IMPROVED OUTCOMES = IMPROVED ACCESS

Through a standardized approach to measurement as part of a strategy to improve care for surgical patients in BC

NSQIP IN BC

BC PATIENT SAFETY & QUALITY COUNCIL

Working Together. Accelerating Improvement.

SUMMARY OF ABBREVIATIONS & TERMS

ERAS

Enhanced Recovery after Surgery

LOS

Length of Stay: duration a patient remains in hospital, from admission to discharge

LOS Operative

Length of Stay Operative: duration a patient remains in hospital from surgery date to discharge

Morbidity

Assigned when a patient has *any* NSQIP-defined adverse outcome in the 30 days post-surgery

Readmission

A return to hospital within 30 days that results in patients being admitted to the hospital

Reoperation

A return to the operating room within 30 days for an unplanned surgical procedure

Scheduled Surgery

Surgery in which patients were pre-booked for their surgical date (in the NSQIP database these are called elective surgeries)

SCR

Surgical Clinical Reviewer: typically an RN who collects NSQIP data from the patient charts and inputs them into the NSQIP database

SSI

Surgical site infection

Unscheduled Surgery

Surgery that is not pre-booked due to the urgent or emergent nature of the illness (in the NSQIP database these are called non-elective surgeries)

UTI

Urinary tract infection

CONTENTS

EXECUTIVE SUMMARY

Since 2011, the active participation of 24 sites throughout British Columbia in the National Surgical Quality Improvement Program (NSQIP) has resulted in many improvements in surgical care across the province. Early efforts to establish the program and subsequent improvement initiatives have had a notable impact on patient care.

- NSQIP data is seen as a **reliable and valuable source of information** on surgical care. Rigorous data collection methodology and risk-adjusted reports are the foundation of the data validity. Additionally, early efforts to introduce NSQIP have been successful in increasing awareness of the program with surgeons and frontline staff.
- There has been a combined effort at the provincial, regional and site levels to address multiple areas of quality improvement in surgical care. An emphasis on **improving clinical outcomes** as well as working to build a **strong team culture** have helped teams to take action on their NSQIP data.
- The cumulative effect of both clinically focused and culture focused improvement initiatives has resulted in **reductions in adverse surgical outcomes** such as morbidity, surgical site infection (SSI), urinary tract infection (UTI) and length of stay (LOS), leading to improved overall care for surgical patients in BC.
- Through improvement efforts, reductions in length of stay have **opened up an estimated 12,000 bed days** in one year among NSQIP cases when comparing 2012 to 2015. Reassuringly, the reduction in length of stay has not resulted in a corresponding increase in readmissions or reoperations.

CLINICAL PROCESSES OF CARE HAVE BEEN IMPROVED THROUGH INITIATIVES SUCH AS:

- Enhanced Recovery After Surgery
- The BC Hip Fracture Redesign Project
- Care pathways for orthopaedic patients
- Individual site work in various sub specialties on urinary tract infections, surgical site infections, pneumonia and other outcomes.

THE SURGICAL ENVIRONMENT AND CULTURE IN WHICH SURGERIES TAKE PLACE HAVE BEEN ADDRESSED THROUGH:

- Culture surveys
- Comprehensive Unit-based Safety Program
- The Productive Operating Theatre

While there have been significant improvements, several gaps remain that provide opportunities for further improvement. These areas relate to communication, teamwork and active use of the NSQIP data.

- Good data alone does not result in improved patient outcomes. There is a **need for focused improvement action** in addition to NSQIP data collection and engagement.
- While all sites have access to the same NSQIP reports, the frequency, content and method of sharing data and results within BC sites is inconsistent. These inconsistencies may result in the *NSQIP* **data not being seen in a timely manner** which may result in the data not being used in strategic planning and other key decision-making about surgical care. Sites that use a variety of data-sharing strategies, tailored to each stakeholder group with a consistent pattern and frequency of sharing, are **1.5 times more likely to be one of the top five performing BC NSQIP hospitals**.
- NSQIP team composition varies across sites; however, stakeholder engagement is needed at all sites to ensure all **multi-disciplinary frontline staff and other stakeholders are included**.
- Data sharing happens within hospitals and health authorities; however, there is also an **opportunity to learn from other sites across Canada**. Engaging in Canada-wide collaboration through data sharing has been requested by sites to learn strategies for improved surgical care.
- Integration of additional data fields into the NSQIP database can expand the reach of the NSQIP program and avoid NSQIP being seen as having **limited utility to larger surgical programs**. NSQIP has shown that it can serve as the primary source for surgical evaluation within a hospital, even beyond the included surgical outcome data.

BACKGROUND

The National Surgical Quality Improvement Program (NSQIP) was implemented in 2011 as a measurement system to help understand the *safety and effectiveness* dimensions of surgical quality in British Columbia.[1] NSQIP was selected from a variety of measurement options due to its cross-specialty focus, strong data collection platform and ability to risk-adjust for comparison.[2]

Risk adjustment takes into account underlying health problems and inherent risk in surgical procedures to allow for comparison between patients of varying acuity.

NSQIP enables sites to provide rigorous and reliable data to surgeons, administrators and other members of the health care team. It provides a platform to collect and evaluate pre-operative risk and 30-day patient outcomes for surgical patients. The hallmark of the NSQIP program is access to risk-adjusted reports that provide performance comparison to other hospitals participating in the program. The rigor and reliability in NSQIP data stems from the standardized definitions applied to patient cases, yearly certification of surgical clinical reviewers (SCRs) and systematic sampling procedures with inclusion/exclusion criteria. Sites are provided with regular risk-adjusted reports, on-demand summary reports, and the opportunity to download raw data at any time for more in-depth analysis. Through these reports, NSQIP sites have timely access to benchmarking and comparison to current norms as opposed to published rates that may be found in the literature and are often older. Sites choose to participate as generalized multi-specialty sampling or as procedure targeted sampling which provides a greater focus on surgical areas that have higher patient acuity or higher volumes of surgery.

NSQIP teams involve a core partnership between a surgical clinical reviewer (SCR) and a surgeon champion. The SCR is the primary data collector for the NSQIP program and the major link between the raw data and NSQIP-generated reports. The surgeon champion acts as the connection between the data and the clinical teams by sharing local results, being an advocate for surgical initiatives and championing best practices at the site. The larger NSQIP team may include quality improvement advisors, frontline staff, administrators, patient advisors, data decision support and other health care team members.

NSQIP provides a way to assess and monitor the quality of surgical care over time, and it enables sites to watch for unintended consequences that may result from work in other areas (e.g., access initiatives).

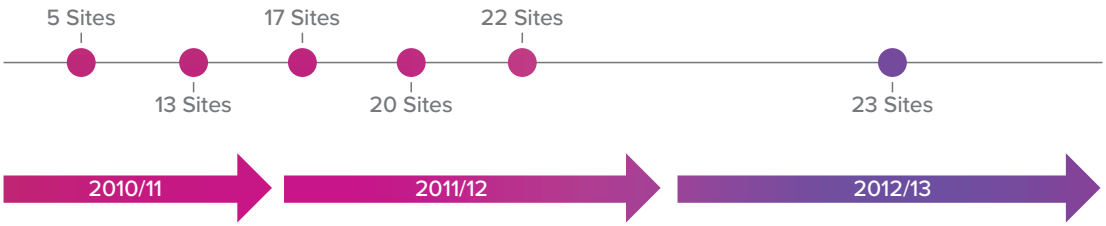
[1] https://bcpsqc.ca/documents/2012/09/BCPSQC-Health-Quality-Matrix-February2017.pdf

[2] Taylor, T. & Matheson, D. (2009). A Surgical Quality Improvement Program for BC: Choosing a Surgical Measurement Tool. Prepared for BC Patient Safety & Quality Council. https://bcpsqc.ca//documents/2012/12/NSQIP-BCPSQC-Report-on-Surgical-Measurement-Systems.pdf

While showing improvement in outcomes is the goal of many quality initiatives, it is equally important to ensure that outcomes do not worsen as other dimensions of quality change and improve.

With 23 adult sites and one paediatric site participating in BC, there is now an extensive amount of validated and peer comparable surgical outcome data that can inform surgical improvement efforts.

Figure 1: Timeline of BC NSQIP Site Enrollment



The BC Patient Safety & Quality Council (BCPSQC) has supported sites in the early implementation and ongoing engagement with the NSQIP program through online and in-person educational sessions that highlighted successful improvement projects, explored complex aspects of data collection (e.g., reading x-ray and microbiology reports) and provided a venue for sites to share challenges. Working groups were created to have a provincial perspective on data collection challenges such as using current procedural terminology codes and application of NSQIP definitions in chart abstraction. Additionally, site visits were completed during the first two years of the program to provide suggestions to improve workflow and address learning needs that were not included in NSQIP training (including data cleaning and data display). The Council has previously reported on improvement progress within the BC NSQIP program:

- In 2013, the first provincial report, *NSQIP 2.5 years after start-up: Is it worth it?*,[3] took a high level examination of the progress in getting NSQIP started in BC and early improvement efforts; and
- In 2014 the report titled *Tackling Complex Problems with Team-Based Solutions: NSQIP in BC 2014*[4] had a strong focus on individual improvement projects and results.

The purpose of the current review is to examine the change in NSQIP data from 2011 to 2015 with the goal of quantifying improvements efforts. The primary focus was to assess changes in adverse outcomes; examine system capacity gained through reductions in length of stay, readmission, and reoperations; and describe organizational characteristics around data sharing and communication. With these results, the aim is to develop a stronger understanding of how the NSQIP data are used, suggest key areas where future surgical improvement efforts can take place, and accelerate the success of the NSQIP program moving forward.

[3] https://bcpsqc.ca//documents/2012/10/NSQIP-2.5-years-later_January-2014_final_v3.pdf

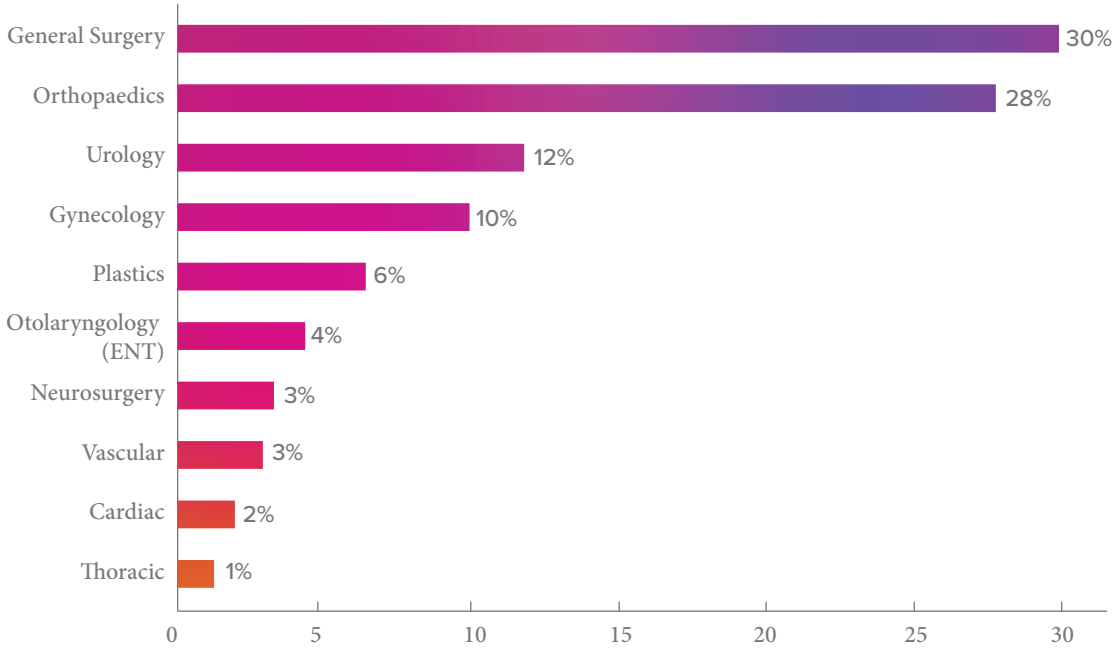
[4] https://bcpsqc.ca//documents/2012/10/Tackling-Complex-Problems-with-Team-Based-Solutions.pdf

NSQIP 5-YEAR REVIEW: SAMPLE CHARACTERISTICS

This evaluation involved the analysis of over 175,000 individual surgical cases collected at 23 hospitals over five years.[5] A qualitative survey was also completed by 19 Surgical Clinical Reviewers (SCR) across 18 sites (Appendix A). NSQIP data collection involves systematic sampling across eligible surgical sub specialties and this analysis includes all available NSQIP cases collected in the study timeframe. Variables collected within the NSQIP platform can be found in Appendix B. Unless otherwise specified, the data used for these analyses are raw rates and not risk adjusted.

