Post-operative nursing activities to prevent wound complications in patients undergoing colorectal surgeries: A scoping review

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Postoperative nursing activities to prevent wound complications in patients undergoing colorectal surgeries: A scoping review.

ABSTRACT

Aims: To identify postoperative interventions and quality improvement initiatives used to prevent wound complications in patients undergoing colorectal surgeries, the types of activities nurses undertake in these interventions/initiatives, and how these activities align with nurses' scope of practice.

Design: A scoping review.

Data sources: Three health databases were searched, and backward and forward citation searching occurred in April 2022. Research and quality improvement initiatives included focussed on adult patients undergoing colorectal surgery, from 2010 onwards. Data were extracted about study characteristics, nursing activities and outcomes. The 'Dimensions of the scope of nursing practice' framework was used to classify nursing activities and then the Patterns, Advances, Gaps, Evidence for practice and Research recommendations framework was used to synthesise the review findings.

Results: Thirty-seven studies/initiatives were included. These studies/initiatives often reported negative wound pressure therapy and surgical site infection bundle interventions/initiatives. Nurses' scope of practice was most frequently 'Technical procedure and delegated medical care' meaning nurses frequently acted under doctors' orders, with the most common delegated activity being dressing removal.

Conclusion: The full extent of possible interventions nurses could undertake independently in the postoperative period requires further exploration to improve wound outcomes and capitalise on nurses' professional role.

Implications for the profession and/or patient care: There may be opportunities to broaden nurses' scope of practice to act more autonomously to prevent wound complication.

Reporting method: Scoping Reviews (PRISMA-ScR) checklist.

Patient or public contribution: A patient interpreted the data and prepared the manuscript.

What does this paper contribute to the wider global clinical community?

- The review reveals that nurses largely enact delegated, technical tasks to prevent postoperative wound complications.
- The findings can be used as a basis for further research that explores activities nurses can enact independently and build evidence for these activities.

Keywords: colorectal surgery, medical-surgical nursing, nurse's role, nursing, patient care team, postoperative complications, review, scope of practice, surgical wound infection

INTRODUCTION

Over 312 million operations are performed annually worldwide [1]. About a quarter of surgical patients develop postoperative complications within 14 days of hospital discharge [2]. The most frequent complication is surgical site infection (SSI). SSI results in poor patient outcomes such as prolonged hospital stay, permanent disability [3, 4] and increased healthcare costs [5]. Colorectal (CR) surgical patients have one of the highest rates of SSI at 15% [6]. Yet, most complications, such as SSI, are potentially preventable. While many risk factors for SSI occur in the intra-operative environment, such as exposure to organisms that can contaminate the surgical site and type of surgical technique used, it is increasingly recognised that SSI prevention measures need to occur across pre-, intra- and postoperative care [7]. Although SSI prevention measures in the intra-operative area are more widely known, postoperative strategies such as dressing removal, incision care and discharged education are emerging and may be initiated by nurses [8, 9]. Thus investigating ways to reduce high rates of wound complications during the postoperative period for CR surgery patients is important, and could contribute to an integrative approach across the phases of surgery [10].

Surgical nurses provide 24-hour care in hospitals and are ideally positioned to prevent postoperative wound complications [11]. These nurses are often described as team leaders who co-ordinate postoperative care across multidisciplinary teams, they discontinue invasive treatments, enable early recovery, and provide fundamental care [12]. However, observational research reveals variation in surgical nurses' practices to prevent wound complications [13]. For example, in a study of 60 surgical nurses conducted in an Australian hospital, more than one-third of nurses did not use clean gloves properly during postoperative surgical wound management, and more than half did not provide postoperative wound management education to patients [14]. Moreover, surgical nurses struggle to articulate the specific activities they undertake to prevent postoperative complications [15]. Overall, nurses' lack of role clarity and variation in practice, may inhibit nurses' ability to influence postoperative outcomes.

A comprehensive synthesis of nursing activities that could prevent postoperative wound complications for CR surgical patients is lacking, hindering our ability to clearly articulate surgical nurses' role. Notably, interventional research and quality improvement projects are reporting initiatives to reduce postoperative complications [16], providing an extensive evidence base to synthesise in relation to nursing activities. Thus, the aim of this scoping review is to identify postoperative interventions and quality improvement initiatives used to prevent wound complications in patients undergoing colorectal surgeries, the types of activities nurses undertake in these interventions/initiatives, and how these activities align with nurses' scope of practice. It is well-known that nurses can influence quality of care, including hospital-acquired infections and mortality [17], thus synthesising nurses' activities may guide future practice development.

