



ONTARIO HEALTH, CLINICAL INSTITUTES AND QUALITY PROGRAMS

Program Evaluation

An Analysis of the Ontario
Surgical Quality Improvement
Network (ON-SQIN)

SEPTEMBER 2023

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Executive Summary

Since 2015, several Ontario hospitals have participated in the American College of Surgeons National Surgical Quality Improvement Program, and in the Ontario Surgical Quality Improvement Network (ON-SQIN). ON-SQIN is a collaborative initiative designed to enhance the quality and safety of surgical procedures by fostering a culture of continuous improvement among health care providers. The aim of this report is to evaluate the numerous benefits for the Ontario health care system by implementing ON-SQIN. Its primary focus is to describe the components of the program and measure the financial returns and patient outcomes that have resulted from its implementation.

By leveraging data analysis, benchmarking, and collaborative efforts, ON-SQIN has successfully reduced surgical complications, enhanced patient outcomes, and promoted the adoption of evidence-based practices across participating hospitals. Key findings are as follows:

- **Cost saving and return on investment:** With reductions in surgical complications, readmissions, and length of hospital stay, the Ontario health care system is saving over \$3,000,000 per year based on 4 analyzed indicators, representing a return on investment of 38%.
- **Enhanced patient outcomes:** ON-SQIN has seen a reduction in surgical complications and improved lengths of stay. For example, since 2016 over 50% of ON-SQIN hospitals have seen reduced rates of surgical site infections in multiple surgical areas. And the reduction in overall lengths of stay at each ON-SQIN hospital is estimated to be in the range of 375 to 631 days based on 4 analyzed postoperative indicators.
- **Mature community of practice:** Members of ON-SQIN meet and engage in virtual communication on a regular basis, as evidenced by an active online forum and steady attendance at all virtual and in-person meetings.

Based on the findings of this program evaluation, we recommend the following for the continued success and growth of ON-SQIN:

- Encourage health care providers to maintain their commitment to continuous improvement by participating in ON-SQIN, sharing best practices, and embracing data-driven decision making.
- Strengthen and expand ON-SQIN's collaborative efforts by engaging more health care facilities, surgical teams, and stakeholders to foster a broader impact on patient care and outcomes.
- Continuously monitor and evaluate ON-SQIN's performance metrics to identify areas for improvement and ensure the sustained delivery of positive results.

ON-SQIN has proven to be a successful initiative, delivering significant financial benefits and improvements in patient care. Via its data-driven approach, ON-SQIN has achieved cost reductions, greater surgical efficiency, and improved patient outcomes. The program stands as a testament to the value of investing in quality improvement initiatives in the health care sector. ON-SQIN is poised to continue its positive impact on surgical care and patient well-being across Ontario.

Background

NSQIP

The American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) is a comprehensive, data-driven program designed to improve the quality of surgical care. NSQIP collects and analyzes clinical data from participating hospitals to identify areas for improvement, develop best practices, and enhance patient outcomes. The program focuses on measuring surgical outcomes, identifying risk factors, and implementing quality improvement initiatives.

NSQIP employs a robust data collection process; trained Surgical Clinical Reviewers collect information on preoperative risk factors, intraoperative variables, and 30-day postoperative outcomes for a wide range of surgical procedures.¹ These data are then analyzed centrally, allowing participating hospitals to compare their outcomes against regional and national benchmarks. This benchmarking process enables hospitals to identify variations in surgical care, implement evidence-based practices, and monitor their performance over time.

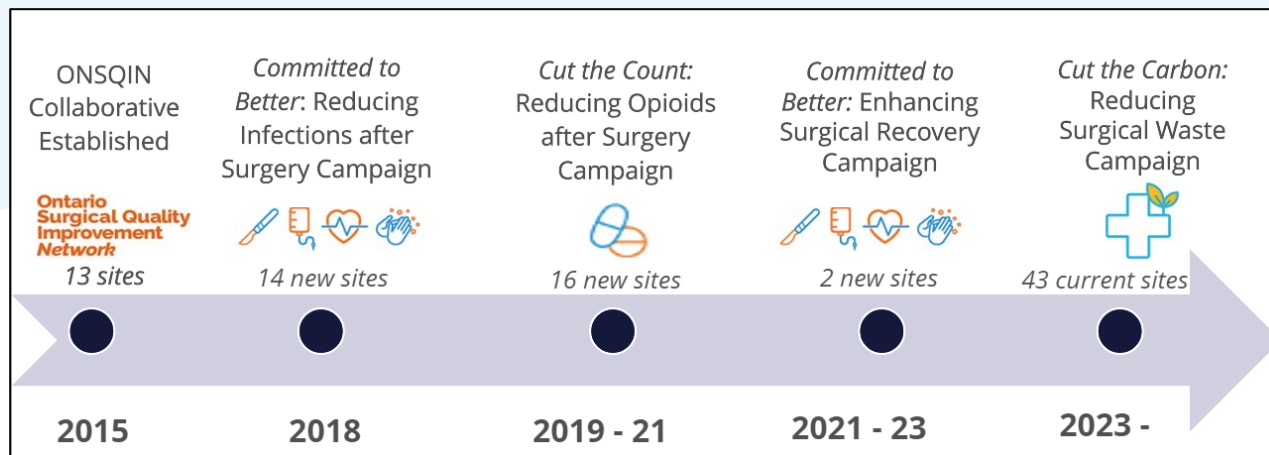
One notable success of NSQIP is its significant impact on reducing surgical complications and improving patient outcomes. For example, NSQIP data have been used to identify modifiable risk factors associated with surgical site infections, such as improper antibiotic use or inadequate surgical site preparation. The Surrey Memorial Hospital in Vancouver, British Columbia, reduced its surgical site infection rate for general, vascular, and breast surgeries by 13% in 2 years, saving the hospital more than \$2.7 million.² Via targeted interventions, hospitals have reduced the incidence of surgical site infections by implementing evidence-based practices, resulting in improved patient safety and reduced health care costs.

NSQIP is a valuable program that has successfully contributed to improvements in the quality of surgical care in Ontario. Its data-driven approach, benchmarking capabilities, and collaborative nature have led to the implementation of evidence-based practices across participating hospitals, resulting in fewer complications and improved patient outcomes.

ON-SQIN

The Ontario Surgical Quality Improvement Network (ON-SQIN) is a collaborative initiative in Ontario, Canada, focused on enhancing the quality of surgical care and patient outcomes across the province. It was established in 2015 by the legacy organization Health Quality Ontario and is currently overseen by the Quality division, Clinical Institutes and Quality Programs, Ontario Health. ON-SQIN membership has grown from 13 hospitals to 43 (see Appendix A for a list of hospitals), and its fourth collaborative campaign is currently in progress (Figure 1). ON-SQIN brings together health care professionals, hospitals, and other stakeholders to collect and analyze data, identify areas for improvement, and implement evidence-based practices in surgical care.