The NSQIP dataset is predominantly scheduled surgeries (77.2%) with the majority of surgeries being inpatient cases (60.8%). General surgery and orthopaedics have the highest volumes (30% and 28% respectively), followed by urology (12%) and gynecology (10%).

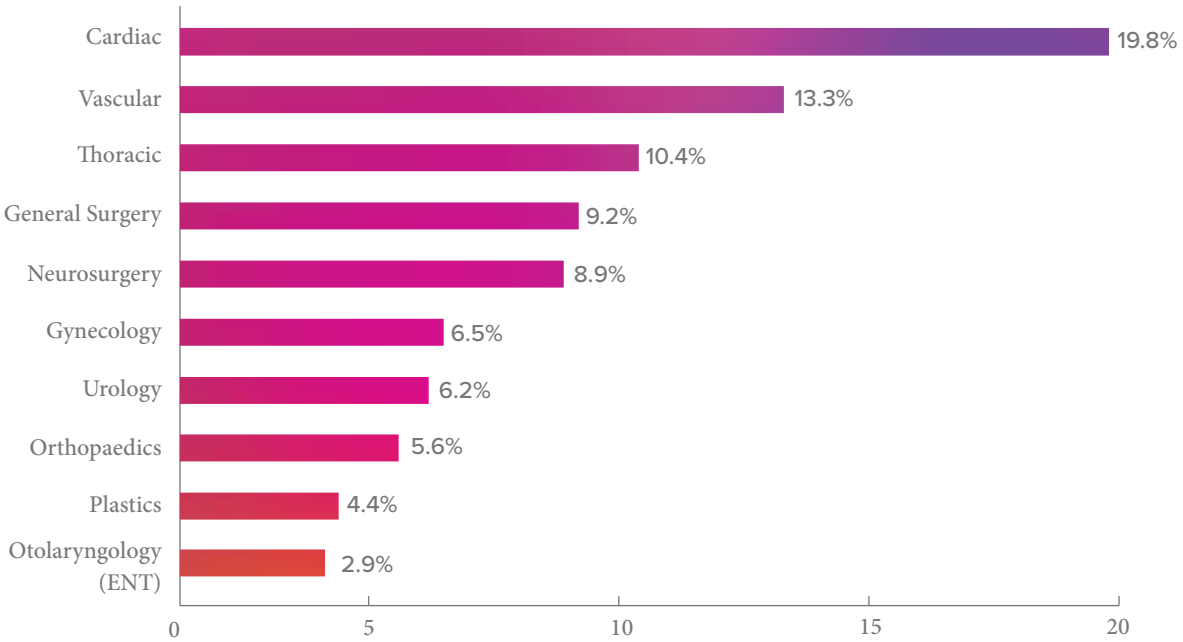
Figure 2: Percent Surgical Volumes in NSQIP Sample 2011-2015



[5] It is important to note that 2011 was a partial year for many of our sites as they were just getting the program started. Therefore, the sample size for 2011, is roughly half the size of other years (17,500 cases compared to 35,000 – 40,000 for 2012-2015).

The overall morbidity rate across the sample was 7.3% (all years and all cases). Morbidity is a summative outcome measure that counts if a patient has *any kind* of adverse event. This means that, on average, 7.3% of surgical patients in the report timeframe were diagnosed with at least one post-operative event. Across sub specialties, cardiac surgery had the highest incidence of morbidity at 19.8%; however, these cases represent only 2% of the overall sample. General surgery, with higher volumes and an overall morbidity rate of 9.2%, had the largest total number of patients who experienced adverse outcomes. Understanding the areas that experience the highest morbidity rates (both in rate and volume) can help both local and provincial initiatives focus improvement efforts to have the greatest impact.

Figure 3: Percent Morbidity Rate by Surgical Subspecialty 2011-2015

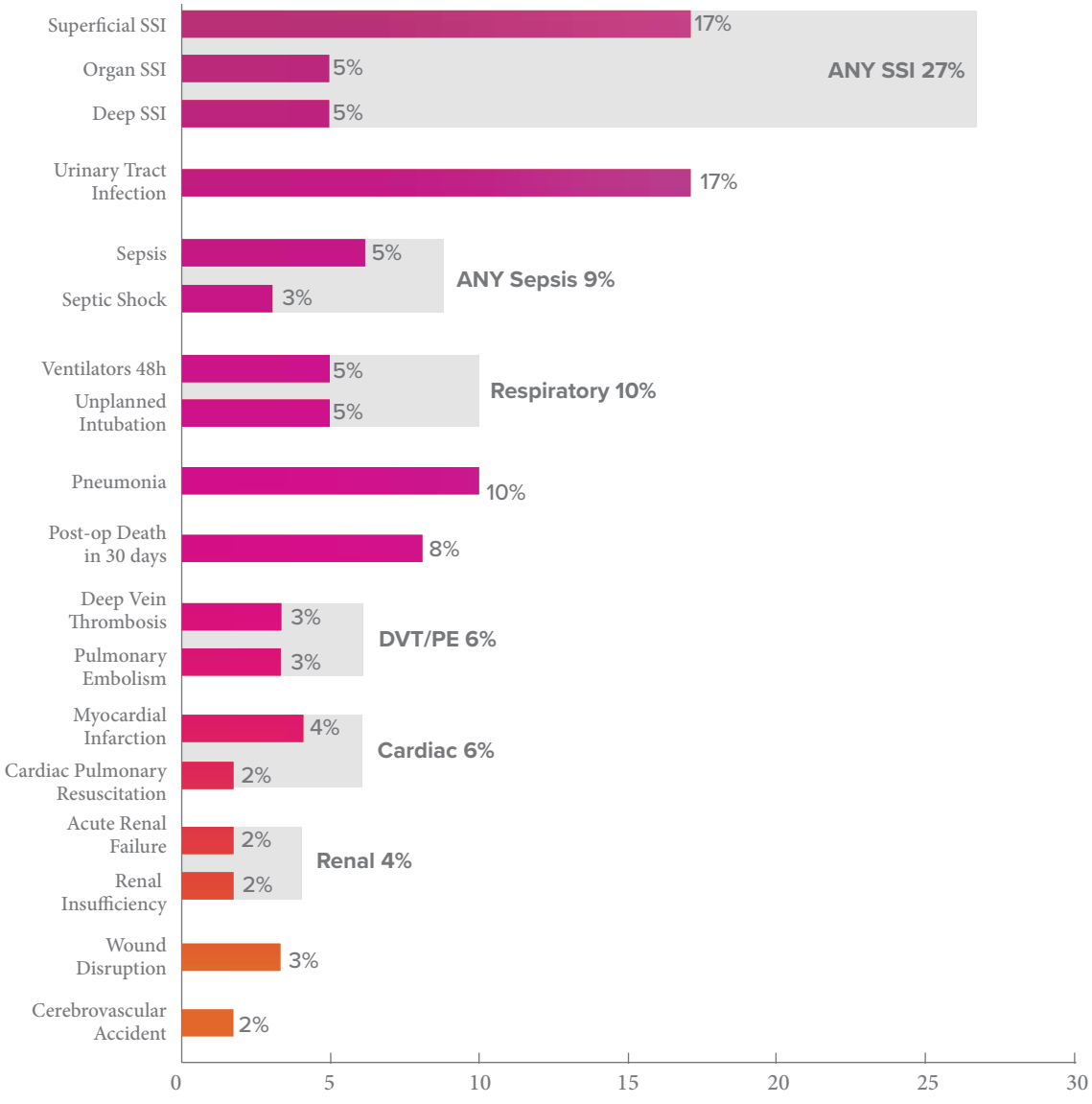


The distribution of adverse events by type is summarized in Figure 4, with urinary tract infections (UTIs) and surgical site infections (SSIs) comprising the majority of adverse outcomes – a total of 47% of the adverse events recorded in NSQIP. UTI prevention was an early focus for many hospitals, with SSI initiatives coming soon after with support from Safer Healthcare Now[6] (2014) and the Council's 10K: Race for Infection Prevention[7] (2015-2016). Again, understanding the areas with the potential for the greatest impact is integral for sites to focus improvement efforts.

[6] http://www.patientsafetyinstitute.ca/en/toolsResources/Documents/Interventions/Surgical%20Site%20Infection/SSI%20Getting%20Started%20Kit.pdf

[7] https://bcpsqc.ca/clinical-improvement/surgery/10000-reasons/

Figure 4: Proportion of Post-Operative Outcomes by Type



TRENDS OVER TIME

While the summary above provides an overview of the characteristics of the NSQIP data set, the purpose of this evaluation is to examine trends in the raw NSQIP data over time and to understand how improvements in surgical outcomes can impact access to the health care system.

General trends in the NSQIP data show reduction in morbidity, SSI rates and UTI rates over time for all cases. These results show the cumulative effect of multiple local and provincial initiatives across the 23 adult NSQIP sites.

Figure 5: Percent of All Sampled NSQIP Cases with Any Morbidity over Time

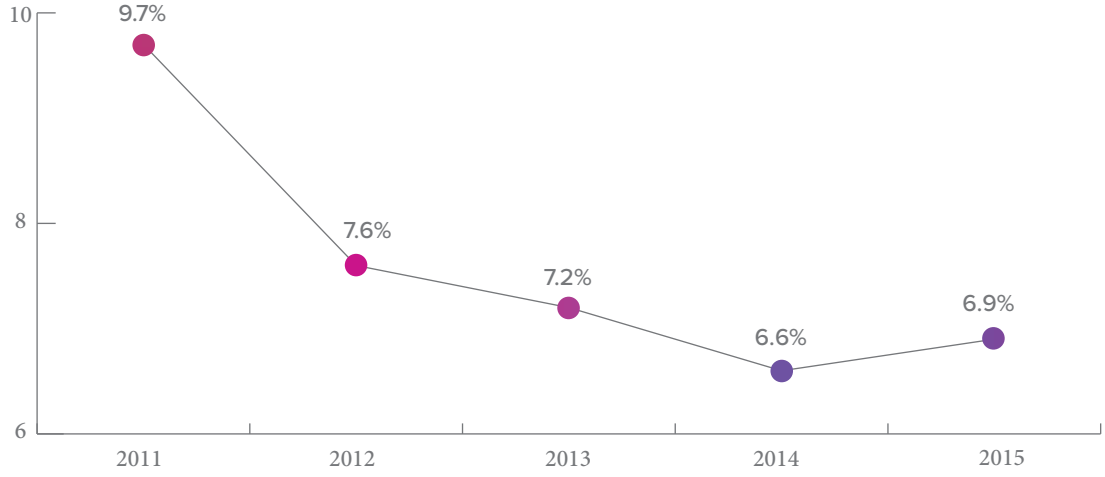


Figure 6: Percent of All Sampled NSQIP Cases with Any Surgical Site Infection over Time

