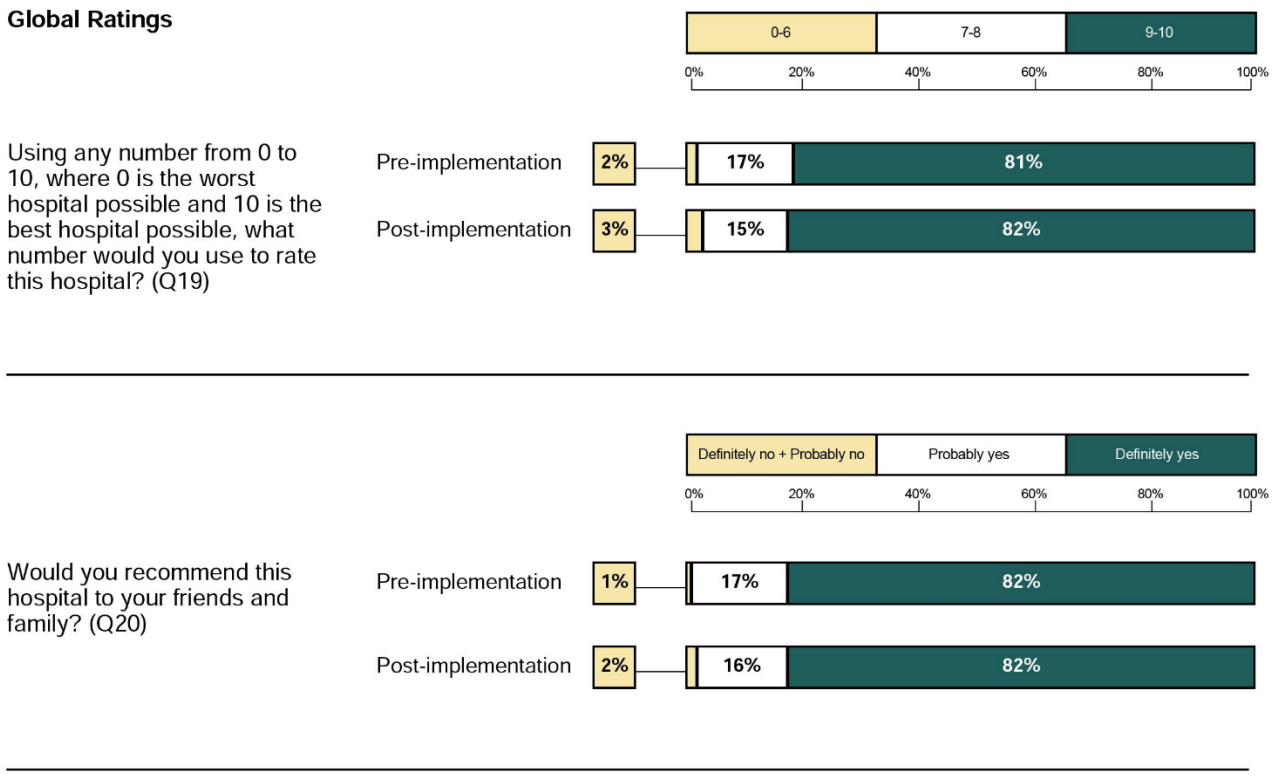
Note: Figure totals exclude missing data and may not sum to 100% due to rounding. Percentages of < 5% are shown to the left of the bar.

Figure 80. Patient Self-Reported Postsurgical Symptoms Results by Implementation Status – All Cohort Gynecologic Surgery Trending Hospitals (N=15)



Note: Figure totals exclude missing data and may not sum to 100% due to rounding.

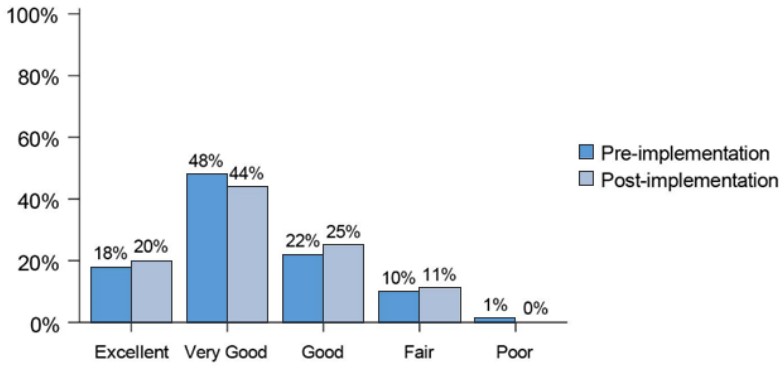
Figure 81. Global Rating Results by Implementation Status – All Cohort Gynecologic Surgery Trending Hospitals (N=15)



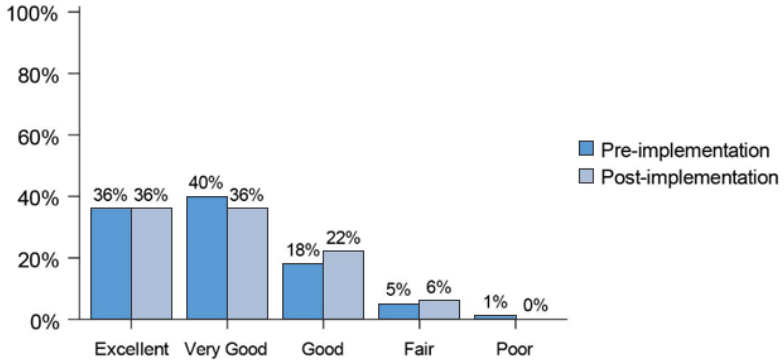
Note: Figure totals exclude missing data and may not sum to 100% due to rounding. Percentages of < 5% are shown to the left of the bar.

Figure 82. Patient Self-Reported Health Outcomes Results by Implementation Status – All Cohort Gynecologic Surgery Trending Hospitals (N=15)

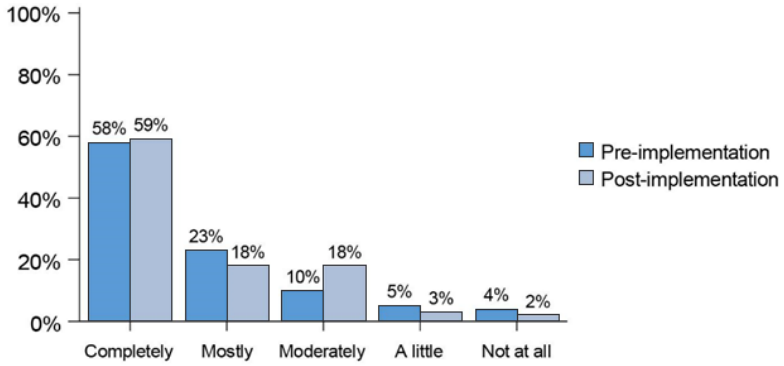
1. In general, how would you rate your overall health? (Q21)



2. In general, how would you rate your overall mental or emotional health? (Q22)



3. In the past 7 days, to what extent have you been able to return to your everyday physical activities such as walking, climbing stairs, carrying groceries, or moving a chair? (Q23)



Note: Figure totals exclude missing data and may not sum to 100% due to rounding.

Discussion

Hospital patient experience scores for colorectal and hip/knee replacement surgeries displayed minimal change from pre-implementation to post-implementation of the enhanced recovery after surgery (ERAS) intervention.

The ERAS intervention may have slightly improved patient abilities to return to normal activities. For example, hospital patient experience scores with participating colorectal surgery patients reported on average pre-implementation (44 percent), that they were completely able to return to normal activities within the past 7 days pre-implementation compared to post-implementation (47 percent). For hip/knee replacement surgery patients, hospital patient experience scores only increased 1 percentage point, where on average patients were completely able to return everyday activities within the past 7 days at pre-implementation (35 percent) compared to post-implementation (36 percent).

There are larger changes for hip fracture surgery and gynecologic surgery hospitals pre and post implementation. However, the number of hospitals participating were very small for hip fracture surgery (n = 7) and gynecologic surgery (n=15) hospitals. Variability in results for hip fracture surgery and gynecologic surgery hospitals should remain suspect as one or two hospitals could dramatically affect the change in scores.

Hip fracture surgeries, which tend to occur more in older adults, had the lowest number of responses and the lowest number of patients participating. This could be due to the higher likelihood of patient mortality in hip fracture surgery patients. For example, a recent article reported that close to 13 percent of hip fracture patients died after their procedures.[16]

Gynecologic surgeries also had a low number of hospitals participating in patient experience. This surgery was only introduced in cohorts 3a and 3b and therefore had the least amount of time to build participation in the program.

Effect of COVID-19 on Patient Experience Scores

During the peak period of COVID-19 for the ISCR Patient Experience Survey (March 2020 through the end of data collection, January 2021), the number of patient records received from the ACS was much lower compared to other data collection periods, which decreased the number of first survey mailings. For example, during the Cohort 3a post-implementation, the eligible discharge dates included patients during the non-COVID-19 and COVID-19 periods (December 21, 2019, to May 21, 2020) and the number of total patient records received was 4,577. For Cohort 3b post-implementation, the eligible discharge dates were only during the COVID-19 pandemic (June 1, 2020, to November 1, 2020) and the total number of records received was 559.

Changes in ISCR patient experience scores for pre- and post-COVID-19 could simply be due to the number of surveys received and the location of the hospital. For example, the number of surveys received is substantially lower between COVID-19 and non-COVID-19 periods which could affect scores simply based on the small number of respondents. Furthermore, states had different COVID-19 peak periods, which may have affected the number and types of surgeries in different geographic areas.

Subgroup Analysis on Patient Demographics

After reviewing the overall results and results by surgical line or pathway, AHRQ requested subgroup analysis by several demographic questions to identify any subgroups where the ISCR intervention may have improved patient experience scores. The memo in Appendix D describes the methods used to examine these subgroup scores and presents results by age, gender, and education for the colorectal surgery line.

Data Limitations

The survey results presented in this report are based on hospitals that participated in both the pre-implementation and post-implementation phases of All Cohorts by surgery type. The number of hospitals in the hip fracture surgery and gynecologic surgery service lines are small and therefore any findings presented may not be reliable. The results for all of the service lines are not representative of a given population, nor representative of all U.S. hospitals and, therefore, have unknown statistical properties. While readers should be cautious when using these results, they do provide a reference for comparison to individual hospital results.

Notes: Data Calculations

To ensure confidentiality and representativeness of hospital survey responses, only hospitals with at least three completed surveys were included in the study results. Hospitals with at least five completed surveys, after data cleaning, also received an individual hospital feedback report that compared their results to aggregate study results.

Average score calculation. The average percent score for each of the three patient experience composites were calculated by averaging the composite-level percent scores across all trending hospitals, and separately for pre-implementation hospitals, and post-implementation hospitals. Similarly, the average percent score for the 23 survey items were calculated by averaging the item-level percent scores across hospitals. Since scores are reported as an overall average, scores from each hospital were weighted equally in their contribution to the calculation of the average.

Composite average score calculation. Each of the composite measures consist of two or more survey items that relate to a topic. Table 61 illustrates how composite scores are calculated. In the example, the composite comprises two survey items, and each item has four response options (or answers). The calculation process is the same for composite measures comprising more than two items.

- Step 1 – Calculate the proportion of responses for each answer option (e.g., usually) for each question.
- Step 2 – Calculate the average proportion responding for each answer option for all survey questions that comprise the composite measure.

Table 61. Example of How To Calculate Composite Average Score Frequencies

Two Items Measuring Pain Management	Never or Sometimes		Usually		Always		Total Number of Non-Missing Respondents
Item Text	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**	**n**
"During your hospital stay, how often was your pain well controlled?" (Q9)	2	(20)	3	(30)	5	(50)	10
"During your hospital stay, how often did the staff do everything they could to help you with your pain?" (Q10)	2	(22)	4	(44)	3	(33)	9
Composite Average Frequencies		**(21)**		**(37)**		**(42)**	**N/A**

Note: If a hospital is missing an item from a composite for all respondents, the proportional score is still calculated on the remaining items, dividing by the number of items for which there are responses.

Section III. Implementation Evaluation

This section details program efforts to evaluate ISCR pathway implementation processes at participating facilities. The overarching goal of data collection and analyses presented in this section were to provide ongoing and near-real time information to the NPT that could be used to adjust offerings so that the ISCR program was as impactful as possible and responsive to participant needs. Specifically, the implementation evaluation consisted of three main components:

1. Assessing organizational readiness for change at participating facilities at the beginning of the cohort;
2. Ongoing assessment of the quality of the implementation process, including four key CUSP elements (leadership involvement, multi-disciplinary teamwork, and the involvement of frontline staff by sharing clinical process and outcome data);
3. Ongoing assessment of barriers to implementation experienced by participating facilities.

Each of these evaluation domains is detailed below, followed by a summary and analysis of the impact of implementation factors on clinical process and outcome measures. Data for cohorts 2 through 4 are included here. Cohort 3A and 3B data are combined due to the small size of cohort 3B. Cohort 1 data are not included in this analysis as the implementation evaluation strategy changed dramatically from lessons learned in the first cohort, and cohort 1 data are not comparable to the remaining cohorts.

Methods

Organizational Readiness for Change

Organizational readiness is an important driver of the ultimate outcomes of change efforts and refers to a shared resolve among the members of an organization to implement a change, and a shared belief in their ability to be successful.[17] ORCA is a structured survey intended to assess organizational readiness to implement a specific, evidence-based clinical practice.[18] It provides an overall indication at baseline of the likelihood of success. We administered the ORCA Context scale, which includes six domains: (1) leadership culture, (2) staff culture, (3) leadership practice, (4) evaluation and accountability, (5) opinion leader culture, and (6) slack resources. Each domain consists of three or four survey items, each responded to using a 5-point Likert scale (ranging from 1 = “Strongly disagree” to 5 = “Strongly agree”). Larger numbers on the scale indicate higher levels of readiness. ORCA surveys were distributed to hospitals through the web portal as part of their onboarding into their cohort(s) and completed by project team leads.

Implementation Quality

Implementation quality was assessed using a check-in survey administered at three time points throughout each cohort, approximately corresponding to each third of the cohorts scheduled time in the program. The specific timing of survey administration varied slightly by cohort to account for disruptions due to COVID-19 and other minor scheduling concerns (e.g., providing additional time to respond when an administration period overlapped a holiday season). This survey assessed four criteria aligned with the CUSP principles driving the implementation, including leadership involvement, multidisciplinary teamwork, sharing process data with frontline staff, and sharing outcome data with frontline staff. Sites completed the check-in survey for each service line they were implementing. Table 62 describes the survey items and criteria for “high-quality implementation” for each CUSP principle listed. Leadership involvement was included as senior leaders bring an

important system-level perspective that complements team members working on the frontlines. Engaged senior leaders can advocate for teams and the work at a high level, ensure teams have the requisite resources for effective implementation, and help team leaders hold staff members accountable for their responsibilities, as needed. Leadership involvement was measured by asking teams how often their senior executive sponsor attends team meetings. Multidisciplinary team engagement was included as successful implementation efforts require a dedicated team containing members from every discipline where the intervention is occurring. By meeting frequently, multidisciplinary teams can discuss defects and barriers they are facing that relate to implementation and identify strategies to address these defects and barriers. Multidisciplinary team engagement was measured by asking teams how often they meet as a group. Sharing process and outcome data with the frontline were included as this offers transparency and accountability. Data keep staff informed on their progress with adoption of targeted processes, allows team leaders to hold staff accountable for complying with processes, and shows staff what kind of effect implementation is having on the patient outcomes of interest. Sharing process and outcome data were measured by asking hospitals if and how often they share reports of process and outcome measures with frontline staff.