Figure 1: ON-SQIN Timeline



An image showing the progression of the ON-SQIN collaborative from its inception in 2015 until now. Milestones over the years are highlighted, including the 4 collaborative campaigns and the steady increase in hospital participation. Source: Ontario Health, Clinical Institutes and Quality Programs.

ON-SQIN’s primary objective is to provide participating hospitals with actionable data and resources to drive quality improvement efforts. By collecting and analyzing clinical data from surgical procedures, ON-SQIN aims to identify variations in care, benchmark performance, and develop strategies to improve surgical outcomes. The collaborative nature of the program and members’ commitment to sharing knowledge and best practices have also been instrumental in its success. Through regular meetings, conferences, and educational initiatives, ON-SQIN facilitates the exchange of ideas and experiences among health care professionals. This collaboration allows hospitals to learn from others’ successes and challenges, promoting continuous improvement and innovation in surgical care.

Program Evaluation

To date, the ON-SQIN program has not conducted a formal program evaluation using structured criteria; therefore, a decision was made to conduct a program evaluation with a return-on-investment analysis. This evaluation of the ON-SQIN program has been structured using the evaluation criteria from the Organisation for Economic Co-operation and Development Network³: relevance, coherence, effectiveness, efficiency, impact, and sustainability (Appendix B). We have used each criterion to examine a different aspect of the program, allowing for a holistic evaluation approach. Together, these criteria provide a framework for determining the value of the program.

This evaluation will help policymakers and funders (e.g., Ministry of Health and Ontario Health) make informed decisions, evaluate performance, allocate resources efficiently, and communicate the monetary impact of investing in NSQIP and ON-SQIN. For example, an assessment of financial performance can help in determining whether the return generated from investment in NSQIP and ON-SQIN is worthwhile and in alignment with the organization’s goals. It can also be used to aid in decision-making, evaluate performance, identify inefficiencies, and keep organizations accountable. This evaluation will be a valuable tool for financial analysis, planning, and strategic decision-making.

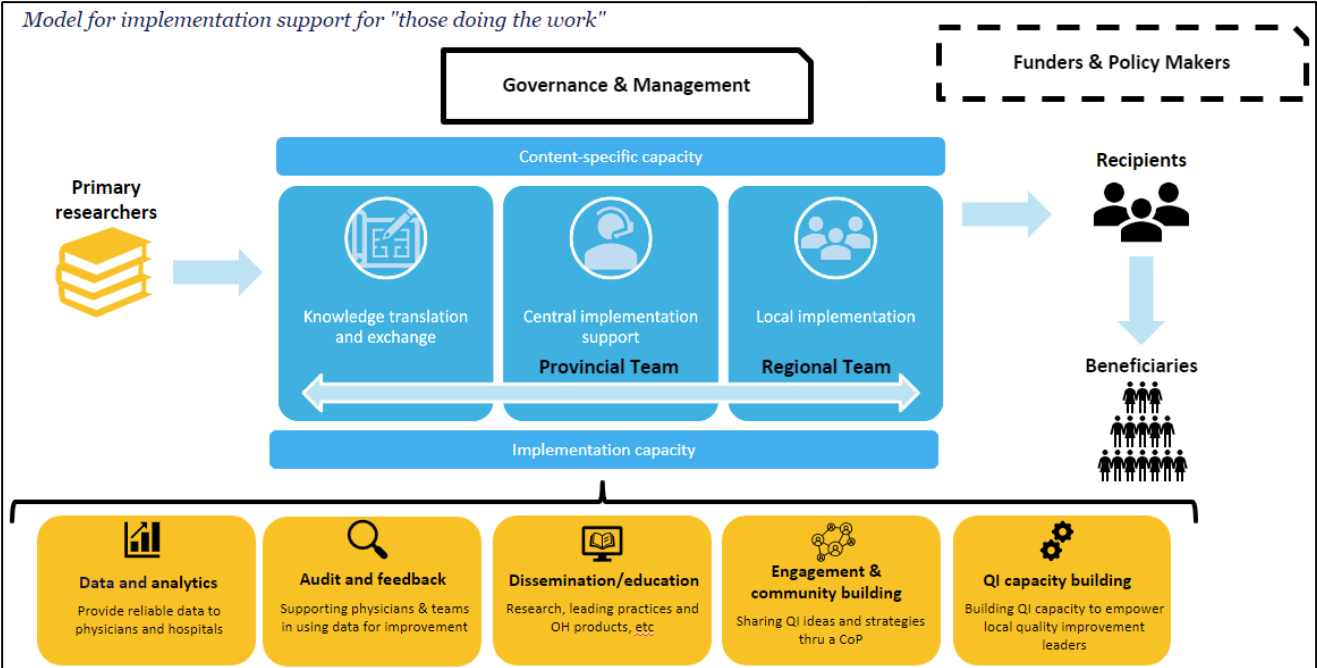
Evaluation

Relevance

Is the intervention doing the right things?

To determine the relevance of ON-SQIN, it is important to look at its individual components. We have divided the program components into 5 categories: data and analytics, audit and feedback, dissemination and education, engagement and community building, and quality improvement capacity building. These components are integral to the long-term success of the program and help demonstrate how it maintains relevance. Figure 2 shows the connection between the 5 program components (yellow boxes at the bottom of the figure) and the larger clinical improvement support system. It is adapted from a diagram from the Center for Implementation,⁴ showing the relationships between the different stakeholders when supporting and implementing clinical programs and improvements. The Ontario Health ON-SQIN team and all participating hospitals have implemented these components; the details of what each program component includes are described below.

Figure 2: Hospital Clinical Improvement Implementation Support System



A flow diagram showing the components of a hospital clinical improvement implementation support system. Source: Center for Implementation,⁴ adapted from an original by Wandersman et al.⁵

Data and Analytics

- ACS NSQIP data collection: Each participating hospital employs Surgical Clinical Reviewers. The Surgical Clinical Reviewers have been trained by ACS NSQIP; they ensure data integrity when entering data into the ACS workstation platform.
- Surgical Quality Improvement Plan: This is a framework for using data to create actionable ideas and goals. Teams submit a Surgical Quality Improvement Plan to Ontario Health each year, based on a collective campaign decided by the network.