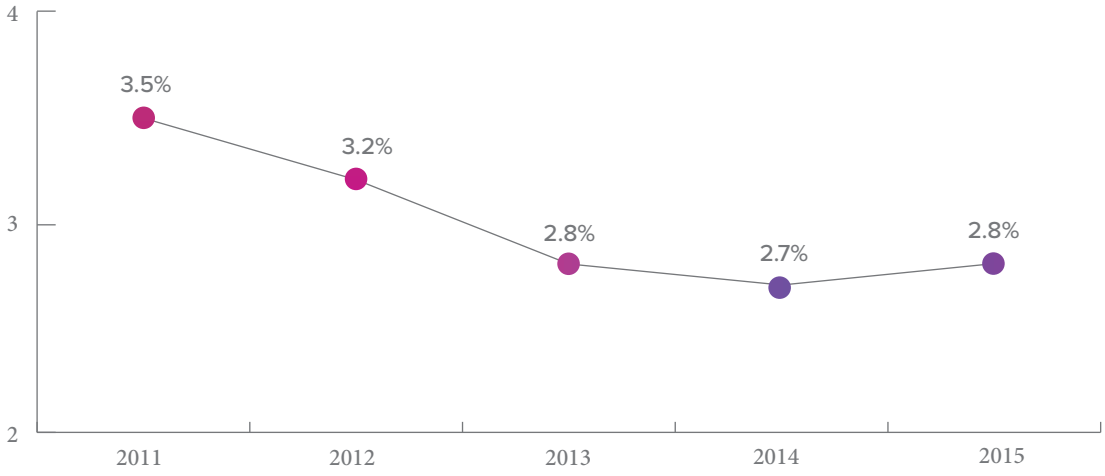


Figure 7: Percent of All Sampled NSQIP Cases with Urinary Tract Infection over Time

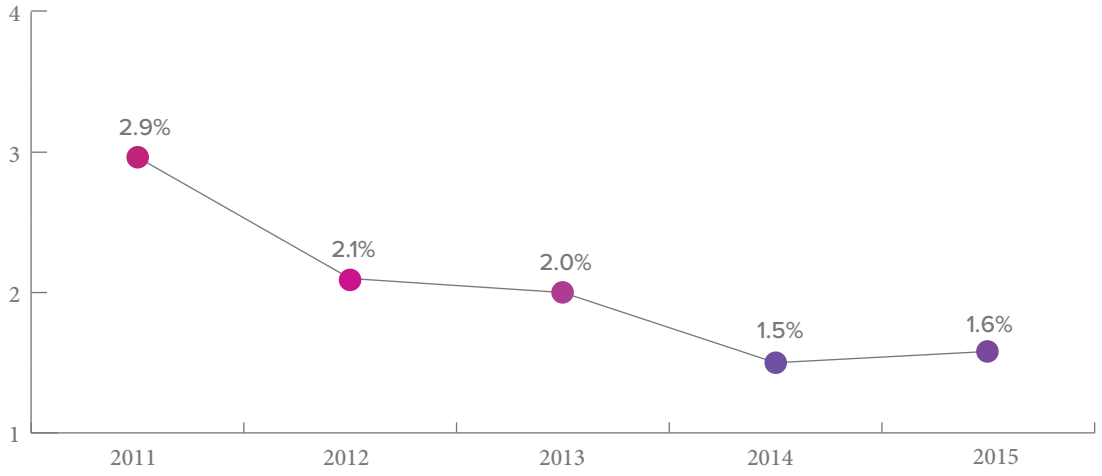
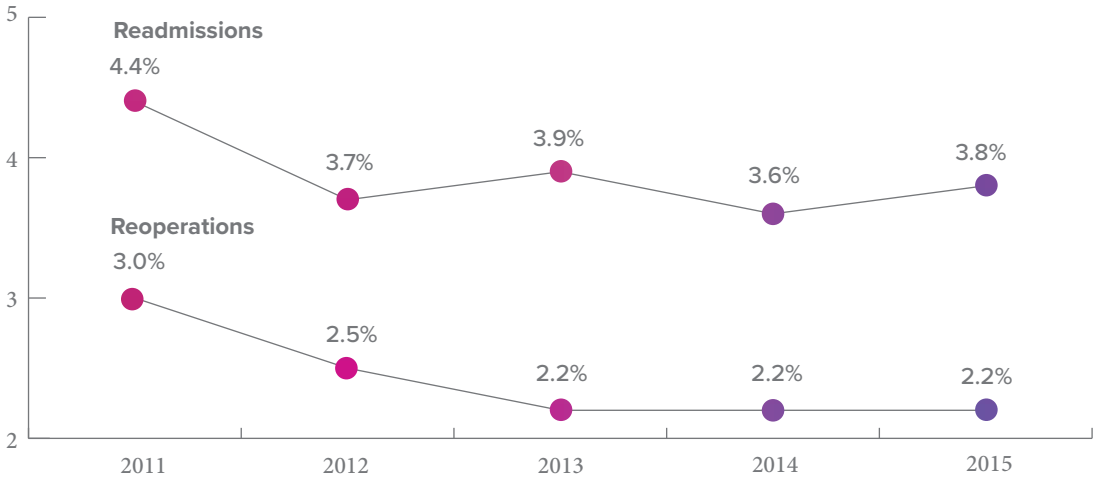


Figure 8: Average Number of Days of Length of Stay (admission to discharge) and Operative Length of Stay (surgery to discharge) over Time

Reductions in LOS can, at times, result in a corresponding increase in readmissions or reoperations because patients may be sent home before they are ready and return to the hospital with complications. That was not the case in BC. Reoperations also showed a decrease while readmissions remained relatively stable. This means patients are not only going home earlier, but they are staying home at a consistent rate and not requiring follow-up surgery due to complications.

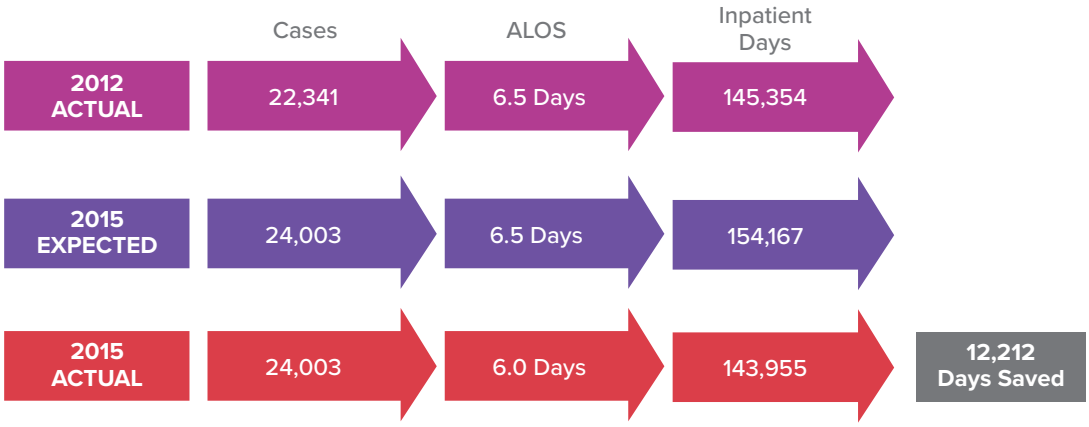
The overall reduction in SSI and morbidity rates may also contribute to the reduction in reoperation. As complications that may require reoperation decrease (e.g., deep or organ space SSI), a corresponding decrease in reoperation rates would be expected and is seen in these data.

Figure 9: Percent of All Cases that required Readmissions and Reoperations over Time



As operative LOS decreases, capacity is created to complete more surgeries or have more patients come through the surgical unit. In 2012, there were 22,341 inpatient cases sampled by NSQIP in BC. Those cases had an actual measured count of 145,354 inpatient days (operative LOS), resulting in an average length of stay of 6.5 days. If the same average length of stay were applied to the 24,003 cases done in 2015 alone, one could expect a count of 156,167 inpatient days. Instead, there were only 143,955 inpatient days used. Therefore it is estimated that 12,212 days were saved in 2015 for the NSQIP sampled cases alone, representing a reduced operative LOS to 6.0 days (Figure 10).

Figure 10: Days Saved Through Reductions in Length of Stay 2012 to 2015



In a more detailed analysis, these same outcomes were examined for scheduled and unscheduled (typically urgent or emergency) cases separately. The acuity, inability to prepare patients for surgery, and severity of presenting disease in unscheduled patients may create a situation where care pathways are difficult to implement, predisposing patients to adverse outcomes. While unscheduled cases do have longer average lengths of stay and higher complications rates than scheduled surgeries, both have decreased over the last five years. Interestingly, when divided into the two groups, there is a steeper decline in morbidity for unscheduled patients; however, morbidity rates remain almost double those of scheduled patients. The higher incidence of morbidity for unscheduled patients in BC is consistent with rates for all NSQIP hospitals.

Figure 11: Percent of All Cases with Any Morbidity over Time: Scheduled and Unscheduled Surgeries

Similar differences are seen between scheduled and unscheduled surgery in SSI rates, with a larger reduction over time in SSI rates for unscheduled surgeries. While unscheduled surgeries only represent 23% of the NSQIP sample, it is an important illustration that infection prevention strategies have been successful in reducing adverse outcomes in both groups.

Figure 12: Percent of All Cases with Any Surgical Site Infection over Time: Scheduled and Unscheduled Surgeries

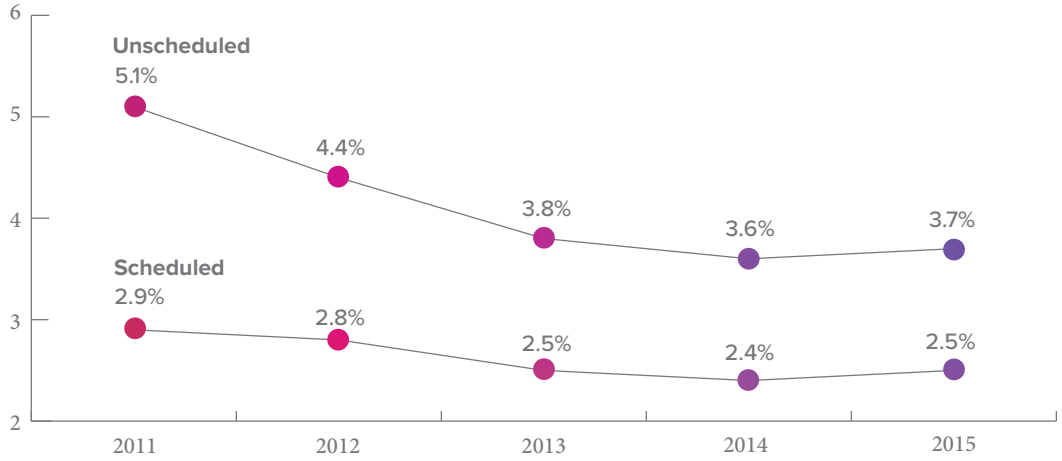


Figure 13: Operative (surgery to discharge) Length of Stay in Days over Time: Scheduled and Unscheduled Surgeries

