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4 1 **Accelerating surgical quality improvement in Ontario through a regional**
5 2 **collaborative**
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3 **38 Abstract**
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6 39 Background: American College of Surgeons National Surgical Quality Improvement Program
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8 40 (ACS NSQIP) collaborative in Ontario (ON-SQIN) was launched in January 2015. We describe
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11 41 its development, approaches to support surgical quality improvement, and its early impact in
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13 42 participating hospitals.
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16 43 Methods: Participating hospitals were provided with quality improvement resources and tools, as
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18 44 well as opportunities to interact with peers through a community of practice. Outcome measures
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21 45 included the level of quality improvement capacity at the initial stage of participation and after
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23 46 18 months, collaborative-wide aggregate outcome on postoperative occurrences, and self-
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25 47 reported surgical wound and urinary tract occurrences.
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29 48 Results: Thirty-three hospitals enrolled in the ON-SQIN by December 2016. The community of
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31 49 practice was established through an online platform, in-person meetings, calls, webinars, and
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33 50 conferences. Eighteen hospitals that enrolled in the ON-SQIN in 2015 reported an increase in
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35 51 their capacity for quality improvement after 18 months. Analysis of the collaborative-wide
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37 52 aggregate data for all 18 hospitals in a 6-month period (14,748 surgical cases) revealed a
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39 53 substantial improvement in the reduction of acute renal failure (relative risk (RR): 0.48, 95% CI:
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41 54 0.25-0.95) and urinary tract infection (UTI) (RR: 0.77, 95% CI: 0.61-0.97). Self-reported
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43 55 surgical site infection (SSI) and UTI occurrences demonstrated a decreasing trend during a 1-
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45 56 year period.
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50 57 Interpretation: ON-SQIN supported the uptake of ACS NSQIP in Ontario hospitals and promoted
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52 58 targeted surgical quality improvement initiatives, resulting in increased quality improvement
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3 59 capacity and development of the community of practice. Furthermore, our early experience
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5 60 suggests that improvements in surgical care are being realized.
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8 9 61 **Introduction**

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11 62 Post-surgical complications are associated with increased mortality, length of stay, and
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13 63 healthcare costs, as well as impaired psychosocial well-being of patients (1-4). With the goal to
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15 64 improve the quality of surgical care, the National Surgical Quality Improvement Program
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17 65 (NSQIP) was initially implemented by the Department of Veterans Affairs in 1994, and has
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19 66 expanded to the private sector through the American College of Surgeons (ACS) (5). As of
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21 67 November 2017, a total of 682 sites, including 59 Canadian sites, participate in the ACS NSQIP.
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23 68 Studies demonstrated that participation in the ACS NSQIP results in the reduction of post-
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25 69 operative adverse events (6, 7). However, non-NSQIP participating hospitals also demonstrated
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27 70 improvement in similar quality metrics over time (8, 9), suggesting that the mechanism alone
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29 71 used to provide feedback on clinical outcomes does not necessarily improve the quality of
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31 72 surgical care.
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38 73 With support from the ACS NSQIP (5), a growing number of institutions in the US have
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40 74 implemented regional collaborative approaches to quality improvement (10-13). Such approach
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42 75 enables data sharing among local peer hospitals, and provides opportunities for education,
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44 76 learning, and implementation of evidence-supported best practice across multiple institutions.
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46 77 Notably, surgical outcomes in hospitals participating in a collaborative improved faster than
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48 78 other NSQIP hospitals that were not participating in a collaborative (12). Therefore, additional
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50 79 support and resources provided by a collaborative may accelerate quality improvement.
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3 80 In Canada, a NSQIP regional collaborative has previously been implemented in British
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5 81 Columbia (14). Ontario Surgical Quality Improvement Network (ON-SQIN) was launched in
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7 82 January 2015 to support a community of surgical teams with a goal to accelerate improvement
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9 83 by sharing and learning through a community of practice. ON-SQIN was established by Health
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11 84 Quality Ontario (HQO) with funding support from the Ontario Ministry of Health and Long-
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13 85 Term Care, and adapted the quality improvement plan mandated by the Ontario Excellent Care
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15 86 for All Act (15). The objective of this report is to describe our initial experience in building a
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17 87 collaborative in Ontario, its impact on hospital quality improvement capacity, and early
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19 88 improvements in surgical outcomes of participating hospitals during the first year of ON-SQIN.
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24 89 **Methods**