Audit and Feedback

- Data analysis: ACS NSQIP data is reported in the Collaborative Semi-Annual Report, and the Surgical Quality Improvement Plan data are extracted each year. Both data sources are analyzed by the Ontario Health Quality data team, and results are shared with the network.
- On-demand data: Surgical Clinical Reviewers can extract on-demand data from the ACS workstation for the hospital they work in. These data are risk-adjusted and allow individual teams to review their results on a continuous basis.

Dissemination and Education

- Evidence: Participating teams contribute new knowledge related to quality surgical care. Abstracts of the teams' work are submitted annually to the ACS Quality Conference and are often chosen as podium and poster presentations. Teams also publish their quality improvement accomplishments in peer-reviewed journals.
- Microcollaboratives: These small groups of network members meet regularly to discuss unblinded surgery-specific data for dissemination and learning. For example, the neurosurgery microcollaborative consists of 7 organizations that meet monthly to share neurosurgery-specific data and quality improvement initiatives.

Engagement and Community Building

- Community of practice: This includes virtual and in-person meetings to review ACS NSQIP data; establish common improvement goals; and share ideas, successes, and lessons learned.
- Mentorship: Peer-to-peer mentoring within the network supports newcomers and provides opportunities for learning and development.
- External partnerships: Partnering with external stakeholders (e.g., CASCADES, Healthcare Excellence Canada) allows for new learning opportunities for network members in surgical quality improvement. It also extends the reach of ON-SQIN beyond Ontario Health.
- Internal partnerships: Partnerships with groups in Ontario Health – such as the General Medicine Quality Improvement Network (GeMQIN), the Quality Standards program, and

regional clinical leadership – allows for the alignment of ON-SQIN with Ontario Health’s vision and priorities.

- Networking: This occurs through mentorship, site visits, workshops at conferences, microcollaborative meetings, and annual conferences.

Quality Improvement Capacity Building

- Quorum: This is an online platform created to help cultivate and sustain the network, providing forums for discussion and a repository for tools and resources.
- Evidence-based care bundles (e.g., Enhanced Recovery After Surgery [ERAS]): These bundles bring together resources related to specific quality topics and share leading practices for teams to implement.
- Focused quality improvement campaigns: Targeted change ideas, process measures, and quality improvement plans are used in each campaign so that network members can work toward a common goal. The campaigns allow the network to leverage one another’s expertise and best practices, and to troubleshoot together. The network is currently in its fourth collaborative campaign, *Cut the Carbon: Reducing Surgical Waste*.⁶ Previous campaigns include *Committed to Better: Reducing Infections After Surgery*; *Cut the Count: Reducing Opioids After Surgery*; and *Committed to Better: Enhancing Surgical Recovery*.

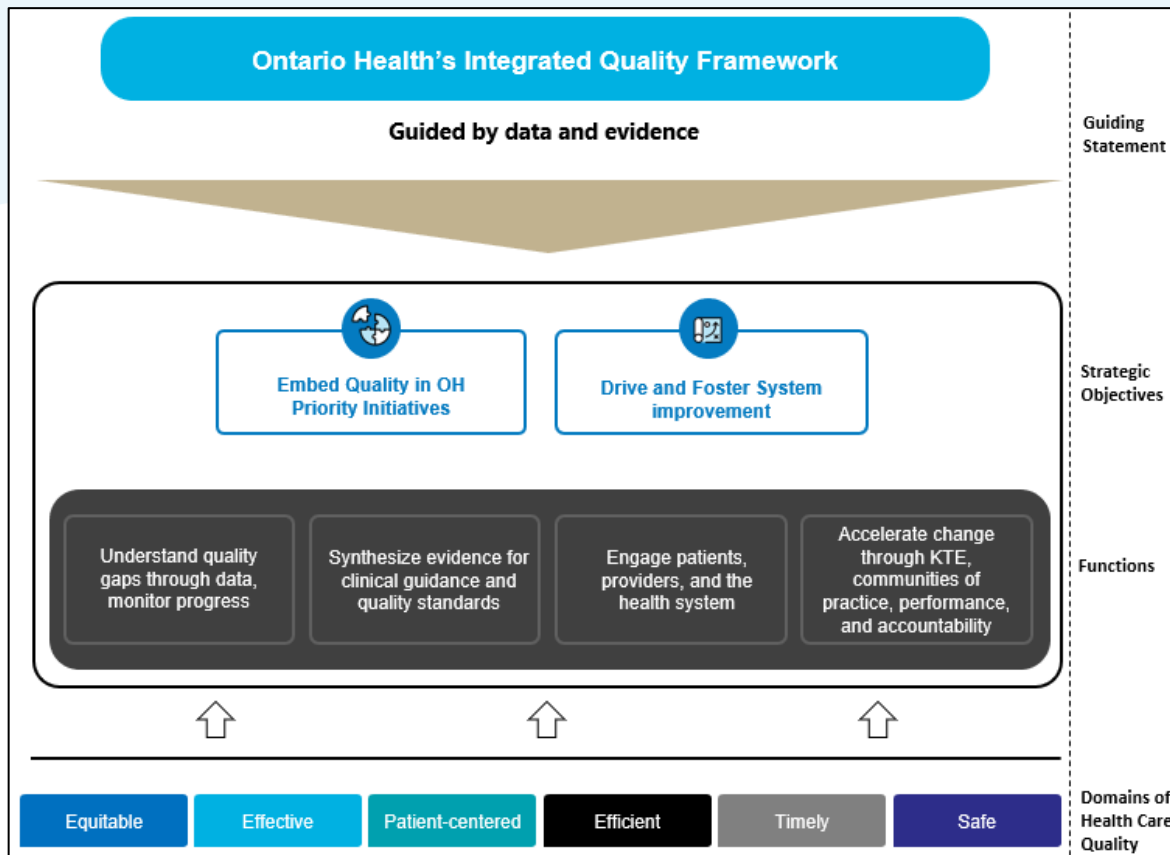
Coherence

How well does the intervention fit?

The ON-SQIN program resides in the Quality division, part of the Clinical Institutes and Quality Programs portfolio in Ontario Health. ON-SQIN’s deliverables aim to match the strategic objectives set out by Ontario Health, which include embedding quality in priority initiatives and driving system improvement. The Ontario Health Integrated Quality Framework (Figure 3) helps guide the program delivery team in planning activities around the listed functions. The program delivery team consists of a clinical lead, a program manager, quality improvement specialists, and project management support. This team meets regularly with Ontario Health leadership and other key members of the network to discuss the ON-SQIN program and maintain its functions within the framework.