THE REVIEW

This scoping review followed the six methodological stages outlined by Arksey and O'Malley [18] and further developed by Peter et al [19]. These stages include: (1) identifying the research question, (2) identifying relevant studies, (3) study selection, (4) charting the data, (5) collating, summarising and reporting the results, and (6) consumer involvement. Scoping reviews focus on the breadth of literature [18], allowing reviewers to summarise and synthesise research, to determine research gaps and recommend the direction of further studies [20]. The review protocol

was registered in Figshare (https://figshare.com/articles/preprint/ScopingReviewProtocol_PostopNursingInterventionPreventWdComplication_docx/19533241).

METHODS

1. Identifying the Research Question

This scoping review used the population, concept and context (PCC) approach [21] to develop the research questions. The population was patients undergoing CR surgery; CR surgery is defined as surgeries that involve the colon, rectum and anus [22]. The concept was activities undertaken by hospital nurses to prevent wound complications, as part of research interventions and quality improvement initiatives. The context was postoperative care.

2. Identifying Relevant Studies

Inclusion and exclusion criteria were based on PCC components. Inclusion criteria were: adult populations; studies with qualitative, quantitative and mixed-method study designs; quality improvement (QI) studies; studies with interventions/quality improvement initiatives implemented from 2010 onwards when enhanced recovery after surgery (ERAS) protocols were universally implemented to improve patient recovery [23]; and studies published in English with full text available. If interventions/quality improvement initiatives had activities that occurred across perioperative phases they were included, as long as the intervention/quality improvement initiative included a postoperative nursing activity that was wound complication prevention specific (e.g. dressing removal). Exclusion criteria were: studies not focused on CR surgery; studies focused only on nursing screening or assessment without any information on resultant actions or interventions undertaken (e.g. postoperative screening activities that predicted high risk cases); reviews; QI studies without ethical approval or approval waiver (waiver by ethical review board); protocols and grey literature (unpublished studies or theses that have not undergone peer-review process).

The computerised database search was developed by referring to key articles in this field, which informed keywords and subject headings selected. A health librarian reviewed the search strategy. Searches were conducted in Medline (Ovid), CINAHL (Ovid) and EMBASE (Elsevier) in April 2022. The search strategy used in Medline (Ovid) is shown in Table 1. Next, backward and forward citation searching was conducted. That is, reference lists of studies included in this review were hand-searched (backward search) and included studies were searched in the Scopus database to identify studies that have cited the work (forward search).

[Table 1 about here].

3. Study Selection

Search results were exported to EndNote 20 and then uploaded into the Covidence systematic review software (www.covidence.org), where duplicates were removed and then studies were screened against inclusion and exclusion criteria. One researcher eliminated clearly irrelevant studies, and following this, two researchers independently screened titles and abstracts and then full texts. Any screening disagreements were resolved by discussion and consensus, and/or adjudicated by a third researcher. The description of the study selection was presented in narrative and a flow diagram following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist [24].

4. Charting the Data

Data extraction tables were developed by the research team and piloted. Data about both study characteristics and the nursing activities that were part of the intervention/quality improvement initiative were extracted. We only extracted data about postoperative nursing activities that were part of the intervention/quality improvement initiative. For example, some SSI bundles had activities that spanned the pre-, intra- and post- operative phase, only postoperative phase activities were extracted. Additionally, we extracted data about activities that occurred prior to the intervention to prepare nurses to deliver activities postoperatively, such as education and training. We also extracted data on the outcomes measured in the studies/projects. When reading full texts with unclear reporting components, authors were contacted via e-mail for clarification. One researcher extracted data, and a second researcher checked its accuracy. For disagreements between the two researchers, a third researcher adjudicated, which was not required.

5. Collating, summarising and reporting the results

Data from included studies was summarised and synthesised. For summarising, descriptive numerical summaries of characteristics of included studies and the characteristics of the nursing activities were undertaken. To find patterns in the data, we first mapped postoperative nursing activities to the 'Dimensions of the scope of nursing practice' [25]. We used the version by Müller at el. [26], as it was adapted and validated for the surgical ward context. The dimensions include patient assessment, care planning, technical procedure and delegated medical care, application of medicinal treatments, activities of daily living, relational care and non-medication interventions, patients and families education, communication and care coordination, integration and supervision of staff, quality of care and patient safety, knowledge updating and utilization, miscellaneous/non-care, personal time.

The Patterns, Advances, Gaps, Evidence for practice and Research recommendations (PAGER) framework was used to synthesise the review findings [27]. This was reported in a table with the columns: pattern (P), to present the data mapped to the 'Dimensions of the scope of nursing practice' framework [26] and other patterns we found in our summaries of data extraction; advances (A), highlighted what categories add to the current body of literature; research gap (G) which identified knowledge gaps; evidence of practice (E) which reported available evidence of practice; and research recommendations (R) which recommended future research based on the previous four domains of the PAGER framework.