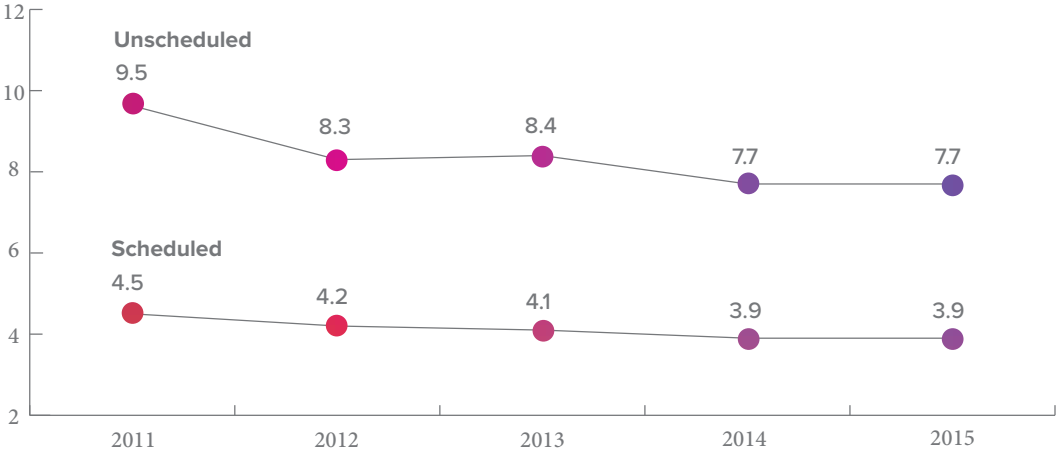
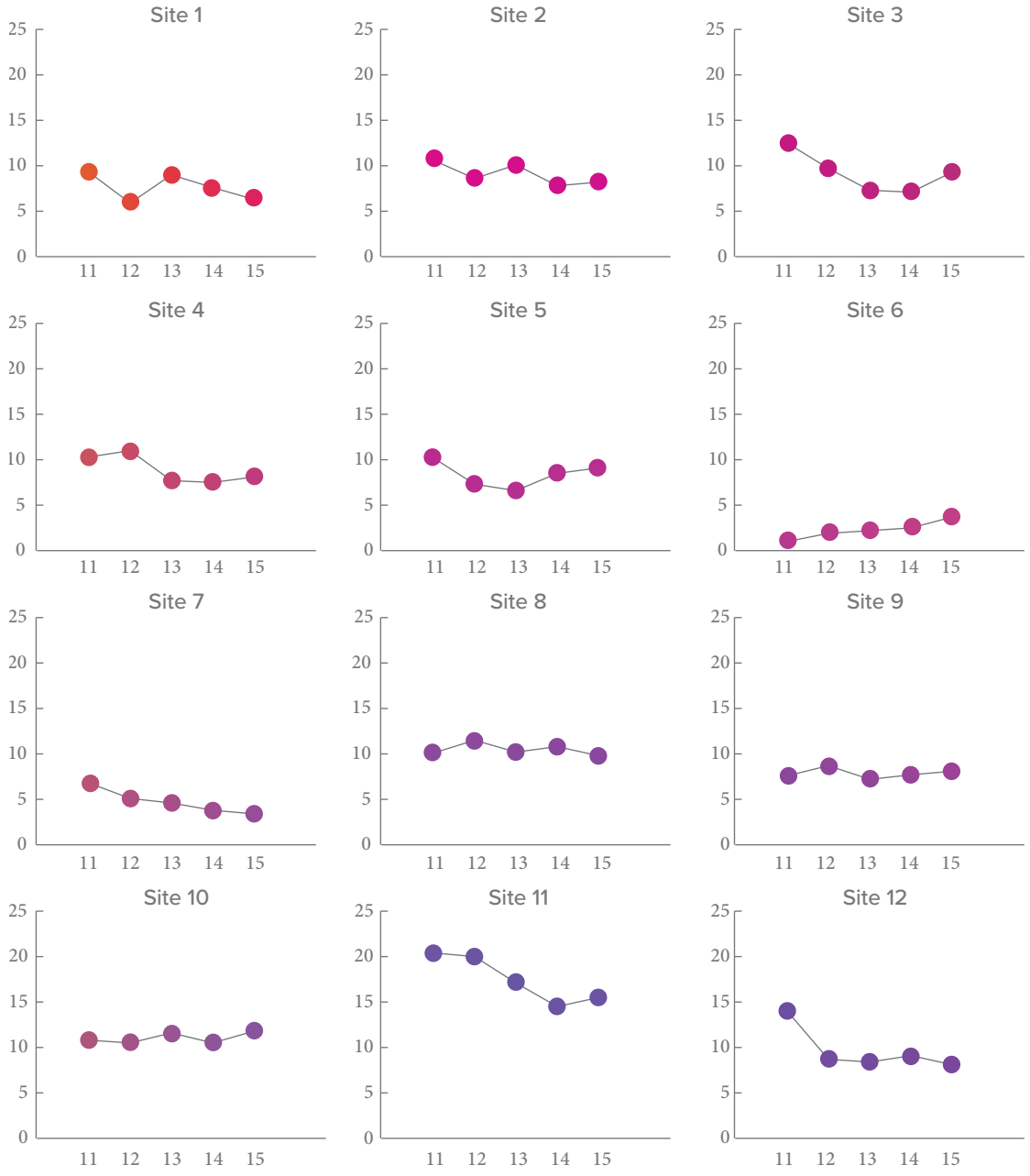
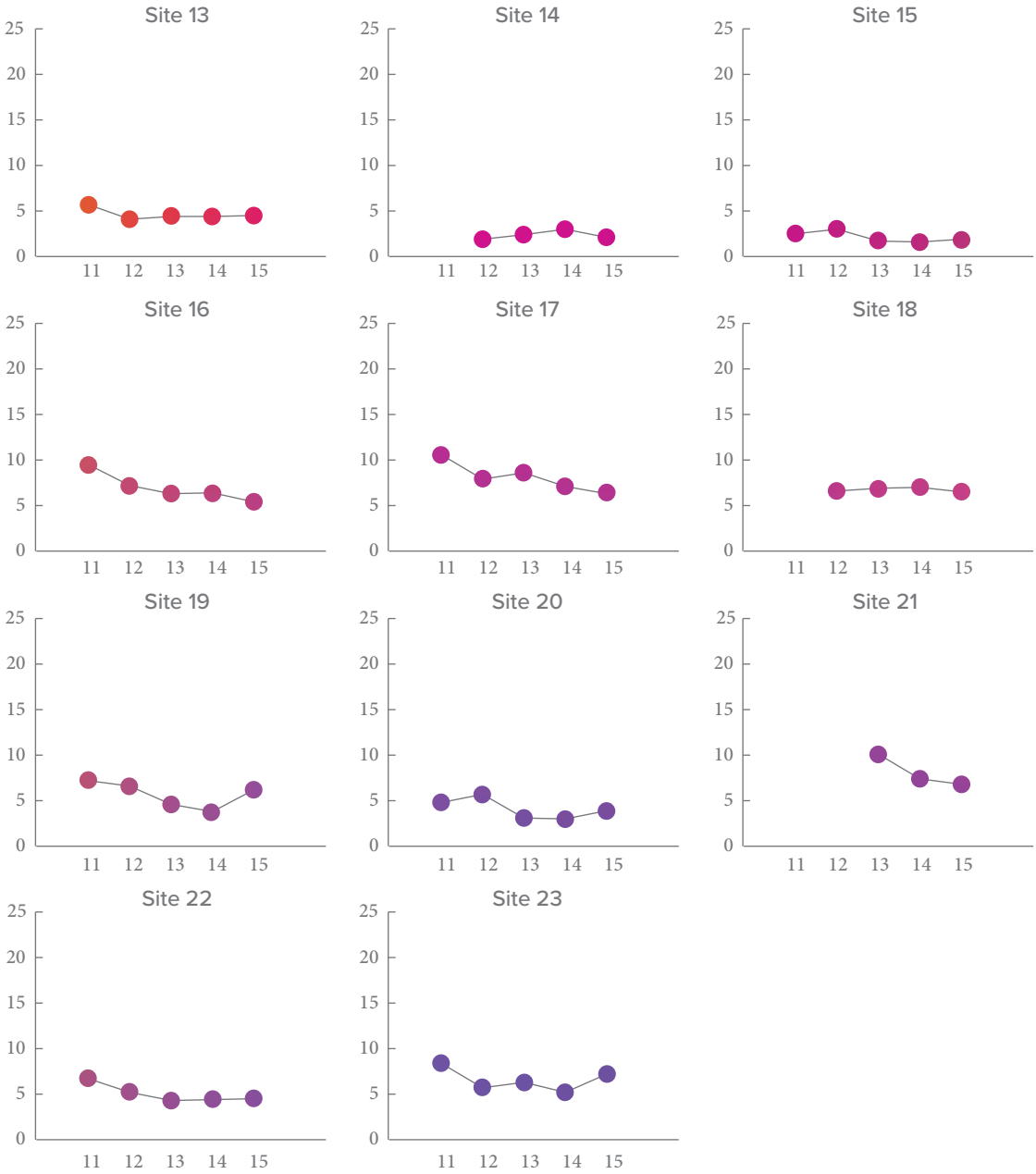


Figure 14: Percent Morbidity Rates for Each NSQIP Site for Years 2011 through 2015



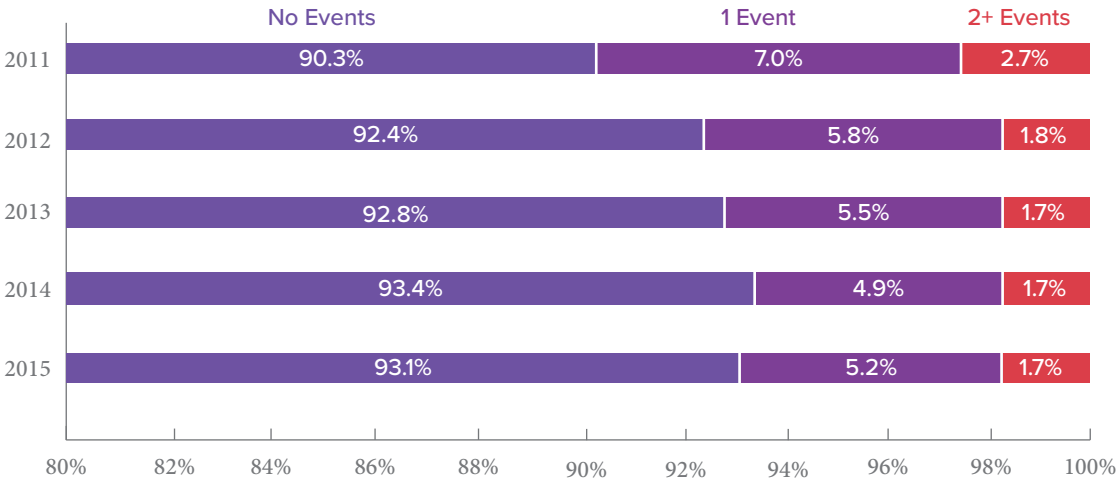
The improvement we have seen provincially in these outcomes may be attributed to significant improvement in key sites, and is not necessarily an indication that all sites are improving equally. As shown in Figure 14, reduction in morbidity rates differ across sites. Additionally, the variability in baseline morbidity rates is readily apparent from this illustration. Many of the sites that are showing



notable improvement are also sites that began with higher baseline morbidity rates. For sites that have low baseline morbidity rates, it is anticipated that they will show less of a change over time as they have less room for improvement in that area overall.

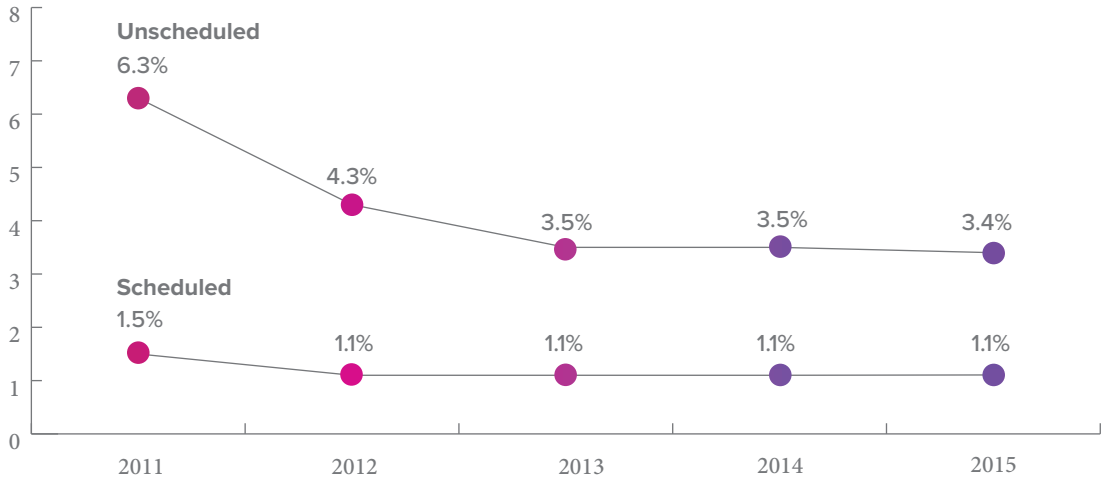
The number of adverse outcomes per patient is another important metric. *Overall, the majority of patients (over 90%) have no adverse events within 30 days of surgery.* For those patients that do, most have a single event. Over time, the number of patients with a single event has decreased from 5.8% in 2012 to 5.2% in 2015. For the small proportion of patients with Two or More Events, the rate has remained stable at 1.7% since 2012. This means that the number of patients with multiple adverse events has been less affected by improvement initiatives compared to patients who experienced single events.