At the local level, participating ON-SQIN hospital sites have different systems of leadership. Each site has a Surgeon Champion who acts as the main spokesperson, leading meetings and implementing best practices and change ideas within their organization. Each site also has administrative leadership, which can include the organization’s executive team, the chief of surgery, and other operational team members. In some cases, the Surgical Clinical Reviewer also works closely with the organization’s quality improvement team. Together, these individuals embed surgical quality in their organization’s culture and priorities.

Figure 3: Ontario Health’s Integrated Quality Framework



A flow diagram showing the components of Ontario Health’s Integrated Quality Framework, including a guiding statement, strategic objectives, and associated functions.

Abbreviation: KTE, knowledge transfer and exchange.

Source: Ontario Health, Clinical Institutes and Quality Programs.

Effectiveness

Is the intervention achieving its objectives?

Since 2015 when ON-SQIN was first implemented, improvements in surgical outcomes for Ontario patients have resulted from focused local quality improvement initiatives and from hospital participation in provincial initiatives. For example, the 2018–2019 provincial campaign to reduce infections after surgery resulted in decreases of 14% in surgical site infections, 31% in urinary tract infections, and 9% in pneumonia; this represents an estimate of over 1,000 patients who have avoided at least 1 infection. The 2019–2021 campaign to reduce opioid prescribing after surgery resulted in an estimated 180,500 fewer pills prescribed. These results show how targeting specific surgical indicators for quality improvement efforts can produce better patient outcomes.

Beyond the yearly changes seen with such campaigns, ON-SQIN also analysed NSQIP data going back to 2016 to identify trends in performance. Four common surgical indicators were chosen for this retrospective analysis, and based on risk-adjusted data, results for all 4 indicators have improved since 2016 across every ON-SQIN hospital:

- Surgical site infections: The average rate declined by 6%, and 56% of ON-SQIN hospitals showed improved performance for multiple surgery types, including general, orthopedic, pediatric, urology, gynecology, and colorectal surgeries.
- Urinary tract infections: The average rate declined by 17%, and 58% of ON-SQIN hospitals showed improved performance for all cases.
- Pneumonia: The average rate declined by 14%, and 44% of ON-SQIN hospitals showed improved performance for all cases.
- Venous thromboembolism: The average rate remained consistent, and 58% of ON-SQIN hospitals showed improved performance for all cases.

As members of NSQIP, the ON-SQIN hospitals are also benchmarked against over 700 hospitals in 11 countries to assess their performance related to 14 indicators of postsurgical outcomes. The Office of the Auditor General of Ontario included these findings in their value-for-money audit of outpatient surgeries.⁶ From 2017 to 2021, hospitals in Ontario showed above-average performance for 10 of the 14 indicators, and below-average performance for the remaining 4. The indicators with above-average performance were hospital readmission, mortality, pneumonia, unplanned intubation, ventilator usage for longer than 48 hours, venous thromboembolism, renal failure, sepsis, *Clostridioides difficile* colitis, and return to operating room. Although performance was below average for 4 indicators (morbidity, cardiac occurrences, surgical site infection, and urinary tract infection), network members have shown improved performance in these indicators over time. The network continues to develop quality improvement initiatives that encompass various indicators, ensuring continued improvement throughout Ontario.

Given the reductions in surgical complications seen among ON-SQIN hospitals from 2016 to 2021, an unadjusted length-of-stay analysis was conducted to estimate the potential number of days saved by reducing the rate of surgical complications. On average, the reduction in overall lengths of stay at each ON-SQIN hospital is estimated to be in the range of 375 to 631 days, based on 2 scenarios (see Appendix D for further information). It is also estimated that 1901 patients avoided a postoperative complication in a given year, resulting in 1901 beds saved. For our analysis, we used data from the Canadian Institute for Health Information and internal Ontario Health database resources to estimate the average length of stay (in number of days) for the 4 postsurgical indicators described above (surgical site infections, urinary tract infections, pneumonia, and venous thromboembolism). Actual length of stay may vary significantly among patients; our results were unadjusted for patient factors (such as pre-existing conditions or comorbidities). Hospitals and health providers may need to consider their local context and patient characteristics to determine a more accurate average length of stay.

ON-SQIN has had success in its role improving overall surgical quality and surgical outcomes for patients across the province. By identifying and addressing variations in care and participating in collaborative campaigns, hospitals have decreased postoperative complications, shortened hospital stays, and promoted faster recovery for patients.

Impact

What difference does the intervention make?

Impact on patient care is increased when a community of practice is built around a program such as ON-SQIN. By comparing the results of their own surgical outcomes with those of their international counterparts in the ACS NSQIP, ON-SQIN members can identify ways to improve care before, during, and after surgery.

Members of ON-SQIN meet regularly and work together to improve surgical quality and outcomes by reviewing ACS NSQIP data reports, selecting areas of care or outcomes that are below the NSQIP average, establishing common quality improvement goals, applying the best evidence in surgical care, and sharing ideas and experiences. To accelerate meaningful improvements, member hospitals are leading the implementation and spread of best practices related to infection prevention, opioid reduction, and other Enhanced Recovery After Surgery outcomes.

The ON-SQIN network uses multiple methods to connect, encourage collaboration, and share information. The online Quorum ON-SQIN group has over 160 members and an average of 470 page views a month. There is also consistent attendance and participation in virtual community of practice touchpoints, which are often hosted over Zoom. In both instances, members present information, ask questions, and network with each other.

ON-SQIN's work to reduce opioid prescriptions started with the Cut the Count campaign in 2019. Although we could not obtain the direct cost benefits of pill reduction, other costs are impacted by reducing the number of opioid prescriptions in Ontario. The Canadian Centre on Substance Use and Addiction released the *Canadian Substance Use Costs and Harms* report,⁷ estimating the costs of substance abuse in Canada based on the following data sources: inpatient hospitalizations, day surgeries, emergency department visits, paramedic services, physician time, and prescription drugs. In Ontario, inpatient hospitalizations related to opioid abuse have been rising since 2007. In 2020, opioid abuse cost the Canadian health care system over \$519 million.⁷ Furthermore, it has been proven that people without opioid prescriptions can also be harmed, through diversion by family or friends, illegal purchases, theft, and improper disposal.⁸ It can be assumed that costs to the health care system would be decreased by reducing the numbers of opioid prescriptions and pills circulating in our communities. ON-SQIN's quality improvement work related to reducing the use of prescription opioids prevents further abuse of these substances and decreases the burden to the health care system.