Table 62. Evaluation Criteria for High Quality Implementation of CUSP Components

CUSP Component	Check-in Survey Items	Criteria for High Quality Implementation
Leadership involvement	How often does your Senior Executive sponsor (or someone from his/her office) attend the ISCR team meetings?	Senior executive sponsor attends meetings: At first and second time point: "About half of the time or more" At third time point: "At least 50% of the time"
Multi-disciplinary teams	At this point in time, how often does your [ORTHOPEDIC / COLORECTAL / GYNECOLOGIC / EGS] ISCR team meet?	Meet as a team at least monthly
Sharing process data with frontline providers	How often do you share reports of your process measures with frontline providers (bedside nurses, surgeons, anesthesia providers, physical therapy, etc.)?	Share process data at least monthly
Sharing outcome data with frontline providers	How often do you share reports of your outcome measures with frontline providers (bedside nurses, surgeons, anesthesia providers, physical therapy, etc.)?	Share outcome data at least monthly

Barriers to Implementation

We tracked hospital experiences with implementation barriers through the check-in survey described above. Participants were asked to respond to how often each of 19 known barriers impacted their own work and to provide additional barriers in a free text response item. The structured survey response items are provided in Table 63.

Table 63. Structured Barrier Survey Items

Barrier Category	Barrier Items*
Knowledge gaps	• Insufficient knowledge of evidence supporting interventions

Leadership support	• Not enough leadership support from
	  ○ EXECUTIVES
	  ○ SURGEONS
	  ○ ANESTHESIOLOGISTS
	  ○ NURSES
	• Insufficient autonomy/authority

Team skills and cohesion	• Lack of quality improvement skills • Confusion about how to proceed with enhanced surgical care and recovery activities • Lack of team member consensus regarding goals • Inability of team members to work together
Stakeholder push-back	• Not enough buy-in from SURGERY staff • Not enough buy-in from ANESTHESIOLOGY staff • Not enough buy-in from NURSING staff • Not enough buy-in from OTHER staff
Workload and time	• Not enough time • Staff turnover on unit • Data collection burden for staff • Problems with data systems • Competing priorities or distractions (e.g., new electronic health record, accreditation visit)

**Sites responded to structured barrier survey items, phrased as follows: Since joining the Improving Surgical Care and Recovery program, how often did each of the following factors slow your team's progress in implementing the enhanced recovery pathway? Responses: Never/rarely, occasionally, frequently, almost always*

Analysis and Results

Organizational Readiness for Change

Overall, 303 ORCA surveys were completed, representing 88.6 percent of hospitals who participated in the ISCR program. Table 64 details domain items for the ORCA Scale. Domain scores were created by averaging item responses. Figure 83 illustrates the mean and distribution of (a) overall and domain scores for ORCA for cohorts 2, 3, and 4, and (b) overall ORCA scores by service line across all Cohorts. Responses across cohorts were remarkably similar. Cohort 4 participating sites reported moderate to high overall levels of readiness with a mean score of 3.96 (compared to 3.90 in cohort 3, and 3.87 in cohort 2) on a scale from 1 to 5, in which larger numbers indicated higher levels of readiness. In cohort 4, 8 sites had an overall readiness score below 3, the

mid-point of the scale, compared to 18 sites in cohort 3 and 8 in cohort 2). Across all cohorts, the widest range and lowest mean in responses were in the slack resources domain which represents the organizations capacity to allocate adequate person, financial, and other resources to the project. There were no marked differences in ORCA scores across the service lines.

Table 64. Organizational Readiness To Change Assessment Context Scale Domains and Items

Domain	Items
Leadership culture	Senior leadership/clinical management in your organization: • Reward clinical innovation and creativity to improve patient care • Solicit opinions of clinical staff regarding decisions about patient care • Seek ways to improve patient education and increase patient participation in treatment
Staff culture	Staff members in your organization: • Have a sense of personal responsibility for improving patient care and outcomes • Cooperate to maintain and improve effectiveness of patient care • Are willing to innovate and/or experiment to improve clinical procedures • Are receptive to change in clinical processes
Leadership practice	Senior leadership/Clinical management in your organization: • Provide effective management for continuous improvement of patient care • Clearly define areas of responsibility and authority for clinical managers and staff • Promote team building to solve clinical care problems • Promote communication among clinical services and units
Evaluation and accountability	Senior leadership/Clinical management in your organization • Provide staff with information on performance measures and guidelines • Establish clear goals for patient care processes and outcomes • Provide staff members with feedback/data on effects of clinical decisions • Hold staff members accountable for achieving results
Opinion leader culture	Opinion leaders in your organization: • Believe that the current practice patterns can be improved • Encourage and support changes in practice patterns to improve patient care • Are willing to try new clinical protocols • Work cooperatively with senior leadership/clinical management to make appropriate changes
Slack resources	In general, in my organization, when there is agreement that change needs to happen: • We have the necessary support in terms of budget or financial resources • We have the necessary support in terms of training • We have the necessary support in terms of facilities • We have the necessary support in terms of staffing

Figure 83 (1 of 2). Organizational Readiness To Change Assessment Responses by (A) Domain and Cohort.

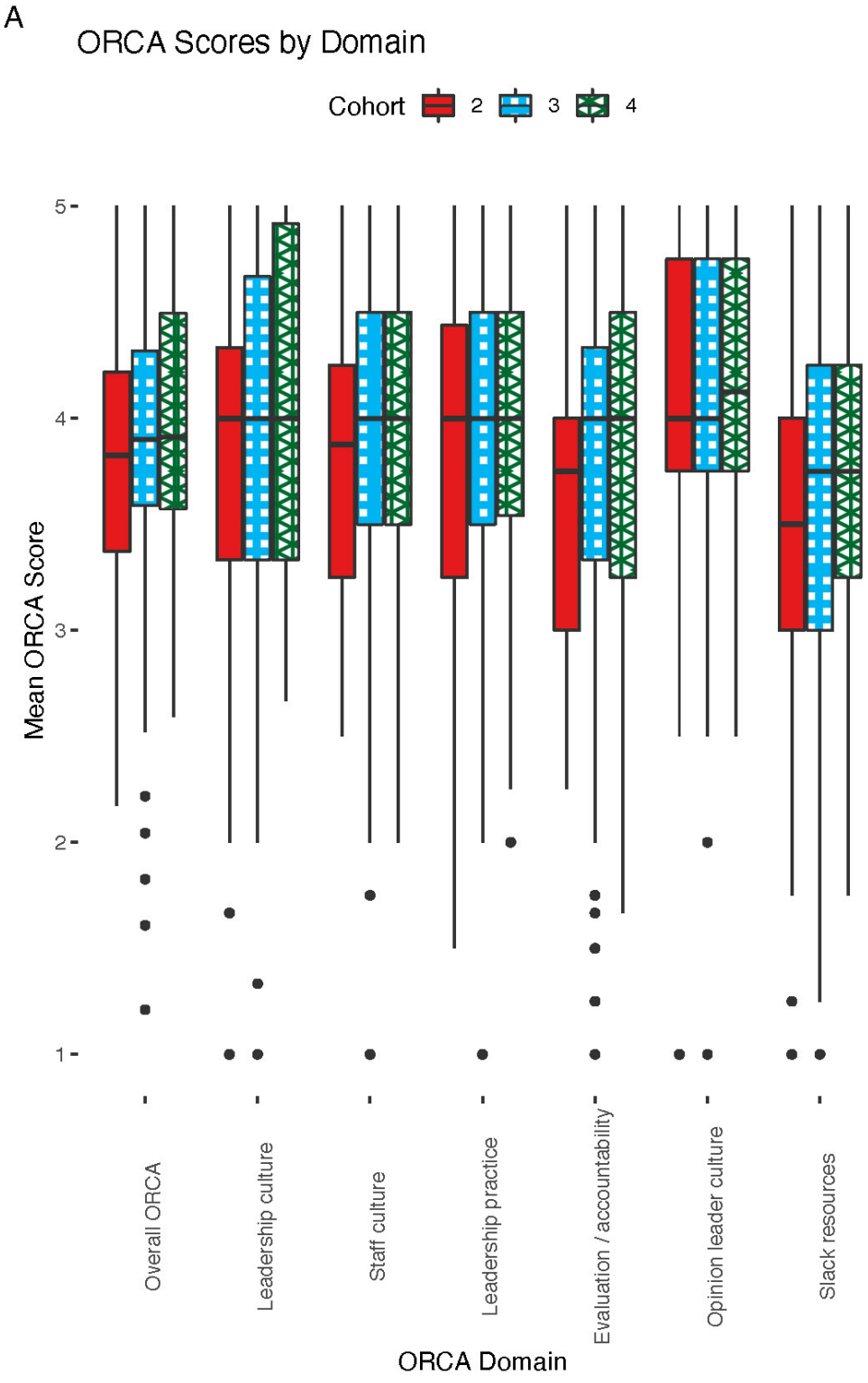
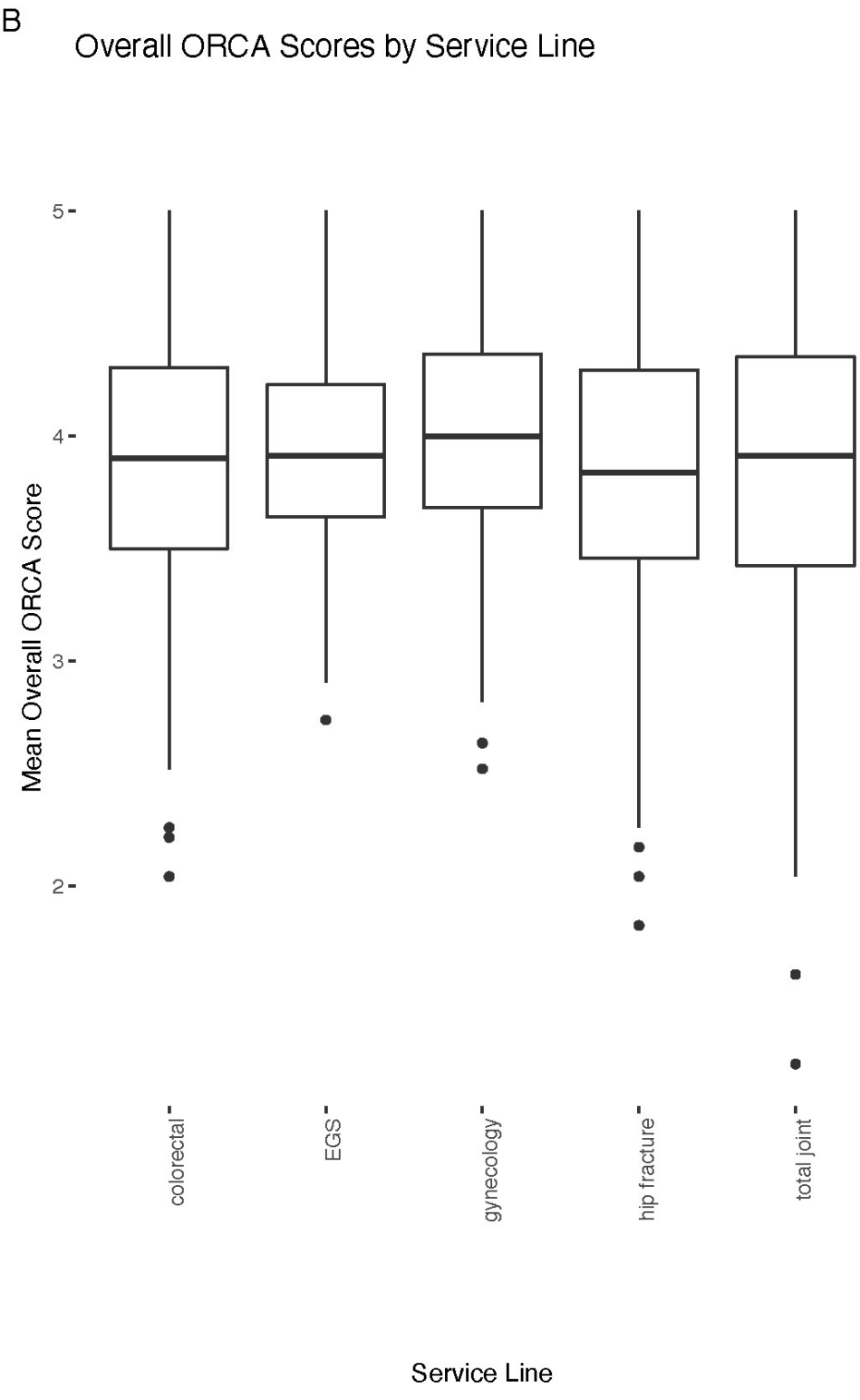


Figure 83 (2 of 2). Organizational Readiness To Change Assessment Responses by (B) Service Line Across All Cohorts.



Note: For these domain scores, 5 indicates high readiness, and 1 low readiness. Respondents rate their level of agreement with Organizational Readiness to Change Assessment (ORCA) items on a 1 to 5 Likert Scale (1 = Strongly Disagree; 2 = Disagree; 3 = Neither agree nor disagree; 4 = Agree; 5 = Strongly Agree). Domain scores are created by averaging all items in that subdimension.

Implementation quality

Table 65 provides a summary of check-in survey response rates across Cohorts and timepoints. Figure 84 illustrates (a) the proportion of responding hospitals at each time point that met the criteria for high-quality implementation for each of the four CUSP principles as defined in Table 68, and (b) the frequency of hospitals reporting different patterns of high-quality implementation across all cohorts and time points. Facilities were most likely to report high-quality implementation for teamwork (i.e., meeting at least monthly; 48.9%), followed by sharing process data (45.4%), sharing outcome data (42.9%), and leadership involvement (35.4%).

Table 65. Response Rates for Check-in Surveys

Cohorts	First Survey Administration *% participating facilities (# responding/# enrolled)*	Second Survey Administration *% participating facilities (# responding/# enrolled)*	Third Survey Administration *% participating facilities (# responding/# enrolled)*
2	37% (104/278)	52% (78/150)	68% (77/114)
3A	86% (109/127)	75% (94/125)	50% (60/121)
3B	90% (35/39)	55% (21/38)	54% (20/37)
4	66% (90/137)	67% (78/116)	63% (71/112)

Notes: The denominator is the number of hospitals enrolled at the time of administration, so changes across the time periods for each cohort. The third administration of cohort 3A and second administration of 3B occurred during the early phases of the pandemic, which likely explains the drop off in response rates.

Of facilities meeting at least one of the four high-quality implementation criteria, there were 15 different patterns, or combinations of implementation processes. Most commonly, facilities were high-quality implementers on either the teamwork or leadership involvement domains individually. This was followed by facilities meeting all four high-quality implementation criteria, and then by facilities meeting all but the leadership criteria. As illustrated in Figure 86B, participating sites employed a wide variety of implementation approaches.

Figure 84 (1 of 2). High-Quality Implementation (A) At Each Time Point for Each Cohort.

