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Development of an Evidence Based Surgical Site Infection Bundle in Patients Undergoing Colorectal Surgery: A Quality Improvement Initiative

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Abstract

BACKGROUND: Surgical site infections (SSI) are among the leading healthcare-acquired infections that negatively impact patient outcomes and increase total cost of healthcare and the patient's length of stay. At a community hospital in West Virginia, trends in SSI rates and the standardized infection ratio (SIR) increased for patients undergoing colorectal surgery. The purpose of this quality improvement project was to identify and implement permanent evidence-based practice changes to reduce SSI rates in colon surgery patients.

METHODS: Baseline rates of SSI and the SIR for the facility was calculated from October 2021 to September 2022. Colon surgery SSI reduction measures were identified based on practice guidelines set forth by the American College of Surgeons (ACS) and the Association of periOperative Registered Nurses (AORN). Measures shown to have the greatest statistical benefit for improving SSI rates were included in a paper bundle checklist. Measures were then divided into three phases including: Pre-operative, intra-operative, and post-operative. A baseline assessment of SSI prevention measures was performed for operating room (OR) staff using best practice guidelines by AORN.

INTERVENTION: OR staff received education on new SSI reduction measures including the use of a separate closing table and sterile glove change during colon surgery cases. A post-intervention assessment was performed to evaluate learning. The Colon Surgery SSI Bundle checklist was distributed for each colon surgery patient for Registered Nurse (RN) completion during all perioperative phases. Education was performed regarding surgical dressings and documentation for all perioperative departments.

RESULTS: Implementation of an evidence-based SSI reduction bundle reduced the rate of colon surgery SSI from 0.06 to 0.03 and reduced the SIR from 1.5 to 0.77. Components of the SSI bundle were successfully integrated into all colon surgery cases utilizing the PDSA cycle. Post-intervention assessment showed a 22% improvement in knowledge scores for OR staff. Low bundle compliance was associated with missing SSI checklist documentation.

CONCLUSIONS: Development of a concise, evidence-based SSI reduction bundle is a reasonable method to improve rates of SSI in patients undergoing colon surgery. Specific SSI bundle education for OR staff participating in bundle use improves knowledge of SSI reduction methods and appropriate bundle measures. Completion of paper checklists to document bundle compliance was not conducive to nurse workflow and efforts should be made to integrate SSI bundles into the EMR. The PDSA cycle is a useful quality improvement method to improve patient care and outcomes.

Keywords: Colon Surgery, SSI Reduction, Bundle, Quality Improvement, PDSA cycle

Table of Contents

Introduction

Nature of the Problem

Surgical site infections (SSI) are broadly defined as those occurring in a site where a surgical procedure took place (CDC, 2019). This definition includes superficial, deep soft tissues, as well as infections involving the organ space (Berríos-Torres, 2016; Anderson et al., 2014). The Centers for Disease Control and Prevention (CDC) further defines SSIs as those occurring within a specified time period, using an operative procedure code, an infection in at least one site where surgery was performed, and the procedure must have taken place in an operating room (OR) (NHSN, 2023).

Surgical site infections are one of the leading types of health care-acquired infections and increase not only the patient's length of stay in the hospital but drastically increase healthcare costs (Seidelman et al., 2023). These infections can range from localized incision site drainage to life threatening systemic infections (Bashaw & Keister, 2019). Advanced age, nutritional status, hydration, obesity, immunosuppressant medication use, diabetes, smoking, and the presence of concurrent infection have been identified as risk factors for development of an SSI (Zabaglo & Sharman, 2022). SSIs increase the risk of complications such as delayed wound healing, abscess, bacteremia, and sepsis (Zabaglo & Sharman, 2022).

It is estimated that approximately 2-4% of patients undergoing surgical procedures will develop an SSI (PSNet, 2019). The National Healthcare Safety Network recently reported that SSIs cost nearly $3.3 billion annually making SSIs the costliest healthcare associated infection (2023). SSIs are also reported to extend a patient's hospital stay by 9.7 days and increase the cost of each admission by nearly $20,000 (NHSN, 2023). Furthermore, SSIs are associated with increased morbidity and a reported 2 to 11 times higher risk of mortality (NHSN, 2023). In fact, approximately 11% ICU deaths were associated with an SSI (Zabaglo & Sharman, 2022). The majority of SSIs are preventable (IHI, 2023).

While the timeframe to classify an SSI differs between surgical cases, colorectal SSI are reported for 30 days after surgery (NHSN, 2023). This information is then reported to the Centers for Medicare & Medicaid Services (CMS) as a part of the value-based Hospital-Acquired Condition Reduction Program for payment adjustment (CMS.gov, 2022). Therefore, it is prudent that leaders pay particular attention to the rates of SSI occurring at healthcare facilities.

At a local community hospital, an increase in the rate of colorectal SSI was noted during the year 2022. The 12-month rate of colorectal SSI was noted to be 0.06 with a standardized infection ratio (SIR) of 1.5 from October 2021 to September 2022. Values greater than 1 indicate SSI rates higher than the expected rate based on national data (CDC, 2023). No trends toward a specific surgeon or colon site were noted on SSI case analysis. There was, however, a significant amount of staff turnover noted during 2022. Seven total surgical technologists and five registered nurses were replaced by new or traveling staff members. The increase in SSI in colorectal surgery cases as well as the influx of new staff members to the OR team provided two areas for further assessment and quality improvement to improve patient outcomes and reduce SSI rates.

Available Knowledge

In 2005, the results from the National Surgical Infection Prevention Collaborative was published as a result of the CMS implemented National Surgical Infection Prevention Project aimed at quality improvement (Dellinger et al., 2005). Although evidence existed that particular measures could reduce surgical site infections, these measures were not generally used (Dellinger et al., 2005). Fifty-six hospitals implemented five practices over a 12 month period aimed at reducing SSIs and reported a 27% reduction in surgical infection rates (Dellinger et al., 2005). The five improvements focused on antibiotic selection and timing, normothermia, hair removal practices, oxygenation, and glucose control (Dellinger et al., 2005).

Based on the results of the SSI prevention project, the Surgical Care Improvement Project (SCIP) was developed in 2006 which demonstrated an 18% reduction in SSI risk (Rosenberger et al., 2011; Zywot et al., 2017). Thus began the CMS created Specifications Manual that provides standard quality measures now known as the Hospital Inpatient Quality Reporting (IQR) Program as a part of Medicare reimbursement (Rosenberger et al., 2011; CMS.gov, n.d.).

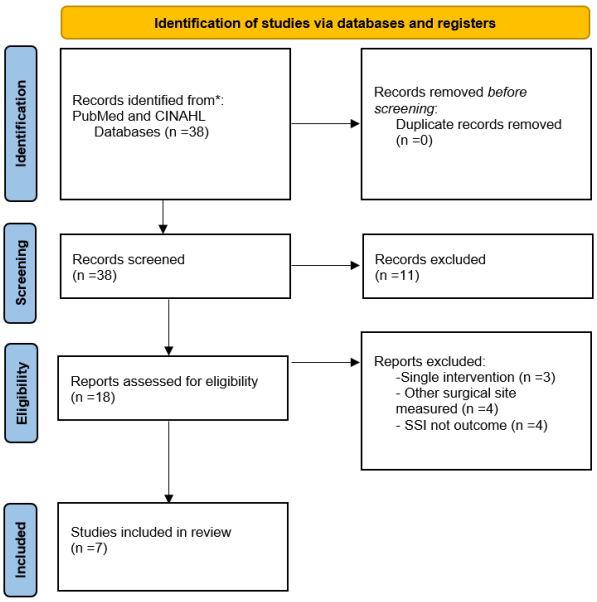
To ascertain the background of SSI bundles, databases including PubMed and CINAHL were searched for evidence-based practice protocols that incorporated "colorectal surgery" or "colon surgery, "surgical site infection" "surgical wound infection" or "infection reduction", and "bundle" within the title or abstract. Search results included articles available in English. In 2007, a study conducted in the Netherlands identified that SSIs were one of ten highly preventable hospital complications (Koek et al., 2017). Subsequently, in 2008, the Dutch Hospital Safety Program worked to support hospitals by establishing care bundles (Koek et al., 2017). The term "bundle" included a small number of evidence based interventions that would presumably reduce the rate of SSI, have high compliance rates, and improve patient outcomes (Koek et al., 2017). Similar to the United States (US) study, the four standard interventions included hand hygiene, hair removal, normothermia, and preoperative antibiotic prophylaxis (Koek et al., 2017). Rates of SSI significantly decreased with compliance of each intervention and was greatest in those who complied with all four interventions included in the bundle (Koek et al., 2017). Authors reported a risk reduction of 14% to 37% (Koek et al., 2017).

Focus was then turned to surgical specialty outcomes and measures specific to colorectal surgery were studied in greater detail. The American College of Surgeons (ACS) and the Surgical Infection Society (SIS) provided updated SSI guidelines in 2016 detailing specific interventions for both pre- and intra-hospital perioperative periods (Ban et al., 2017). These guidelines included practices from preoperative bathing practices to wound closing trays and postoperative glucose control (Ban et al., 2017).

The same search criteria were again used and limited to studies published within the last 5 years. Thirty-five results were initially obtained PubMed. An additional 3 studies were obtained through CINAHL. Pediatric studies were removed as pediatric surgeries are not performed at the studied facility. Based on title and abstract, opinion and discussion pieces were removed from search results as were studies that included surgery types other than colorectal. Studies were removed from results if they explicitly studied only one intervention rather than a care bundle. Additional studies were removed after reading article content if SSI bundle outcomes were not the primary goal. Seven articles were retained.

Figure 1

Prisma Flow Diagram



In 2020, Pop-Vicas et al. sought to consolidate the ACS and SIS previously published clinical practice guidelines that highlighted 20 interventions aimed at reducing SSIs (2020). This meta-analysis found that bundles incorporating high-quality evidence-based practices such as preoperative antibiotics, implementing glycemic control, and using alcohol-based antiseptic scrub on the skin demonstrated the greatest SSI risk reduction (2020). Forty randomized controlled trials as well as prospective and

retrospective single and multicenter studies were included for analysis (Pop-Vicas et al., 2020). Mechanical bowel preparation with oral antibiotics and preoperative chlorhexidine showers showed risk reduction by 32% and 51% respectively for the development of deep organ space SSI (Pop-Vicas et al., 2020). Superficial SSI risks were reduced by nearly half when incorporating a separate wound closure tray, glove change prior to wound closure, and delaying wound dressing changes until 48 hours post op (Pop-Vicas et al., 2020). The findings were statistically significant (Pop-Vicas et al., 2020).