ON-SQIN has now started to track environmental outcomes in addition to patient outcomes. The network has been focusing on sustainability with the launch of the 2023–2024 campaign *Cut the Carbon: Reducing Surgical Waste*.⁹ The campaign will have a combined focus: reducing waste and carbon emissions and improving Enhanced Recovery After Surgery outcomes. Operating rooms generate up to a third of total hospital waste, with items such as single-use devices, medical waste, anesthetic gas, and disposable materials; this waste has a negative environmental impact.¹⁰ Early research has begun to emerge, calculating the carbon emissions produced by different health care interventions. For example, a study in England calculated that the environmental impact of a surgical site infection was 0.58 tonnes of carbon dioxide equivalent (tCO₂e).¹¹ Following the same metrics, preventing 100 surgical site infections could save 58 tCO₂e, equivalent to over 42,000 L of gasoline –

enough energy to power 23 homes for 1 year.¹² With this year’s campaign, ON-SQIN hopes to inspire other organizations in health care to start thinking about providing patient care with better environmental outcomes.

Efficiency

How well are resources being used?

Participating in ACS NSQIP has a monetary cost (Table 1). In the past, Ontario Health has funded a portion of the participation fees for 3 years for sites that were new to the program. After the initial 3 years, hospitals are encouraged to continue their participation in ACS data collection out of their own budgets. Based on the experience of over 700 North American hospitals, it takes 3 years to achieve results, and the efficiencies and cost savings can be directed to sustaining the program.¹ With this ongoing investment, hospitals will see not only improved patient outcomes, but also significant cost savings related to those outcomes.

Table 1: Cost of Participating in ACS NSQIP

Type	Total cost per year (CAD)
ACS licensing fee	\$36,000–\$41,000 ^{a,b}
OPTUM 360 Encoder Pro translation software	\$380 ^b
Surgical Clinical Reviewer 1.0 FTE	\$85,000–\$100,000
Surgical Clinical Reviewer 0.5 FTE	\$45,000
Discretionary costs: Surgeon Champion stipend, travel to conferences (ACS conference in United States, ON-SQIN conference in Toronto)	\$5,000–\$25,000
Total	\$171,380–\$211,380

Abbreviations: ACS, American College of Surgeons; FTE, full-time equivalent; ON-SQIN, Ontario Surgical Quality Improvement Network; NSQIP, National Surgical Quality Improvement Program.

Note: ACS recommends 1,680 cases annually for 1 Surgical Clinical Reviewer FTE.

^a Dependent on hospital type.

^b Based on USD to CAD currency exchange May 4, 2023.

Table 2 highlights the estimated cost savings related to 4 common postsurgical indicators: urinary tract infections, pneumonia, venous thromboembolism, and surgical site infections. These indicators are tracked by each participating ON-SQIN hospital as part of the ACS NSQIP data collection.

Table 2: Estimated Cost Savings Related to 4 Postsurgical Indicators

Indicator	Baseline cost per year (CAD) ^a	Cost per year after applying the reported indicator decline rate from hospitals that participated in ON-SQIN (CAD)
Urinary tract infections	\$20,052,602	\$16,643,660
Pneumonia	\$22,167,600	\$18,975,466
Venous thromboembolism	\$11,617,884	\$11,606,266
Surgical site infections	\$77,346,362	\$72,628,234
Total	\$131,184,448	\$119,853,626
Projected savings per year	\$11,330,822	

Note: Costs are rounded to the nearest integer. The unit cost for each hospital ranges from \$171,380 to \$211,380 CAD (Table 1). To calculate total costs, we took the median as an estimate.

^a See Appendix C for a detailed analysis of costs and indicator incidence.

The unit cost for each hospital that participates in the NSQIP program ranges from \$171,380 to \$211,380 (Table 1). For estimation purposes, we considered the median cost of \$191,380 per hospital, resulting in an approximate total program cost of \$8,229,340 across 43 Ontario hospitals (median cost per hospital \$191,380 × 43). In Table 2, 4 indicators are described, projecting a total annual savings of \$11,330,822. Subtracting the total cost from the projected savings (\$11,330,822 – \$8,229,340) yields an estimated net return per year of \$3,101,482. Therefore, the return on investment for the ON-SQIN program is 38%, based on reducing the incidence of these 4 postsurgical adverse events alone (projected net return \$3,101,482 / sum cost \$8,229,340 × 100). These figures highlight the program’s financial viability and the potential benefits for participating hospitals in Ontario.

The analysis above demonstrates the actual and potential cost savings for a participating hospital as a result of avoiding and reducing the rates of postoperative adverse events (see Appendix C for a detailed explanation of how costs were calculated). These findings are comparable to those of other Canadian NSQIP collaboratives. For example, in 2019 the NSQIP collaborative in Alberta completed a return-on-investment analysis and concluded that every \$1.00 invested in NSQIP would bring \$4.30 in returns to the system.¹³ Growing bodies of evidence are showing comparable results: targeting quality improvement efforts using ACS NSQIP leads to financial and patient benefits.

It is important to note that the analysis above includes only the 4 most common postoperative indicators, and potentially underestimates the total overall savings. Participation in the ON-SQIN program has led to improvements in other surgical indicators and reductions in opioid prescribing; these also contribute to health system cost savings but are not described in this report. As a result, the 38% return on investment described above is likely only a portion of the savings that could be realized from participation in the program.

Furthermore, participation in ON-SQIN can be synergistic with other quality improvement activities. Most organizations have multiple forms of quality improvement, including programs, bundles, and process measures. ACS NSQIP offers a way to measure a hospital’s progress in improving surgical outcomes, but the data from NSQIP can be used for internal hospital key performance indicators, public reporting, and accountability metrics. As well, the Surgeon Champion and Surgical Clinical

Reviewers can support existing operational structures focused on quality improvement. For example, at The Ottawa Hospital, the Surgeon Champion and Surgical Clinical Reviewers work with the quality improvement coordinator and report back to the surgical department on projects and metrics. Such an interdisciplinary approach can enhance quality improvement efforts and promote collaboration.

With ongoing commitment to surgical quality improvement via participation in ON-SQIN, hospitals can offset the costs of ACS NSQIP with the savings realized by improved postsurgical patient outcomes.

Sustainability

Will the benefits last?

Since its inception in 2015, ON-SQIN has become a mature community of practice. The sustained momentum of the program is due largely to the members of the network and their willingness to connect, share their successes and struggles, and use data to drive quality improvement changes. Many activities are informed by the network, such as microcollaboratives, smaller groups that meet to discuss topics of interest. For example, an emergency general surgery microcollaborative was started to connect general surgeons across the province, and members have been able to share deidentified data to find opportunities for quality improvement. Another example is the Cut the Carbon working group, which helped inform the focus for the 2023–2024 campaign. This working group initially met to discuss how teams could reduce waste and create sustainable practices in their operating rooms, and these ideas energized teams to continue to improve outcomes for Enhanced Recovery After Surgery indicators while also reducing waste. The ON-SQIN program delivery team at Ontario Health will continue to facilitate such touchpoints in the network and use network feedback to inform activities. These strategies will help maintain the sustainability of the program and increase its maturity over time.