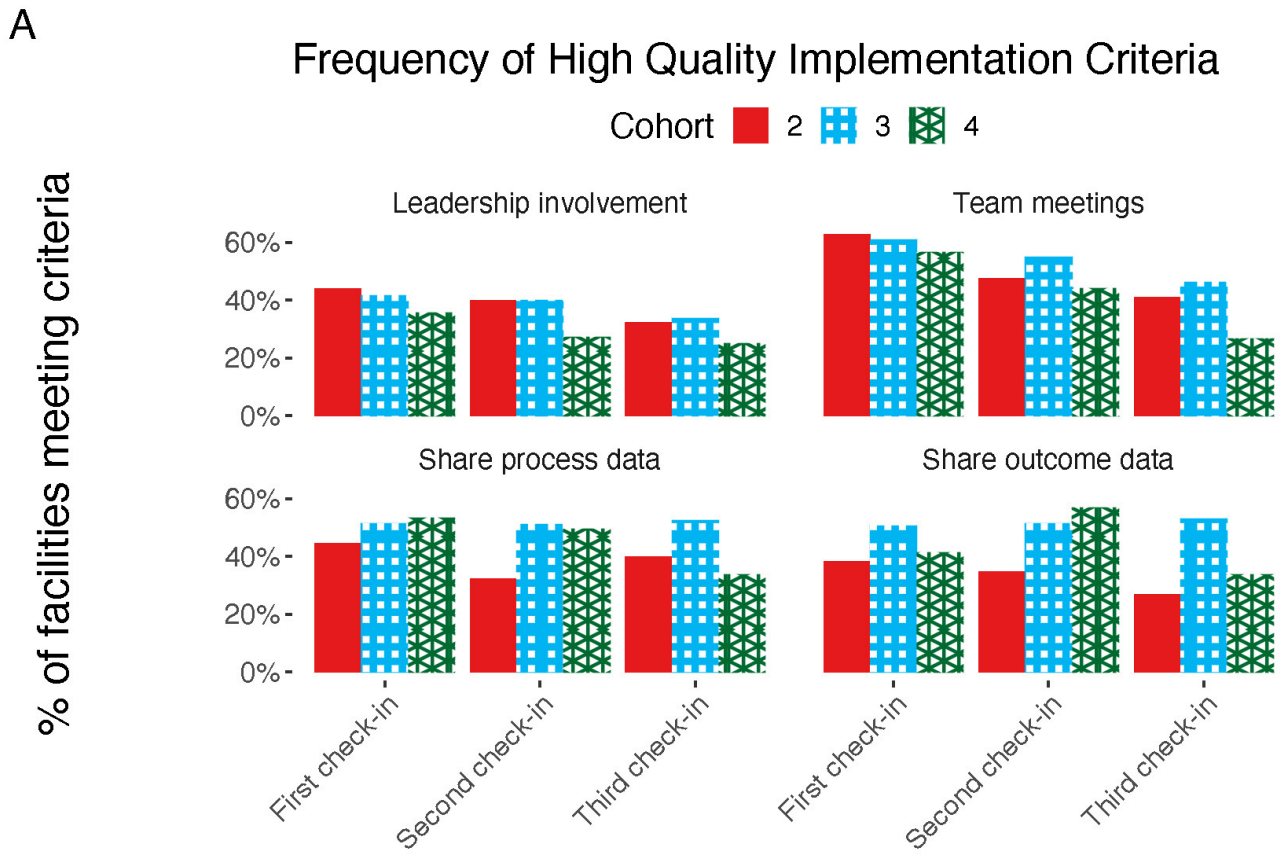
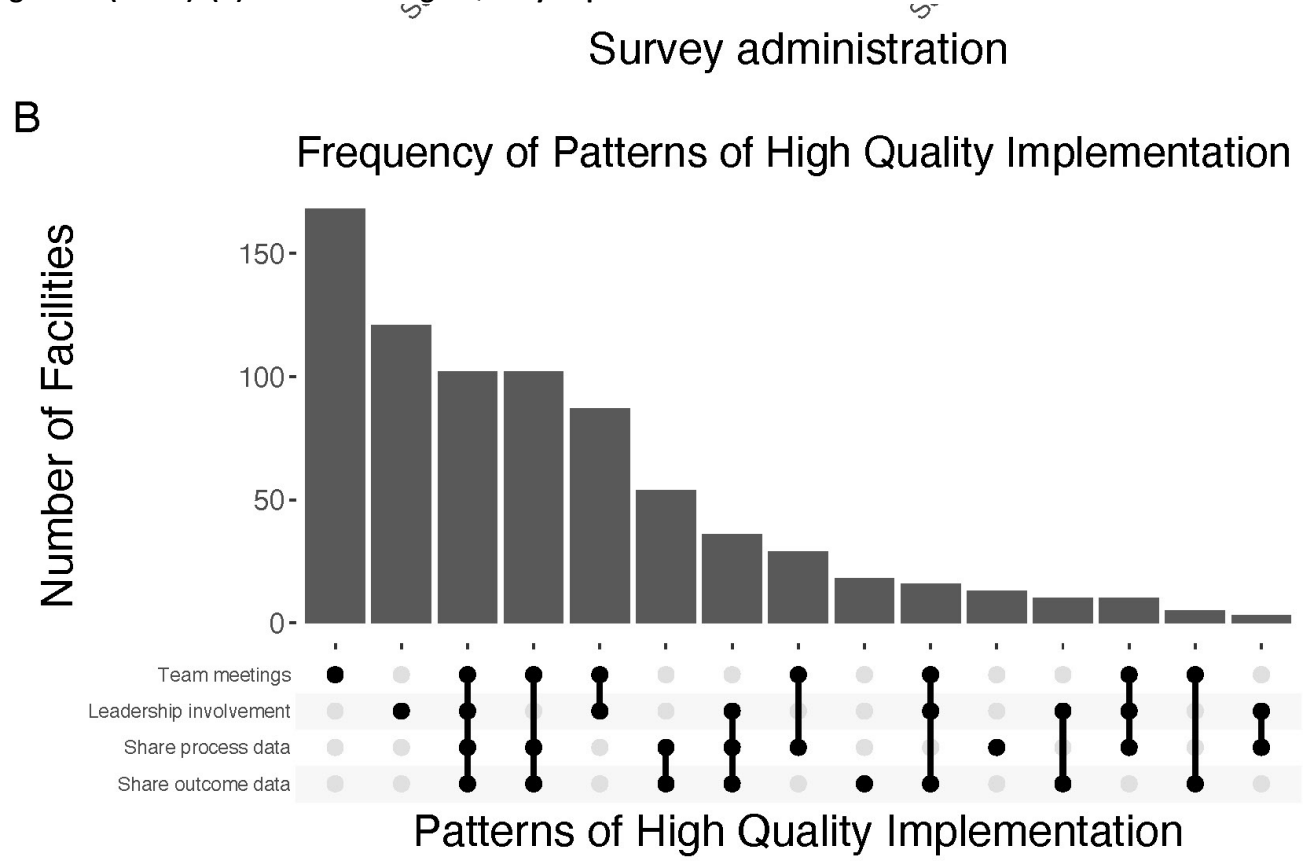


Figure 84 (2 of 2). (B) Patterns of High-Quality Implementation Across All Cohorts and Time Points.



Barriers to Implementation

Figure 85 illustrates the percentage of sites reporting that at least one barrier in a barrier category "frequently" or "almost always" impacted their work. Across all cohorts and time points, workload-related barriers were most frequently reported at 29.8%. This was followed by leadership support (12.2%), pushback (9.4%), knowledge (8.5%), and team skills and cohesion (6.1%). Table 66 summarizes other barriers reported in free-text response items, and Table 67 details the frequency by which themes of barriers were mentioned across cohorts 2 through 4. It is important to note the overall number of barriers reported increased in each cohort, likely influenced by the size of the cohorts as well as the impact of COVID-19 on later cohorts. Of the 19 separate themes, 6 accounted for most concerns. COVID-19 related barriers emerged as a top concern during Cohort 3 (14.8% of responses) and became the dominant concern in cohort 4 (28.9% of responses). Stakeholder buy-in was a top concern in cohorts 2 and 3 (21.3% and 23.0% of responses, respectively) but dropped significantly in cohort 4 (9.5%). Both registry reporting/data abstracting and EHR/documentation barriers decreased across the three cohorts. Competing priorities and limited resources jumped from 12.5% and 9.4% in cohorts 2 and 3 to 20.0% in cohort 4. While these concerns were not directly about COVID-19, it is likely that pressures created by the pandemic created more challenges for organizations to manage increasingly scarce resources. Turnover among key staff rose slightly from 4.4% in cohort 2 to 7.0% in both cohorts 3 and 4.

Figure 85. Percentage of Responding Hospitals Reporting That Barriers Impacted Their Work

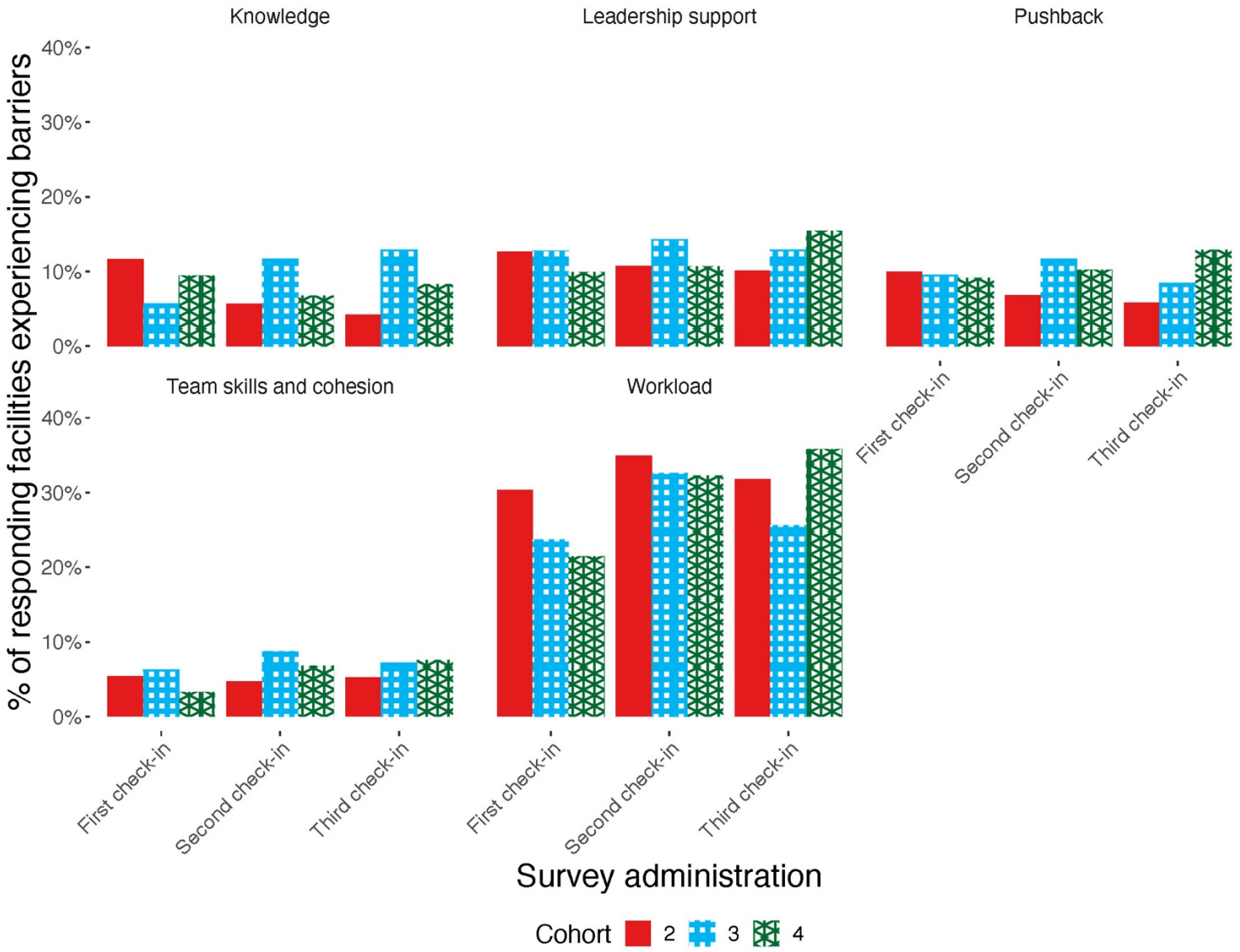


Table 66. Themes in Other Barriers Reported

Barrier	Reported Themes
COVID-19	• Hospitals have reallocated most of their ISCR enhanced recovery pathway (ERP) team into other roles due to COVID. • Hospital's surgical volume was negatively impacted due to COVID-19 but is now trending towards pre-COVID-19 levels. • Hospital's resource allocation was negatively impacted in recent months due to COVID-19.
Key Stakeholder Buy in/Engagement/Compliance	• Hospitals continued to experience minimal participation from key team leaders. • No established regular meeting for all general surgeons. Lack of buy in for order sets from some surgeons, and refusal to use pathway and refusal to consider data. • Some staff and surgeons don't have much interest in conducting patient education, and most of their issues were related to a surgeon champion who was not engaged or organized in leading this effort. • Inconsistent implementation pathway by nursing, analgesia pain management protocols not in alignment with multi-modal pain management.
Electronic Health Record /Documentation	• Main issue is that order set building is being prioritized to only critical patient safety issues. • Hospital merge so their order sets have taken longer to update than planned. Their Epic order sets were on hold until the pathway could be vetted by the enterprise which includes many other hospitals. • Getting the order set built in EHR was slower than hospitals expected. • Cumbersome EHR system hindered the ease of implementing non-elective enhanced recovery cases.
Competing Priorities and Limited Resources	• Finances did not allow hospitals to hire the abstraction/admin staff needed to complete this project. • Hospitals found it difficult to collaborate on the planning/pre-implementation phase when nurses cannot be spared from the bedside and neither can emergency medicine personnel. As well as quality services staff being redeployed to meet COVID-19 needs.
Time Required To Implement and Change Culture	• Despite the willingness of the leaders, changing processes in this environment as well as achieving consistency has been a challenge. • It is difficult to devote time to the teaching, meetings, planning, implementation of the EGS pathway, nonconsensus among hospital group. • At times, it was difficult to get all parties involved to do (what was perceived to be) more work, or a major change in their workload/ work flow. • Working from home, some participants lost communication with the others that work on the project. They found it difficult establishing a reconnection.

Barrier	Reported Themes
Data Analysis	• Finding someone to manually abstract the data was one of the biggest challenges. Even though some hospitals participate in NSQIP- adding the additional enhanced recovery metrics to the SCR workload was not possible. • Low case numbers limit ability to rely on data. 1-2 fallouts were considered "a bad day" • There were also challenges with identifying who would collect the data metrics and how they would be collected.

Abbreviations: EGS = emergency general surgery; EHR = electronic health record; ISCR = AHRQ Safety Program for Improving Surgical Care and Recovery; NSQIP = National Safety and Quality Improvement Program

Table 67. Frequency of Barrier Themes Reported in Implementation Check-ins

Implementation Barrier Theme	Cohort 2 %	Cohort 2 N	Cohort 3 %	Cohort 3 N	Cohort 4 %	Cohort 4 N
COVID-19	n/a	n/a	14.8%	36	28.9%	107
Key Stakeholder Buy in/Engagement/Compliance	21.3%	34	23.0%	56	9.5%	35
Registry/Reports/Data Abstracting	20.6%	33	7.0%	17	4.3%	16
EHR/Documentation	18.1%	29	13.1%	32	5.4%	20
Competing Priorities and Limited Resources	12.5%	20	9.4%	23	20.0%	74
Turnover Among Key Staff/Champions	4.4%	7	7.0%	17	7.0%	26
Onboarding and Keeping Stakeholders Informed on Pathway	3.8%	6	6.1%	15	0.0%	0
Low Case Volume	3.8%	6	2.5%	6	5.7%	21
ISCR Resources and NPT Support	3.1%	5	0.8%	2	2.7%	10
Lack of Meetings and Time for Key Team Members	2.5%	4	5.7%	14	0.5%	2
Gaining Consensus on Practice Elements	2.5%	4	4.9%	12	0.8%	3
Time Required to Implement and Change Culture	1.3%	2	2.5%	6	7.0%	26
Data Analysis	1.3%	2	0.0%	0	1.1%	4
Developing Patient Education	1.3%	2	1.2%	3	1.6%	6
Implementing Multiple Pathways at Once	1.3%	2	0.4%	1	0.0%	0
Lack of Clarity on How to Proceed with Pathway	0.6%	1	1.2%	3	0.5%	2
Variation in Resident Rotation	0.6%	1	0.0%	0	0.0%	0
Aligning Across the Continuum of Care	0.6%	1	0.4%	1	0.3%	1
Lack of Belief in Implementation Effort	0.6%	1	0.0%	0	1.1%	4
Total	100.0%	160	100.0%	244	100.0%	370

Abbreviations: EHR = electronic health record; ISCR = AHRQ Safety Program for Improving Surgical Care and Recovery; n/a = not applicable; NPT = national project team

Implementation Evaluation Discussion

Looking across findings from the three aspects of the implementation evaluation presented above, a complex picture emerges of wide variation in that starting points for facilities (i.e., readiness), how they approached implementation (i.e., high quality implementation analysis), and the barriers they experienced throughout the program. Throughout the program, the NPT used these data to inform program modifications to support participating facilities as best as possible.