Figure 15: Proportional Representation of the Number of Adverse Events for Post-Surgical Cases over Time



Patients in this group may suffer from a cascade effect where one adverse outcome leads to others, or they may have poorer health to begin with, leading to worse outcomes overall. Unscheduled surgical patients make up a smaller proportion of the overall sample but have three times the rate of multiple adverse events. This is anticipated: patients who come in for emergency surgery are likely to have poorer baseline health status at the time of surgery, have not had the opportunity for complete pre-operative optimization and are more likely to have a complicated surgical course.

Figure 16: Percent of Cases with Two or More Events Adverse Events over Time: Scheduled and Unscheduled Surgeries



While understanding the changes that have been made within BC is important, another metric that can be used to understand how well BC is performing is comparing its participatory hospitals to others enrolled in the NSQIP program across North America. The BC NSQIP collaborative began receiving twice yearly reports in 2014. These reports show where BC stands compared to the rest of NSQIP (if all BC NSQIP hospitals were combined into a single data point). After risk-adjusting the data, NSQIP designates hospitals as 'exemplary', 'as expected' or 'needs improvement'. At the first report, BC was designated 'needs improvement' in 5 different areas: colorectal UTI; colorectal return to the OR; colon surgery death and serious morbidity; colon surgery SSI; UTI; and all cases morbidity. By July 2016, BC sites were only designated as 'need improvement' in colon SSI and UTI. BC, as a whole, is not exemplary in any single area, although some individual hospitals are exemplary in some areas.

Looking at the distribution of individual hospitals (using risk adjusted odds ratios) does give us a sense of where sites are doing well and where there are further opportunities for improvement. The following table is a summary of the outcomes for 'all cases', meaning that all specialties are included in the model. As is illustrated, most BC NSQIP hospitals fall into 'as expected'. Morbidity, UTI and SSI have the largest number of hospitals designated as 'needs improvement' whereas mortality and unplanned intubation have the most hospitals designated as 'exemplary'.

Designation of BC Hospital Performance based on NSQIP Risk-adjustment across Morbidities

Outcome (All Cases)	Number of Hospitals Exemplary	Number of Hospitals 'As Expected'	Number of Hospitals 'Needs Improvement'
Mortality	5	17	1
Morbidity	1	13	9
Cardiac	1	22	0
Pneumonia	1	18	4
Unplanned Intubation	4	18	1
Ventilator > 48 hours	2	20	1
Venous Thromboembolism	2	20	1
Renal Failure	3	18	2
Urinary Tract Infection	1	14	8
Surgical Site Infection	1	15	7
Sepsis	0	21	2
Clostridium difficile	2	16	5
Return to Operating Room	1	20	2
Readmission	1	22	0

THE AREAS IN WHICH THE LARGEST NUMBER OF BC HOSPITALS WERE DESIGNATED AS 'EXEMPLARY' WERE MORTALITY AND UNPLANNED INTUBATION.

THE AREAS IN WHICH THE LARGEST NUMBER WERE DESIGNATED AS 'NEEDS IMPROVEMENT' WERE SSI, UTI, AND MORBIDITY.

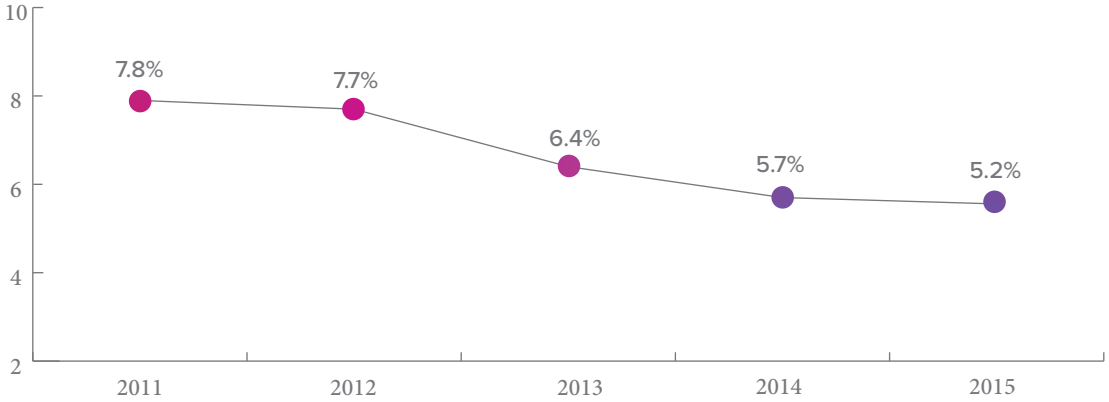
FINDINGS BY SPECIALITY

For the purposes of this report, specific surgical sub specialties were selected to be analyzed either due to their high incidence of outcomes (to show opportunity for future improvement) or their involvement in improvement initiatives (to show the impact of focused improvement work).

Orthopaedics – Hip Fracture & Hip/Knee Arthroplasty

Total hip and knee arthroplasty are, generally, scheduled procedures that follow a standard pathway of recovery. Many initiatives in this area have focused on implementing and improving care pathways in this patient group. Over time, morbidity has decreased from 7.7% in 2012 to 5.2% in 2015.

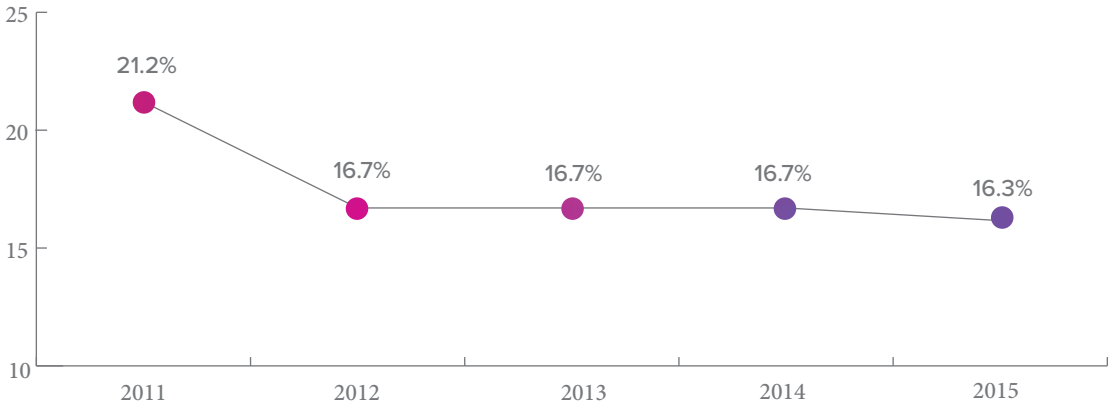
Figure 17: Percent of Total Knee Arthroplasty and Total Hip Arthroplasty with Any Morbidity over Time



Care of patients with hip fractures has been the focus of a provincial collaborative. The BC Hip Fracture Redesign Project, led through the Specialist Services Committee, has been working since 2013 to address the needs of this group-typically non-scheduled surgeries in a frail elderly population. Morbidity in this population and has remained stable since 2012[8] and LOS has decreased over time.

[8] Case volumes for 2011 were half of subsequent years and 3 new sites started contributing to the hip fracture data in 2012. Due to these factors, it is more accurate to look at trends between 2012 to 2015.

Figure 18: Percent of Hip Fracture Repair Cases with Any Morbidity over Time



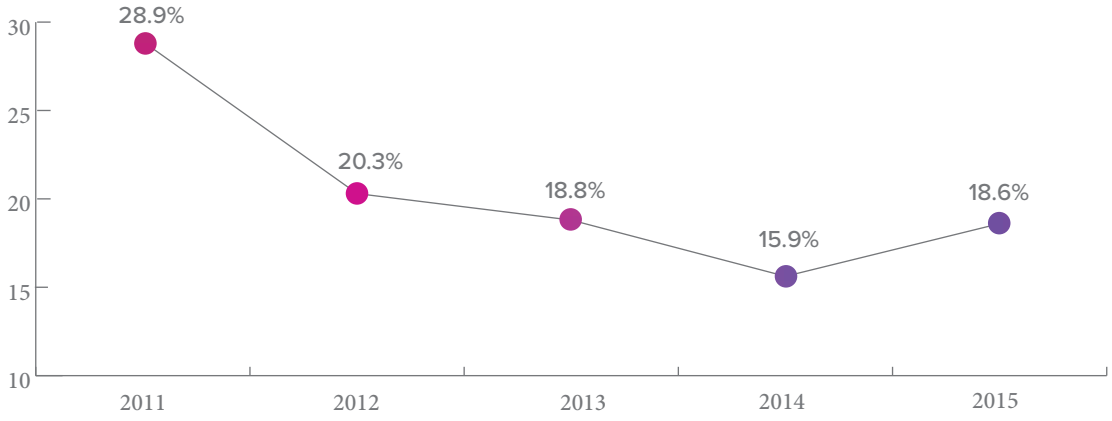
One of the goals of the Hip Fracture Redesign Project was to reduce wait times prior to surgery. The gap between admission to hospital and surgery date was 2 days in 2011 and 1.6 days in 2015. While a reduction of 0.6 days may not seem like big change, getting patients to surgery more quickly is an important factor for the patient's experience as well as their long term recovery.

Figure 19: Average Length of Stay in Days after Hip Fracture Repair over Time

Cardiac Surgery

Cardiac surgery is the surgical subspecialty with the highest incidence of adverse outcomes in BC. The overall volume of procedures completed in cardiac surgery is small compared to other subspecialties, but the impact of improving care can be substantial. Adverse outcomes in cardiac surgery are a high cost to the system and have significant impact to the patient. As shown in Figure 20, morbidity in cardiac surgery has been decreasing since 2011 with a slight uptick in 2015.

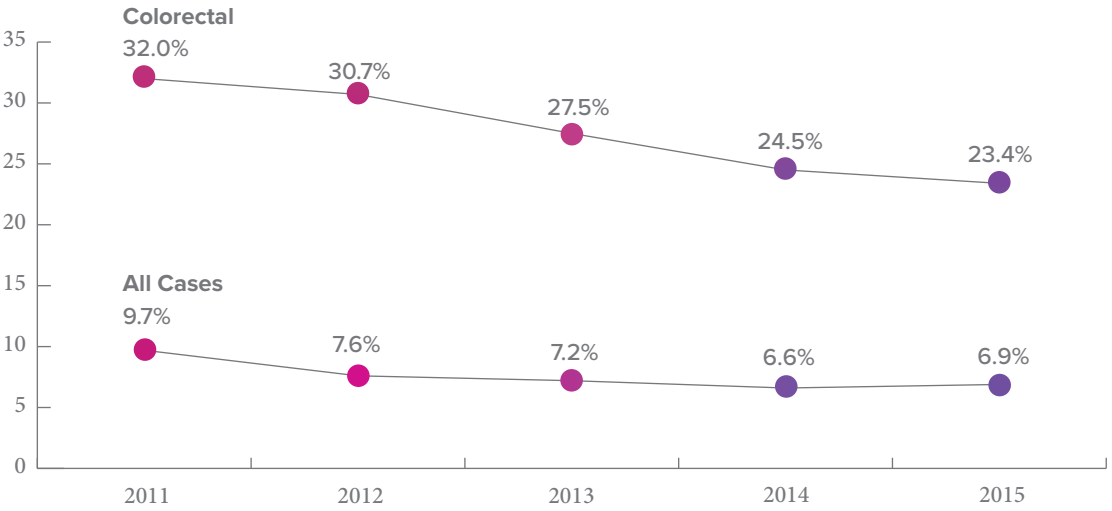
Figure 20: Percent of Cardiac Surgical Cases with Any Morbidity over Time



General Surgery – Colorectal

The colorectal sub-group of general surgery has a much higher overall complication rate, with initial morbidity rates over 30% compared to less than 10% for all general surgery cases. Over time there have been significant reductions in morbidity, SSIs and length of stay in this population. Work in the area of colorectal surgery has been of great interest to NSQIP sites, with many engaging in targeted initiatives and eight sites participating in the BC Enhanced Recovery after Surgery (ERAS) collaborative (led by Doctors of BC).