Study results coincide with an earlier meta-analysis by Zywot et al. who found that bundles based on the principles set forth by the ACS and SIS did show a significant risk reduction particularly when incorporating mechanical bowel prep with oral antibiotics, utilizing a sterile closing tray, and glove change prior to closure (Zywot et al., 2017). This study also concluded that perioperative personnel should strive to standardize and reduce variation during the perioperative period for patients undergoing colorectal surgeries (Zywot et al., 2017).

It should be noted that although postoperative glucose management is standard in most articles published in meta-analyses and practice guidelines set forth by ACS, goals for postoperative glycemic control differ among studies and diabetes experts (American Diabetes Association, 2020; Ban et al., 2017; Pop-Vicas et al., 2020; Thompson et al., 2016; Zywot et al., 2017). The American Diabetes Association (ADA) recommends maintaining glucose levels between 80- 180mg/dL and advises against tighter glucose control as it increases hypoglycemia risk and may lead to adverse outcomes (American Diabetes Association, 2020).

In a retrospective cohort study by Guerrero et al., implementation of similar bundle interventions resulted in an 85% reduction in SSI rates (2021). This bundle incorporated combination oral antibiotics the day before surgery and intravenous (IV) antibiotics within 60 minutes of incision (Guerrero et al., 2021). Temperature management was obtained with the use of a Bair Hugger™ warming device (Guerrero et al., 2021). A separate closing tray was used prior to fascial closure with a required gown and

glove change (Guerrero et al., 2021). This protocol followed ADA recommendations of postoperative glucose management less than 180mg/dL for 48 hours (American Diabetes Association, 2020; Guerrero et al., 2021). Finally, wound dressings were kept in place for 48 hours (Guerrero et al., 2021). The outcomes of this bundle reached statistical significance and drastically reduce the rate of SSI in colorectal surgery patients at this facility (Guerrero et al., 2021). This care bundle closely followed the recommendations of Pop-Vicas et al. in incorporating interventions shown to have the greatest benefit to SSI rates and patient outcomes (Pop-Vicas et al., 2020).

The improvements in SSIs in patients undergoing colorectal surgery have been redemonstrated internationally. In Ireland, researchers implemented a care bundle for colorectal surgery patients incorporating several of the above named interventions including blood glucose control, temperature management, antimicrobial prophylaxis within 1 hour of incision, separate surgical instrument closing trays, and preoperative mechanical bowel preparation combined with oral antibiotics (Horgan et al., 2023). As expected, authors noted more than a 50% decrease in the rate of SSI among these patients which was statistically significant (Horgan et al., 2023). This study was unique in its incorporation of the discussion of multidisciplinary groups and special staff education (Horgan et al., 2023). An introductory educational PowerPoint was provided for providers and staff in an effort to reduce variation and standardize practice as this was previously noted to be problematic (Horgan et al., 2023). Ongoing education of the SSI initiative was also provided through conferences, meetings, and flyers available at the institution (Horgan et al., 2023). Authors noted the importance of engagement across the facility that included providers, staff, educational leaders, and hospital leadership as a whole (Horgan et al., 2023).

In Switzerland, nine previously described interventions were included as part of a care bundle for SSI reduction for more than 1,500 patients (Jurt et al., 2021). Unfortunately, a significant reduction in SSI was not reported in this study, however, it was noted that compliance with evidence based infection reduction measures was problematic with an overall compliance rate of 77% with perioperative temperature management compliance rates of 55% (Jurt et al., 2021). Ban et al. previously reported that

when compliance is high SSI bundles make a significant difference in outcomes (2017). Zywot et al. again demonstrated this finding in a meta-analysis and systematic review where high compliance with 3-6 elements of an SSI bundle significantly reduced SSI risk and reduced SSI associated costs as expected (Zywot et al., 2017). Pop-Vicas et al. also reported that while bundles with 11 or more interventions improved SSI rates and patient outcomes, high compliance was extremely difficult to achieve which negated the positive effects a bundle could have (Pop-Vicas et al., 2020).

These findings highlight the need to include evidence-based practices shown to provide the greatest SSI risk reduction while limiting unfounded interventions to achieve optimum bundle adherence. Overall, implementation of an evidence-based colorectal surgery bundle is a reasonable method to reduce variability in SSI prevention measures, reduce SSI, and improve patient outcomes.

Rationale

Despite a significant number of surgical guidelines and research studies having shown clear improvement in SSI rates with the use of bundles, there is not a standard bundle for facility use regardless of surgical site. Rather, guidance for recommended elements of a care bundle is provided by organizations such as the Institute for Healthcare Improvement (IHI), ACS, SIS, and the Association of periOperative Registered Nurses (AORN). A colorectal SSI patient care bundle was developed utilizing a multidisciplinary team based on the best available evidence. Tracking for this bundle was initiated at the preoperative area and continued through discharge after surgery. Therefore, bundle components included preoperative, intraoperative, and postoperative phases. Completion of elements were initially tracked by perioperative nursing staff and further audited by this author using the electronic medical record (EMR) if documentation was not complete. Given the proportion of new staff members in the OR, a survey was administered to assess baseline knowledge of SSI prevention measures in colorectal surgery to highlight where knowledge deficits exist. An education session was provided by the OR team leaders followed by a

post intervention survey to measure change. The education provided to staff was intended to reduce practice variability and improve care outcomes.

The intervention utilized the Plan-Do-Study-Act (PDSA) method (Figure 2) introduced by the Institute for Healthcare Improvement (IHI, n.d.). This method is particularly useful for evaluating and adjusting changes in processes (IHI, n.d.). Monthly reports are generated internally by the Infection Prevention Department for SSIs and categorized by surgical site including SSI rates for colorectal surgery. Using this ongoing data, frequent process evaluations were completed and adjusted for results in the next month's tracking cycle. The monthly reported data served as a baseline from which changes were tracked and measured. The PDSA method was combined with Lewin's Change Theory and recognized both the driving and resisting forces of change (Practical Psychology, 2023). With the understanding that driving forces would need to be stronger than resisting forces in order to promote the desired change, leadership, managers, and lead perioperative staff were ramped up through education on the current problem (Practical Psychology, 2023). As reflected in Figure 3, change was then implemented on a specified start date and freezing the new process to become permanent continues to be the primary focus at the facility (Practical Psychology, 2023).

Figure 2

PDSA Method

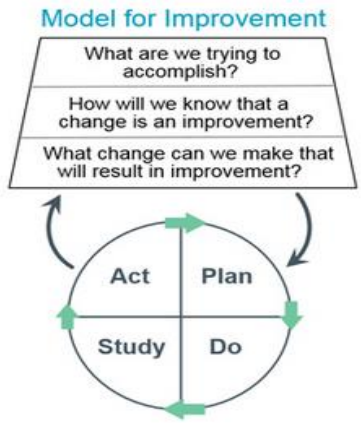
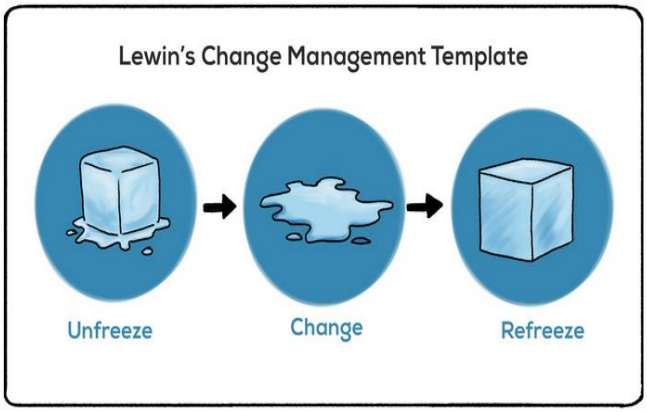


Figure 3

Lewin's Change Theory



Each SSI is subject to a root cause analysis (RCA) where perioperative procedures are reviewed in detail with an interdisciplinary team that includes the surgeon. This provided opportunities to identify where process breakdowns may have occurred in real time and allowed for rapid reeducation and correction. The AORN supports the use of bundles while recognizing that no specific bundle has been identified to reduce SSI (AORN, 2023b). Rather, the AORN strongly encourages organizations to develop a bundle that meets patient care needs with the understanding that the positive effect of bundles is noted by the cumulative effect of the interventions implemented (AORN, 2023b).

Bundle implementation by quality improvement (QI) committees with the support of administration and those working at the bedside have shown to improve compliance (Zywot et al., 2017). As predicted based on Rogers' Diffusion of Innovation Theory, process improvements did not take place at a single point in time, rather changes were started with the "innovators" and "early adopters" who were interested in new or novel ideas and those in leadership roles (LaMorte, 2022). This gradually permeated to those with more conservative mindsets such as those who wished to see how others completed the task and its outcome (LaMorte, 2022). These staff members would otherwise be known as the "early and late majority" according to Roger's Diffusion of Innovation Theory (LaMorte, 2022). Staff unwilling to

complete the requested tasks and required repeated education on process changes are reflected in perioperative areas with lower bundle compliance rates. According to Roger's Diffusion of Innovation Theory, these staff represent the "laggards" who are very conservative and resistant to change (LaMorte, 2022). Additional time and leadership support was directed to these staff members. With ongoing support from the providers, OR team, hospital administration, and QI teams combined with the PDSA method of continuous process improvement, it was expected that SSI rates in colorectal surgery would decrease over the study timeframe.

Global Aim

The global aim of this quality improvement project was to assess the SSI rate of colorectal surgery cases after implementation of an SSI bundle compared to that of the previous year by incorporating the best available evidence on best practices.

Specific Aim

The specific aim of this quality improvement project was to assess the sterile technique and procedural knowledge of the participating OR staff and provide adequate background and education to successfully implement and retain the interventions presented to improve knowledge over the study timeframe. The bundle was intended to include all necessary elements while eliminating burdensome tasks or interventions not shown to have statistical benefit to achieve highest compliance. It was expected that utilizing an evidence based perioperative SSI bundle dedicated to colorectal cases, combined with education of OR staff, the SIR and rates of SSI in colorectal cases would decrease and post education knowledge would improve above the baseline assessment.

Methods

Context

The SSI bundle was implemented at a single 164-bed acute care hospital located in West Virginia (WV). This community hospital exists as part of a larger health system serving areas of WV, Pennsylvania, and surrounding regions to provide inpatient care, emergency and surgical services, primary care, birth center, and oncology care. The facility is also affiliated with a family medicine residency program and is partnered with a local junior college to provide nursing education.