First, sites reported overall moderate to high levels of readiness to engage in the program, but there was wide variation across sites, with a small proportion of facilities reporting low (i.e., below the scale midpoint) readiness levels. Overall readiness scores may serve as an early indicator of facility success in the program and, therefore, we used these scores as a tool to intervene in real time. The ORCA scale was administered early in the onboarding process and plays a central role in individualized coaching. However, the slack resources domain was the most consistently low aspect of readiness. This domain assessed the availability of appropriate financial, facility, training, and staffing resources for the program. These aspects of readiness are not easily addressable by the NPT.

Second, many sites reported that they were successful at implementing core CUSP principles, though fewer than 50 percent of facilities reported high quality implementation on each domain. Program improvements following cohort 2 included tools to help with adaptive components of the program (e.g., resources for team leadership best practices including tip sheets and instructional videos based on content developed from a Delphi Panel of experienced leaders of change in perioperative safety and quality), and technical program components (e.g., tools to promote more process and outcome data sharing including more proactive methods of "pushing" reports to facilities). These strategies may have had a positive impact on implementation quality and were carried forward in the program. There was a slight downward trend in teamwork across time points within cohorts, as well as across the three cohorts. Within cohort decreases are somewhat expected as the need for interdisciplinary teams is greatest early in the project when decisions are being made about the content of pathways and implementation process. The decrease across cohorts could have been influenced by challenges to meeting as a team presented by COVID-19.

Third, clear patterns emerged about project barriers. Workload, time constraints, and competing priorities dominated sites' experiences with barriers. The NPT engaged in creative problem solving to reduce the demands of program participation. Strategies included streamlining of communication and outreach processes, review and harmonization of program materials (e.g., increasing the clarity and consistency of pathway documents), and discussion of guidance to sites for efficient data abstraction.

Section IV. Hospital Site Visits

To complement the broader implementation evaluation efforts described above, the NPT conducted a series of focused qualitative evaluations. The first employed in-person site visits in the early years of the ISCR to assess and learn from the implementation processes of participating hospitals. The second and third evaluations were conducted during the pandemic and employed virtual site visits to explore implementation of the EGS pathway, and sustainment of the ISCR program over time. Each of these efforts are presented individually followed by a discussion of findings across the three studies.

In-Person Site Visits: Implementation of the Improving Surgical Care and Recovery Program

As part of an ongoing effort to understand "what works" in the implementation of ISCR pathways, the NPT conducted a series of hospital site visits to qualitatively assess barriers and facilitators of the pathway implementation process. From June 2018 to October 2019, the NPT completed nine site visits with hospitals enrolled in cohorts 1 and 2 of the ISCR program. The analysis presented here focuses on the eight hospitals, as one facility dropped from the ISCR program before completion of data collection.

The ISCR pathways are an evidence-based approach to patient care that include preoperative, intraoperative, and postoperative practices that can decrease complications and accelerate recovery for patients undergoing surgery. Despite the tremendous potential of pathways to improve clinical outcomes, reduce hospital length of stay, and improve the patient experience, putting pathways into practice can be difficult to achieve.[19-22] The effectiveness of pathways implementation varies widely, with little known about what contextual factors distinguish between higher and lower levels of implementation success.[23,24] In a departure from prior work, which has largely focused on successful pathway implementations within the context of academic medical centers, the hospitals in our sample were diverse with respect to structural characteristics (e.g., geography, teaching status, size) and the degree to which they were successful in implementing pathways. We leverage these differences to highlight key factors that distinguished hospitals that achieved greater levels of implementation success, as measured by adherence with nine pathway process metrics over time. We conclude with a discussion of how our findings, as well as the wider literature on implementation science, can shed light on the "how-to" of putting pathways into practice.

Methods – In-Person Site Visits

Study Design and Setting

We used mixed methods to qualitatively explore the relationship between perceived barriers and facilitators of pathway implementation with quantitative measures of implementation success. We did so in the context of hospitals implementing pathways in colorectal surgery as part of the Agency for Healthcare Research and Quality (AHRQ) Safety Program for Improving Surgical Care and Recovery. The ISCR Program included both adaptive elements (e.g., a toolkit on how to promote multidisciplinary teamwork, coaching calls to share best practices) and technical elements (e.g., ready-to-use pathways, access to the ACS data collection platform) to support pathway implementation.

Data Collection

We used purposive sampling to recruit eight hospitals that varied by ownership type, teaching status, size, and geographic location (Table 68). Purposive sampling is a nonprobability sampling method that was used to ensure representation from hospitals with characteristics that would provide a heterogeneous sample. We conducted in-person, 1-day site visits at each hospital between June 2018 and October 2019. Site visits consisted of individual and group interviews with key hospital staff across the continuum of care who were most involved in and affected by pathway implementation for patients undergoing colorectal surgery (n = 151 participants). The site visit teams consisted of three to six researchers from the Johns Hopkins Armstrong Institute for Patient Safety and Quality and the University of California, San Francisco. The researchers had extensive expertise in surgery, nursing, health services research, human factors, and implementation science.

During the interviews, the research team used a semistructured discussion guide that addressed barriers and facilitators to pathway implementation and strategies hospitals used to overcome barriers. Interviews lasted approximately 30–60 minutes. After obtaining informed consent from each participant, interviews were audio-taped and then transcribed by a professional transcriptionist. All research procedures were approved by the Johns Hopkins School of Medicine Institutional Review Board [Approval #: IRB00130799].

Table 68. Hospital and Participant Characteristics—*Performance Category: Site 1 and 2= High Improvement; Site 3 and 4= High Performance; Site 6, 7, and 8= Strives*

Category	*Site 1*	*Site 2*	*Site 3*	*Site 4*	*Site 5*	*Site 6*	*Site 7*	*Site 8*
Ownership Type	Voluntary Nonprofit	Governmental Hospital District	Voluntary Nonprofit	Government, City-County	Governmental State	Voluntary Nonprofit	Governmental Hospital District	Voluntary Nonprofit
Teaching Status	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Size (# beds)	> 700	300 – 700	< 300	> 700	300 – 700	< 300	> 700	300 – 700
Geographic Location	Northeast	West	Northeast	South	West	Northeast	Midwest	West
Surgeon	2	7	2	5	1	6	3	3
Anesthesiologist	1	2	1	2	0	3	0	1
Nurse	8	5	8	3	7	19	14	4
Informatician	4	3	0	0	7	2	1	2
Quality	7	4	13	13	4	13	6	2
Other or Missing[2]	15	5	7	7	6	10	11	10

1 Professional categories include frontline and leadership roles.

2 Other roles include pharmacist, physician's assistant, epidemiologist, dietician, and physical therapist.

Quantitative Measures of Implementation Success

In order to discern which of the contextual factors are associated with different levels of implementation effectiveness, we used data on process measures obtained from the ISCR registry to stratify the hospitals into three performance groups based on their adherence to process measures over time. We focused on nine core process measures that were mandatory for hospitals to collect during the study period: (1) preoperative bowel preparation, (2) preoperative oral antibiotics, (3) regional analgesia, (4) early mobilization, (5) early liquid intake, (6) early solid intake, (7) appropriate Foley catheter duration, (8) multimodal pain control, and (9) VTE prophylaxis. The analysis included patients who were 18 years or older and underwent elective colorectal surgery at a hospital that participated in the ISCR collaborative for at least 12 months.

Hospitals' level of implementation success was classified as either: (1) High Performance, (2) High Improvement, or (3) Striving. High Performance hospitals (n = 3) were defined as those with consistently high process measure adherence (i.e., >80% adherence to 6 of 9 process measures) throughout the study period. High Improvement hospitals (n = 2) were defined as those with the greatest increase in process measure adherence over time (i.e., hospitals ranked in the top quartile in terms of change in process measure adherence during the study period). The remaining hospitals (n = 3) were categorized as Striving.

Qualitative Data Analysis

A multidisciplinary coding team reviewed the interview transcripts line by line and applied deductive codes from the Consolidated Framework for Implementation Research (CFIR) codebook (which includes precise definitions and inclusion/exclusion criteria for each CFIR construct) and project-specific subcodes that emerged inductively from the data.

We then analyzed the coded data using two complementary approaches. First, we conducted a thematic analysis of barriers and facilitators of pathway implementation by collating the coded segments for each domain and synthesizing recurrent themes related to each CFIR construct. Targeted analyses were performed to identify distinctions in themes across hospitals with differing levels of implementation success.

Second, using a rating process pioneered by Damschroder and Lowery,[25] the coding team rated the perceived effect of each CFIR construct on pathway implementation by assigning a valence (positive, negative, or neutral influence on pathway implementation) and magnitude (strongly positive, moderately positive, neutral, moderately negative, strongly negative) to each of the coded segments (Table 69). To facilitate comparisons across hospitals, we created a "heatmap" of the perceived effects of CFIR constructs on pathway implementation, arrayed by hospitals' level of implementation success. MAXQDA 12 was used to organize the data and facilitate analysis (Table 70).

Table 69. Criteria Used To Assign "Ratings" to Constructs in the Consolidated Framework for Implementation Research

Rating	Description
+2	The construct is a **strongly positive** influence in the organization, a facilitating influence in work processes, and/or a facilitating influence in implementation efforts.
+1	The construct is a **moderately positive** influence in the organization, a facilitating influence in work processes, and/or a facilitating influence in implementation efforts.
0	A construct has **neutral** influence if it appears to have neutral effect (purely descriptive) or is only mentioned generically without valence; credible or reliable interviewees contradict each other; or different aspects of the construct have positive influence while others have negative influence and overall, the effect is neutral.
-1	The construct is a **moderately negative** influence in the organization, an impending influence in work processes, and/or an impeding influence in implementation efforts.
-2	The construct is a **strongly negative** influence in the organization, an impending influence in work processes, and/or an impeding influence in implementation efforts.

Results – In-Person Site Visits

Table 70. Heatmap of Ratings Across Select Consolidated Framework for Implementation Research Constructs

	High Improvement (HI)			High Performance (HP)				Strivers				
	Site 1	Site 2	Subtotal HI	Site 3	Site 4	Site 5	Subtotal HP	Site 6	Site 7	Site 8	Subtotal Strivers	Total All Categories
Domain 1: Intervention Characteristics												
Adaptability	1	1		2	1	Missing		1	2	0		
Complexity	-1	Missing		-2	-2	Missing		-2	-1	-1		
Evidence Strength & Quality	1	2		2	1	1		Missing	2	-2		
Domain 2: Outer Setting												
External Policies and Incentives	1	1		2	2	1		-2	1	1		
Patient Needs and Resources	2	2		1	1	2		-2	2	1		
Domain 3: Inner Setting												
Structural Characteristics	-2	2		0	-2	-2		0	2	-2		
Networks and Communications	2	2		2	0	1		0	2	1		
Available Resources	1	1		2	2	0		2	2	1		
Access (Information & Knowledge)	1	2		1	2	1		1	1	1		
Domain 4: Individual Characteristics												
Knowledge & Beliefs	2	0		-2	-2	1		2	-2	-2		
Domain 5: Implementation Process												
Planning	2	2		2	0	1		1	2	1		
Engaging	1	2		2	1	1		1	2	2		
Executing	-2	-1		-1	-1	-1		-2	-2	-2		
Reflecting and Evaluating	-2	2		1	1	1		-2	2	1		

The Outer Setting – or the wider economic, political, and social context within which the hospitals reside (CFIR Domain 2) – was also largely viewed as conducive to pathway implementation. External policies and incentives that were most frequently mentioned included: (1) national guidelines from the American Society of Anesthesiologists that aligned with pathway elements, (2) increased pressure from Joint Commission and other regulatory bodies to document EBPs, and (3) the industrywide shift towards bundled payments, which tend to incentivize lower lengths of stay. For several sites, the national awareness of the opioid epidemic and mounting pressure from state Legislatures to reduce opioid use were also mentioned as important reasons for wanting to adopt the opioid-sparing elements of the pathway.

There were also facilitating factors within the inner context of the hospitals (CFIR Domain 3) that were common across hospitals. In terms of the hospitals' implementation climate, participants from all of the hospitals voiced that pathways were strongly aligned with prior initiatives and organizational goals to improve surgical quality and safety. Past participation in programs such as ACS NSQIP and State-level quality improvement collaboratives not only helped lay the foundation for practice changes related to specific pathway elements, but also foster the staff's understanding of quality improvement more generally.

The importance of alignment continued to be a common theme in discussions of the implementation process (CFIR Domain 5), which CFIR broadly categorizes into four components: planning, engaging, executing, and reflecting and evaluating. In terms of planning for pathway implementation, all hospitals used multidisciplinary teams—a key recommendation of the ISCR program—to facilitate the alignment of role responsibilities and workflows across the perioperative continuum of care. Through regular team meetings and discussions aimed at building consensus, most sites were able to foster a deeper sense of interdisciplinary collaboration:

> *"I think the collaboration between departments and everybody coming together to try to work on the pathway and make sure that it's a seamless process... that it's not the surgeons deciding how they want to do it, but they're getting input from anesthesia, nursing, and pharmacy and everybody to make sure that it's all running in the right direction and that we're all moving forward."*

Fostering alignment at many sites also involved adaptations—either to the pathway itself (e.g., deciding to selectively implement only certain components of the recommended pathway bundle) or existing workflows (e.g., revamping processes for patient education)—to create a better fit among the pathway itself, the hospital context, and providers' preferences. Although some of these adaptations may not have been consistent with the evidence base supporting the efficacy of pathways, they were viewed as necessary to increase engagement and uptake of the pathway.

In terms of engaging appropriate individuals in the implementation and use of pathways, all hospitals found that having champions was critical to gaining buy-in, particularly when champions could effectively explain the "big picture," provide evidence and supporting literature in response to providers' concerns, and problem solve as challenges arose. As a nurse from a high-performance hospital recalled, *"I think when we were first introduced to [pathways], the surgeon came in and she gave a PowerPoint of her research and why it was important... hearing from the actual surgeon, we can ask questions from her directly and that, I think got everybody on board."*

Champions also played a key boundary-spanning role by representing their department in multidisciplinary team meetings, and in turn, relaying information back to their respective departments. By serving as a bridge between

different groups of stakeholders, champions played a key role in helping to build consensus as a group and alignment across the care continuum, particularly in high improvement and high-performance hospitals. In addition to enlisting champions, another common engagement strategy was to educate clinicians and staff on the pathway, which was perceived to be most effective when delivered early in the implementation process; when educators employed creative strategies to promote learning (e.g., "multimodal" education); and when clear and consistent messaging was used.