25 26 27 28 90 *Data source*

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31 91 Analysis included 18 Ontario hospitals that participated in ON-SQIN in 2015. The level of
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33 92 quality improvement capacity at each participating hospital was assessed via web-based
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35 93 questionnaires at the time of their initial enrollment in ON-SQIN and after 18 months. The initial
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37 94 performance status of the 18 hospitals relative to all ACS NSQIP hospitals was determined based
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39 95 on the July 2016 risk-adjusted semi-annual report (SAR) encompassing surgeries performed
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41 96 between January and December 2015. In parallel, collaborative-wide aggregate data on post-
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43 97 operative occurrences was collected in accordance with the ACS NSQIP data sharing methods.
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45 98 Additionally, self-reported outcomes were collected from participating hospitals through
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47 99 Surgical Quality Improvement Plan (SQIP), which was submitted by hospitals to describe
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51 100 change ideas and methods of their quality improvement activities, and to report on their chosen
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53 101 indicators, baseline measures, 6-month progress measures, and year-end measures. Teams at
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3 102 each hospital were provided with a SQIP template and a list of potential surgical evidence-based
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5 103 change ideas and related process measures. The SQIP was reviewed by HQO quality
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7 104 improvement professionals and assessed for feasibility and appropriateness of quality
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9 105 improvement methodologies.

106 *Quality improvement resources*

107 Hospitals were provided with various resources and tools to increase their quality improvement
108 capacity. They included site visits, an established quality improvement program designed for the
109 Ontario health system (IDEAS: Improving and Driving Excellence Across Sectors) (16), access
110 to the Institute for Healthcare Improvement e-Learning module (17), support to implement
111 enhanced recovery after surgery (iERAS) (18), manuals and guidelines, and an online platform
112 providing information to implement the Comprehensive Unit-based Safety Program (CUSP)
113 approach (19). A community of practice was established to provide opportunities for interaction
114 among peers, including Surgeon Champion and surgical clinical reviewer (SCR) conference calls,
115 annual conferences, webinars, newsletters, and SQIP summary reports that enabled participating
116 members to identify common quality improvement efforts in other hospitals.

117 *Outcome measures*

118 Quality improvement capacity for each participating hospital was assessed using web-based
119 questionnaires. Questions were assigned a value using an ordinal scale, and an overall score
120 between 0 and 1 was used to describe the sites' overall quality improvement experience,
121 knowledge, and readiness to engage in the work. To examine the initial performance status of the
122 18 ON-SQIN hospitals, 13 indicators for general, vascular, colorectal, and all cases surgeries
123 were analyzed. Specifically, the odds ratio (OR) presented in the SAR was obtained, and the

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3 124 percentage of hospitals within the collaborative that are categorized as “needs improvement”, “as
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5 125 expected”, and “exemplary” with respect to the performance for all ACS NSQIP hospitals was
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7 126 calculated for each indicator. To assess the impact on surgical quality improvement at a
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10 127 collaborative-wide level, unadjusted aggregate data reports on all cases entered in NSQIP by the
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12 128 18 ON-SQIN hospitals were collected between August 2015 and January 2016. Data after
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14 129 January 2016 was not considered in this analysis as it included data from new hospitals that
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16 130 participated in ON-SQIN. In addition, self-reported measures of surgical site infection (SSI) and
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18 131 urinary tract infection (UTI) occurrences were analyzed for hospitals that indicated reduction of
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20 132 these target measures in the SQIP between September 2015 and September 2016.
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25 133 *Statistical analysis*