Patients presenting for inpatient surgical procedures arrive through registration and are moved to the preoperative area where an intake assessment is completed, preoperative medications are given if indicated, and serves as an area to ensure that all preoperative measures have been carried out prior to transfer to the OR and ultimately to the surgical post op floor. Orders to be completed by the perioperative staff are included as electronic order sets that are provided by the surgeon prior to admission. Perioperative order sets are surgeon specific rather than procedure specific and provide an opportunity for variation in perioperative practices.

An SSI bundle was created for use in the main perioperative areas separate from the orthopedic and endoscopy suites positioned in other units of the hospital. For the purposes of this project, the bundle was presented as a paper checklist that followed the patient through each department as time constraints did not allow the checklist to be incorporated into electronic order format at the outset of this project. This bundle was for dedicated use in patients undergoing colorectal surgery on an elective basis and excluded patients with a contaminated surgical abdomen such as those with perforated diverticula. Infections present at the time of surgery (PATOS) are excluded from the standard SSI reporting protocols and therefore were not reflected on SSI dashboard reporting (NHSN, 2023). Given that abdominal, laparoscopic-, and robotic-assisted colorectal surgeries are included in SSI reporting, these surgical types were included for outcome analysis. However, it should be noted that the reported increase in SSI trends in colorectal cases at the institution had previously attributed to those using the abdominal approach which may be necessary due to prior abdominal surgeries or comorbidities (Lewis et al., 2023).

Best practice for SSI reduction in colorectal surgery cases includes several factors. Preoperative bathing with chlorhexidine wash at least the night before surgery is recommended to decrease skin pathogens prior to surgical procedures followed by an alcohol based skin prep such as ChloraPrep™ prior to skin incision (Ban et al., 2017; Seidelman et al., 2023). Hair clipping should be performed rather than shaving (AORN, 2023b). Hypothermia, defined as a core body temperature less than 36ºC, should be avoided and warming methods should be implemented per hospital policy as needed (AORN, 2023a; Ban et al., 2017; Seidelman et al., 2023). Oral antibiotics combined with mechanical bowel preparation are the standard recommendations for elective colorectal surgeries (Ban et al., 2017). Preoperative antibiotics should be administered within 1 hour of surgical incision (Seidelman et al., 2023). Sterile gloves should be changed prior to fascial closure and a new sterile closing tray should be available (Ban et al., 2017; Pop-Vicas et al., 2020). Surgical wound dressings should remain in place for at least 48 hours prior to removal (Pop-Vicas et al., 2020). The target range for blood glucose should be between 80-180mg/dL as recommended by the ADA to prevent unintentional hypoglycemia (American Diabetes Association, 2020).

Cost Benefit Analysis

Based on available data, each admission for SSI increases care costs by $20,000 (NHSN, 2023). In a brief published by the AHRQ, the inpatient cost of a colectomy averaged $25,900 per stay (McDermott & Liang, 2021). Therefore, each colorectal SSI would cost nearly $49,500 and increase the cost of a colorectal surgery by 67%. Furthermore, hospitals are subject to payment reduction as surgical site infections are monitored as part of value-based programs through Medicare (CMS.gov, 2022). The interventions utilized existing resources present within the hospital combined to create a streamlined bundle for surgeons and staff to follow without incurring additional costs or requiring the purchase of new equipment. This approach redefines how and when current resources are used and provides a cost-effective method to reduce SSI.

Interventions

Pre- and Post- Intervention SSI Prevention Assessment

A competency test evaluating knowledge of perioperative colorectal surgery best practices has not been published. Therefore, a pre-intervention assessment was developed in collaboration with the OR director and team leaders (Appendix A). This assessment included questions regarding general sterile technique principles as defined by the Association of periOperative Registered Nurses (AORN) and more specific skills related to colorectal surgical procedures as directed by ACS guidelines. Items included: best practices for hair removal, normothermia maintenance, antibiotic timing, surgical skin prep technique, glove change practices, and placement of closing instrument table. A short demographics section was included for each assessment to categorize respondents by position, education, certification status, age, and length of experience. The pre-intervention assessment labeled "Colorectal Surgery Quiz" was administered prior to the implementation of the SSI prevention bundle. The assessment was voluntary and anonymous. Staff then received education on the correct answers to the assessment and instruction on the components and utilization of a new sterile closing tray. Education was provided during a weekly morning OR staff meeting.

A post-intervention assessment utilizing the same "Colorectal Surgery Quiz" was given to OR staff after the completion of the quality improvement project timeframe. Staff present for the OR staff meeting were asked to complete this survey regardless of whether they had completed the initial survey. Again, post-intervention assessments were voluntary and anonymous. Changes in demographic data from the pre-intervention to post-intervention assessments were recorded.

Colon Surgery SSI Bundle

Being mindful of interventions showing the greatest statistical benefit to SSI and accounting for the existing processes of the surgeons, nurses, and OR staff, the following best practice interventions were combined to create a comprehensive colorectal SSI bundle. A "Colon Surgery SSI Prevention Checklist"

was previously available for inpatients, however, compliance with documentation was historically low in the intraoperative and postoperative areas. The previous checklist also included some redundant elements making compliance problematic. This checklist was revised as a "Colon Surgery SSI Bundle" that aimed to abbreviate and streamline processes (Appendix A). The intervention bundle focused on measuring compliance in the following: (1) combined oral and mechanical bowel preparation, (2) preoperative bathing with chlorhexidine, (3) appropriate preoperative antibiotic prophylaxis within 1 hour of incision, (4) postoperative glucose control <180mg/dl for 48 hours, (5) perioperative normothermia with a temperature >36ºC, (6) patient skin preparation with an alcohol-based antiseptic scrub, (7) glove change prior to surgical site closure, (8) use of a separate sterile site closure tray, and (9) wound dressing change no sooner than post operative day (POD) 2 or 48 hours (AORN, 2023b, 2023a; Berríos-Torres et al., 2017; Pop-Vicas et al., 2020; WHO, 2018).

The use of neomycin plus metronidazole oral antibiotic prophylaxis in combination with mechanical bowel preparation per surgeon's preference in addition to current recommendations for intravenous preoperative antibiotic prophylaxis continued as the standard of care (Bednarski, 2023). Patients were given a chlorhexidine solution to bathe in the night before surgery with instructions to sleep on freshly laundered sheets and avoid co-sleeping with pets (Berríos-Torres et al., 2017). Guidelines differ regarding best practice for glucose management in the perioperative period. For this reason, a conservative approach was chosen for maintaining glucose <180mg/dl with glucose monitoring every 6 hours until the patient is able to eat and then before meals and at bedtime thereafter (American Diabetes Association, 2020; Ban et al., 2017). Surgeons were asked to include monitoring as part of their post operative EMR order set. Sliding scale insulin was provided based on existing hospital protocols for glucose outside of the target range.

The CDC recommends maintaining normothermia in the perioperative period but does not provide specific recommendations for execution of this measure (AORN, 2023a; Berríos-Torres et al., 2017). Therefore, existing hospital protocols were used for preoperative warming with the Bair Hugger™

warming system with perioperative temperature monitoring. Surgical skin antisepsis was completed with an alcohol based antiseptic scrub such as ChloraPrep™ unless contraindicated by allergy (AORN, 2023b; Berríos-Torres et al., 2017; Graves, 2022). All scrubbed personnel, including surgical technologists, were instructed to change their surgical gloves prior to the closure of abdominal fascia and a separate sterile closing table was made available (Pop-Vicas et al., 2020; Zywot et al., 2017). These interventions have been shown to further statistically reduce SSI rates (Pop-Vicas et al., 2020; Zywot et al., 2017). Finally, surgeons and staff were instructed to leave surgical dressings in place at least until POD 2 as some evidence shows correlation with this intervention and lower SSI rates (Pop-Vicas et al., 2020). Dressings currently available at the institution allow for dressings to remain in place for up to seven days.

Education was provided to all nursing units that could potentially provide care during the post operative period for colorectal cases. These units included ICU, med-surg, step-down, and oncology. Nursing directors, nurse managers, unit nurses, and support staff were instructed on bundle checklist workflow and use as well as expectations for surgical wound and dressing documentation.

Pop-Vicas et al. (2020) noted that although bundles with at least 11 interventions had a more significant decrease in SSI rates, adherence was a major concern. There were nine interventions which were distributed between pre-, intra-, and postoperative phases to limit tasks on any one department or individual. These interventions required communication and a cooperative team approach.

Specifics of the Team

Surgeons and Advanced Practice Providers (APPs) were responsible for ensuring appropriate medications were ordered and perioperative practices were followed. Providers maintained their responsibility for providing electronic order sets for each surgical patient which included surgeon's preference for preoperative antibiotic. Ambulatory clinic managers were tasked with educating preoperative personnel on distribution of CHG scrub for each colorectal case at the time of their office visit. Perioperative nurses and surgical technologists were asked to implement bundle changes and check

off and initial elements of the bundle as they were completed. Education was provided for OR staff by the OR and perioperative nursing directors, the OR nursing educator, and lead perioperative nursing team. The sterile processing department was included for instruments required in creating a separate sterile closing tray. The wound care department participated in recommendations of sterile dressing best practices and individualizing them to patient needs accounting for allergies and comorbidities.

The Quality Improvement committee was responsible for oversight of the SSI dashboard on an ongoing basis. Infection Prevention committee provided continual oversight of SSI rates throughout the study timeframe. Medical Executive Committee provided approval of the practice changes implemented. Final approval of interventions and executive oversight of the quality improvement project was provided by the Chief Administrative Officer, a Doctor of Nursing Practice (DNP) prepared nurse. Continuous dialog between perioperative areas and nursing managers was encouraged and meetings were held routinely throughout the intervention period to make procedural changes according to the PDSA cycle to improve patient care outcomes.

Study of the Interventions

To determine if the new SSI bundle was effective at reducing SSI rates, it was necessary to measure bundle compliance with each colorectal case while simultaneously measuring the monthly SSI rate for colorectal cases. Each perioperative department was responsible for tracking a portion of the recommended tasks defined in the SSI bundle that were formatted as a checklist. Although no one bundle or checklist is recommended by organizations, this format allowed for implementation of multiple interventions so that its cumulative effects could be appreciated (AORN, 2023b). Therefore, the bundle was presented as an organization guided paper checklist of best practices in a concise format to enhance compliance. Time constraints of the project did not allow for the entire bundle to be presented in electronic format for perioperative charting. The checklist was labeled “Colon Surgery SSI Bundle” (Appendix B). The checklist was completed by the Registered Nurse (RN) indicating a “yes” or “no” of

each task and the recorder's initials (Appendix B). The checklist accompanied the patient's physical chart to each department and followed them from admission in the preoperative area to discharge from the inpatient surgical floor. The checklist was collected at discharge and distributed back to the unit managers for tracking. Occasionally, the checklist mistakenly was sent to the medical records department and was then distributed back to this author. Deviations from these standards were documented in the "comment" section of the checklist. It is assumed that procedural changes in perioperative practices correlate with changes seen in the rates of SSI.