In terms of executing the pathway implementation according to plan, nearly all hospitals faced serious challenges. However, hospitals across performance categories found that developing pathway-specific order sets in the EHR was critical for both integrating the pathway into users' workflows and for supporting data collection efforts that were needed for continuous improvement. Another common strategy was to start with "small wins" by implementing the pathway incrementally, rather than attempting to roll out the entire pathways at once. For example, as the ISCR Project Lead from a high improvement site remarked, *"We're not waiting for the perfect package to be developed. As things come online, we put them in use."*

Common Barriers to Implementation Success

A notable challenge across hospitals was the sheer complexity of the pathway itself (CFIR Domain 1), which comprises some 20-plus elements. Nearly all sites experienced notable disruptions from pathway elements that were novel to their hospital, with NPO guidelines and lidocaine drips often highlighted as being particularly disruptive. Moreover, despite strong evidence for the pathway overall, there was little guidance on which pathway elements to focus on if time and resources were scarce. Because of the limited evidence related to prioritizing pathway elements, some hospitals decided to "pick and choose" specific elements the team felt were most important; whereas other hospitals decided to implement the pathway as is, given the evidence-based nature of the pathway.

A significant number of barriers were rooted in process challenges associated with the executing (i.e., carrying out the implementation according to plan) and reflecting and evaluating components of the implementation process (Domain 5). The implementation barrier mentioned most often, no matter the hospitals' performance level, was the extreme difficulty in implementing changes within the EHR. Participants frequently mentioned bureaucratic hurdles (particularly in hospitals that were a part of larger health systems), long wait times (often amplified by bureaucratic hurdles and, in some cases, under-resourced IT departments), and a lack of alignment between clinician workflows and EHR functionalities. As one participant remarked on the challenges associated with building pathway order sets:

> *"I didn't realize it would be so difficult building that. You know... you just have everybody coming into play because when you do the order set and you say, 'I would like to have this here and this here,' then it has to go to pharmacy to be approved, it has to go to physical therapy to be approved, and it has to go to a board to be approved, and then it's a month or more before you're getting that order set back to proof it and then make changes and then send it back. And I think that took us the longest time."*

Distinguishing Factors

Although most implementation barriers and facilitators were common across performance categories, two factors distinguished hospitals that were able to achieve the greatest improvement over the study period. First, providers' knowledge and beliefs about pathways (CFIR Domain 4), was largely positive in high improvement hospitals. As one participant reflected on the collective value the staff placed on pathways, *"I think everyone believed in the program to keep it going. We did"*. Conversely, participants from 4 of the 6 other hospitals perceived that providers' attitudes towards pathways had a strongly negative impact on pathway implementation. As a participant from a striver hospital reflected:

> *"The challenge that we encountered was getting anesthesia comfortable with [NPO guidelines] … we've been doing a lot of things about the same way since the millennium began… and so, I think we just got comfortable doing what we were doing."*

High-improvement hospitals were also better able to achieve consensus between stakeholders, and subsequently, a greater degree of standardization in workflows and EHR order sets. Conversely, high performance and striver hospitals experienced higher levels of continued variation in processes, largely driven by variability in physician buy-in and uptake of the pathway. Participants from these hospitals often mentioned that physicians would only select parts of the order sets they deemed beneficial, creating confusion for other clinicians, especially nurses.

High-performance hospitals differentiated themselves from other hospitals in terms of their data collection and reporting infrastructure, which helped drive their efforts to provide timely and regular feedback about uptake of pathway elements and demonstrate evidence of improvement. As one participant commented on the importance of timely feedback in fueling improvement efforts:

> *"We oftentimes see folks saying oh, we've got to wait, two, three, four, five months before we can see whether that thing we started in January is working and then realize it's not... We've been trying to get as much data as we can get our hands on so that we can get timely feedback both individually and as a group, you know... our oversight group every month, because that'll allow people to see what is working and what is not working. And that has been difficult to do in the past. So, that's a step that I think our department has made a huge step on that because that has been one of the things that people would say 'I don't know where we are and if we succeeded.'"*

Both high-improvement and high-performance hospitals were also more likely to have an "ERAS Coordinator," who had dedicated time to oversee the implementation process. As a participant from a high performance site reflected on the importance of having someone who could consistently devote time and attention to the implementation process, *"It's been really excellent to have [the ERAS Coordinator] because I think if we didn't have her, and this was just put before us as a service to do, we would've certainly done it, but it wouldn't have had the kind of direction that somebody like --1-- has been able to bring to it."* High improvement and high-performance hospitals were also distinguished by their focus on educating staff on how to appropriately set patient expectations (particularly around pain management) and their emphasis on aligning the information communicated to patients across the continuum of care (e.g., creating scripts that could be consistently followed).

Virtual Site Visits: Emergency General Surgery Cohort

The diverse presentation and severity of disease in an estimated 900,000 patients who undergo EGS per year pose challenges to pathway implementation. The complexity associated with the patient population means that the pathway is relatively novel, and more information is needed to identify appropriate ways to implement EGS pathways and address some of its unique challenges (e.g., improving antimicrobial stewardship, decreasing time to the operating room, and understanding the influence of social determinants of health on process measure compliance and clinical outcomes).

The ISCR quality improvement project sought to explore process facilitators and barriers that influence EGS pathway implementation. To that end, the study team conducted brief quarterly phone calls (~30 minutes duration) with the ISCR project lead and one to two clinical champions quarterly post-implementation to examine how implementation facilitators and barriers evolved over time. During those conversations, participants were queried about their perceptions of: (1) the process mapping provided by the project (i.e., failure mode and effects analysis) designed to help participating hospitals and the NPT better understand the hospital's current EGS pathway and identify improvement opportunities; and (2) implementation facilitators and barriers to implementing ISCR protocols for EGS patients.

The initial design included plans to conduct in-person site visits with six hospitals enrolled in the EGS (4B) cohort beginning approximately 2 to 3 months into their implementation process (November 2020). However, the timeline was shifted due to delays arising from the COVID-19 pandemic, and site visits were converted to virtual interviews. The process mapping activities were slated for November 2020 to February 2021, but the schedule was modified to February and June 2021, while the baseline interviews were conducted between February and April 2021. The quarterly interviews following the baseline interviews were completed between May 2021 and June 2022.

Methods – Virtual Site Visits: Emergency General Surgery

The qualitative data collection to assess the implementation of ISCR EGS protocols of the project was similar to the methods carried out to assess the ISCR project implementation and sustainability. The interviews for the EGS cohort were conducted virtually with participants (N = 33). One-day virtual site visits were conducted at three separate sessions for each site, ranging from February 2021 to June 2022. Participants included various ISCR project team member roles (i.e., ISCR project lead, clinical champions), senior executives, data abstractors, frontline staff, and surgical services leadership. A description of participant demographics can be found below in Table 71. The site visit team comprised two to three researchers from the Johns Hopkins Medicine Armstrong Institute for Patient Safety and Quality. Team members had extensive expertise in surgery, nursing, health services research, human factors, and implementation science.

During the interviews, the research team used a semistructured discussion guide that posed questions about barriers and facilitators to ISCR EGS protocol implementation, strategies hospitals used to overcome barriers, and the role of the multidisciplinary implementation team during the implementation process. Interviews lasted approximately 30–60 minutes. After obtaining informed consent from each participant, the interviews were audio-recorded and then transcribed by a professional transcriptionist. All research procedures were approved by the Johns Hopkins School of Medicine Institutional Review Board [Approval #: IRB00130799].

Table 71. Demographics of Site Participants

Site	Participant Interviewed	Role in organization	Role in Project
1	Participant 1	Trauma Director	Clinical Champion
1	Participant 2	Trauma Director	Project Lead, Surgeon Champion
1	Participant 3	Anesthesiologist	Anesthesia lead
1	Participant 4	Surgeon Partner	Project Lead
1	Participant 5	Data Manager	Local Champion
1	Participant 6	n/a	Data Abstractor
2	Participant 1	General Surgery Specialist	Surgeon Lead
2	Participant 2	Anesthesiology Specialist	Anesthesia Lead
2	Participant 3	Senior Executive	Project Lead
2	Participant 4	NSQIP Surgical Nurse Reviewer	SCR
2	Participant 5	n/a	SCR
3	Participant 1	Clinical Quality Compliance	Project Lead
3	Participant 2	Peri-op Safety Specialist	Local Champion
3	Participant 3	Program Director	Project Lead
3	Participant 4	Surgery Manager	Project Lead
3	Participant 5	Surgery Physician Assistant	Local Champion
3	Participant 6	Acute Care Surgery Fellow	n/a
3	Participant 7	Director of EGS	Surgeon Champion
3	Participant 8	Nutrition Manager	Local Champion
3	Participant 9	Pharmacist	Local Champion
3	Participant 10	Nursing Educator	Local Champion
3	Participant 11	Respiratory Care Director	Local Champion
4	Participant 1	Former Trauma Director	Project Lead, Surgeon Champion
4	Participant 2	EGS Director	Project Lead
4	Participant 3	Lead APP for EGS	Local Champion
4	Participant 4	EGS Director	n/a
5	Participant 1	Surgery Specialist	Senior Executive
5	Participant 2	Surgery Director of Quality	Project Lead
6	Participant 1	Project Coordinator	Project Lead, SCR
6	Participant 2	Nurse Practitioner	Nursing Champion
6	Participant 3	Emergency Department Nurse	n/a
6	Participant 4	Processes	n/a
6	Participant 5	General Surgery Specialist	Surgeon Champion

Abbreviations: APP = Advance Practice Provider; EGS = Emergency General Surgery; n/a= not applicable; NSQIP = National Surgical Quality Improvement Program; SCR = Surgical Clinical Reviewer

Results – Virtual Site Visits: Emergency General Surgery

Coding of all participating site transcripts (n = 22) resulted in a total of 990 codes. All codes with a frequency greater than 15 across all transcripts are presented below in Table 72. Code frequency and percentages were extracted using qualitative analysis functions in MAXQDA 2022 software. Discussed below are codes extracted and resulting themes organized under barriers/challenges, enablers, and COVID-19. Codes under the first section outline the emergent themes regarding barriers to implementation, or a challenge associated with program implementation. Codes organized under the theme enablers facilitated program implementation and were perceived by the participants as making implementation more effective or efficient. The final section on COVID-19 outlines the participants' perceptions of how the pandemic affected program implementation.

Table 72. Breakdown of Qualitative Code Frequencies and Percentages

Code	Frequency	Percentage
Collaboration between disciplines	46	4.65
COVID-19 era (things that changed)	31	3.13
Patient education	26	2.63
Challenges associated with aligning across the continuum	25	2.53
Size of hospital or health system/other contextual details	24	2.42
System work processes / dynamics	21	2.12
Absorptive capacity from a previous iteration	21	2.12
Job title in the hospital	20	2.02
Role in the ISCR project	20	2.02
Using EHR in workflow / order sets	20	2.02
Staffing Turnover	19	1.92
Gaining buy-in	19	1.92
Team cohesion	18	1.82
Automation as an integrating mechanism	18	1.82
Collaboration between leaders / champions	17	1.72
Dedicated Resources	17	1.72
Challenges with the EHR	17	1.72
Figuring the process of the workflow	17	1.72
Who participates	15	1.52
Champion	15	1.52
COVID-19	15	1.52

Abbreviations: ISCR = AHRQ Safety Program for Improving Surgical Care and Recovery; EHR = electronic health record

Barriers/Challenges

Participants indicated several factors as barriers to program implementation, including EHR issues integrating order sets, lack of regular contact/meetings, absence of dedicated resources, aligning across the continuum of care, and staffing issues.

Some sites found it challenging to use electronic platforms to manage and standardize workflows, perceiving changes to electronic medical records (EMR) systems as a barrier to implementation, particularly when attempting to integrate EGS order sets. Additionally, participants indicated that transitioning between different systems (e.g., EPIC, Cerner) affected program implementation. They indicated that the ISCR program launch was slowed to avoid issues and the loss of buy-in from colleagues. One participant explained:

> *"So, I don't think we're going to have an issue with the concept, but it does have to be an easy and efficient process with the order set on the computer that it's not like we're kind of launching this thing that's bumbling and difficult and they're just going to give up on it and we'll lose that buy-in early on. So, I've been a little bit hesitant in our kind of launching to go all in before we have a real streamline process."*

A participant from a different site described the challenges with using the medical records system to manage EGS patient workflows, stating:

> *"we have some variability in terms of who's doing the orders and depending on what time it's... and there's issues because I don't know if we've talked about this before, if they come straight from the ER, like the team was telling me, it's better not to admit the patient because it causes problems and then we've had issues with med recs and orders not getting activated by the nursing staff."*

In addition to issues with integrating technology systems into workflows and implementing order sets, participants repeatedly acknowledged a lack of contact or changes in the frequency of their team meetings impacted program implementation. One participant described their situation:

> *"Again, you know... we really haven't had much interaction. You know... other than that initial phone call like I mentioned earlier. I meet her in the hallway. We talk about a few things and that's about it. Nothing organized that I'm aware of unless there are some things going on without me due to my clinical duties."*

Several participating sites also indicated that they were experiencing challenges with aligning the program initiatives across the continuum of care, particularly for EGS patients. Participants mentioned challenges of aligning across the continuum of care due to patient population being geographically spread throughout hospital. On participant said:

> *"...to institute something as far as an anesthesia portion of the pathway, when you get a patient up from the emergency room, those nurses don't necessarily look at our order sets. The order sets that we have are looked at by the recovery room nurses and our preop nurses and not necessarily by other departments. For example, if I get a patient down from the floor... an inpatient from the floor, they don't look at my order sets, so those orders are instituted once they come to the recovery room prior to going back to surgery unless I specifically call the floor and say, did you look at my preop orders because this is what I want on this patient? Unless I go the extra step... they don't look at those orders. They look at the surgical orders, obviously, but not the anesthesia orders."*

Another participant from a separate site expressed: "...our patients are spread throughout the hospital which has sort of been an issue. Again, based on the ratio of the nursing staff, sometimes they're able to get the

patient's up walking and sometimes they're waiting for physical therapy and what not." Moreover, another participant described their issue with aligning the program across the continuum of care for EGS:

> *"...the biggest challenges with this particular pathway compared... and [Participant], you can speak to this, too. Compared to some of the others, what we've done, especially the colorectal, which we also did with the ISCR groups, is just the nature of the beast of EGS. It is so much different. It doesn't have... you know... your preop time. You know... you have your clinic and you have all these specific things. I think to me, it isn't going to be the biggest challenge as we discussed in that process mapping is just having you get this pathway and get to the patients at the right time when they're you know... having an issue that you didn't plan on. You know... you have an elective case... you kind of know you're going there. So, it's just to me... I think that's going to be the biggest challenge that we have faced and going to face."*

Finally, along with the other barriers and challenges discussed, there was an emergent theme of repeated issues related to changes and fluctuations in staffing. Participants from various sites reported that they experienced issues with program implementation due to staffing issues. Issues discussed here were mentioned separate from those perceived to have been caused by, or related to, the COVID-19 pandemic (discussed in a later section). One participating site expressed:

> *"...we had a particular challenge with consistency in our anesthesia staff over the last three years. We've had, I would say, a 50% turnover in staff, including leadership at the department chair level and at the acute pain service level, so that's been somewhat of a challenge...." and "We've had tremendous, tremendous, tremendous turnover in our nursing staff. I think that if we were to look at who our nurse managers were at the beginning of this and who our nurse managers are at the end of this, I would say 90% are new nurse managers. So, trying to sustain something where the nursing leadership is constantly changing is an enormous challenge."*

Another site went into detail about the staffing issues they were experiencing, saying:

> *"We actually lost a recovery room nurse yesterday because she was looking for a job that did not include call in weekends. We are losing our preop nurse. When I say losing, I don't exactly mean that hard and fast. She's actually going to be doing some of her work from home, but she will not be present in the hospital. We've lost a couple nurse anesthetists and we've hired some p.r.n. and locum coverage to fill that void until we can get some permanent people in. And like I've mentioned, we've lost two people in our group, one to retirement, and one moving back to a hometown. But we have since replaced those positions and one has just recently been hired over the past three weeks and then the other one will be coming on board in two weeks. So, it's been a little bit of a challenge to keep things going and keep everybody up to date, so to speak. I think for me, that's one of the biggest challenges because I not only have to bring them up to speed on the group dynamics, we have to bring them up to speed on policies and guidelines and how we operate within the system."*

Enablers

In addition to the various barriers to program implementation, several enabling factors were identified in site visit transcript analysis that may facilitate more effective and efficient program implementation. Participants reported several factors that they viewed enabled successful program implementation, including, but not limited to, absorptive capacity, ISCR program resources, and dedicated hospital resources.