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28 134 Percent change and relative risk (RR) for postoperative occurrences were calculated from the
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30 135 baseline measurement for the collaborative-wide aggregate data. $P < 0.05$ was considered
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32 136 statistically significant.
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35 137 **Results**

38 138 *Building the Collaborative*

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42 139 ON-SQIN was launched in January 2015 with 4 academic organizations (5 hospitals) that were
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44 140 already enrolled in the ACS NSQIP. In 2015, additional 13 hospitals (2 academic, 6 community,
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46 141 5 small/rural) participated in the ACS NSQIP with support from ON-SQIN. The number of
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48 142 participating hospitals grew to 33 by the end of 2016. Currently, 11 of the 14 Ontario Local
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50 143 Health Integration Networks (LHINs) have hospitals participating in ON-SQIN (Figure 1). All
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52 144 Ontario hospitals that have enrolled in the ACS NSQIP since January 2015 have also enrolled in
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55 145 ON-SQIN. Participating hospitals and departments represented a wide array of surgical
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3 146 specialties, including neurosurgery, pediatrics, and surgical oncology (Table 1). Currently, ON-
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5 147 SQIN participating hospitals perform 46.4% of all adult surgeries in Ontario. In addition, 3 of 5
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8 148 pediatric hospitals in Ontario participate in ON-SQIN.
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10 11 149 *Building the Quality Improvement Capacity across Participating Hospitals*

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14 150 At the initial stage of participation in the ACS NSQIP and ON-SQIN, members reported limited
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16 151 availability of quality improvement capacity and initiatives (Table 2). Collaboration within the
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18 152 surgical team was markedly lacking, with only 44% of ON-SQIN hospitals indicating that they
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21 153 had sufficient ongoing collaboration. In addition, access to resources and tools were lacking in
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23 154 over 30% of hospitals. At the 18-month follow-up, all 17 hospitals that answered the
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25 155 questionnaire indicated that they had access to resources, ongoing quality improvement
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27 156 initiatives, and engagement within their organization. Four hospitals still indicated lack of
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30 157 collaboration within their surgical team at the 18-month follow-up.
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33 158 *Establishing the Community of Practice*

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36 159 Participating members received comprehensive support through the community of practice,
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38 160 which included the online platform, telephone calls, webinars, in-person meetings, and
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40 161 conferences (Table 3). The initial telephone call with Surgeon Champions occurred in March
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42 162 2015, and calls among the Surgeon Champions are currently being held on a monthly basis.
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44 163 Similarly, SCR calls have been held monthly. In-person meetings with Surgeon Champions
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46 164 have been held annually prior to the Ontario Surgical Quality Conference to discuss areas of
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48 165 current and future focus for ON-SQIN. Implementation of the CUSP approach was proposed in
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50 166 the first meeting as a strategy to address common challenges related to the culture and teamwork.
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53 167 Consequently, ON-SQIN collaborative workshop was held to develop a common approach for
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3 168 introducing CUSP into the surgical programs. Individuals representing all 18 hospitals
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5 169 participated in the workshop. In-person events, such as the Surgeon Champion meetings,
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7 170 conferences, and workshops were particularly well-represented by both Surgical Champions and
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9 171 SCRs, with 83-100% representation of ON-SQIN hospitals.
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13 172 *Impact on Surgical Outcomes*