Voluntary and anonymous pre- and post-intervention assessments were administered to RNs, surgical technologists, and clinical associates who participated in colorectal procedure types and excluded staff whose exclusive role was in cardiac or orthopedic operating rooms. These tests were administered in paper format and now serves as part of OR competencies since its introduction across the organization. Post-intervention assessments were administered after receiving education on the assessed topics, a full orientation on the new SSI bundle requirements, and the quality improvement intervention timeline was completed. It was expected that the number of correct responses to the assessment would increase for each staff member participating in the educational sessions and SSI bundle orientation. Continuing education (CE) was not offered for this orientation and training due to time constraints but should be evaluated for appropriateness in the future.

Measures

Pre- and post-intervention assessments were collected by the OR director and OR educator for scoring by this author. The number of correct responses out of the total number of questions was calculated and recorded for each staff member. Assessments included four demographic questions regarding age, training, certification status, and OR experience. Results were compared to post-education assessments to ensure that each participating staff member had an adequate foundation for permanent implementation of an SSI bundle.

Measurements of colorectal SSI rate used the operational definition set forth by the National Healthcare Safety Network (NHSN) defined as the number of SSI occurring within 30 days of a colorectal surgery divided by the total number of colorectal surgeries performed and expressed as a rate (NHSN, 2023). This rate was used for monitoring trends of colorectal SSI from October 2021 to September 2022 compared to the SSI rate from October 2022 to September 2023. The intervention ran for ten weeks beginning July 26, 2023 through September 29, 2023. This timeframe was determined based on project time constraints and time required to develop bundle elements including the sterile closing tray. Completion of documentation was measured for each component of the paper checklist and divided by the total number of colorectal surgeries performed and expressed as a rate. SIR was determined by the number of actual colon surgery SSI divided by the expected number of colon surgery SSI which is defined by the NHSN (CDC, 2023). Hospitals strive to obtain an SIR of less than 1 indicating lower than the expected number of SSI.

For the purposes of this project, the term "component" reflects each individual intervention included within the SSI bundle. This measure was assessed to determine adherence to paper documentation requirements and labeled "Checklist Completion". Bundle compliance was assessed for each component and marked as "no" if the component was not completed or lacked appropriate documentation. For checklists that were not entirely complete, results were documented as such for "Checklist Completion" and bundle compliance was determined based on manual chart audits performed by this author using the EMR. This measure was labeled "Bundle Compliance".

Analysis

Quantitative analysis of the number of SSI was performed to calculate a new rate of SSI at the end of the intervention period. This rate was compared to the baseline SIR of 1.5 and SSI rate of 0.06. The percent change was calculated from baseline results. A paired t-test was used to determine statistical significance based on pre- and post-intervention data in this within-subjects design where all patients

participated in the intervention. Quantitative analysis of bundle compliance was measured for each bundle component and expressed as a percentage. Quantitative analysis was performed on pre- and post-assessments for OR staff education calculating the change from baseline knowledge to post education knowledge. Qualitative analysis was performed on the baseline knowledge assessment performed to better understand where knowledge deficits exist and to adjust education accordingly. Qualitative analysis was also performed on the paper SSI checklist noting any themes in comments made by documenting staff. It should be noted that although outcomes are reported monthly, the intervention period was a relatively short period of time and may be underpowered to reach statistical significance.

Ethical Considerations

After discussion with hospital administrators, it was decided that this SSI bundle would not need Institutional Review Board (IRB) approval. This was determined with the knowledge that these interventions are evidence based rather than experimental and are currently used by other institutions across the US based on ACS and AORN guidelines. Any financial conflicts of interest between participating surgeons, APPs, or administration and the use of any recommended products were identified and disclosed per hospital credentialing policies as a condition of employment.

Results

Prior to the implementation of the Colon Surgery SSI Bundle, unit managers and directors were instructed on checklist use and workflow which was disseminated to their respective units (Figure 4). Outpatient surgical practices were instructed to distribute CHG bath for each colorectal surgery patient. OR staff members were asked to take the Colorectal Surgery Quiz as a pre-intervention assessment prior to the Colorectal Surgery SSI Bundle implementation. The intervention formally started on July 26, 2023 where staff was educated on appropriate use of the sterile closing tray and timing for glove change during a colorectal surgery case. Education on new practices was provided in addition to providing the correct responses to all questions included in the pre-intervention assessment (Appendix A).

Perioperative nurses were asked to complete the bundle checklist with initials, date and time, and any additional comments that may be helpful during audit (Appendix B). Preoperative nurses completed the preoperative phase portion of the checklist. This included one component that addressed the administration of mechanical bowel prep and oral antibiotic prior to the procedure. This component could not be tracked in the EMR based on chart audits performed in the first two weeks of the quality improvement project. The PDSA cycle was utilized to assess the current state of the problem. IT was contacted to place this component into the required preoperative procedure checklist in the EMR as part of the pre-procedure workup performed by preoperative nursing staff. As per the PDSA cycle, the upgrade was implemented on September 6, 2023. Staff was educated on its use by the preoperative nurse manager, sign off was obtained by each preoperative nurse receiving the information, and this process was implemented for permanent use.

The Colorectal SSI Bundle checklist was then moved intraoperatively for the circulating nurse to complete. A sterile closing tray including all surgeon-requested closing instruments was sent to the OR for cases scheduled for colorectal surgery. All scrubbed personnel were prompted to change their sterile glove prior to fascial closure by the Surgical Tech.

After three weeks, review of completed checklists showed that none were fully completed with all the required components. Two components including glove change and use of a sterile closing tray could not be verified in the EMR as this was not part of the required intraoperative documentation. A second request for IT to add this component to required intraoperative documentation was launched. Although this change was ultimately made after the quality improvement project completion, it was not available for tracking within the project timeframe. Intraoperative nurses were re-educated on intraoperative tracking using the SSI checklist, but the overall process remained unchanged until after QI project completion. SSI checklists were attached to the front of the patient's chart for transport to the postoperative nursing units.

Postoperative nurses were required to complete the postoperative portion of the SSI checklist. Tracking of surgical dressing placement time was a required component during the postoperative phase. Again, review of data two weeks into the study timeframe revealed missing postoperative documentation on most patients and missing checklists that were not returned to the department managers. Further investigation showed that nursing staff documented surgical dressings in different areas of the EMR depending on their preceptor and training history. Formal education regarding correct documentation was provided by the IT educators and dispersed to unit-based educators to disseminate the correct process to all nursing staff. During this re-education period, it was found that wound documentation performed by nurses in the recovery room was not carrying forward to postoperative nursing care areas. Nurses on the postoperative floors had to duplicate incision wound charting thereby increasing the risk of documentation error. IT was alerted and an EMR upgrade was implemented on October 16, 2023 that allowed recovery room nurses to accurately document the surgical wound and for the same document to be carried forward to the surgical floors.

Education was also provided to the nursing unit managers regarding checklist workflow as some checklists were sent to the Medical Records Department. Nursing staff was re-educated on returning the checklists to nursing unit managers for collection. This author also discussed SSI checklist use with the Medical Records Department to ensure that checklists received unintentionally were sent back to this author for data collection.

Figure 4

Colorectal SSI Bundle Checklist Workflow

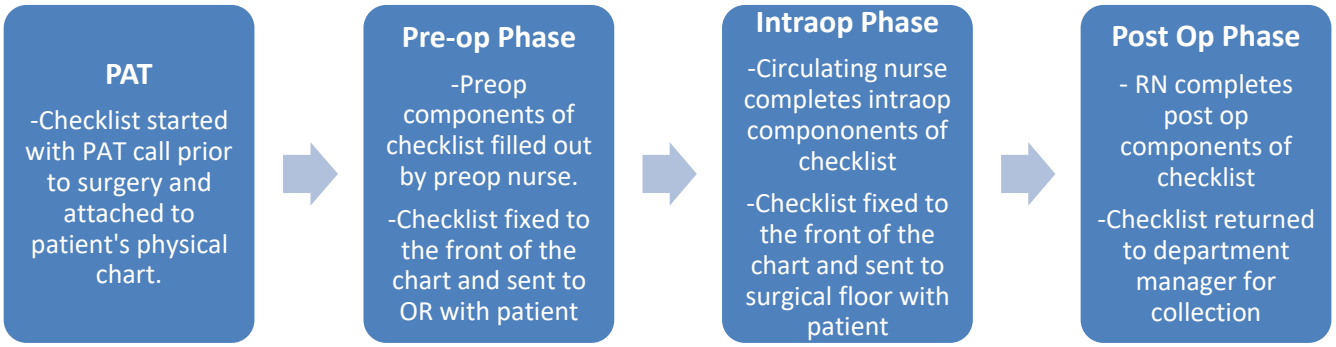
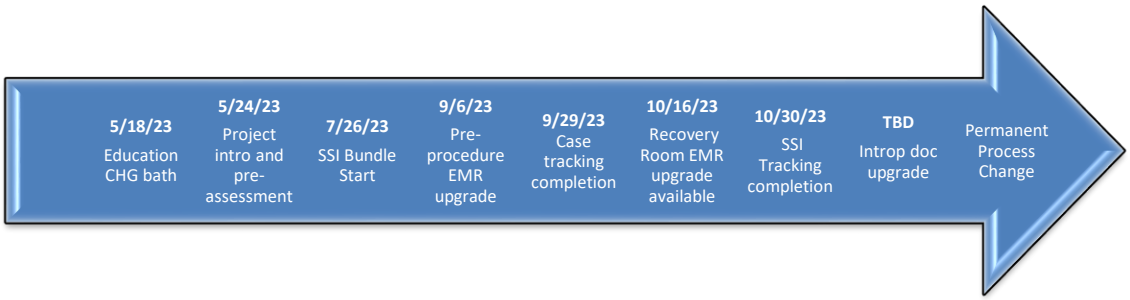


Figure 5

Timeline of Colorectal SSI Bundle Changes



Process Measures and Outcomes

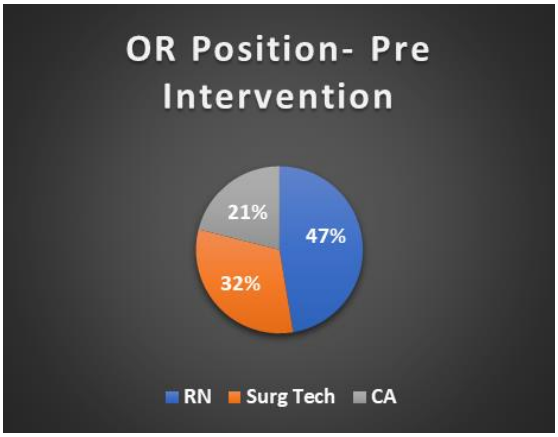
A total of 19 staff members completed the Colorectal Surgery Quiz prior to bundle implementation to assess sterile technique and SSI prevention knowledge. The same assessment was repeated at the completion of the intervention to evaluate learning and identify areas for improvement. Pre-intervention respondents included: 9 RNs, 6 surgical technologists (Surg Techs), and 4 clinical associates (CAs). In post-intervention analysis, the demographics of the OR staff had changed slightly. In this group there were 10 responding RNs, 8 Surg Techs, and 1 CA for a total of 19 post-intervention respondents. As shown in Figure 6, RNs represented 47% of the total pre-intervention responders

followed by Surg Techs and CAs at 32% and 21%, respectively. Respondents included 53% RNs, 42% Surg Techs, and 5% CAs in post-intervention analysis (Figure 6).