Figure 21: Percent of Colorectal Cases with Any Morbidity over Time



Colorectal surgeries almost always involve an inpatient stay. That being the case, it is impossible to reduce length of stay to zero. One of the goals of enhanced recovery is to reduce length of stay and have these patients home earlier. As is illustrated in Figure 22, LOS decreased in this patient population.

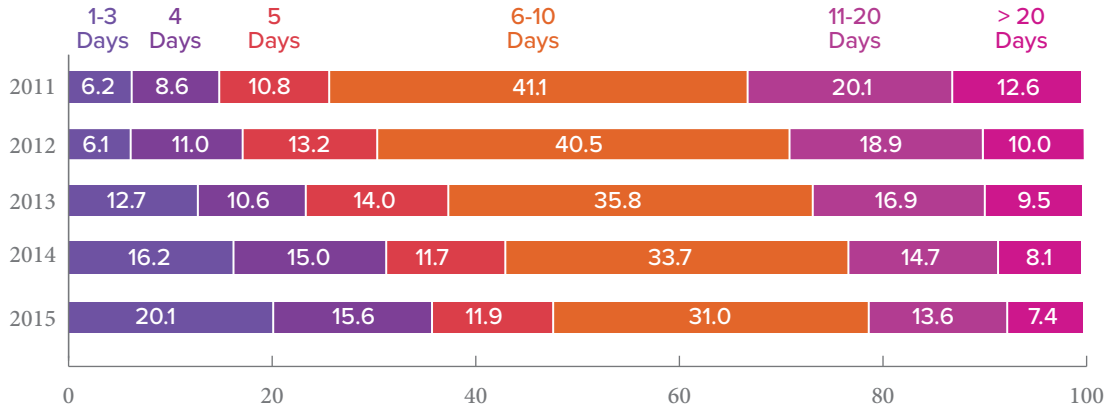
Figure 22: Average Length of Stay and Operative Length of Stay (surgery to discharge) for Colorectal Patients over Time

Another way to look at length of stay is by grouping it by range of days. For this evaluation, LOS groupings consisted of: 1-3 days, 4 days, 5 days, 6-10 days, 11-20 days and >20 days. As shown in Figure 23, between 2011 and 2015, the proportion of patients staying 5 days or less has increased from 25.6% to 47.5%. Almost half of colorectal surgery patients (including both scheduled and non-scheduled) went home within 5 days of their surgery in 2015.[10]

If we considered the procedure volume to bed day ratio (how many days were used to complete required number of procedures) in 2012 and compared it to 2015, we would have expected to use 21,891 bed days in 2015. In actuality, only 17,599 were used. With a median LOS of 5 days, this could translate into access for 800 more colorectal surgeries in that year.

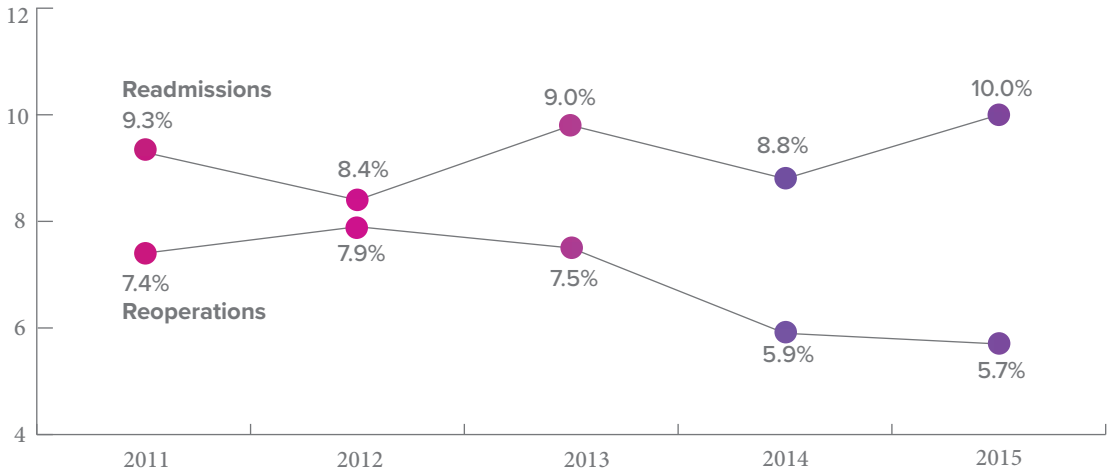
[10] Aarts, M. A., Okrainec, A., Glicksman, A., Pearsall, E., Victor, J. C., & McLeod, R. S. (2012). Adoption of enhanced recovery after surgery (ERAS) strategies for colorectal surgery at academic teaching hospitals and impact on total length of hospital stay. Surgical endoscopy, 26(2), 442-450.

Figure 23: Proportion of Grouped LOS for Colorectal Cases Over Time



As patients go home earlier after surgery, there is a risk that they will experience complications associated with early discharge and need to return to the hospital for care. It is important to monitor readmission and reoperation to ensure that improvements in one outcome are not adversely affecting other outcomes. Similar to findings in the larger overall sample, reoperations have decreased and readmissions have remained stable.

Figure 24: Percent of Colorectal Surgery Requiring Readmission or Reoperation over Time



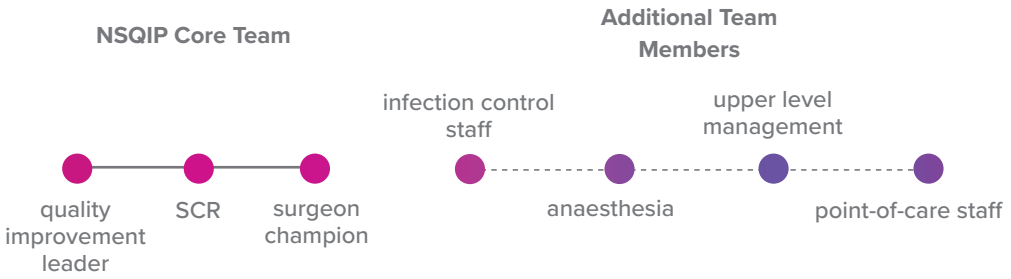
NSQIP DATA USE & COMMUNICATION

Another goal of this review was to provide insight into the reporting structure, information flow and data usage at participating NSQIP sites. In the early implementation of NSQIP in BC, individual sites developed the NSQIP program in a way that aligned with their organizational structures. NSQIP sites were not asked to set up their core teams or reporting structure in a prescriptive way; instead they were given the opportunity to implement processes that fit their local organizational and operational contexts.

Through qualitative interviews with SCRs at the sites (Appendix A), we explored these factors to understand the change management and support structures that aid in success.

NSQIP Team Composition

For the majority of sites, the NSQIP team includes the surgeon champion, SCR and quality improvement leader. The inclusion of additional members who represent point-of-care staff, anaesthesia, infection control staff and upper level management varies. The role of the SCR also varies from site to site, with some having solely a data retrieval/input focus, while others have an additional hands-on role in project work or a defined quality improvement component to their job description.



Data Sharing

The frequency and method of NSQIP data sharing also varies between sites. Sharing data within the NSQIP core team (between SCR and surgeon champion) and at a unit level (to the point-of-care staff involved in projects) is the most consistent between sites. Sharing at the department, executive and hospital board levels is less consistent, with some respondents being unclear of how (or if) NSQIP data is presented to the higher levels of health authority leadership.

NSQIP reports often need to be adjusted to provide a more audience-specific data report; point-of-care staff, surgical quality committee, infection control staff and surgical administrators would benefit from NSQIP reports that focus on their specific areas of care and roles within the hospital. This is done at many hospitals, usually by the SCR or quality improvement team members. Various data sharing methods are used, including posters, newsletters, huddles and presentations. Four respondents indicated that they felt that transparency outside the local NSQIP team was not encouraged therefore data was not shared widely within or outside the organization.

Trust and Value

All respondents indicated that they believe NSQIP data are important to improving the quality of surgical care. Not all respondents believed that there was the same value placed on NSQIP data by all stakeholders within their organization. Some respondents indicated that management support was present but at times they would like to see more active support from leadership and more consistent presentation of the NSQIP data to various stakeholders.

The value and importance of having a standardized process for data collection was clearly expressed. There remain some concerns about trust in the data from surgeons, in particular about the applicability of a data collection system that was designed to work within the American health system being used in Canada. Small sample sizes for certain low volume procedures also make the data less useful for those particular groups. While the rigid coding used in NSQIP provides strong reliability in the rigour of the data, there is concern that some outcomes are underestimated (e.g., UTI) due to the coding criteria. Some sites have also expressed that despite the risk-adjustment methodology, there is still belief that the acuity of patients is not accurately taken into account.

IMPROVING CARE PROCESSES AND CULTURE

There were two main categories of initiatives that supported improved care for patients throughout the first five years of NSQIP in BC: efforts to *improve the processes of patient care*, and efforts to *improve the surgical environment* in which those care processes took place.

Improving Patient Care Processes

The most visible work was aimed at improving the direct care that patients receive while in hospital. This work typically focused on the implementation of best care practices and care bundles with the goal of reducing adverse outcomes, reducing the time patients are in hospital and improving quality of life after surgery.

Early in the implementation of the NSQIP program in BC, sites were encouraged to look at their initial non-risk-adjusted results and to plan for their first initiatives based on NSQIP data. In 2012, the Council worked with sites with high UTI rates to start planning for improvement initiatives. Ten sites implemented UTI initiatives as their first NSQIP-based action and reduced UTIs by 25% between 2012 and early 2013.

As hospitals progressed with the NSQIP program, individual sites focused on other areas such as SSI and pneumonia. This site-specific work used NSQIP data to identify areas that needed improvement and used the ongoing collection of NSQIP data to monitor for improvement. Some sites also began to explore the use of Enhanced Recovery after Surgery (ERAS) principles in key patient populations as a method to improve processes of care.

In 2013, the provincial BC Hip Fracture Redesign Project, supported by the Specialist Services Committee, focused on elements of care for hip fracture patients to improve outcomes for a predominately frail elderly population. Goals of increasing access to surgery and reducing complications and LOS through streamlined care processes and early surgery were the primary focus of the initiative. The project initially involved eight sites and was then spread to 28 sites[11] in BC by the end of 2015. The BC Hip Fracture Redesign Project had its own data collection; however, patients were also captured concurrently within NSQIP samples.

In 2014, Doctors of BC ERAS improvement collaborative that supported 10 hospitals to implement ERAS best care practices in colorectal patients. Eight NSQIP hospitals were a part of the initial BC ERAS pilot and worked to integrate process measurement (such as early ambulation, fluid restriction and pain control) into their existing NSQIP data. Some sites are now moving ERAS principles to other surgical sub specialties and continue to use NSQIP as their data collection platform for both processes and outcomes. The ERAS data elements are not a part of the NSQIP risk-adjustment; however, sites are able to have real-time access to data and monitor it on a daily, weekly or monthly basis.

Improving the Surgical Environment

Work in surgical improvement also focused on the culture and teamwork environment within surgery as a means to addressing patient safety. In April 2012, the Council, in collaboration with many of the health authorities in BC, embarked on a culture survey to gain point-of-care knowledge from staff and physicians who are involved in the care of a surgical patient in acute care settings. This survey measured domains that contribute to culture such as job satisfaction, safety attitudes, management, stress and working conditions. The link between culture and clinical outcomes shifts at the 60% and 80% satisfaction threshold. When survey results are less than 60% there is a greater risk for adverse events, whereas survey results over 80% are linked to more positive patient outcomes. Overall, results were significantly below the 60% threshold in five of seven domains, and no domains scored above the 80% threshold.