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16 173 The performance of ON-SQIN hospitals on postoperative indicators was compared to that of all
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18 174 ASC NSQIP hospitals. ON-SQIN hospitals were considered exemplary or as expected in
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20 175 preventing prolonged use of ventilators, unplanned intubation, return to the operating room, and
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22 176 sepsis (Figure 2). However, there was a room for improvement in various outcomes, particularly
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24 177 in the prevention of morbidity, SSI, and UTI. Accordingly, in the initial SQIP submitted in
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26 178 September 2015, 13 hospitals indicated reduction of SSI as their primary focus. Common
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28 179 initiatives shared among hospitals included iERAS, participation in the national SSI prevention
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30 180 audit, normothermia, and development of standardized evidence-based procedures such as a
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32 181 surgical dressing protocol. Similarly, 4 hospitals selected reduction of UTI as their primary focus
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34 182 in the initial SQIP. Common initiatives shared among the participating hospitals included iERAS,
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36 183 reduction of the use of indwelling catheters, and staff education.
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42 184 Analysis of the aggregated data included all surgical cases performed at 18 participating
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44 185 hospitals in Ontario: 4,806 cases in August-September 2015, 4,821 cases in October-November
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46 186 2015, and 5,121 cases in December 2015-January 2016. Overall, there was a significant
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48 187 aggregate improvement in the occurrence of acute renal failure (RR: 0.48, 95% CI: 0.25-0.95)
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50 188 and UTI (RR: 0.77, 95% CI: 0.61-0.97), as well as a trend for improvement in both the overall
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52 189 occurrence of superficial incisional SSI (RR: 0.89, 95% CI: 0.74-1.07) and deep incisional SSI
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3 190 (RR: 0.86, 95% CI 0.57-1.32) in the 4-month period following the initial submission of the
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5 191 SQIP in September 2015 (Table 4). There was a trend for an increased incidence of organ/space
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7 192 SSI, wound disruption, and progressive renal insufficiency.
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11 193 In the SQIP, hospitals reported either their raw data or their risk-adjusted data. Among them, 10
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13 194 hospitals targeted SSI reduction, 1 hospital targeted UTI reduction, and 3 hospitals targeted
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15 195 reduction of both SSI and UTI. Two hospitals did not submit the year-end SQIP, and were
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17 196 therefore excluded from the analysis. 6-month progress report was submitted by 3 hospitals
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19 197 targeting UTI reduction and 5 hospitals targeting SSI reduction. There was a trend for a decrease
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21 198 in the self-reported SSI rate, and a more dramatic decrease in the self-reported UTI rate (Figure
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23 199 3). After 1 year, the overall average of self-reported SSI and UTI rates decreased from 4.11% to
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25 200 3.03% and from 2.81% to 1.40%, respectively.
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30 201 **Interpretation**