Of the responding pre-intervention RNs, 11% reported having a Certified Perioperative Nurse (CNOR) certification while 100% of Surg Techs reported Certified Surgical Technologist (CST) certification status (Figure 7). National certification is not applicable to CAs. In post intervention analysis, 20% of RNs reported CNOR certification and 75% of Surg Techs reported CST certification. Figure 8 shows the age distribution by position held during the pre- and post-intervention quizzes. Pre-intervention findings showed 78% of RNs were 40 years old or greater and the majority had 10 or more years of OR experience (Figure 9). Post-intervention analysis showed 100% of RNs were ages 40 and above with the majority having greater than 10 years OR experience (Figure 9). Of note, there was turnover in some OR staff members from pre- to post-intervention assessments. Furthermore, due to the anonymous nature of this survey, post-intervention respondents may have changed from the initial survey.

Figure 6

OR Position



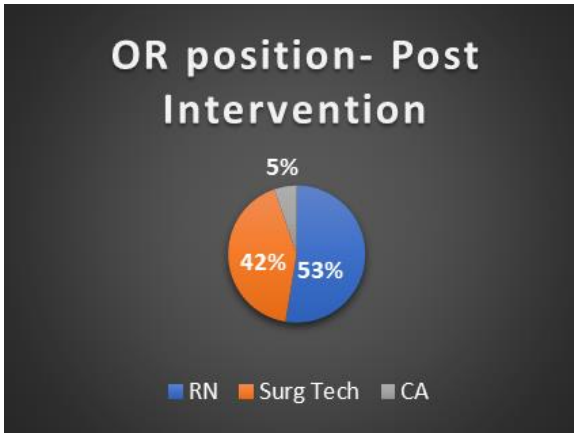


Figure 7

Certification Status

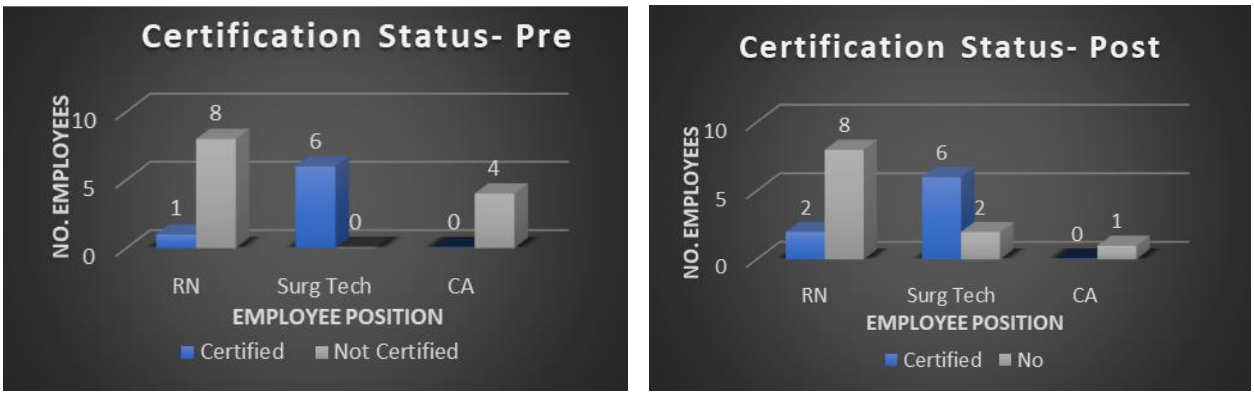
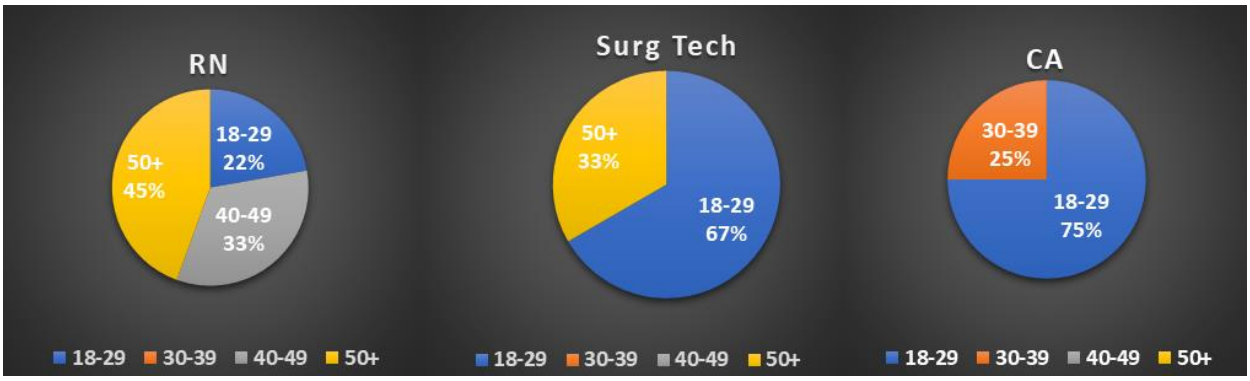


Figure 8

Age Distribution- Pre-Intervention



Age Distribution- Post- Intervention

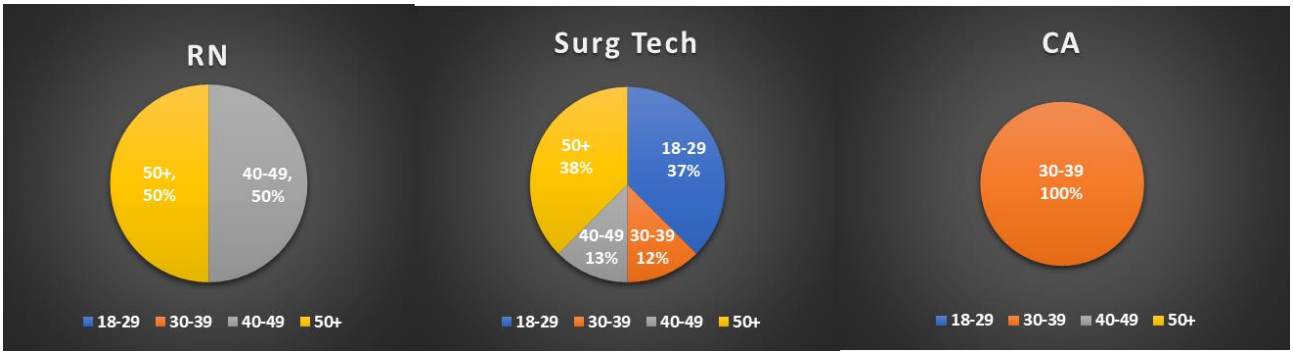
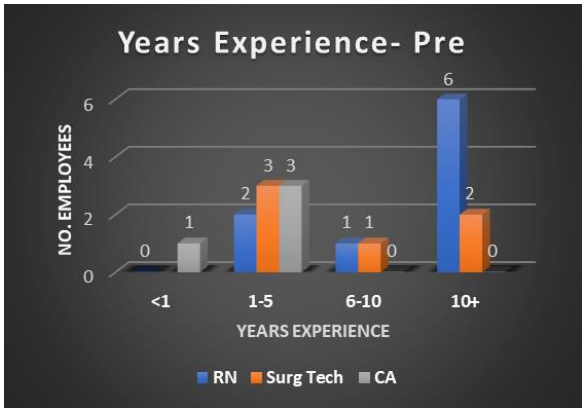
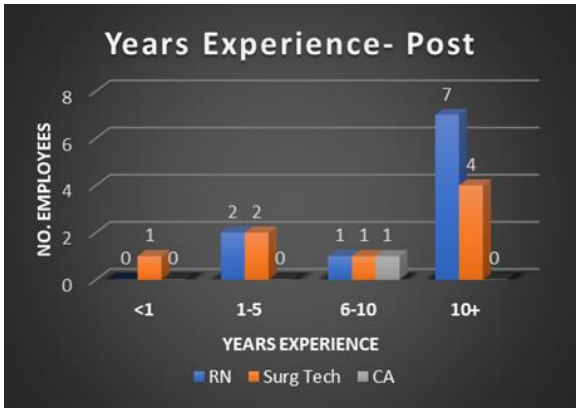


Figure 9

Years of OR Experience





Staff were asked to complete a short survey assessing their personal knowledge of SSI infection risk reduction measures. Total scores were calculated and stratified by position (Figure 10). Final scores showed an approximate 22% increase from pre-intervention test results across all groups. More specifically, RNs increased their final score by 6.9% and Surg Tech scores increased by 21.8%. Results were further analyzed by individual question (Figure 11). Across all positions, quiz question number 6 regarding the appropriate time to change surgical gloves was most often incorrect in the pre-intervention assessment. The post-intervention assessment showed improvement in this knowledge area particularly in the Surg Tech group. The RN group showed improvement in knowledge of glove change timing from their baseline score of 44% to 60%.