With these results, teams created plans to improve culture in their facilities. After the initial evaluation of the survey results, two distinct programs were offered for sites to implement. In partnership with all health authorities, the BC Perioperative Improvement Project was created by the Council. It consisted of two distinct methodologies: The Productive Operating Theatre from the NHS and the Comprehensive Unit-based Safety Program from Johns Hopkins Hospital. The end goal was to improve both the quality and efficiency of operating rooms and perioperative units. Both projects encompassed an 18 month training period in which the teams could build on the data gathered to improve culture, efficiencies and safety.

[11] Included NSQIP and non-NSQIP enrolled hospitals.

LOOKING FORWARD: ACCELERATING SUCCESS IN NSQIP

Ensure clear communication pathways for NSQIP data to engage leadership & point-of-care staff

The Opportunity

Before any action can be taken on NSQIP data, data need to be seen by the appropriate stakeholders at all levels of the organization. From engaging point-of-care surgical teams to executives who oversee large clinical portfolios, there is a need for NSQIP data to be presented and understood. NSQIP provides 30-day surgical outcome data that is peer comparable and benchmarked every three months. Beyond the reports provided by NSQIP, sites can retrieve their own non-risk adjusted data at any time. Access to such high quality data is an opportunity to closely examine the quality of care provided to surgical patients. It is also important that core NSQIP team members understand where the NSQIP data are shared and how it is used in higher level decision-making. The current lack of clarity in how data are shared with health authority senior executive and board members suggests that some NSQIP team members are either left out of this part of data sharing or that the data are not regularly shared at that level.

Why is this important?

In sites where data sharing is done irregularly and the method of data sharing is inconsistent, there is a risk of the NSQIP program becoming siloed and losing traction as an valuable tool for surgical improvement. Data sharing with frontline teams enables the opportunity for two-way communication and feedback from those that are doing the improvement work. Data sharing with high level executives provides for an opportunity for NSQIP data to inform decisions to improve quality within each organization. Infrequent updates or poor understanding of NSQIP data undermines the importance of what NSQIP can provide to organizations to improve their quality of care. Sites that shared data in a variety of ways and shared data consistently were 1.5 more likely to be in the top five performing sites out of BC NSQIP hospitals.

Recommended Action

NSQIP data should be shared with each level within the organization regularly and in a format that addresses the needs of each respective stakeholder. While the timing of data sharing and review may be different for each stakeholder group, the frequency should be consistent and a regular part of surgical and health authority leadership meetings.

Continue Focused Quality Improvement Initiatives Using NSQIP Data

The Opportunity

Previous studies have indicated that having NSQIP data alone does not improve patient outcomes.[12] In order for data to be a catalyst for change, it needs to be used to improve care. Beyond regular sharing in a format that is appropriate for the audience, focused action to address areas of improvement are needed to make improvements in patient care. The success of large scale initiatives such as ERAS in BC, the 10K: Race for Infection Prevention, and the BC Hip Fracture Redesign Project show the value of a coordinated effort to work collaboratively on well-established processes of care. Focused improvement efforts can also take place at a more local level; site-specific work on SSI, and UTI has shown considerable benefit to patient care at several NSQIP sites across BC. The keys to success of both large and smaller scale improvement work is the dedication of time and resources to move initiatives along and the commitment to making clear changes to processes of care.

Why is this important?

At some sites NSQIP data are underutilized. NSQIP data indicates which areas can be a focus for improvement; action should be taken to make improvements in a systematic manner in those areas.

Recommended Action

Improvement work should be clearly planned and ideally would happen as part of coordinated initiatives that aim to improve the entire surgical process. The role of leadership in enabling this work cannot be overstated. It is important to remember that improvement initiatives on surgical outcomes that happen at the point-of-care can occur in parallel with administrative work to address timely access. While there is current focus on reducing waitlists and improving resource utilization, clinical focused improvement work on infection prevention and care pathways also has the opportunity to contribute to improved care and access. Additionally, there are many hospitals across BC that do not have NSQIP as a data collection platform. While NSQIP may not be practical for all small/rural hospitals[13], larger surgical sites in BC would benefit from NSQIP to monitor their surgical care and outcomes.

[12] Etzioni, David A., et al. Association of hospital participation in a surgical outcomes monitoring program with inpatient complications and mortality. JAMA 313.5 (2015): 505-511.

[13] Small/rural hospitals may not benefit as much from NSQIP as larger hospitals due to the volumes of surgeries performed at those sites. While NSQIP offers a rural option, some procedures that are more common at rural sites, including obstetrical procedures, are excluded from NSQIP data collection. Additionally the data collection requirements may result in a notable staffing burden in sites with very limited human resources.

Expand Multidisciplinary NSQIP Teams

The Opportunity

Inclusion of appropriate stakeholders within NSQIP teams can be improved at many sites. While there is certainly a core membership to the NSQIP teams comprised of the SCR and surgeon champion along with quality improvement leads and clerical support (where provided), steps need to be taken to ensure that additional team members are brought in frequently to enhance problem solving and have direct input into projects and interpretation of NSQIP results.

Why is this important?

Expanding NSQIP teams to include representation from point-of-care nursing, various surgical sub specialties, allied health groups, anaesthesia, and leadership can provide additional perspectives and improve both the understanding of NSQIP data and engagement with improvement initiatives.

Recommended Action

NSQIP teams should consider expanding to include a greater variety of professions and roles from within the health authority. Active participation of core NSQIP team members on surgical quality councils or working groups is needed to share NSQIP data widely and to leverage the wisdom of experts within these groups.

Promote National Collaboration and Data Sharing

The Opportunity

There are over 50 NSQIP sites across Canada with more planning to join. NSQIP enables sites to participate in 'collaboratives' which provide opportunities to select their collaborative as a single comparator group in NSQIP on-demand reports. All BC sites are a part of a BC collaborative and most are a part of a Canadian collaborative. Therefore, an individual NSQIP site in BC can see their outcome rates compared to the rest of BC or the rest of Canada. This form of comparison is useful for generalized benchmarking; however, it does not allow for specific site-to-site comparison.

Why is this important?

Through peer collaboration, NSQIP sites have the opportunity to improve on the surgical care they provide. Presently, there is no formal structure for NSQIP sites to discover and learn from high performing sites. While there are instances where hospitals do connect with each other, an organized data sharing structure would better link all NSQIP hospitals. This would reduce duplication of improvement efforts and resources.

Recommended Action

Currently, informal networks of data sharing exist within BC and across Canada. Individual links between similar hospitals has resulted in focused exchanges of results but there is not a network in place that will allow more robust and expansive data sharing. A more formalized Canada-wide network of NSQIP hospitals could support this kind of collaboration.

Customize NSQIP Data Collection for Local and Specific Improvement Needs

The Opportunity

The NSQIP platform enables sites to create custom fields and use existing data collectors to enhance the type of data collected on surgical patients. Sites are using currently using these fields to capture a variety of information including additional ERAS variables not included in the basic NSQIP platform, information on catheter usage to augment UTI initiatives, and a myriad of other variables related to individual initiatives.

Why is this important?

The integration of additional ERAS variables into the NSQIP program during the BC ERAS Collaborative was the first provincial-wide use of custom fields in NSQIP. While the additional fields are not a part of NSQIP risk-adjustment, it does enable the connection between processes of care and outcomes. From a provincial perspective, NSQIP has the potential to be used to provide a broader picture into care process, patient experience (through outcomes as reported by patients/experience measures) and additional quality metrics that are not collected consistently or systematically. For individual sites, NSQIP custom fields can make connections between multiple initiatives that may be happening within a hospital by collecting additional data on NSQIP patients.

Recommended Action

Sites should look at the main areas requiring improvement and consider customizing their sampling strategies through the NSQIP data portal. NSQIP offers a procedure-targeted sampling methodology for specific procedures that can provide additional information on specific surgical sub-groups. Custom data entry fields can then be used to learn more about performance and outcomes in areas that are not measured in standard NSQIP data collection.

CONCLUSION

The National Surgical Quality Improvement Program is a validated and trusted data collection platform used by 24 hospitals in BC to evaluate the quality of surgical care. Since the widespread adoption of NSQIP across the province in 2011, there have been many quality improvement initiatives that have used NSQIP data to monitor changes in outcomes across surgical specialities. This report illustrates the significant improvements that have been made in care: morbidity, surgical site infection rates and urinary tract infection rates have improved in many hospitals across the province.

The important role of coordinated, province-wide initiatives in supporting improvement efforts is notable, though individual sites have also made progress by engaging point-of-care teams, sharing data widely and incorporating NSQIP into the larger surgical landscape at their site. While reductions in adverse outcomes are seen, BC remains in the lower-performing 50% of all NSQIP hospitals in several outcome areas.

To use NSQIP to its full potential, data reports should be tailored to the needs of those receiving it, shared frequently within participating hospitals and across the province/country when appropriate, and used to plan and coordinate improvements in surgical care at all levels. NSQIP is a valuable measurement tool that has been integral in providing hospitals with data for baseline measurement and continuous improvement monitoring.

Additional Information

A technical appendix that describes the data collection and analysis process can be found at the end of this document.

Acknowledgements

Statistical consultation was provided by Dr. Jonathan Berkowitz. Qualitative content analysis was completed under the direction of Dr. Maura MacPhee.

APPENDIX A SURVEY TOOL

Questionnaire on Flow of NSQIP Data

Purpose: The purpose of this questionnaire is to obtain initial qualitative data from SCRs on the flow of NSQIP data in their respective sites and organizations. The data is a starting point for understanding how NSQIP data is shared and utilized across participating NSQIP sites in BC.

Intended Respondents: NSQIP SCRs

Questions

1. When you have new NSQIP data, describe how the data are prepared for sharing and reporting:
   a. Describe if and how reports are analyzed, interpreted, packaged, or reformatted for sharing.
   b. Who is responsible for doing this work?

2. Where do the NSQIP Data go? Within each level, please list all key contacts you share the NSQIP data with. Please describe their role, department, and responsibility.
   a. Unit Level
   b. Site Level Department Leadership
   c. Site Level Executive Leadership
   d. Health Authority Administration
   e. Health Authority Board
   f. Other

3. How frequently do you share the NSQIP data? Indicate for each level.
   a. Unit Level
   b. Site Level Department Leadership
   c. Site Level Executive Leadership
   d. Health Authority Administration
   e. Health Authority Board
   f. Other

4. Beyond where you directly report data, where else do you think the data are shared?

5. Do you think the NSQIP data are trustworthy and reliable? (i.e. the data are accurate and representative of what actually happens). Please describe why or why not.

6. Do you think the NSQIP data are considered valuable to quality and safe delivery of care? Please describe why or why not.