Since 2015, Ontario Health has funded 47 hospitals, some of which are no longer participating because of financial or capacity issues, representing a sustainability of 92%. The reasons why 92% of teams have remained past the 3-year period of external funding are described in the sections above on Effectiveness, Impact, and Efficiency. ON-SQIN has proven to be effective in improving patient outcomes, enhancing collaboration between teams, and impacting the environment by reducing greenhouse gas emissions. It has also proven to be cost-effective, with a 38% return on investment across 4 common postoperative indicators. As the network moves forward with upcoming campaigns, business intelligence tools, and the implementation of new best practice change ideas, more hospitals in the province can sustain, spread, and even accelerate their surgical quality improvement efforts.

Summary and Next Steps

ON-SQIN has helped hospitals enhance their care process, resulting in fewer postoperative complications, lower readmission rates, shorter hospital stays, and improved patient satisfaction. By sharing best practices and carrying out quality improvement initiatives, ON-SQIN members have supported the implementation of protocols that have benefited multiple patients and providers. Since 2015, the program has led not only to improvements in patient-specific indicators but also to savings of millions of dollars for the health care system. Continuing to foster this community of practice will be imperative for maintaining the momentum to improve patient care and reduce the carbon footprint created by the health care system.

Based on the findings of this program evaluation, we recommend the following for the continued success and growth of ON-SQIN:

- Encourage health care providers to maintain their commitment to continuous improvement by actively participating in ON-SQIN, sharing best practices, and embracing data-driven decision making.
- Strengthen and expand ON-SQIN's collaborative efforts by engaging more health care facilities, surgical teams, and stakeholders to foster a broader impact on patient care and outcomes.
- Continuously monitor and evaluate ON-SQIN's performance metrics to identify areas for improvement and ensure the sustained delivery of positive results.

The 2021 Office of the Auditor General of Ontario report *Value-for-Money Audit: Outpatient Surgeries*⁶ noted that the province lacks a centralized way to measure surgical quality and outcomes for all surgeries. However, it did identify the ACS NSQIP as 1 of 3 programs that monitor surgical quality and outcomes in Ontario.

At present, 66% of all Ontario surgeries occur in an ON-SQIN hospital. To ensure that most patients having surgery in Ontario benefit from a hospital that participates in the ON-SQIN program, Ontario Health recommends that all large-volume surgical centres participate in NSQIP (an established audit and feedback program) and ON-SQIN (a community of practice). If hospitals with elective surgical volumes of greater than 5,000 participate, the number of patients having surgery in an ON-SQIN hospital would increase to 89%.

To learn more about the ON-SQIN program and how you can provide safer surgical care, please contact the program delivery team at ONSQIN@ontariohealth.ca

Acknowledgments

Ontario Health would like to acknowledge the following team who contributed to the creation of this program evaluation.

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References

1. ACS NSQIP [Internet]. Chicago (IL): American College of Surgeons; 2023 [cited 2023 Aug 10]. Available from: <https://www.facs.org/quality-programs/data-and-registries/acs-nsqip/about-acs-nsqip/>
2. BC Patient Safety and Quality Council. NSQIP report: improved outcomes = improved access [Internet]. Vancouver (BC): The Council; 2017 [cited 2023 Jul 14]. Available from: <https://bcpsqc.ca/resource/nsqip-report-improved-outcomes-improved-access>
3. Organisation for Economic Co-operation and Development. Applying evaluation criteria thoughtfully [Internet]. Paris, France: OECD Publishing; 2021 [cited 2023 Aug 9]. Available from: https://www.oecd-ilibrary.org/development/applying-evaluation-criteria-thoughtfully_543e84ed-en
4. Moore JE, Khan S. StrategEase: the HOW of creating sustainable change. Toronto (ON): Center for Implementation; 2022.
5. Wandersman A, Duffy J, Flaspohler P, Noonan R, Lubell K, Stillman L, et al. Bridging the gap between prevention research and practice: the interactive systems framework for dissemination and implementation. *Am J Commun Psychol*. 2008;41(3-4):171-81.
6. Value-for-money audit: outpatient surgeries [Internet]. Toronto (ON): Office of the Auditor General of Ontario; 2021 [cited 2023 Jul 14]. Available from: https://www.auditor.on.ca/en/content/annualreports/arreports/en21/AR_Outpatient_en21.pdf
7. Canadian Substance Use Costs and Harms Scientific Working Group. Canadian substance use costs and harms 2007–2020. Ottawa (ON): Canadian Centre on Substance Use and Addiction; 2023.
8. Canadian Institute for Health Information. Opioid prescribing in Canada: how are practices changing? Ottawa (ON): The Institute; 2019.
9. Cut the carbon [Internet]. Toronto (ON): Ontario Health; 2023 [cited 2023 Jul 14]. Available from: <https://hgontario.ca/Quality-Improvement/Quality-Improvement-in-Action/Ontario-Surgical-Quality-Improvement-Network/Cut-the-Carbon>
10. Simms N, Devitt K, Irani C, Khan N, Meng F. Sustainable perioperative care playbook [Internet]. Toronto (ON): CASCADES; 2023 [cited 2023 Jul 14]. Available from: <https://cascadescanada.ca/resources/sustainable-perioperative-care-playbook/>
11. Kocaman M, Galvain T. POSA113 the cost analysis of the environmental impacts of surgical site infection from the perspective of NHS England. *Value Health*. 2022;25(1 Suppl); S55.
12. Greenhouse gas equivalencies calculator [Internet]. Ottawa (ON): Natural Resources Canada, Office of Energy Efficiency, Demand Policy and Analysis Division; 2017 [cited 2023 Jul 14]. Available from: <https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/calculator/ghg-calculator.cfm>
13. Thanh NX, Baron T, Litvinchuk S. An economic evaluation of the National Surgical Quality Improvement Program (NSQIP) in Alberta, Canada. *Ann Surg*. 2019;269(5):866-72.
14. Canadian Institute for Health Information. Inpatient hospitalization, surgery and newborn statistics, 2021–2022. Ottawa (ON): The Institute; 2023.
15. Canadian Institute for Health Information. Patient cost estimator: methodology notes and glossary. Ottawa (ON): The Institute; 2022.

16. Van Katwyk S, Thavorn K, Coyle D, Moloo H, Forster AJ, Jackson T, et al. The return of investment of hospital-based surgical quality improvement programs in reducing surgical site infection at a Canadian tertiary-care hospital. *Infect Control Hosp Epidemiol.* 2019;40(2):125-32.