Participants specified that having the absorptive capacity at both the institutional and individual levels from previous ISCR programs was beneficial. In the current context, absorptive capacity can be thought of as either the individual's (e.g., program lead, champion) or organization's (e.g., health system, hospital, unit) ability to recognize the value of the program, assimilate the necessary knowledge about the program, and apply that program to their context. When individuals or organizations have undergone previous enhanced recovery programs, they may already recognize its value, be familiar with the program, and more readily able to apply the program to repeated or new contexts. Specifically, one participant said:

> *"I think having the template to follow certainly allows us that leverage of understanding what has come before us and maybe what might apply to this particular patient population."*

Another participant reported that:

> *"...the colorectal service had had some improvement in their outcomes. I think specifically with wound infection, I'm not sure. But this is what he'd mentioned to me and he thought that we could... because you know... traditionally patients that undergo emergency general surgery have worse outcomes, so if we could optimize any of our outcomes that would be beneficial for our patients. So, whether it's wound infection, readmission, length of stay, any of the potential... and he'd sort of initiated the processes as the executive sponsor and then luckily... it allowed our NSQIP team to shift and be able to capture 100% of our emergency general patients so that we'd be able to get the data and move forward with our plans implementing the ISCR program."*

Additionally, it may be that absorptive capacity from previous cohorts may play a part in buy-in and rapid implementation. At least one participating site indicated that improved outcomes from a previous ISCR cohort influenced their decision to re-enroll in the program for another cohort. Specifically, one participant said: "*I was involved with the... we were involved with the colorectal collaborative, so when this one came up, and we presented it … they were all anxious to do a pathway for EGS. So, yeah. It was great. A great opportunity.*" Future research on program implementation should investigate the impact that both organizational and individual absorptive capacity may have on program implementation success.

Along with having the absorptive capacity for program implementation, participants indicated that ISCR program resources were beneficial. Specifically, process mapping was repeatedly mentioned by different participants as a helpful resource for sites. On participant explained that:

> *"...I do think the process mapping exercise that we went through with you guys several weeks ago I think was a tremendous help and I do feel like that, especially for [Participant] and [Participant], who were moving.... doing a pathway, I think it really helped them start to think about what process... you know... how to kind of lead this process along and it gave us some great places to see where we need to start building from."*

The periodic check-in meetings, in addition to the process mapping, was indicated by participants as being beneficial for promoting progress on program implementation. A participant expressed:

> *"I think one of the biggest things for me with you guys is... I thought the process mapping was extremely helpful. It doesn't seem like something that at first glance you're... you know... because it's like outlining what we need to do but actually having the thoughtful provocative questions and being guided through the process with my multidisciplinary team, I think we all felt like that was a really helpful thing and then meeting with you periodically is really holding me accountable in a way, you know... in a way. It's like, "Okay, I've got a meeting with [Interviewer] and [Interviewer] coming up. What have I been doing? What did I figure out?" It's like having a punctuated... you know... it's like I said. If I don't have these meetings with my team members, it's difficult to kind of keep picking up the pieces and moving forward when there's so much other stuff going on so us having frequent contact does help move the whole process forward and I know it's a little bit handholding, but I think that's been very helpful."*

Finally, in addition to ISCR program resources and absorptive capacity, participants mentioned that having dedicated hospital resources for the ISCR program was beneficial for implementation. One participating site explained how beneficial having dedicated IT services was, specifically saying:

> *"... we involve IT from the beginning and we have the same IT person that we've used from the beginning. She's not always at every single meeting because she's very familiar now with what needs to happen but we've always included them from the beginning just so we don't go down a road or start creating something that can't really be done or is not following the IT rules or whatever. So you know... as soon as we start thinking about okay, what needs to be in this pathway, we'll start including her in the meetings." In a later site visit, they re-iterated this enabling factor with the following: "We have had sort of the same IT partner from the very beginning December 1st pathway, and that has also been a very important partnership... she has also sat in on some of our meetings, especially in the beginning to hear what's going on and she will also you know... speak up if there's something that he sees might be an issue or a problem within our EMR... within our EPIC build for whatever reason and that partnership with her and [Participant] is to the point where we don't let anybody else but [Participant] and ----- work together on the order set and she has even mentioned to her partner that when one of our other surgical services would come up and say they wanted to use part of an order set, she was like, "have you talked to [Participant] first?" She will put the stop on it before they go creating something so that we don't have all these little pieces and parts of order sets, so I can't stress how important that particular partnership has been with our IT folks."*

Participants also indicated that the lack of dedicated resources for program implementation caused issues or slowed implementation progress. This factor may be connected to the issue of staffing, such that when hospitals experience staffing shortages, their staff are overworked and do not have the time to dedicate to program implementation, which may have inspired the expressed need for a specific role for someone to help guide program initiatives and champions. Specifically, one participant explained:

> *"I think really, I mean I think one of the biggest things for me is that I as an individual, kind of trying to lead this forward, don't have as much time as I'd like to dedicate to it. I think having somebody who is supported in that role, even in administrative assistant that can help guide*

the champions but someone who can really be working on the ground, getting things done on a regular basis, I think that would be very helpful."

COVID-19

In the interviews, participants reported that the COVID-19 pandemic may have affected program implementation in various ways. Participants indicated that the pandemic affected staffing, ISCR-related team meetings, and restrictions on elective cases which resulted in decreased number of EGS eligible patients to receive recommended pathways. These topics, discussed below, were reoccurring themes identified in qualitative analysis of the EGS-specific site visit transcripts. These were self-reported by participating sites, and qualitative analysis of their perspectives does not provide a causal link between the COVID-19 pandemic's effect on implementation process or success. However, they may provide preliminary insight into how the pandemic affected the program implementation for cohort 4.

One of the most mentioned challenges related to the pandemic that sites self-reported was the issue of being understaffed. As mentioned in a previous section, the challenge of being understaffed or experiencing staffing turnover was widely mentioned across sites. While it is not always possible to disentangle COVID-19–related staffing issues to routine hospital turnover, the quotes from participating sites given below specifically mentioned the pandemic as being related. Sites also indicated that the usual staff dedicated to other cases or hospital initiatives were diverted to support pandemic-related needs. Specifically, participants explained that:

"*Everybody's redeployed. All of our staff is redeployed... all of my trauma nurses that do PI, everybody has been redeployed. They're all working as nurses in the hospital currently. So, like we're... we're just trying to keep up with our standard PI stuff" and "I have three nurses that work on the trauma program so our trauma program is you know... we're a level 3, it's funded, it's supported by the administration, and they put the people power behind it. That being said, they were all redistributed for COVID so how we're kind of running, trying to catch up." Additionally, another participant expressed: "...it's sort of a double whammy because OR staffing is short and a lot of the cases are going late. You know... the volume that we used to have, not so much for us, but so if we're doing our cases latera and there's only one anesthesiologist, they're less likely to place an epidural, I think, you know... for an abdominal case."*

Sites also reported that understaffing due to COVID-19 has caused issues with staff feeling overworked. Sites self-reported that this was particularly a problem with their nursing staff. One participant said:

"The nurses have definitely really been just overworked and everybody's gotten... COVID... or everybody's out with COVID or recovering from COVID or a family member is... they've been really short" and another participant reported: "...we're limited on our nurse resource end... nurses that are kind are kind of overworked right now...."

Staffing shortages and turnover were also subsequently reported regarding issues with educating staff. The fluctuations and lack of continuity in staff trained on the ISCR protocols was particularly a perceived problem with traveling staff, with one participant saying that:

"I do think it's even harder with all the travelers we have. We did do... [Participant] did do some education with the nurses and I think a lot of them are gone. They went to travel because they make so much more money. So, we have brand new faces and it's been really challenging. I

mean, I think a lot of that is COVID." Additionally, another participant explained: "we had a bunch of the older nurses retire early with COVID. A lot of the younger nurses have kind of left to go to local places so that... you know... because they have family and you know... the usual work/life balance so, you know... we're using more travelers which, again, it's adequate. I don't think it's idea. You know... they're an iterant labor force so they're not really invested, I think, in the institution and there's variability in their performance and sort of what we've seen and when I come in and stuff, that's usually on my cart. For standard stuff like an appendectomy, isn't there. Then I ask for it, and they have to go get it and they don't know where it is and just... it adds to the time of the case which, you know... increases complications or the possibility of complications so again, it's not ideal but this has sort of been an ongoing issue."

To further understand issues that sites experienced with COVID-19 and staffing issues, included below is Table 73. This table outlines the frequency of COVID-19 and staffing-related codes by participating site. It should be noted that two additional interviews were conducted with sites 1 and 2, potentially partially accounting for the higher frequency of COVID-19 and staffing codes. High frequency of codes in Table 80 reported by sites may indicate that those sites experienced higher disruption to program implementation due to the pandemic.

Table 73. Frequency of COVID-19 and Staffing-Related Codes by Site

Code	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Staffing Turnover	3	10	3	1	1	1
Too much other stuff going on	0	2	0	6	0	0
Diverted resources (pandemic, other priorities)	2	3	0	5	1	1
Furloughed staff (pandemic, other reasons)	0	0	0	0	0	0
Figuring out the hospital / human resources (staffing)	2	5	0	2	0	0
COVID-19 (outer setting/external policies)	1	2	0	1	0	0
COVID-19 (general code)	4	5	2	1	2	1
COVID-19 era (things that sustained)	1	1	2	1	0	0
COVID-19 era (things that changed)	7	8	1	7	7	1
Change of champion	0	2	0	0	0	0
Figuring out the hospital / human resources (staffing)	1	1	0	1	0	0

In addition to staffing issues, participants have indicated that the pandemic has affected the type and number of cases that they are able to take and the organization's capacity to implement various hospital initiatives. Participants specify that elective cases that are eligible for the current program are limited, decreasing program participation. Participants explained that:

"...we've been limited in our elective surgeries for the past couple of months... it's taking out a lot of the elective colons that would be utilizing that ERAS kind of pathway" and "...on what used to be a primarily EGS floor but has recently... half of it was adopted for COVID patients, so that really messed up things for the project."

Participants also indicated that certain hospital initiatives were essentially put on hold while COVID-19 cases surged. Related to the previous theme discussed about staffing shortages, it was reported that hospitals and providers experienced a surge in COVID-19 related cases, reducing their capacity for EGS initiatives and EGS-eligible cases. Participants indicate that hospital resources such as IT services and designated floors for EGS were diverted to address pandemic needs. Specifically, participants said:

> *"One of the things that we've really struggled with is our hospital has been destroyed by COVID. It's not like... we're 150–180% capacity for a while, which put us in a very weird position and all the resources were drained away... even for a little bit... and we're just starting to get back to this point where they're even willing to re-discuss some of the things we had been discussing pre COVID like getting all these patients to the same floors and the same units and stuff to help implement some of these things and so it's... it's only been really in the last couple weeks that they have actually released some of these resources that we had tied up before, which has been frustrating."*

Finally, participants indicated that COVID-19 also impacted the frequency and format of team meetings. Across most sites, the pandemic reportedly reduced or completely ceased project-related team meetings for an unknown amount of time, which seemed to have negative effects on the implementation process. Several participating sites indicated that meetings had been disrupted due to the pandemic, explaining that:

> *"We haven't scheduled any [meetings]... because unfortunately we're still getting over our... basically our COVID surge...." and "We were meeting pretty regularly before... well, before everything. We've sort of met regularly at the beginning of the year when we were starting with the... that code thing... process mapping. When we started with that we were meeting regularly but we've fallen off."*

In conjunction with reducing the frequency of team meetings, COVID-19 reportedly caused a change in the format of team meetings, forcing some teams to switch fully to virtual meetings or have a hybrid model. One participant said:

> *"Meetings have been a challenge at every level during the pandemic and I would say that that's one of the barriers to consistency is we have virtual meetings. We don't have in face meetings. It's hard to coordinate them. People are off site and that is certainly an opportunity for us to get better."*

However, participants indicated that teams had started to reconnect and begin scheduling regular meetings again. One participant explained:

> *"I will say that in person meetings are starting to come back. We're probably seeing that about 20-30% of our meetings are now in person with the option of having a virtual meeting. Meetings have fluctuated a little bit but we're starting to get back on track with those...."*

The effect of the pandemic on team meetings varied across sites and qualitative analysis of site visits cannot establish a direct relationship between the pandemic, team meetings, and subsequent implementation success. However, the disruptive nature of the pandemic on program implementation in EGS contexts should be considered before drawing conclusions about implementation success in these contexts, particularly when comparing with other cohorts and different service lines.

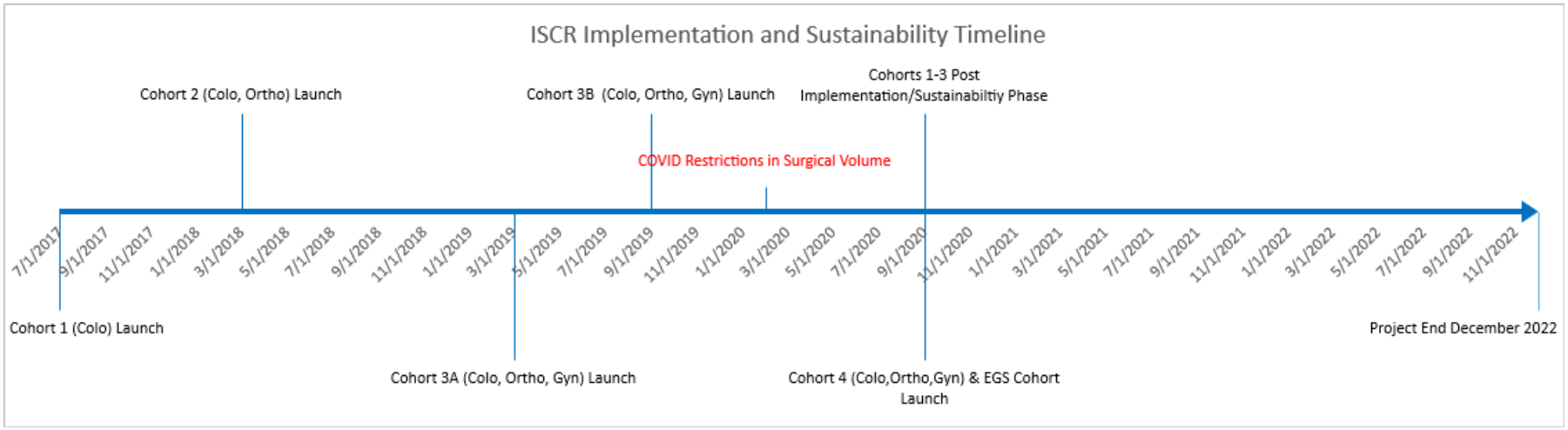
Virtual Site Visits: Sustainability

ISCR pathways can potentially reduce complications, hospital stays, and costs. However, such pathways must be implemented across the continuum of care to realize these intended benefits. Over time, teams often experience and overcome challenges in maintaining the ISCR pathway. The sustainability of quality improvement initiatives is facilitated when the practices become embedded into the daily workflow and are no longer described as change but as "this is how we do things here." Sustainability is enabled by a combination of top-down and bottom-up supports to amplify and maintain improvements.[26]

The NPT recognizes that the COVID-19 pandemic introduced several unexpected external factors that affected implementation efforts to implement ISCR protocols and, in turn, affected the sustainment of gains achieved during the implementation phase of the program. Consequently, the NPT sought to assess the sustainability of the ISCR program. The study team initially planned to conduct in-person site visits but shifted to virtual site visits and interviews due to COVID-19 precautions and travel restrictions.