Figure 10

Overall Quiz Scores

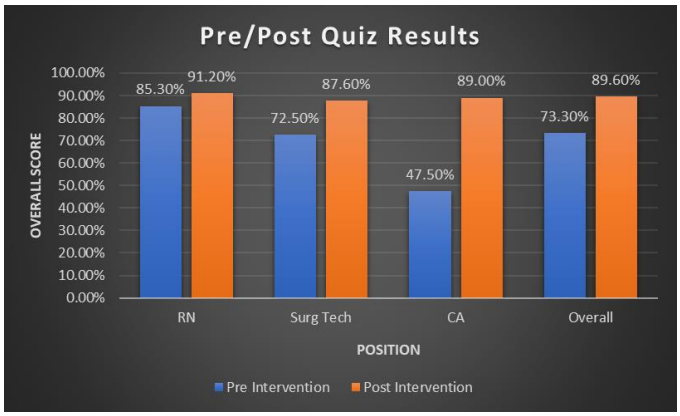
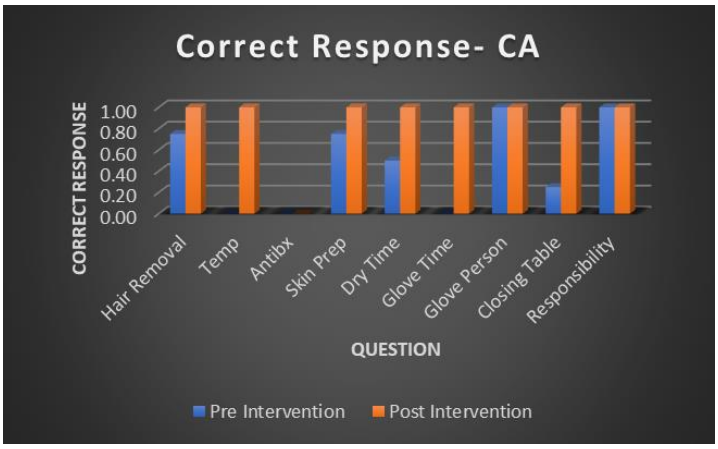
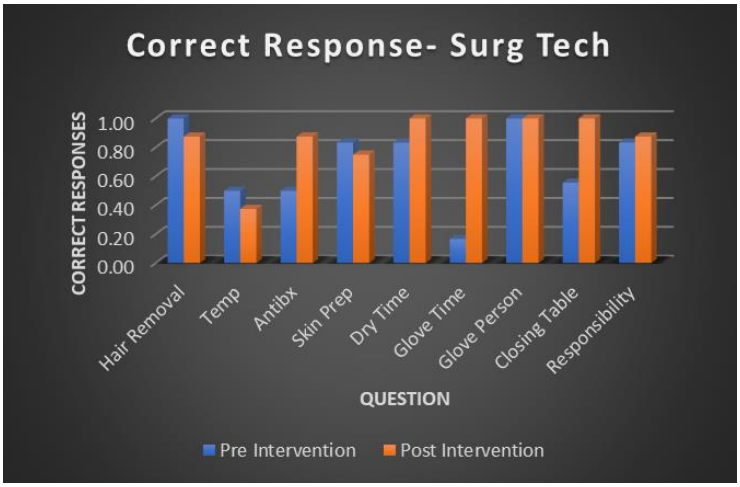
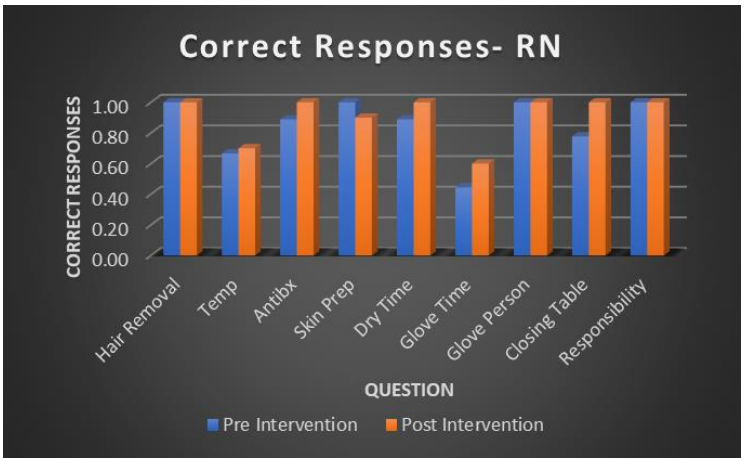


Figure 11

Correct Responses by Question



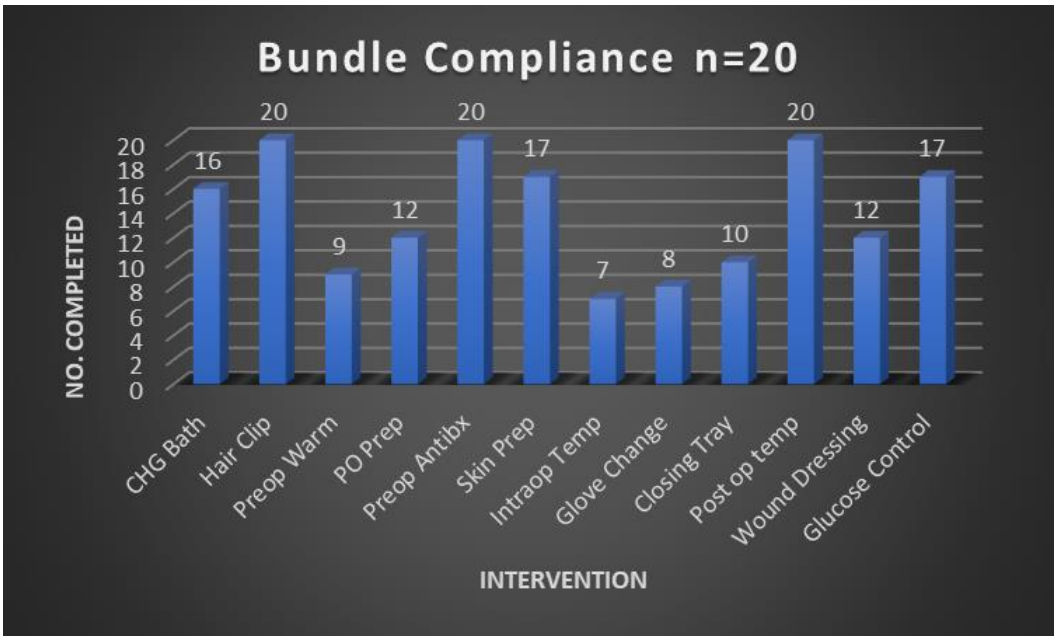




Twenty colorectal surgeries were performed that met inclusion criteria during the intervention time-period. The facility performed well in the areas of hair clipping, on time preoperative antibiotic administration, and post operative temperature management with compliance rates of 100% for each component (Figure 12). Staff performed well in the components of preoperative CHG bathing, alcohol-based skin prep, and postoperative glucose control with compliance rates of 80% or greater (Figure 12). Preoperative warming and timing of glove change for scrubbed providers were among the lowest performing components with compliance rates of 45% or lower (Figure 12). Maintenance of intraoperative temperature greater than 36ºC was lower than anticipated with compliance at 35%. These findings were confirmed in the EMR during manual chart audits.

Figure 12

Bundle Compliance

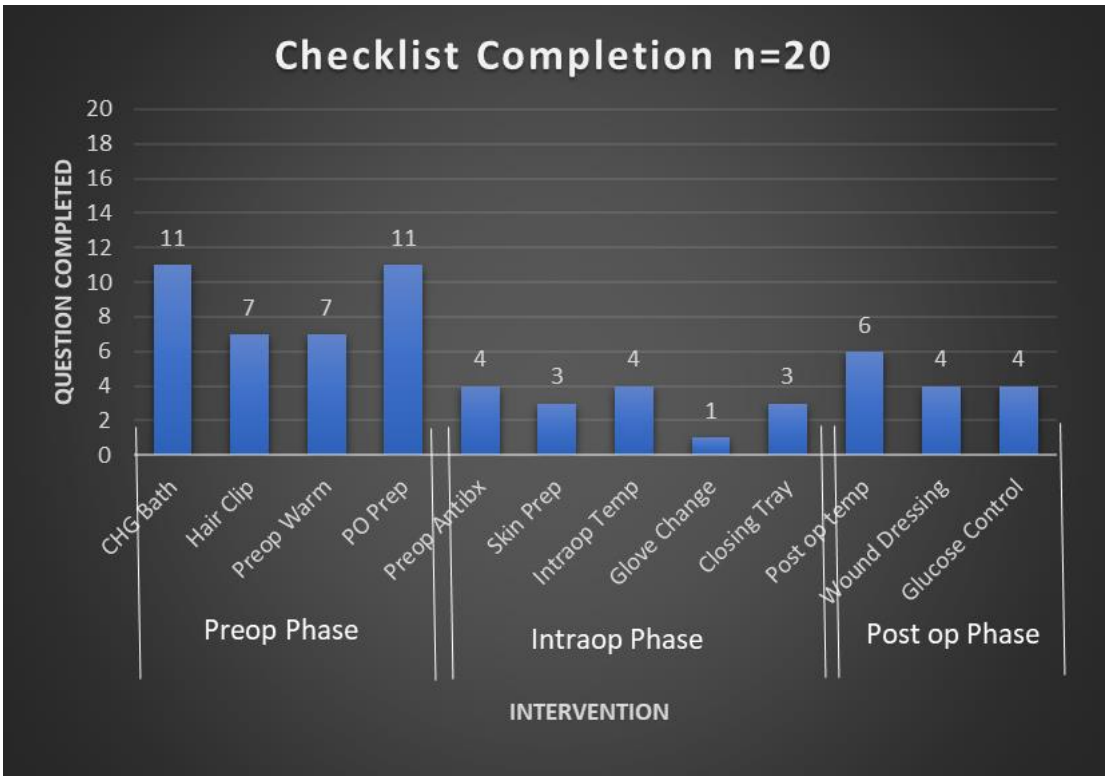


Completion of bundle components by staff members was also analyzed for the intervention time-period. Documentation was further categorized by perioperative phase reflecting the patient's change in physical location. As shown in Figure 13, documentation was most often completed by the preoperative

phase nurses and tended to decline during the intraoperative and postoperative phases. Documentation of a preoperative CHG bath and by-mouth (PO) bowel prep was most frequently completed by preoperative nurses with only a 55% documentation rate. Documentation of the use of alcohol-based skin prep, glove change, and use of a closing tray was least frequently completed with documentation rates between 5-15%. Qualitative analysis of bundle checklists also revealed no documentation in the provided free-text comment areas.