Appendices

Appendix A: ON-SQIN Membership

As of July 1, 2023

ON-SQIN Membership

	Participating Hospital	Location
1	Cambridge Memorial Hospital	Cambridge
2	Children's Hospital of Eastern Ontario	Ottawa
3	Collingwood General and Marine Hospital	Collingwood
4	Cornwall Community Hospital	Cornwall
5	Grand River Hospital, Kitchener Waterloo Campus	Kitchener
6	Grey Bruce Health Services	Owen Sound
7	Halton Healthcare, Oakville Trafalgar Memorial Hospital	Oakville
8	Hamilton Health Sciences, Juravinski Hospital	Hamilton
9	Hamilton Health Sciences, McMaster Children's Hospital	Hamilton
10	The Hospital for Sick Children (Sick Kids)	Toronto
11	Humber River Hospital	Toronto
12	Kingston Health Sciences Centre, Kingston General Hospital	Kingston
13	Lakeridge Health, Oshawa Hospital	Oshawa
14	London Health Sciences Centre, Children's Hospital	London
15	London Health Sciences Centre, University Hospital	London
16	London Health Sciences Centre, Victoria Hospital	London
17	Mackenzie Health	Richmond Hill
18	Michael Garron Hospital	East York
19	Hôpital Montfort	Ottawa
20	Niagara Health System, St. Catharines Site	St. Catharines
21	North York General Hospital	North York
22	Oak Valley Health, Markham Stouffville Hospital	Markham

	Participating Hospital	Location
23	Orillia Soldiers' Memorial Hospital	Orillia
24	Quinte Heath Care	Belleville
25	The Ottawa Hospital	Ottawa
26	Trillium Health Partners, Mississauga Hospital	Mississauga
27	Pembroke Regional Hospital	Pembroke
28	Queensway Carleton Hospital	Ottawa
29	Renfrew Victoria Hospital	Renfrew
30	Royal Victoria Regional Health Centre	Barrie
31	Scarborough Health Network, Centenary Hospital	Scarborough
32	Scarborough Health Network, General Hospital	Scarborough
33	Sinai Health System, Mount Sinai Hospital	Toronto
34	Southlake Regional Health Centre	Newmarket
35	Sunnybrook Health Sciences Centre	Toronto
36	St. Joseph's Healthcare Hamilton	Hamilton
37	Unity Health, St. Joseph's Health Centre Toronto	Toronto
38	Unity Health, St. Michael's Hospital	Toronto
39	Thunder Bay Regional Health Sciences Centre	Thunder Bay
40	University Health Network, Toronto General Hospital	Toronto
41	University Health Network, Toronto Western Hospital	Toronto
42	William Osler Health Centre, Brampton Civic Hospital	Brampton
43	William Osler Health Centre, Etobicoke General Hospital	Etobicoke

Appendix B: Organisation for Economic Co-operation and Development Evaluation Criteria



Evaluation criteria: effectiveness (is the intervention achieving its objectives?); impact (what difference is the intervention making?); relevance (is the intervention doing the right things?); efficiency (how well are resources used?); sustainability (will the benefits last?); and coherence (how well does the intervention fit?).

Source: Reprinted with permission from Organisation for Economic Co-operation and Development³

Appendix C: Return-on-Investment Financial Analysis

Table A1: Return-on-Investment Input Parameters

Parameter name	Value	Patient volume (typical cases)	Source
2016 baseline prevalence for postoperative complications (based on ON-SQIN hospitals)			
Urinary tract infection	1.30%	–	ON-SQIN SAR trend analysis
Pneumonia	1.00%	–	ON-SQIN SAR trend analysis
Venous thromboembolism	0.70%	–	ON-SQIN SAR trend analysis
Surgical site infection	3.50%	–	ON-SQIN SAR trend analysis
Unit cost of managing each complication (CAD)			
Urinary tract infection			
Lower	\$4,877	11,968	CIHI, Patient Cost Estimator, 2022 ^{14,15}
Upper	\$3,889	2,634	CIHI, Patient Cost Estimator, 2022
Pooled	\$4,699	14,602	Estimate ^a
Pneumonia			
Aspiration	\$9,242	3,901	CIHI, Patient Cost Estimator, 2022
Bacterial	\$7,226	5,062	CIHI, Patient Cost Estimator, 2022
Viral or unspecified	\$6,055	17,352	CIHI, Patient Cost Estimator, 2022
Pooled	\$6,753	26,315	Estimate ^b
Venous thromboembolism			
Deep vein thrombosis	\$4,839	536	CIHI, Patient Cost Estimator, 2022
Pulmonary embolism	\$5,090	3,427	CIHI, Patient Cost Estimator, 2022
Pooled	\$5,056	3,963	Estimation ^c
Surgical site infection, all types (unspecified)	\$6,732	–	Van Katwyk et al, 2018 ¹⁶
Number of surgical operations per year in Ontario			
All surgeries (Inpatient and day surgeries)	~328,263	–	2021 ON-SQIN surgeries indicator ^d
Hospital participating in ON-SQIN	43	–	ON-SQIN SAR trend analysis

Parameter name	Value	Patient volume (typical cases)	Source
Aggregated decline rate for hospitals that participated in ON-SQIN			
Urinary tract infection	17.00%	–	ON-SQIN SAR trend analysis
Pneumonia	14.40%	–	ON-SQIN SAR trend analysis
Venous thromboembolism	0.10%	–	ON-SQIN SAR trend analysis
Surgical site infection	6.10%	–	ON-SQIN SAR trend analysis

Abbreviations: CIHI, Canadian Institute for Health Information; ON-SQIN, Ontario Surgical Quality Improvement Network; SAR, semi-annual report.

^a Average cost for urinary tract infection: $\$4,877 \times 11,968$ (cases of lower urinary tract infection) + $\$3,889 \times 2,634$ (cases of upper urinary tract infection) / $11,968 + 2,634 = \$4,698.78$ per case.

^b Average cost for pneumonia: $\$9,242 \times 3,901$ (cases of aspiration pneumonia) + $\$7,226 \times 5,062$ (cases of bacterial pneumonia) + $\$6,055 \times 17,352$ (viral or unspecified) / $3,901 + 5,062 + 17,352 = \6752.70 per case.

^c Average cost for venous thromboembolism: $\$4,839 \times 536$ (cases for deep vein thrombosis) + $\$5,090 \times 3,427$ (cases for pulmonary embolism) / $536 + 3,427 = \$5056.05$ per case.