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33 202 The NSQIP collaborative has been successfully implemented in Ontario, resulting in the
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35 203 development of the community of practice, increase in hospital quality improvement capacity,
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37 204 and a wealth of surgical quality improvement activity captured within the SQIP framework.
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39 205 Analysis of the first 18 hospitals revealed an early indication of improvement in preventing acute
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41 206 renal failure and UTI in the first 4 months. Furthermore, hospitals that indicated SSI and/or UTI
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43 207 as their targets demonstrated improvement over a 1-year period.
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48 208 By participating in the ACS NSQIP, hospitals receive feedback on their risk-adjusted
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50 209 performance. The ability to benchmark performance to all other participating hospitals allows for
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52 210 identification of opportunities for targeted quality improvement. While participation in the ACS
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54 211 NSQIP has been clearly associated with a reduction of postoperative adverse events (7), the
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3 212 collection of outcomes data alone may not be sufficient to improve care (8, 9). Development of
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5 213 the community of practice within ON-SQIN enabled rapid spread of NSQIP and sharing of best
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7 214 practices within the province through training opportunities, tools and resources, and mentorship.
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10 215 In addition, hospitals used the SQIP to select their target quality improvement indicators and
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12 216 activities, and to track progress over time. The process of SQIP submission and review included
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14 217 assessment of feasibility and appropriateness of quality improvement methodologies by quality
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16 218 improvement professionals. We believe this has been a critical success factor in engaging and
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19 219 supporting participating hospitals as they review and act on their own outcomes data.
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22 220 Hospitals participated in ON-SQIN at the time of their enrollment in NSQIP. This mechanism
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24 221 ensured that there was no delay in providing support to build necessary capacity to maximize the
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26 222 use of data collected through NSQIP. The observed increase in the quality improvement capacity
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28 223 supports the impact of the collaborative. In addition, continuous decrease in SSI and UTI
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30 224 occurrences indicates increased engagement and capability in the quality improvement initiatives
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32 225 over time. Of 2,257 morbidity cases reported in the July 2016 SAR for Ontario hospitals, 1,568
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34 226 (69.5%) were due to either SSI or UTI. Therefore, the reduction of SSI and UTI may translate
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36 227 into a reduction of overall morbidity. However, these are only initial results; further analysis and
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39 228 monitoring of data is needed to determine the long-term impact of ON-SQIN.
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44 229 Few rural and small ON-SQIN hospitals were unable to maintain their participation in the ACS
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46 230 NSQIP due to the associate cost, highlighting challenges to sustain and disseminate the
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48 231 collaborative to hospitals across Ontario. To reduce the cost of administering the program, the
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50 232 NSQIP collaborative of Florida launched the NSQIP “lite” system that applies the NSQIP data
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52 233 collection process to a limited sample, and demonstrated evidence for improvement and cost
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54 234 saving (11). This strategy may also be useful in Ontario. In addition, studies demonstrated that
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3 235 the cost savings associated with the care for postoperative complications exceeds the cost of
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5 236 administering the ACS NSQIP program, and suggested that approximately a 2% reduction in
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7 237 complication rate is sufficient to offset the cost of maintaining the ACS NSQIP participation (12,
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9 238 20). Similar cost analysis in the context of Ontario hospitals is underway to promote further
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11 239 dissemination of the ACS NSQIP and ON-SQIN program in community and small/ rural
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13 240 hospitals.
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18 241 *Limitations*

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21 242 We used unadjusted aggregate data reports on all cases in ON-SQIN to examine the change in
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23 243 postoperative outcomes. As ON-SQIN was initially set up as a blinded collaborative, HQO did
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25 244 not have direct access to any risk-adjusted hospital-level data. Limitations of the use of
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27 245 aggregated data include the inability to consider the impact of hospital size and varying
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29 246 capacities on the overall performance of the collaborative, and the inability to examine
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31 247 postoperative outcomes for different specialties. Furthermore, since additional hospitals joined in
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33 248 2016, the analysis of the first 18 hospitals was limited to the first 6-month period. The SQIP
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35 249 overcomes these limitations, enabling tracking of the progress of individual hospitals over time.
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37 250 As we expect more hospitals to expand their work on different surgical specialties, we aim to
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39 251 establish a standardized online reporting system to capture postoperative outcomes for various
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41 252 surgical specialties. The system would also ensure hospitals to submit their risk-adjusted data to
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43 253 enable direct comparison across hospitals in an unblinded manner.
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49 254 *Conclusion*

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52 255 Establishment of ON-SQIN led to the rapid uptake of NSQIP among Ontario hospitals and
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54 256 development of the strong community of practice dedicated to improving surgical care. Our
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3 257 initial findings suggest that the support provided by ON-SQIN improved capacity for quality
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5 258 improvement and ability to respond to their own data. Implementation of the SQIP provided a
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8 259 blueprint for hospitals to move from data to improvements in care. As the collaborative evolves,
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10 260 it is critical to move toward unblinding hospital-level data and initiating collaborative-level
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12 261 campaign to scale and spread early success. To this end, a provincial campaign aimed at
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14 262 reducing postoperative SSI, UTI, and pneumonia is underway to continue supporting
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17 263 participating hospitals. Ongoing data collection and analysis will help determine the long-term
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19 264 effect of the collaborative on the growth of quality improvement capabilities, impact on quality
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21 265 of surgical care, and potential cost saving.
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Confidential

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54 326 **Figure Legends:**
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3 327 Figure 1: Location of ON-SQIN hospitals. a) Ontario Local Health Integration Networks
4 (LHINs). 1. Erie St. Clair; 2. South West; 3. Waterloo, Wellington; 4. Hamilton, Niagara,
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8 329 Haldimand, Brant; 5. Central West; 6. Mississauga, Halton; 7. Toronto Central; 8. Central; 9.
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10 330 Central East; 10. South East; 11. Champlain; 12. North Simcoe, Muskoka; 13. North East; 14.
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12 331 North West. b) Toronto central LHIN. Location of each hospital is indicated in blue.