7. From your perspective, what are the reasons your organization collects these kinds of data?

8. Who do you consider a part of your NSQIP team? Please list names, groups, professions, and roles.

APPENDIX B NSQIP VARIABLES

Data Variables collected on all reviewed cases

Surgical Profile	Pre-op Risk Factors	Lab Data (w/in 90 days)
Demographics	Height/Weight/BMI	NA
Inpatient/Outpatient	DM	BUN
Elective surgery- y/n	Current smoker 1 year	CR
Origin Status	Dyspnea	ALB
Hospital Admit Date	Functional Health Status	TB
Operation Date	Vent > 48 hours	SGOT
Anesthesia Technique	COPD	ALK Phos
Additional Anesthesia	Ascites w/in 30 days	WBC
Technique	CHF w/in 30 days	Hct
Surgical Specialty	HTN	Plt
Attending Surgeon	ARF w/in 24 hours	INR
	Dialysis w/in 2 weeks	PTT
	Disseminated Cancer	
	Open wound	
	Steroid use	
	>10% loss of body wt	
	Bleeding disorder	
	Pre-op transfusion w/in 72 hours	
	Sepsis w/in 48 hours	

*Indicated if present at the time of surgery

Operative Information	Postoperative Occurrences	Hospital Discharge Information
Emergency case	Superficial Incisional SSI*	Discharge Date
Wound class	Deep Incisional SSI*	Discharge Destination
Surgical Wound Closure	Organ Space SSI*	Still in hospital > 30 days
ASA class	Wound Disruption	Death
Operative Times	PNA*	Hospital Readmission w/in 30 days
	Intra-op or post-op unplanned intubation	Was Readmission unplanned
	PE	Was readmission related to principal procedure
	On vent > 48 hours*	What was the primary suspected reason for readmission
	UTI*	Unplanned re-operation w/in 30 days
	Progressive Renal Insufficiency	
	ARF	
	CVA	
	Intra-op or post-op cardiac arrest requiring CPR	
	Intra-op or post-op MI	
	Transfusion intra-op or post-op	
	Vein Thrombosis	
	Sepsis/Septic shock*	

TECHNICAL APPENDIX

INTRODUCTION

This purpose of this appendix is to summarize the data collection and analysis process used to compile the Improved Outcomes = Improved Access (IO-IA) report. This report summarizes the first five years of the NSQIP program in British Columbia and reports on trends in surgical site infection (SSI), urinary tract infection (UTI) and morbidity rates during the five years NSQIP has been in place in BC hospitals. Additional outcomes studied include length of stay (LOS), reoperation rates and readmission rates.

DATA PREPARATION

Participating sites provided encrypted NSQIP records to BCPSQC. The individual records submitted included all 173 NSQIP variables. Sites were given a unique hospital code that was attached to the submitted records allowing stratification by hospital while preserving anonymity. Data fields were recoded to allow analysis in SPSS version 24. Categorical text data were recoded to numerical codes following general coding conventions for binary variables (no = 0, yes = 1). Where the categorical variable had multiple possible responses, coding was based on the order that the responses appeared in the NSQIP software menus. The original data file was saved in its entirety and a second working copy was created. The following variables were not used in the analysis and were deleted from the working copy.

- Completion Status
- LMRN
- Race
- Hispanic Ethnicity
- CPT Description
- Principal Operative Procedure
- Additional Anesthesia Technique(s)
- Attending/Staff Surgeon
- NPI
- Encounter Number
- Height
- Height Unit
- Height Unknown
- Weight
- Weight Unit
- Weight Unknown
- All Pre-op Laboratory Testing Results
- All C. diff related variables
- LCN
- More than 2 unplanned returns to OR
- All Enhanced Recovery in NSQIP Variables
- 30 Day F/U Complete
- Follow-up Days
- # Contact Attempts Phone
- # Contact Attempts Letter
- Contact: Documentation
- Contact: Other

Data validity was checked in the following fields: date, time, age, body mass index, scheduled (elective) surgery status, surgical subspecialty and length of stay.

Date and time format were reviewed to ensure internal consistency. Data were screened for entry errors such as: length of stay > 120 days (120 days is the longest time that a patient can be followed in NSQIP), age greater than 100 years (likely entry error on year of birth), very high or low body mass index (possibly pound/kilogram errors). Cases with these errors were excluded from analyses that used those specific variables.

Scheduled Surgery	
Valid	175869
Excluded (missing or blank)	102

Hospital Length of Stay	
Valid (<= 120 days)	175722
Excluded (>120 days)	249

Surgical Specialty	
Valid	175970
Excluded (coded as Interventional Radiologist)	1

NSQIP allows coding of events present at the time of surgery (PATOS) and those occurring after the surgical procedure. The PATOS designation is intended to differentiate events that were a likely a result of the surgical procedure, from adverse events that meet the NSQIP criteria but were present before the surgery took place. A new variable was created to flag events present after surgery (event – PATOS = "actual"). Only these "actual" events were analysed.

Sample Size

The NSQIP evaluation included all data available between 2011 and 2015. There were 175,971 cases submitted for review. Many of the BC NSQIP sites joined the program throughout 2011. Therefore 2011 was a partial year for data collection at most sites. The 2011 sample was approximately half of the subsequent years.

Figure 1: Number of surgical cases per year

	2011	2012	2013	2014	2015	All Years
Participating NSQIP sites	20	22	23	23	23	-
Total case volume	17502	37756	40809	40227	39677	175971

The effect of the smaller 2011 sample size was noticeable when evaluating surgical subspecialties but was large enough to be included in the analyses of all cases.

Figure 2: Number of surgical cases per year for each surgical subspecialty

	2011	2012	2013	2014	2015	All Years
General Surgery	4852	10935	12273	12448	12445	52953
Orthopaedics	4630	10027	11535	11610	11355	49157
Urology	2519	4877	4641	4438	4345	20820
Gynecology	1927	3895	3962	3946	3808	17538
Plastics	900	2532	2706	2658	2505	11301
Otolaryngology (ENT)	733	1799	1774	1676	1681	7663
Neurosurgery	730	1286	1415	1199	1157	5787
Vascular	504	1218	1243	1088	1068	5121
Cardiac	455	687	761	691	846	3440
Thoracic	252	500	499	473	466	2190

Data Comparisons

Line graphs were used to describe the trend of outcomes over time (2011-2015). For comparative analysis, 2012 was selected as the 'baseline' year as it included 22 out of 23 enrolled hospitals. T-tests were used for these comparisons (level of significance of 0.05).

In the IO-IA report, we describe the changes in outcomes over time (increase, decrease, stable). Most t-tests that included 'All Cases' reached statistical significance (see Figure 3).

Figure 3: Change in Outcome Rates between 2012 and 2015 – All Cases

Year	Sample size	Mean	Standard Deviation	t-statistic	p-value (two-tailed)
Any Morbidity: All Cases					
2012	37756	0.076	0.264	3.593	0.0003
2015	39677	0.069	0.253		
Any SSI: All Cases					
2012	37756	0.032	0.175	2.986	0.0028
2015	39677	0.028	0.165		
Any UTI: All Cases					
2012	37756	0.021	0.143	4.777	<0.0001
2015	39677	0.016	0.127		
LOS: All Inpatient Cases					
2012	22158	6.476	10.190	5.148	<0.0001
2015	23863	6.008	9.320		
LOS Operative: All Inpatient Cases					
2012	22158	5.453	8.186	3.773	0.0002
2015	23863	5.172	7.806		
Any Readmission: All Cases					
2012	37756	0.037	0.189	-0.430	0.6675
2015	39677	0.038	0.190		

Any Reoperation					
2012	37756	0.025	0.156	3.067	0.0022
2015	39677	0.022	0.145		
Any Morbidity: Unscheduled					
2012	7777	0.142	0.348	4.445	<0.0001
2015	9559	0.119	0.323		
Any Morbidity: Scheduled					
2012	29971	0.058	0.234	2.897	0.0038
2015	30111	0.053	0.223		
Any SSI: Unscheduled					
2012	7777	0.044	0.204	2.421	0.0155
2015	9559	0.037	0.187		
Any SSI: Scheduled					
2012	29971	0.028	0.166	2.441	0.0147
2015	30111	0.025	0.156		
LOS Operative: Unscheduled					
2012	6861	8.291	11.342	3.398	0.0007
2015	8016	7.678	10.628		
LOS Operative: Scheduled					
2012	15474	4.217	6.115	4.905	<0.0001
2015	15984	3.896	5.482		
Two or More Adverse Events: Unscheduled					
2012	7777	0.433	0.204	3.343	0.0008
2015	9559	0.336	0.180		
Two or More Adverse Events: Scheduled					
2012	29971	0.011	0.106	0.138	0.8900
2015	30111	0.011	0.105		

Figure 4: Change in Outcome Rates between 2012 and 2015 – Sub-specialities

Year	Sample size	Mean	Standard Deviation	t-statistic	p-value (two-tailed)
Any Morbidity: Total Knee Arthroplasty and Total Hip Arthroplasty					
2012	3529	0.077	0.267	4.625	<0.0001
2015	4356	0.052	0.221		
Any Morbidity: Hip Fracture Repair					
2012	982	0.167	0.373	0.274	0.7840
2015	1578	0.163	0.369		
LOS: Hip Fracture Repair					
2012	979	13.467	12.991	1.625	0.1044
2015	1572	12.634	11.912		
LOS Operative: Hip Fracture Repair					
2012	980	11.386	10.962	0.844	0.3990
2015	1573	11.011	10.804		
Any Morbidity: Cardiac					
2012	685	0.203	0.405	0.920	0.3578
2015	843	0.198	0.391		
Any Morbidity: Colorectal					
2012	1566	0.307	0.461	4.948	<0.0001
2015	2059	0.234	0.424		
LOS: Colorectal					
2012	1556	12.350	12.965	6.443	<0.0001
2015	2052	9.749	11.232		
LOS Operative: Colorectal					
2012	1558	10.806	11.324	6.309	<0.0001
2015	2052	8.612	9.548		
Any Readmission: Colorectal					
2012	1566	0.084	0.278	-1.569	0.1168
2015	2059	0.010	0.299		
Any Reoperation: Colorectal					
2012	1566	0.079	0.270	2.615	0.0090
2015	2059	0.057	0.232		

Raw LOS data for colorectal patients was recoded into 6 categories based on clinical expectations for length of stay for specific populations. The categories were not of equal duration (Figure 5)

Figure 5: Categories for Colorectal LOS

Category	Clinical Group Captured	Number of Patients in Category (2012)	Percent
0 days	omitted from analysis	5	3.2%
1-3 days	laparoscopic patients with uncomplicated recovery times	95	6.1%
4 days	early discharge of patients with open procedures	170	11.0%
5 days	discharge goal for patients an ERAS pathway	205	13.2%
6-10 days	patients with some delay in discharge	629	40.5%
11-20 days	patients with complicated recoveries	293	18.9%
>20 days	patients with complicated recoveries & lengthy delays in discharge	115	10.0%

By comparing the LOS over the period of the study (2012-2015), the "days saved" could be calculated. The calculation for estimating the change in inpatient days is as follows:

Length of Stay for 2012 NSQIP Cases	
Number of hospital days:	145,354 inpatient days
Number of surgeries:	22,341 inpatient cases
Average length of stay:	6.51 days (145,354 divided by 22,341)

Length of Stay for 2015 NSQIP Cases	
Number of hospital days:	143,955 inpatient days
Number of surgeries:	24,003 inpatient cases
Average length of stay:	6.00 days (143,955 divided by 24,003)

Calculating Days Saved	
Estimated number of hospital days:	156,167 inpatient days (24,003 multiplied by 6.51)
Difference between estimate and actual:	12,212 inpatient days (156,167 minus 143,995)

Qualitative Analysis

This analysis was used to characterize information flow, reporting structures and outcome dissemination techniques.

NSQIP sites were surveyed using an online survey tool (FluidSurvey). A total of 19 surgical clinical reviewers at 18 NSQIP sites responded. Qualitative responses were analyzed using content analysis: a qualitative research technique that is used to "interpret meaning from the content of text data…" (Hsieh & Shannon, 2005, p. 1277).

Categories were constructed that corresponded to each survey question, for example 'Types of data sharing', 'Contacts at the unit level', 'Members of the NSQIP team'. Within tables, symbols (X), were used to record the relationship of coded responses to sites (Figure 7).

Figure 7: Example of Qualitative Coding Table

Categories & Codes	Site 1	Site 2
Contacts at the Unit Level		
Clinical Nurse Educator	X	
Patient Care Coordinator		X
Surgeon Champion	X	X

Manual and automated coding techniques were used. One researcher manually reviewed all responses and coded responses. A second researcher, blinded to the results of the manual coding, used NVivo 10©, a qualitative software program that can automatically sort and organize codes under categories and update frequency counts for specific codes. Disagreements in coding were resolved through review and discussion by the research team. The two coding techniques were assessed for inter-rater reliability with overall agreement in coding at 86%.

References

Hsieh, H-F., Shannon, S. (2005). Three approaches to qualitative content analysis. Qualitative Health Research, 15(9), 1277-1288.

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