The COVID-19 pandemic brought several disruptions in the delivery of surgical services that affected the implementation of ISCR protocols. In the early stages of the pandemic, the ACS published guidance about how to assure that patients continued to receive necessary surgeries, e.g., cancer surgeries, and created a triage criteria where necessary operations for breast, colorectal, and thoracic surgery could still take place amid the operational restrictions.[27] However, after the initial restrictions in surgical operations (i.e., cancelations of elective surgeries and redeployments of personnel) beginning in early February 2020, several states and hospital sites varied (and continued to vary) in their capacity to carry out elective surgeries. As a result, some participating sites experienced significant decreases in surgical volume, while others were able to resume regular surgical services. Figure 86: ISCR Implementation and Sustainability Timeline shows when each of the ISCR cohorts launched relative to the timing of the projected transition to the post-implementation and sustainability phase of the program and restrictions in surgical operations. Cohorts 1–3 were in the implementation phase of the program at the onset of the COVID-19 pandemic. In the later part of 2020, cohort 4 launched nearly 1 year into the pandemic response.

Figure 86. Improving Surgical Care and Recovery Implementation and Sustainability Timeline



Methods – Virtual Site Visits: Sustainability Cohort

Sustainability Phase: Qualitative Data Collection (Cohorts 1–3)

The qualitative data collection to assess the sustainability of the project's implementation was similar to the methods carried out to assess the implementation phase of the project with one significant modification, interviews were conducted virtually rather than during in-person site visits. Interviews were conducted with participants at each of the hospitals from October 2020 to May 2021 (Table 74). During the virtual interviews, we conducted individual and group interviews with key hospital staff who were most involved in and affected by ISCR protocol implementation (N = 27 participants). Participants included various ISCR project team member roles (i.e., ISCR project lead, clinical champions), patient safety and quality staff, data abstractors, surgical services leadership, and frontline staff. The site visit teams consisted of two to three researchers from the Johns Hopkins Medicine Armstrong Institute for Patient Safety and Quality. Team members had extensive expertise in surgery, nursing, health services research, human factors, and implementation science.

During the interviews, the research team used a semistructured discussion guide that addressed barriers and facilitators to ISCR program implementation and sustainability, strategies hospitals used to overcome barriers, and the role of the multidisciplinary implementation team during the implementation process. Interviews lasted approximately 30–60 minutes. After obtaining informed consent from each participant, the interviews were audio-recorded and then transcribed by a professional transcriptionist. All research procedures were approved by the Johns Hopkins School of Medicine Institutional Review Board [Approval #: IRB00130799].

Table 74. Improving Surgical Care and Recovery Sustainability Participating Site Demographics

Site	Ownership Type	Teaching Status	Size(# beds)	Geographic Location
1	Voluntary Nonprofit	Yes	> 700	Northeast
3	Voluntary Nonprofit	Yes	< 300	Northeast
5	Government, City-County	Yes	> 700	South
6	Governmental Hospital District	Yes	> 700	Midwest
7	Governmental Hospital District	Yes	300 – 700	West
8	Voluntary Nonprofit	Yes	300 – 700	West
9	Governmental, State	Yes	300 – 700	West

**Names of sites were not disclosed for anonymity of organization.*

***One site was excluded from sustainability analyses due to loss of contact and could not be scheduled for an interview.*

Interview participants held various roles within the organization representing perspectives across various levels of the organization and surgical service lines (e.g., frontline clinicians, mid-level managers, and senior managers) (Table 75). All participating sites are teaching hospitals.

Table 75. Demographics of Sustainability Interview Participants

Site	Participant Number	Role in Organization	Role in Project
1	Participant 1	Perioperative Performance Improvement Manager	ISCR Project Lead
1	Participant 2	Colorectal Surgeon	NSQIP Surgeon Champion
3	Participant 3	Performance Improvement Coordinator	ISCR Project Lead, Data Abstractor
3	Participant 4	Coordinator	Educator on the Colorectal ISCR Unit
3	Participant 5	Nurse Manager	Operating Room Nurse Manager
3	Participant 6	Service Line Coordinator	Service Line Coordinator
3	Participant 7	Chief of Surgical Oncology	Surgeon Champion
5	Participant 8	ERAS Nurse Navigator	ISCR Project Lead
5	Participant 9	General Surgeon	Surgeon Champion (for all service lines)
6	Participant 10	Quality Outcomes Improvement Director	ISCR Project Lead
6	Participant 11	Surgical Clinical Reviewer , Nurse	Surgical Clinical Reviewer
6	Participant 12	General Surgeon	Physician Champion
7	Participant 13	Quality and Patient Safety Clinical Analyst	Quality and Patient Safety Clinical Analyst
7	Participant 14	Nursing Manager	Nursing Manager
7	Participant 15	Data Abstractor for Colorectal	Data Abstractor for Colorectal
7	Participant 16	Director of Post-Surgical Services	Involved with Colorectal ERAS rollout
7	Participant 17	Assistant Nurse Manager	Assistant Nurse Manager
7	Participant 18	Operating Room Nurse Manager	Operating Room Nurse Manager
7	Participant 19	Director of Surgical Services	Director of Surgical Services
8	Participant 20	Quality Improvement Coordinator	ISCR Project Lead
9	Participant 21	Quality Improvement Manager	Quality Improvement Manager
9	Participant 22	Colorectal Surgeon	Surgeon Champion for Colorectal
9	Participant 23	Infection Prevention Nurse	Infection Prevention ISCR Champion
9	Participant 24	NSQIP Surgical Clinical Reviewer	NSQIP Surgical Clinical Reviewer
9	Participant 25	Chief Quality Officer	Senior Executive for ISCR Team
9	Participant 26	Nurse Practitioner	Nurse Practitioner
9	Participant 27	Quality Improvement Nurse Analyst	ISCR Project Lead, Data Abstractor

Abbreviations: ERAS = enhanced recovery after surgery; ISCR = AHRQ Safety Program for Improving Surgical Care and Recovery; NSQIP = National Safety and Quality Improvement Program

Sustainability Qualitative Data Analysis

We used multiple strategies to maintain rigor in our data collection and analysis. We reviewed the transcripts for accuracy, used a codebook, and assessed for consistent coding. A multidisciplinary coding team first reviewed 10 percent of the transcripts line by line using the constant comparative approach[28] to create an inductively derived initial code set. As with the analyses conducted of the ISCR implementation activities, our initial code set was augmented by incorporating the CFIR codebook,[29] which provides precise definitions of 39 CFIR constructs

across five domains. The final code set also included codes related to the sustainment of activities carried out during the implementation phase of the ISCR project (e.g., "factors unique to sustaining"). When coding was complete, the team conducted a thematic analysis of barriers and facilitators of factors related to sustainment. All interviews were double coded, and the emergent themes were discussed during weekly meetings. Coding discrepancies were systematically reviewed and discussed until we reached consensus. Finally, we reviewed the codes for commonalities and discussed potential themes and subthemes.[30]

Coding of all participating site transcripts (n =12) resulted in a total of 788 codes. All codes with a frequency greater than 15 across all transcripts are presented below in Table 76. Code frequency and percentages were extracted using qualitative analysis functions in MAXQDA 2020 software. Extracted codes and resulting emergent themes are described in the subsequent sections. Thematic analysis resulted in four major themes: (a) organization response to COVID-19, (b) continuous auditing and feedback on performance to sustain gains, (c) use of digital and virtual systems to sustain changes in clinical practices, and (d) key influencers and boundary spanners as nodes of sustainment.

Table 76. ISCR Sustainability Code Frequencies

Total codes = 788	Frequency	Percentage
"Late phase"	47	5.96
COVID-19 era (things that changed)	31	3.93
Using Electronic Health Record in workflow	28	3.55
Using data to give directed feedback	21	2.66
Factors unique to sustaining	20	2.54
Training new staff on the pathway	18	2.28
Job title in the hospital	17	2.16
COVID-19 era (things that sustained)	17	2.16
Shifts of attitudes and norms	16	2.03

Organizational Response to COVID-19

The COVID-19 context affected ISCR implementation and *whether* and *how* ISCR activities were sustained. Teams could only sustain what had already been implemented, and some of the previously implemented activities were subject to organizational decisions to respond to the conditions brought on by COVID-19. Participants described various approaches their organizations undertook in response to COVID-19 that required rapid adaptations and resulted in immediate changes in surgical operations. These approaches mainly focused on reducing unnecessary surgical procedures (i.e., elective procedures) and adapting clinical processes to minimize the risk of COVID-19 transmission to patients and the workforce.

The reductions in surgical volume sometimes resulted in severe shifts in personnel. Participants talked about "furloughed" staff as distinct from reports of other familiar experiences of "staff turnover." In some cases, clinicians were redeployed to work in other non-surgical clinical areas, or resources were diverted to treat COVID-19 patients specifically. The mentions of furloughed staff versus other staffing changes, i.e., staff turnover or shortages, links domain 2 (outer context) and domain 3 (inner context) per the CFIR framework in a way that highlights the connection between COVID-19 related policies and the subsequent trickle-down operational effects present within the sites. Some organizations chose to furlough the hospital quality personnel

(e.g., data abstractors) while other organizations furloughed personnel at multiple sectors of the organization, including managers and frontline surgeons. One surgeon exclaimed:

> *"So, what essentially happened for us is that when COVID kind of hit, we went into... we shut down elective surgical cases and went to an emergent only moderate and what that did was it threw the hospital into a financial spiral, to say the least. One of the consequences of the financial spiral is that they furloughed large parts of the Quality Staff for one, and the second component was the effect on surgeons where most elective cases were dried up to nothing – so that ERAS in general kind of went down to nothing."* The same surgeon then closed his statement by saying, *"Yeah. It's been pretty difficult to be honest with you, from a surgeon's perspective. It's been very chaotic."* A colorectal surgeon at another site commented on the effect of diverted resources and the redeployment of nursing staff as a barrier to consistency in implementing the pathways saying, *"Yeah, I think the biggest thing was just the nursing work... workforce was shifted. You know... they pulled nurses out. Most of our patients were cohorted to one floor, so the nurses there... they knew the pathway. We were the only pathway in the hospital, so I think... I think CABG is on it now. There's a little bit more, but initially we were the only one. When those nurses got pulled out, they had other people coming in, or temps [temporary nurses], and it kind of just fell apart, you know."* This statement highlights one negative effect of relocating personnel (i.e., nurses) and units on the retention of ISCR-trained team members to sustain ISCR protocols and serve as educators to other staff members.

The site that reported furloughs across various personnel types, e.g., managers and quality staff, also tended to report decreases in implementing and sustaining other ISCR program activities like regular contact/meetings with the project team. All teams mentioned "COVID-19 era things that changed" which included changes in the data collection, frequency and format (from in-person to virtual) of ISCR team meetings, and resources diverted to COVID-19 patients (e.g., reconfiguration of surgical units) as illustrated by one surgeon's comment: *"So just from a clinical standpoint, I think it's been challenging you know... we lost our recovery room because we turned it into an ICU so we were recovering our patients in the ORs."* The SCR nurse at the same site discussed how the reconfiguration of hospital units and patient flows affected the implementation of ISCR pathways (e.g., multimodal pain interventions) and data collection processes used to track which patients received the pathways. The SCR nurse expounded on the comments of her surgeon colleague by saying, *'..but I know when I'm abstracting the data, I can see a difference in the mobilization as the multimodal usage of pain meds and that kind of stuff that we know probably wouldn't have happened if they had been on the other floor, which is contributing to some of our process measures being a little different."* A director of post-surgical services at another site had a similar observation about the organization's response to COVID-19, explaining: *"one of my surgical units actually became a COVID isolation unit. So... and that... it's our medical... general surgical area where all of those colorectal patients would have gone. So, they flipped and were a respiratory isolation unit. So, we had staff that were onboarded during the last fourteen months... a large number of them, probably thirty or forty nurses just on this one unit that have never experienced true post-op care."*

Alternatively, some sites talked about "COVID-19 era things that sustained" or activities that continued like patient education and electronic systems used to educate staff and extract data in a standardized fashion. So, despite the ever-evolving processes to respond to the pandemic, sites with integrating mechanisms like electronic platforms to deliver staff education and routine data collection and abstraction were able to rely on these systems to sustain and monitor compliance to recommended changes in clinical practice to enhance recovery after surgery. Where some sites associated the redeployment of ISCR-trained staff to other units as a

barrier to sustaining the ISCR team member knowledge, some sites adapted the delivery of new staff (namely nurses) to do "just in time" training complemented by self-paced training. One operating room nurse described how they could sustain their team's knowledge of ISCR by making the information accessible:

> *They made a module that you can get ahold of in our learning management system. So, if we ever had one of these and I wasn't here, one of the other unit educators that was familiar with it, they weren't aware of it, they can always go in and watch a real time video that's got like live interaction play documentation with it. Again, it would be self-paced that they would... and self-initiated that they would have to do where they'd say, "Oh, I see something unfamiliar, let me see what I can find out about it," as opposed to like... ignoring it. So, we do have those."*

Some teams were able to sustain their ISCR team activities just as they had done before COVID-19. For example, when asked about the frequency of the monthly ISCR team meetings and team participation during 2020, the performance improvement coordinator at one site affirmed that they had consistently held their meetings and replied emphatically.*" All of them are* [present] *100% of the time."* Another site's Performance Improvement Coordinator reported that during COVID-19 "Our pathway didn't change."