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15 332 Figure 2: Incidence of postoperative occurrences in general, vascular, colorectal, and all
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17 333 surgeries in ON-SQIN hospitals relative to all ACS NSQIP hospitals. The data represents
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19 334 outcomes of all 18 hospitals between January and December 2015. The performance status was
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21 335 assigned in SAR as follows; “exemplary” status was assigned when a hospital is a low statistical
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23 336 outlier or in the first decile, “needs improvement” status was assigned when a hospital is a high
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25 337 statistical outlier or in the tenth decile, and “as expected” status was assigned when a hospital is
26
27 338 neither an outlier nor in the first or the tenth decile.

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32 339 Figure 3: Self-reported rates of a) SSI (n=11) and b) UTI (n=3) between September 2015 and
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34 340 September 2016. Majority of hospitals elected to target SSI and UTI in the general surgery
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36 341 population. Error bars = mean \pm SEM.

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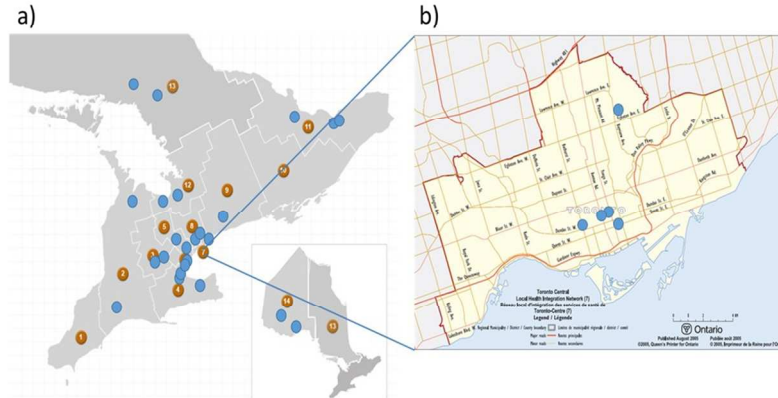


Figure 1: Location of ON-SQIN hospitals. a) Ontario Local Health Integration Networks (LHINs). 1. Erie St. Clair; 2. South West; 3. Waterloo, Wellington; 4. Hamilton, Niagara, Haldimand, Brant; 5. Central West; 6. Mississauga, Halton; 7. Toronto Central; 8. Central; 9. Central East; 10. South East; 11. Champlain; 12. North Simcoe, Muskoka; 13. North East; 14. North West. b) Toronto central LHIN. Location of each hospital is indicated in blue.

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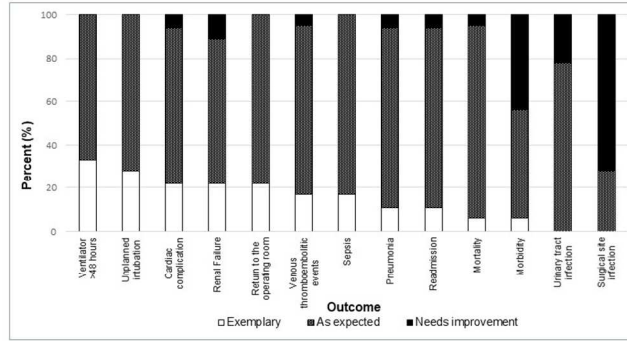


Figure 2: Incidence of postoperative occurrences in general, vascular, colorectal, and all surgeries in ON-SQIN hospitals relative to all ACS NSQIP hospitals. The data represents outcomes of all 18 hospitals between January and December 2015. The performance status was assigned in SAR as follows; “exemplary” status was assigned when a hospital is a low statistical outlier or in the first decile, “needs improvement” status was assigned when a hospital is a high statistical outlier or in the tenth decile, and “as expected” status was assigned when a hospital is neither an outlier nor in the first or the tenth decile.