^d The estimate is based on 2021 data from the Discharge Abstract Database and National Ambulatory Care Reporting System, accessed through IntelliHealth; 66% of surgeries took place in an ON-SQIN hospital.

Table A2: Model Results – Comparison of Forecast Consequence

Indicator	Year 1 baseline, no decline rate applied	Applied reported decline rate from hospitals that participated in ON-SQIN
Prevalence of each postoperative complication		
Urinary tract infection	1.30%	1.08%
Pneumonia	1.00%	0.86%
Venous thromboembolism	0.70%	0.70%
Surgical site infection	3.50%	3.29%
Projected number of patients (328,263 × corresponding prevalence)		
Urinary tract infection	4,267	3,542
Pneumonia	3,283	2,810
Venous thromboembolism	2,298	2,296
Surgical site infection	11,489	10,788
Total	21,337	19,436
Projected total cost (unit cost × number of patients)		
Urinary tract infection	\$20,052,602	\$16,643,660
Pneumonia	\$22,167,600	\$18,975,466
Venous thromboembolism	\$11,617,884	\$11,606,266
Surgical site infection	\$77,346,362	\$72,628,234
Total	\$131,184,448	\$119,853,626
Projected health expenditure savings per year		
Urinary tract infection	–	\$3,408,942
Pneumonia	–	\$3,192,134
Venous thromboembolism	–	\$11,618
Surgical site infection	–	\$4,718,128
Total	–	\$11,330,822
Projected net return		
Net return	–	\$3,101,483

Note: Baseline prevalence refers to the average event rate in 2016, derived from all hospitals that participated in ON-SQIN. All currencies are in CAD. Costs are rounded to the nearest integer.

Appendix D: Length-of-Stay Analysis

We considered and included 2 separate scenarios in our length-of-stay analysis.

- Scenario 1: Postoperative complications occur in a separate hospitalization from the initial surgery stay or day surgery visit.
- Scenario 2: Postoperative complications occur during the same hospital stay. If a postoperative complication occurs, the patient usually has a longer length of stay.

Based on internal Ontario Health data, over 328,000 surgeries occur in an ON-SQIN hospital per year. From this total, it is estimated that 40% are outpatient surgeries and 60% are inpatient surgeries. The average ON-SQIN hospital will have a mix of outpatient and inpatient surgical procedures, and therefore, will have patients who fall into both scenarios 1 and 2.

We used data from the Canadian Institute for Health Information^{14,15} and internal Ontario Health database resources for this analysis. The mean length-of-stay for surgical site infection is taken from a research study by Van Katwyk et al.¹⁶ Table A3 showcases the average length of stay for patients in scenarios 1 and 2. For example, for patients who develop a urinary tract infection in a separate hospitalization from their initial surgery (scenario 1), the mean length of stay is 4.7 days; for patients who develop a urinary tract infection in the same hospitalization (scenario 2), they will experience an additional 19.0 days in their length of stay.

It is important to note that actual length of stay may vary significantly among patients; the following results are unadjusted for patient factors. Hospitals and health providers may need to consider their local context and individual patient characteristics to determine a more accurate average length of stay. It is also important to note that only 4 postoperative indicators were considered in this analysis.

Table A3: Acute Length of Stay Among Surgery Patients

Postoperative complication	Scenario 1	Scenario 2		
	Mean length of stay, days ¹⁴⁻¹⁶	Median length of stay when complication occurs, days*	Median length of stay when complication does not occur, days*	Difference, days
Urinary tract infections	4.7	22.0	3.0	19.0
Pneumonia	5.9	20.0	3.0	17.0
Venous thromboembolism	4.9	28.0	3.0	25.0
Surgical site infections	14.1	21.0	3.0	18.0

*Source: internal Ontario Health database.

Table A4: Projected Reductions in Length of Stay

Postoperative complication	Year 1 baseline, no decline rate applied	Applied reported decline rate from hospitals that participated in ON- SQIN
Prevalence of each postoperative complication		
Urinary tract infections	1.30%	1.08%
Pneumonia	1.00%	0.86%
Venous thromboembolism	0.70%	0.70%
Surgical site infections	3.50%	3.29%
Projected total number of patients who are expected to have a complication (328,263 × prevalence for each postoperative complication)		
Urinary tract infections	4,267	3,542
Pneumonia	3,283	2,810
Venous thromboembolism	2,298	2,296
Surgical site infections	11,489	10,788
Sum	21,337	19,436
Number of patients who avoided a complication (number of inpatient beds saved)	–	1,901
Scenario 1: Postoperative complications occur in a separate hospitalization from the initial surgery stay or day surgery visit		
Projected total length of stay, days (mean length of stay × number of patients who are expected to have a complication)		
Urinary tract infections	20,216	16,781
Pneumonia	19,317	16,534
Venous thromboembolism	11,353	11,344
Surgical site infections	161,995	152,111
Sum	212,881	196,769
Projected <u>reduction</u> in length of stay, days		
Urinary tract infections	–	3,435
Pneumonia	–	2,783
Venous thromboembolism	–	10
Surgical site infections	–	9,884
Sum	–	16,112

Postoperative complication	Year 1 baseline, no decline rate applied	Applied reported decline rate from hospitals that participated in ON- SQIN
Average per ON-SQIN hospital, days	–	375
Scenario 2: Postoperative complications occur during the same hospital stay		
Projected total length of stay, days (mean length of stay × number of patients who are expected to have a complication)		
Urinary tract infections	56,730	47,091
Pneumonia	41,213	35,275
Venous thromboembolism	39,011	38,977
Surgical site infections	188,879	177,355
Sum	325,834	298,699
Projected <u>reduction</u> in length of stay, days		
Urinary tract infections	–	9,639
Pneumonia	–	5,938
Venous thromboembolism	–	34
Surgical site infections	–	11,524
Sum	–	27,135
Average per ON-SQIN hospital, days	–	631

Note: Values have been rounded to the nearest integer. Please see Appendix C, Table A1, for the input parameters used to calculate patient case volumes. Please see Table A3 for mean lengths of stay. Scenario 1 uses a population that has returned for a subsequent hospitalization. Scenario 2 uses the overall surgical population and assumes that 60% of inpatients and 40% of outpatients have a postoperative complication. For example, an estimated 4,267 patients develop a urinary tract infection postoperatively. From this number, we can assume that 60% (approximately 2,560 patients) were inpatients and 40% (approximately 1,707 patients) were outpatients. Inpatients would experience an additional 19 days' hospital stay, and outpatients would experience a second hospitalization of 4.7 days. Combining the lengths of stay for both patient types, we see a total overall length of stay for all patients of 56,730 days).

Looking for More Information?

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ISBN 978-1-4868-7383-8 (PDF)

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