Figure 13

Checklist Completion

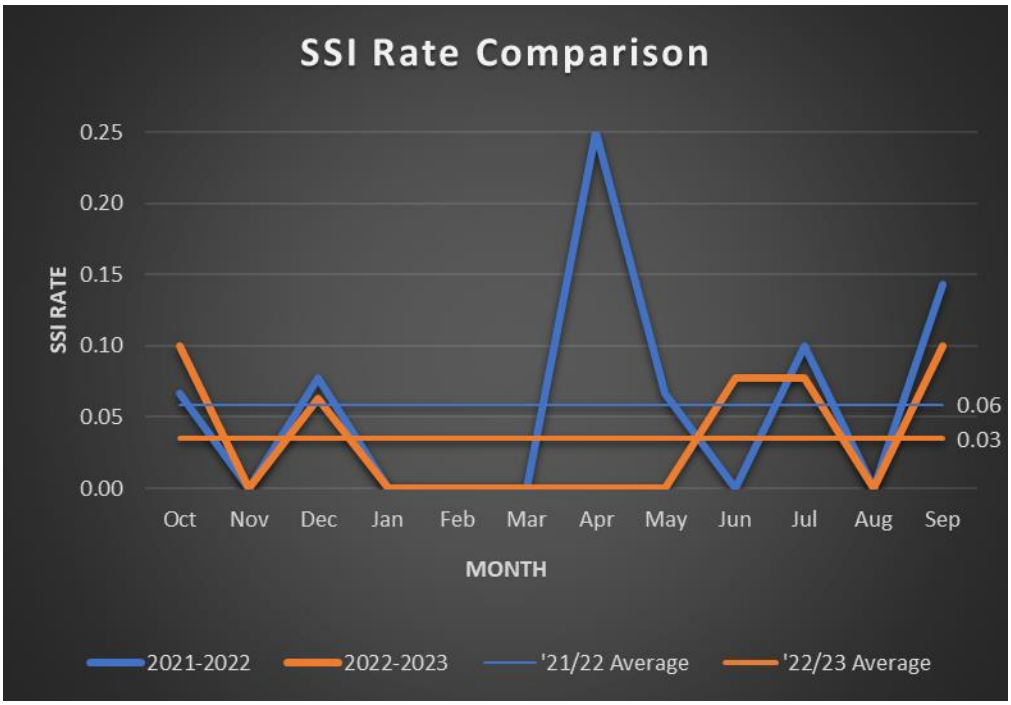


The rolling twelve-month rate of SSI among colorectal surgeries from October 2021 to September 2022 was 0.06. The same twelve-month SSI rate was recorded from October 2022 to September 2023 for the purpose of SSI rate comparison. As of September 2023, the new twelve-month SSI rate was 0.03 indicating a 50% reduction (Figure 14). The change in SSI rate did not meet statistical

significance (p-value= 0.2657). The baseline SIR was 1.5 at the identification of this quality improvement measure. The new SIR for October 2022-Sept 2023 was calculated at 0.77 indicating a lower-than-expected colon surgery SSI rate based on CMS data.

Figure 14

SSI Rate Comparison



Contextual Elements and Associations

Data analysis from pre-intervention data compared to post-intervention data showed a change in demographics including the number of responding OR staff in each position. This can be attributed to the anonymous nature of the Colorectal Surgery Quiz and timing of weekly OR staff meetings. Pre- and post-intervention assessments were given to those in attendance during two separate weekly education meetings. Therefore, the same staff members may not have been in attendance or taken the post-intervention assessment due to scheduled time off, abstinence from quiz participation, or staff turnover from the time the pre-intervention quiz was given.

Demographic results from both the pre- and post-intervention Colorectal Surgery Quizzes revealed most participating RNs had greater than 10 years of OR experience. The ACS released SSI prevention guidance in 2016, after many of the responding nurses had already been in practice. This may help explain lower scores reflected on pre- and post-intervention quizzes in areas such as timing for sterile glove changes and use of a separate closing table. Furthermore, demographic data analysis also revealed most RNs were not CNOR certified by the AORN. Achieving CNOR certification for circulating RNs may be a desired performance improvement area as the AORN routinely publishes SSI prevention guidance as part of continuing education to maintain certification status. SSI prevention measures may also be an appropriate topic for weekly OR staff meetings and annual competency evaluations held by this facility.

Review of Surg Tech demographics showed a greater percentage reporting more than 10 years OR experience. This group also demonstrated a 21% increase in knowledge scores from their baseline knowledge assessment. This may be attributed to receiving education specific to SSI prevention measures but may also be attributed to greater length of OR experience in the post-intervention Surg Tech group.

It was necessary to perform manual chart audits of each colorectal case during the intervention time-period due to the low rate of checklist completion by RNs. It was noted during this time that several elements were not able to be tracked as they were not part of the EMR. Although some of the required bundle elements were later added to the EMR for future documentation, intraoperative and post operative elements were not added until after the intervention was completed as previously discussed. For these reasons, low bundle compliance in areas of preoperative warming, PO bowel prep, glove change, closing tray, and dressing documentation may be more accurately explained by the inability to track these measures in the EMR. Checklist completion rates were low and congruent with several of the bundle components found to have low compliance scores. Checklist completion also decreased with each transfer of the patient to a different perioperative area. This highlights the need to incorporate all bundle components into the EMR to capture discrete data and improve auditing ability for bundle compliance.

Correct responses by RNs regarding appropriate time to change sterile gloves showed improvement but continued to be low at 60% on post intervention quiz results. However, in discussion with RN staff members, they were able to verbalize the appropriate time for scrubbed staff to change their gloves during a colorectal surgery case. It is the opinion of this author that this question may have been poorly worded for RNs who does not assist in surgical cases and their written responses on this question may not accurately reflect their working knowledge of the surgical case.

Although the rate of colorectal SSIs decreased by the end of the intervention time-period, the components of this quality improvement project were only implemented for a total of 10 weeks. Therefore, improvement in SSIs rates may not be entirely attributed to bundle compliance. It should be noted that discussions regarding colorectal SSI rates and perioperative SSI reduction measures were initiated in January 2023 with the Infection Prevention department and all areas of leadership. Therefore, some of the change in SSI rates may be attributed to the change in focus towards colorectal SSI rates prior to and during the implementation of the SSI reduction bundle. Furthermore, the final data point in September 2023 appears to show an increase in SSI rate. However, the total number of colon surgery cases performed during the month was much lower than previous months and one SSI was reported.

Unintended Consequences

Due to the inability to audit oral antibiotic administration as part of the preoperative bowel prep, this author worked with the information technology (IT) department to add this option to the electronic "Pre-procedure Form" performed prior to surgical procedures. This was included in addition to the already existing electronic option for mechanical bowel prep. The EMR change was available as of September 6, 2023. Also noted was the inability to electronically audit glove changes and use of a separate closing tray as part of the intraoperative record. IT was again consulted to add check boxes for these two elements to the required intraoperative documentation forms specific for colorectal surgeries in the EMR. Unit based educators and managers were utilized for both EMR changes to educate

perioperative nurses on additions and requirements for documentation and to ensure permanent practice change.

On the surgical units, detailed chart audits revealed inconsistent postoperative documentation of surgical dressings. Discussion with unit managers found that the quality of dressing documentation was preceptor dependent at the time of orientation rather than having standard documentation across the unit. While some nurses used EMR fields designated for surgical wounds, others preferred free text boxes as part of their skin assessment. Unit based educators and managers were educated on the correct "wound/incision" components of their nursing assessment and instructed to use this for discrete documentation of surgical dressings rather than free text. This education was distributed to all nursing staff across the facility. This continues to be an ongoing performance improvement measure across nursing departments.

A discrepancy on where the documentation was reflected in the EMR highlighted a previously unknown EMR issue. IT was notified of the discrepancy and the issue was escalated for rapid review and correction. At the completion of this quality improvement project, an EMR solution was made available with a new documentation process in place. This workflow now begins with recovery room nurses who initiate wound documentation which then flows to the postoperative nursing units for continued documentation throughout the patient's hospital stay. Overall, the new documentation process lessens the documentation burden on the receiving RN and provides greater continuity of care.

In addition to nursing process improvements, surgeons began to change their operative report documentation although not required by this quality improvement project. By project completion, most surgeons began incorporating the components of sterile glove change and utilization of the closing tray as part of their standard colorectal surgery operative report which improved the ability to perform manual chart audits. Intraoperative temperature maintenance was also found to be lower than the expected 36ºC benchmark for SSI prevention. This was confirmed in the EMR despite poor checklist completion. As a

result, findings were discussed with anesthesia leadership and a performance improvement plan was implemented by anesthesia providers for future colorectal surgery cases.

Overall, staff members verbally reported improvement in the ability to perform the required bundle elements for colon surgery SSI prevention and expressed interest in continuing quality improvement measures due to a noticeable difference in SSI rates in this patient population.

Missing Data

Due to the sporadic completion of paper checklists, each colorectal case performed within the study timeframe was audited via the EMR for bundle component compliance. This audit revealed that while most elements were easily found in the EMR, there was no ability to electronically track elements such as oral antibiotic administration, glove change, and separate closing tray. Therefore, if the checklist was not marked “yes” or “no” and was unable to be found in the EMR, the result was counted as “no” in final analysis. An EMR update for oral antibiotic administration tracking was made available for use after September 6, 2023 and was used to electronically audit oral antibiotic administration on subsequent patients. This was not the case, however, for tracking glove change and use of a separate closing tray. All results during the intervention time-period that were not specifically marked on the checklist or dictated by the surgeon in their operative report were tracked as a “no” result. The ability for nurses to track this component was not made available in the EMR until after the intervention timeframe due to additional resources required for this IT upgrade. Although it was not available during this ten-week period, it was made available in November 2023 for future SSI tracking by Infection Prevention.

Missing documentation on surgical incision sites from either the paper checklist or in the EMR was qualified as a “no” result. As noted above, wound dressing documentation became part of a larger performance improvement project across all nursing units that has been expanded to a hospital-wide initiative to improve wound and incision documentation.

Discussion

Summary

Findings from this quality improvement project suggest that implementation of a bundle specific to colorectal surgery may reduce SSI rates. Colon surgery SSI rates at this facility decreased from 0.06 to 0.03 and reduced the SIR from 1.5 to 0.76. Although the reduction in SSI rate did not reach statistical significance, it did make a clinically significant impact for the healthcare organization and the results are reportable to Medicare. This quality improvement project met the global aim of combining the best available evidence to create a standard bundle for colorectal surgery cases for SSI rate reduction.