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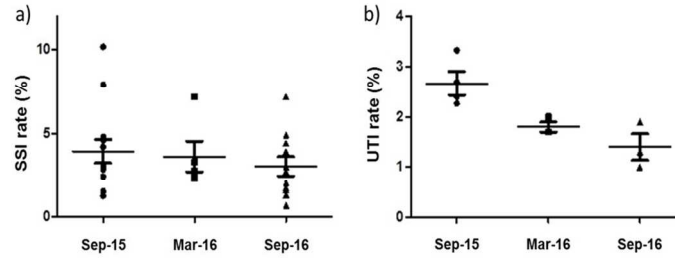


Figure 3: Self-reported rates of a) SSI (n=11) and b) UTI (n=3) between September 2015 and September 2016. Majority of hospitals elected to target SSI and UTI in the general surgery population. Error bars = mean \pm SEM.

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	ON-SQIN activity	Participating hospital	Surgical specialty
2015	Program implementation; Initial QI assessment	5 early-adopter hospitals (5 academic) 13 additional hospitals (2 academic, 6 community, 5 small/rural)	general, orthopedic, colorectal, gynecology, all surgery, vascular, urology, plastic cardiac, ENT, bariatric
2016	SQIP progress (April) and year-end (October) reports; Follow-up QI assessment	15 additional hospitals (7 academic, 7 community, 1 small/rural)	Additional specialty: pediatrics, oncology, neurosurgery

Table 1: Overview of the activities of the ON-SQIN and participating hospitals. QI: quality improvement, ENT: ear, nose, throat.

Category	Initial (n=18), n (%)	18-month follow-up (n=17), n (%)
Access to QI resources	12 (67)	17 (100)
Collaboration within surgical team	8 (44)	13 (76)
Active surgical QI initiative	13 (72)	17 (100)
Organizational engagement in surgical QI	14 (78)	17 (100)

Table 2: Self-assessment of each hospital's available capacity in quality improvement. QI: quality improvement.

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	Number offered	Average number of ON-SQIN participants	Average number of sites represented (n=18), n (%)
Calls			
Surgeon Champion call	16	9	9 (50)
SCR call	16	17	9 (50)
Joint Surgeon Champion and SCR call	3	10	9 (50)
Meetings			
Surgeon Champion in-person meeting	2	15	15 (83)
Events			
Webinar	13	15	10 (56)
Ontario Surgical Quality conference (open invitation)	2	58	16 (89)
NSQIP-ON Collaborative Workshop	1	39	18 (100)

Table 3: List of calls, meetings, and events organized by HQO between 2015 and 2016 to support the community of practice.

	Aug- Sept 2015	Oct 2015- Jan 2016	
Occurrences per 10,000 procedure	n	n (% change)	Relative risk (95% CI)
Wound Occurrences			
Superficial Incisional SSI	345.40	307.78 (-10.89)	0.89 (0.74-1.07)
Deep Incisional SSI	68.66	59.34 (-13.57)	0.86 (0.57-1.32)
Organ/Space SSI	120.68	123.72 (2.51)	1.03 (0.75-1.40)
Wound Disruption	66.58	69.40 (4.23)	1.04 (0.69-1.58)
Urinary Tract Occurrences			
Progressive Renal Insufficiency	14.57	28.16 (93.36)	1.93 (0.85-4.42)
Acute Renal Failure*	35.37	17.10 (-51.66)	0.48 (0.25-0.95)
Urinary Tract Infection*	228.88	176.02 (-23.09)	0.77 (0.61-0.97)

Table 4: Frequency and relative risk of postoperative wound and urinary tract occurrences. * p<0.05.