Continuous Auditing and Feedback on Performance To Sustain Gains

The use of data to track compliance with the ISCR pathways and clinical performance was reported as a means to maintain momentum, sustain practice changes and prevent backsliding. *"So, we had to be sharing the data with the with the surgeons and the staff. We had to be sharing the data with whatever they were non-compliant with. We had to share the data and ask them to please make sure they're following this and following that. Wherever the fallouts were." [Performance Improvement Coordinator]* Some participants articulated the connections between the project implementation and desired changes in outcomes (e.g., decrease in length of stay) as a way to maintain engagement. For example, one colorectal surgeon recalled:

> *"I think overall, when we review those patient outcomes and we want to... you know... like Dr. "__" said, to improve the overall care, all the ERAS committee and the ISCR committee, everybody looks... what can we do better, how can we improve, and everybody's pretty much engaged. Then we're trying to look at maybe even other institution to find out what they have done to improve our processes. So yeah, I think that everybody's engaged. It's never like, oh, we don't want to...". The perspective shared by another Perioperative Performance Improvement Manager reflected back to the interviewers that "So, [Interviewer 3], I guess we agree then that it starts with the order sets and it starts with the shared understanding, too, about what matters. And then when you take that data and you do a better job than we do, and reliably feed data back about how we're doing and where we're not doing so well to the people who are providing care, then it becomes very meaningful and the actual care processes can be adjusted and it does not need a whole lot of technology to do it, particularly because wit the way we're using the technology, it forces additional documentation."*

Use of Digital and Virtual Systems To Sustain Changes in Clinical Practices

Participants frequently mentioned the use of the EMR when discussing the implementation of order sets and efforts to standardize practices. One performance improvement coordinator credited the integration of the order sets into the EMR with implementation of the ISCR pathway *"100% of the time. Yeah. Now we have it built into our EMR database, so it's activated and they just... basically, it's just part of the process now."* One

participant thought that one of the inadvertent consequences of furloughed IT was that the order sets remained unchanged in the EMR, stating:

> *"I don't think that anything has happened to the order sets, mainly because there was no one in the IS team that was available to change order sets because of COVID. So, a bunch of those people were also either furloughed or their time was used in other places to support COVID patients."*

Some participants also attributed the integration of the order sets into the EMR as means to spread to other services as stated by a Chief Quality Officer:

> *"The antibiotics stuff is through retrieval of... it took a lot of work, actually to put those two together for just colorectal and GYN. They're starting to spread those to other services. But it's drawing the data directly from the EHR and then putting it in a Tableau dashboard and then feeding it back to the surgeons and it breaks it out by surgeon/anesthesiologist because they're kind of jointly responsible for some of those things. And that really helped us improve the data because at first, obviously, it had some things that weren't quite correct and we had to refine the dashboard for a while, but I think we're through a lot of that hard bedding and now we're ready to ramp up to other services."*

Key Influencers and Boundary Spanners as Nodes of Sustainment

Many participants referred to a specific person or specific individual(s) as the reason for success or as "the go-to" person to get the work done. These (boundary-spanning) individuals were often talked about by other participants in very positive framing and as having "been here forever" and able to gain the respect and engagement of others. One Quality Improvement (QI)coordinator spoke of various influencers within their ISCR team:

> *"I do. I consider her the nurse champion because I feel like we have a... like our triad for ERAS is the quality improvement coordinator... is kind of the project coordinator. And then we have the surgeon champion and the nurse champion and I think the nurse champion I would definitely consider ----- just because she has that experience, that gravitas... she's been involved in this project forever. This is her service line and just the respect that she has. She can make changes and surgeons listen to her. Nurses listen to her. She's just... I would say she's our nurse champion, for sure."*

Another repeated perception about these individuals is that the project might not be successful without their involvement. They may be an emergent leader or an appointed leader, but they are generally thought to be respected and have a great degree of influence and the capacity to mobilize engagement and resources to keep the work going. Sustainability is enabled by a combination of top down and bottom up support and these boundary spanners act as nodes of sustainment as they engage others across the organization in the implementation of the project." One QI coordinator spoke about female surgeon in that light, by saying:

> *"So, I would say at this point, Dr. ----- ----- has kind of been a consistent surgeon champion and really a good kind of... she is very even-keeled as far as pushing the things that are important or saying we don't need to push that. It's not as important. Just kind of laying the priorities of some of the things we present and she's always, of course, taken the time to go up to the units and talk to the nurses and round and you know... help with the resident education and provide*

feedback to her office staff if they need it for that continuum. So, she's been great. ----- ----- you know... is kind of our... has been here forever. She's very respected, I think, across the organization for her knowledge and her skills and her time here. So, I think just having her on these projects speaking with the managers, just from her experience, people really listen to her and she's a really great leader in that respect."

Summary of Sustainability Virtual Site Visits

The four themes discussed (a) organizational response to COVID-19, (b) continuous auditing and feedback on performance to sustain gains, (c) use of digital and virtual systems to sustain changes in clinical practices, (d) key influencers and boundary spanners as nodes of sustainment provide some guidance about how teams can effectively implement future iterations of the ISCR program despite the constraints posed by highly uncertain conditions such as COVID-19. Some of the themes describe the technical (evidence-based clinical practice changes) aspects of program implementation, where others (e.g., multidisciplinary collaboration in engaging and educating one another) indicates interpersonal and cultural dynamics at play during the implementation and efforts to sustain QI initiatives.

The timing of the site visits and interviews offered a highly unique opportunity to study the implementation of the ISCR program at a time when hospitals were experiencing unprecedented constraints and required to rapidly adapt and respond to the unpredictable demands on the healthcare system due to the COVID-19 pandemic. Nevertheless, some of the factors that enabled teams to sustain prior gains during the pandemic mirror other factors commonly associated with sustained QI interventions, such as continuity in staff, engaged leaders and local champions willing to provide financial and other support, the use of standardized and evidence-based data to drive clinical and operational changes.[31]

Notably, all participating sites included in the virtual site visits/interviews represent perspectives of those working at teaching hospitals, which may differ from other sites in different contexts and resources. Additionally, each site's transition from implementation to sustainability phases is dynamic and site-specific. Some sites experienced false starts and restarts in their implementation, making it difficult to discern or pinpoint exact stages of sustainability.

Separate from emergent themes identified during the qualitative analysis, we extracted several "great quotes" from participants that represented remarkable reflections of their participation in the ISCR program. The quotes depict the sensemaking and "most proud of accomplishments" expressed during the conversations. For example, a Quality Outcome Improvement Director provided a summary of their experiences and perceived impacts of the ISCR program which demonstrated an advanced understanding of the many aspects of effective implementation of the programs:

And I echo all that. Of course, the big thing is our patients are doing better. That's what this was all about. Our outcomes are better. Length of stay is less. Fewer urinary tract infections. Pneumonias are minimal. So, you know... on the individual patient care level, our patient care is much better. You know... on the grander level, this is facilitated for us a complete transition from the last millennial thinking of surgical outcomes and now the modern day. Before the surgeon's attitude was heck, if I do good surgery, my patients are going to do well and that is not necessarily the case. Doing good surgery is a component. I think this has brought us into the day that we all know is truth that for our patients to do well, it's a team effort. The captain of the ship idea that I'm going to take care of this patient and you guys are just ancillary to me

thinking as a surgeon, I think we've made tremendous strides of getting away from that. And the fact that you guys basically packaged his and then tossed it out to the rest of the world was enormous because for any individual institution to put this together is a tremendous amount of work which you guys did, and then you just tossed it out... we just were able to pick it up and it required bringing all the components... all the people together on every level to make it work and make it meaningful from data extraction, hospital leadership positions, pharmacy, nurses, physical therapy, case managers, and it moved us way down the road away from the siloed approach to patient care to the team approach. It also, particularly from the physicians and nurses, embracing the evidence-based care, and getting away from, "well this is the way I did it when I was a resident 25 years ago, so it's good enough now," to you know, "There are better ways to do things now. Let's embrace those and when we do our patients do better." I think part of the meritorious data likely comes from the fact I think many of us are using our postop order sets from the colorectal ISCR... I'm using it for all of my abdominal surgeries with multimodal management, tap blocks, warming the patient's, high flow oxygen... while there's not as much data in those areas as there is in colon, the principle still applies so I've been using it and the outcomes are better in other arenas other than just colorectal surgery for us. "

Another participant talked about the multidisciplinary collaboration resulting from participating in the program and expressed enthusiasm for sustained improvement in outcomes and a desire to participate in future QI efforts:

"We had nursing, we had surgery, we had anesthesia, pharmacy, you know... whatever... all the stuff you guys coach people about, I'm sure. It works, you know... and I think it worked well. You know... part of this stuff is every institution's unique and what you have to do is unique to you. I think we did a good job with it and I'm still talking but I think that's kind of where we are. I look forward to doing these types of things. I think it's better for patients."

Overall Discussion of In-Person and Virtual Site Visits

The three qualitative evaluations conducted within the ISCR program each offer unique insights as well as some converging trends across the evaluations.

First, in-person site visits focusing on the implementation process revealed common barriers and facilitators in the program. The strength and quality of evidence behind the ISCR program, the adaptability of pathways to local context, and alignment of the program with national guidelines, regulatory requirements, and shifts in payment models were perceived as important facilitators. Throughout the planning, aligning, engaging, and executing phases of implementation, successful facilities were able to build and manage a coalition of stakeholders and effectively use technology, specifically EHR order sets. However, the complexity of the ISCR program presented challenges to participating hospitals, and likely led to variations in the content of what was included in pathways at individual facilities. This variability in pathway content likely produced complicated the quantitative evaluation of clinical process and outcomes. Additionally, the administrative and technical challenges involved in implementing a clinical pathway in the EHR was a universal experience in the program.

Second, findings from the virtual site visits focusing on the EGS pathway share commonalities with the in-person site visit findings, particularly around the importance of working with the EHR to implement pathways and how challenging that can be. Similarly, teams struggled with the social complexity of an intervention that spanned multiple points of the perioperative space. Engaging team members within the project, and turnover of staff in

general were commonly reported challenges. EGS was conducted entirely within the COVID-19 pandemic, and therefore the severe challenges related to resource limitations and competing priorities presented a pervasive set of challenges for implementing this pathway.

Third, virtual site visits focusing on sustainability highlighted the dramatic impact of the COVID-19 pandemic and the organizational response to this crisis, as well as continuous auditing and feedback on performance to sustain gains, the use of technology to sustain ISCR improvements, and the critical role of boundary spanning team members to manage the complexity of the ISCR pathways across professional and geographic boundaries within the perioperative space.

Across these evaluations, the importance of the complexity of the ISCR program content as well as the complexity of EHR management within hospitals becomes salient. Even though most pathway elements for each service line were firmly rooted in existing and well-established guidelines, sites did perceive the content to be complex. Each pathway contained multiple elements, with different stakeholders responsible for the execution of different pathway components. ISCR pathways touch practices along the entire perioperative continuum, and involve surgeons, anesthesia providers, nursing and potentially others such as physical therapists and pharmacists. The use of the EHR to support pathway implementation was an effort to maintain consistency across these different geographic and social boundaries. However, all sites experienced difficulty moving as quickly as they felt they needed to when building pathways into their EHRs.

Chapter 5. Conclusions

This report documents the Agency for Healthcare Research and Quality's Improving Surgical Care and Recovery (ISCR) Program, and it details findings from a comprehensive set of evaluation activities. In this final chapter, we highlight several key findings and provide recommendations for future collaboratives of this nature.

Key Findings Across Evaluations

Significant improvement was observed in some (but not all) clinical process and outcome measures. For colorectal surgical procedures, six of the seven process measures demonstrated significant improvement in adherence over the project duration: preoperative mechanical bowel prep, preoperative oral antibiotics, use of multimodal pain management, the first postoperative intake of liquids, the first postoperative intake of solids, and indwelling urinary catheter duration. Only adherence to the first postoperative mobilization process measure did not significantly improve. Five of the nine outcome measures demonstrated significant improvements. The risk of experiencing an extended length of stay decreased by 9.83 percent. The risk of experiencing ileus decreased by 20.16 percent, and the risk of experience either ileus or an extended length of stay decreased by 14.69 percent. There was a 5 percent reduction in the duration until return of bowel function, and a 4 percent reduction in the duration of length of stay. Risk of experience venous thromboembolism, urinary tract infection, surgical site infection, or a composite of all three of these outcomes was not significantly changed during the project.

For hip fracture procedures, none of the eight process measures or eight outcome measures demonstrated significant improvement over the project duration. For hip/knee replacement procedures, none of the six process measures demonstrated significant improvement. Two of the eight outcome measures demonstrated significant changes, with a 12 percent decrease in the duration of length of stay and an 88.4 percent increase in risk of experiencing a transfusion. As detailed in the report, this finding for transfusion was unexpected. It is difficult to know if this represents increased perioperative blood loss or increased attention to perioperative optimization of patient risk factors (e.g., low hemoglobin). For gynecologic surgery procedures, two of the seven process measures demonstrated significant change over the project duration: with patient-controlled analgesia significantly decreasing, and local wound analgesia significantly increasing. Two of the six outcome measures demonstrated significant improvement over time with the risk of experiencing a prolonged length of stay decreasing by 41.4 percent and a 20 percent reduction in the duration of length of stay.

For the emergency general surgery (EGS) appendectomy and cholecystectomy procedures, two of the seven process measures demonstrated significant improvement over the project duration with adherence to patient education and use of multimodal pain management increasing. None of the nine outcome measures demonstrated significant change over the project duration. For the EGS major abdominal procedures, four of the nine process measures demonstrated significant improvement over the project duration. Adherence to advanced care planning, patient education, Foley catheter removal, and first postoperative venous thromboembolism prophylaxis done after surgery all increased significantly. However, none of the nine outcome measures demonstrated significant improvement.

The most consistent effects were in the colorectal service line, where the evidence base is most mature and where the program was most successful recruiting facilities to participate. The orthopedic, gynecologic, and EGS service lines had fewer participating hospitals, and a less consistent pattern of improvement across clinical processes and outcomes. As most pathway components were well established in existing guidelines, there was

variability in the starting points for implementation of different hospitals, and consequently differences in which aspects of the pathways different hospitals focused on. This undoubtedly created challenges in the overall assessment of the program.

AHRQ's ISCR Program had wide reach. Over all cohorts and service lines, 342 hospitals from 44 of the 50 U.S. states and Washington, DC, participated in the ISCR program. There was remarkable diversity in the size, setting, and geography of these facilities, suggesting a broad appeal of the program aims, content and structure.

The community of participating hospitals was dedicated and resilient. The ISCR Program was able to recruit and launch its final cohort after the onset of the COVID-19 pandemic, which is a testament to both the importance of the ISCR program and the passion of the workforce at participating facilities. They chose to take on additional work to improve the care they provide for their patients during a time of staggering hardship and uncertainty in healthcare. Throughout the program high levels of engagement from sites was apparent through participation on coaching calls, national leader calls, and continued data submission.

The ISCR Program produced a wide range of resources that sites felt were valuable. This included patient education materials, evidence reviews, pathway planning documents, and resources to build and manage the team responsible for implementing the program. Patterns of access of these materials on the project portal and findings from qualitative evaluations indicate these resources were viewed as valuable by participating sites.

The implementation of the ISCR program did not adversely impact patients' experience of care. The program was not designed to improve patient experience, but there were initial concerns that components of the program like early mobility or opioid sparing approaches to analgesia could be perceived negatively by patients. Findings from the patient experience evaluation indicate that this did not occur.

Recommendations for Future Collaboratives

Allow for the time it takes to make progress in surgical services. ISCR shifted from an initial 12-month program structure to an 18-month structure early in the program, as it quickly became clear how challenging implementing some of these pathway elements would be for some facilities. For the most complex pathway elements and the newer or more challenging service lines, even this timeline may have been too aggressive. Perioperative services are complex systems, and safe, deliberate change takes time.

Explore approaches to streamline use of electronic health records (EHRs) as a component of the improvement intervention. Participating hospitals clearly viewed their EHRs as critical tools in the pathway implementation process, but there was remarkable consistency in how difficult this was. The path forward is not immediately clear, but small-scale solutions like sharing example order sets did help within ISCR.

Focus on community building. The NPT adopted deliberate strategies to build relationships with participating hospitals through individual onboarding and nurse consult calls, office hours, and coaching calls. These strategies were based on lessons learned from previous collaboratives. While extremely labor intensive, these personal connections with participating sites helped keep the NPT informed of how sites were doing, and they helped participating sites feel more connected and have a source of personalized information and coaching.

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