In accordance with the specific aims of this quality improvement project, an assessment of sterile technique and procedural knowledge was completed for OR staff members. Education was provided for each of the assessed areas and an improvement in overall knowledge was noted at the end of the intervention time-period evidenced by improved Colorectal Surgery Quiz scores. Findings suggest that years of OR experience and OR certification status may play a role in knowledge of current SSI prevention measures and recommendations. Prior to colon surgery education, Colon Surgery SSI Quiz scores among OR staff averaged 73% compared to post-intervention quiz scores of 89.6%. This demonstrated a 22% increase in results overall.

Colorectal surgery bundle compliance proved difficult to track if not integrated into the EMR. Documentation compliance with the Colon Surgery SSI Bundle checklist decreased with each patient transfer to a different perioperative department. The Colon Surgery SSI Bundle checklist completion rate was 5-55% for all components indicating difficulty with paper documentation compliance among participating RNs. This quality improvement project improved the EMR documentation capability and enhanced the ability to audit patient records for discrete data analysis. EMR integration also met the specific aims of this project of reducing burdensome tasks such as paper tracking and documentation.

The PDSA cycle was an integral part to identifying problems within a reasonable amount of time and making immediate process changes to improve patient outcomes. The PDSA cycle allowed for

identification of gaps in the EMR documentation that slowed nursing workflows and allowed for missed opportunities for accurate documentation. The use of the PDSA cycle was also an opportunity for leadership to provide input to current processes and give feedback to participating staff members. Overall, this quality improvement intervention harnessed the best available evidence for colorectal SSI prevention, presented the intervention in concise format, and allowed for the participation of multiple perioperative areas to improve patient outcomes.

Interpretation

Findings from this quality improvement intervention suggest that implementation of evidence-based bundle components across perioperative areas improve SSI rates for patients undergoing colorectal surgery. The Colorectal Surgery SSI bundle was based on principles set forth by ACS and SIS principles and was shown to reduce surgical site infections at the studied facility as predicted in studies such as Zywot et al. (2017). The intervention also reduced practice variation among perioperative personnel by implementing standard components for colorectal surgery cases as it has been shown to reduce colorectal SSI rates (Zywot et al., 2017). Findings also suggest that specific education for perioperative staff and leadership improves with frequent process adjustments utilizing the PDSA cycle improves knowledge of SSI prevention measures and bundle compliance.

Impact on Systems

The development and implementation of a standard colorectal surgery SSI bundle reduced the rates of SSIs in patients undergoing colorectal surgery at this facility. In addition to improving SSI rates, separate closing trays were developed for use as the standard of care for colorectal surgery cases. Education was provided for perioperative staff regarding SSI rates and best practice measures to reduce them. As a result, knowledge regarding SSI reduction measures improved for perioperative staff. EMR upgrades to streamline bundle documentation and compliance were implemented across all perioperative departments. Staff reported improved workflow because of these EMR changes. Finally, due to the

improved SSI rates for colorectal surgeries, senior leadership has recommended that all changes made during bundle implementation be made permanent.

Some unexpected occurrences were noted during this intervention. Rates of SSIs in colorectal surgery cases slightly declined immediately prior to the implementation of this intervention. It is the opinion of this author that this observed decrease can be attributed to increased awareness of the SSI problem. Measures may have been taken by some perioperative personnel to improve SSI rates prior to the intervention commencement date. Turnover of some perioperative staff members occurred in the period between the pre- and post- intervention quizzes. This may explain some of the variation in demographic data and knowledge results from baseline to post-intervention. Also noted during the intervention were limitations in EMR documentation found during bundle checklist audits which had a significant impact on bundle compliance results.

Full and permanent implementation may be difficult for other facilities without leadership engagement. The purpose of this intervention was to limit tasks that were not evidence based and spread SSI prevention measures across all perioperative departments. This model requires continuous process evaluation, education, and a collaborative relationship with involved team members which may prove to be difficult in larger facilities or those with limited resources and staff. Furthermore, based on these findings it may be beneficial for facilities to invest in EMR integration of SSI prevention bundles prior to implementation of components for improved data and result tracking.

Limitations

The reduction in SSI rates for colon surgeries did not meet statistical significance. This is likely due to the small sample size comparing two twelve-month time periods. Findings from the pre- and post-intervention assessments may be also limited by the small sample size of OR staff at this community hospital. Effectiveness of the intervention may be better supported by ongoing pre- and post-education assessments given at scheduled intervals. Findings may also be limited by the administration of

knowledge assessments at a weekly OR staff meeting. This was scheduled to include the greatest number of OR staff members in one location at a given time but may have excluded OR staff not able to attend the meeting. Also of note, there was turnover of OR staff in all positions between pre- and post-intervention assessments and the assessments were administered anonymously. This did not allow for continuity in tracking post-intervention scores of the same OR staff.

One of the greatest challenges of this intervention was participation with the SSI Colon Surgery Checklist presented in paper format. Participation may have been limited by the requirement of tracking a paper document rather than continuing the current workflow of EMR documentation. However, integration of bundle components into the EMR was not possible within the time constraints of this quality improvement project. It was also necessary for the paper checklist to accompany the patient with every transfer to each different nursing unit. This allowed for misplaced checklists and opportunities for missed documentation. Every effort was made to reduce the impact from these limitations by performing manual chart audits with review of dictated operative reports performed by the surgeons. Recovery of missing checklists was also attempted through constant contact with medical records if the checklist was sent inadvertently. Continuous dialogue with nursing staff, nursing management, IT, and leadership was required for accurate data tracking.

Conclusion

Surgical site infections place an unnecessary burden on the patients and healthcare systems who provide care for them. SSI increase the patient's length of stay, worsen patient outcomes, and compound the costs of healthcare. Professional organizations such as the ACS and AORN have presented evidence-based principles to help guide healthcare organizations to reduce their rates of SSIs (AORN, 2023b; Ban et al., 2017). Adherence to these principles affects positive results on patients undergoing colorectal surgery as findings demonstrated in this quality improvement initiative. However, adherence to SSI bundles declines as the number in interventions increase (Pop-Vicas et al., 2020). Principles of colon surgery SSI reduction were presented in a concise format and dispersed between all perioperative nursing

departments to reduce workload, improve compliance, and promote sustainability. Particular attention was paid to the development of a separate closing table for colon surgery cases.

Shared responsibilities dispersed across perioperative staff was essential to the development of a successful SSI reduction bundle. Knowledge assessments and education were presented during weekly OR staff meetings to enhance engagement and maximize learning. These interventions have been shown to be achievable and sustainable at this community hospital. More importantly, these measures have demonstrated efficacy at reducing colorectal surgery SSIs.

The effectiveness of these interventions suggests an opportunity to expand the use of SSI bundles across other surgical sites. Additional studies may include evaluation of best delivery methods for educational sessions to enhance participation and retention. Focused efforts to integrate SSI bundle components into the EMR should include feedback from perioperative nursing staff, nursing leaders, and IT to improve compliance and workflow. The change in process from EMR documentation to additional paper documentation proved problematic and should be avoided for future interventions due to issues of compliance. The PDSA cycle or similar model was effective at identifying process issues and allowing for rapid correction and should be utilized for quality improvement projects involving patient care. Finally, a multidisciplinary, collaborative approach to SSI reduction allows for enhanced engagement from perioperative staff and improves patient outcomes.

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Appendix A

Colorectal Surgery Quiz

Please do not put your name on the quiz! Thank you!

Demographics

1. Are you a:
    - **a.** RN
    - **b.** Surgical Tech
    - **c.** CA

2. Are you certified?
    - **a.** No
    - **b.** CNOR
    - **c.** CST

3. Age range:
    - **a.** 18-29
    - **b.** 30-39
    - **c.** 40-49
    - **d.** 50 and over

4. How many years of OR experience do you have?
    - **a.** less than 1 year
    - **b.** 1-5 years
    - **c.** 6-10 years
    - **d.** 10+ years

Quiz Questions:

1. How should hair be removed prior to surgery if needed?
    - **a.** Razor
    - **b.** Wax
    - **c.** Clipping with clippers

2. What is the ideal preop, intraop, and postop temperature for patients having surgery?
    - **a.** 36C or above
    - **b.** 37C or above
    - **c.** 38C or above

3. Antibiotics should be given how soon before surgery?
    a. Within 3 hours
    b. Within 2 hours

c. Within 1 hour

4. What is the best skin prep prior to abdominal surgery?
   a. Chlorhexidine
   b. Chloraprep
   c. Betadine

5. How long should the skin prep be allowed to dry before incision?
   a. 1 min
   b. 2 min
   c. 3 min

6. When should gloves be changed during a colon surgery?
   a. Before anastomosis
   b. After anastomosis, before irrigation
   c. After anastomosis, before closing abdomen

7. Who should change gloves in the surgical team?
   a. All scrubbed personnel
   b. Surgeon only
   c. Scrub tech only

8. The closing instruments should be:
   a. On the mayo stand ready for use
   b. Kept separate on the main OR table
   c. Kept on a separate table for use after gloves are changed

9. Who is responsible for maintaining the sterile field?
   a. Scrub tech
   b. Surgeon and assistant
   c. Circulator
   d. All the above

Appendix B

Colon Surgery SSI Bundle					
	Intervention	**Completed**	**Initials**	**Date/Time**	**Comments**
Pre-op	CHG bath night before and scrub in Surgicare	☐ **Yes** ☐ **No**			
	Hair clipping performed if required	☐ **Yes** ☐ **No**			
	Preoperative warming >36C	☐ **Yes** ☐ **No**			
	Mechanical and oral antibiotic prep	☐ **Yes** ☐ **No**			
Intra-op	Hair clipping performed if required	☐ **Yes** ☐ **No**			
	Preop antibiotics within 1 hour of incision	☐ **Yes** ☐ **No**			
	Alcohol containing surgical scrub prep	☐ **Yes** ☐ **No**			
	Intra-op temperature >36C	☐ **Yes** ☐ **No**			
	Glove change prior to closing (Surgeon, APP, and Surg Tech)	☐ **Yes** ☐ **No**			
	Separate closing tray	☐ **Yes** ☐ **No**			
Post-op	Post op temp >36 (arrival to floor)	☐ **Yes** ☐ **No**			
	Wound dressing removed ≥POD 2	☐ **Yes** ☐ **No**			
	Glucose control <180mg/dL for 48hr	☐ **Yes** ☐ **No**			

Please return to your department manager/director

Please write MRN but <u>do not place patient sticker</u> on this paper