6. Patient involvement

In the current review, a patient interpreted preliminary results. Arksey and O'Malley [18] suggest that patient involvement, is an optional extra which could bring added value to the review. Levac et al. [28] suggested that fruitful timing for this consultation exercise is when preliminary results are available. Patient involvement was reported as per the "Guidance for Reporting Involvement of Patients and the Public 2- Short Form" (GRIPP2) reporting checklist (See Supplementary File 1) [29].

RESULTS

In total, 37 studies were included. For health literature database searching, 5965 studies were screened, of which 24 were included (See Figure 1). Twenty-two studies were retrieved in backward and forward citation searching, of which 13 were included. Four studies were linked; two papers were from the same group of authors, with each paper reporting interim and final results of the intervention [30, 31]. Also, we noticed that one research team conducted their two studies with similar aims and inclusion/exclusion criteria over the same time period [32, 33] . We included all

studies, as each study reported different outcome data. However, when counting patterns in the data using the 'Dimensions of the scope of nursing practice' the studies by Keenan et al [30, 31] were counted as one study, and the studies by Pellino et al and Selvaggi et al [32, 33] were counted as one study, as they reported the same nursing activities.

Summary of study characteristics

Across the 37 included studies, 11,611 patients were included. Some of the most common surgical procedures that patients underwent were low anterior resection, colectomy and abdominoperineal resection (See Table 2). Most interventions were delivered in academic [30, 31, 34-46] and tertiary facilities [30, 31, 35, 36, 39, 43, 45-49]. The units where interventions/quality improvement initiatives were delivered were surgical [32, 50-52], colorectal [44, 53, 54], gastroenterology [42], and general surgical units [34]. There was no patient engagement in the research process in any study included.

(Table 2 here).

Summary of nursing activity characteristics

The most frequent interventions/quality improvement initiatives were negative pressure wound pressure therapy (NWPT) [32, 33, 35, 37, 39, 40, 46, 47, 49, 52, 55-61] and SSI bundles [30, 31, 36, 38, 43, 45, 48, 50, 53, 62]. We found no interventions/quality improvement initiatives with nursing activities exclusively occurring in the postoperative phase; activities also occurred in the pre- and intra- operative phases, and all interventions/quality improvement initiatives had multidisciplinary input (See Table 3). There were only seven instances where details were provided about nurses delivering activities, across six studies, including ward nurses [45, 48, 62, 63], stoma specialists/therapists [41, 48], clinician practice educators [48] and nurse practitioners [44]. A range of outcomes were reported, the most common were SSI, length of stay (LOS), return to operating theatre and readmission to hospital (See Table 4). Nine SSI bundle studies found reductions in SSI and four found reduced LOS [30, 31, 36, 43, 45, 48, 50, 53, 62]. For NWPT studies, eight found reduced SSI and five reduced LOS [32, 33, 35, 37, 39, 46, 49, 52, 55, 57, 61].

(Table 3 and 4 about here).

Patterns and PAGER framework results

'Technical procedure and delegated medical care' was the most frequent dimension of care undertaken by nurses (n=63 activities) (See Table 5). Within this domain, wound management activities were common, such as removal of NWPT [32, 33, 35, 37, 39, 40, 46, 47, 49, 52, 55-58, 60, 61], removal of other dressings [30, 31, 36, 45, 48, 50, 53, 62-66], dressing changes [32, 33, 39, 44, 52, 59, 63], and removal of staples and sutures [39, 44, 60, 63] (See Table 3). Dressing removal activities ranged from postoperative day (POD) 2 to POD 14. NWPT was commonly removed on POD 7 [32, 37, 47, 49, 52, 55, 60] or POD 5 [35, 37, 40, 46, 56, 61]. Other dressings were removed at POD 2 [30, 31, 36, 48, 50, 53, 62] or POD 5 [64-66], and sutures and staples were removed POD 7-14 [44, 60], or as needed [63]. Nurses also applied dressings [32, 39, 52], assessed wounds after application of NWPT and drains [44, 57, 60], and cleansed wounds [30, 31, 62]. Wounds were cleansed daily in some studies [30, 31, 62]. NWPT dressings were changed at POD 3 [32, 33, 52, 59] or when gauzes were too wet [32, 33, 52], and other dressings were changed as needed [63] (See Table 3).

[Table 5 about here].

‘Application of medicinal treatment’ was the second most frequent dimension of care (n=11 activities). Nurses were tasked with maintaining euglycemia [30, 31, 38, 43, 50, 54, 62]; the exact timing of these activities was not explicit [54] except for one study, where an insulin infusion continued for 48 hours post operation, after which diabetic patients returned to usual medications [54]. Nurses also administered antibiotics 8-hourly [47, 60], and antibiotics continued for 24 hours post operation [47, 59-61].

The findings were synthesised using the PAGER framework (See Table 6).

[Table 6 about here].

DISCUSSION

In this scoping review, we found that nurses often undertook ‘technical procedure and delegated medical care’ and ‘application of medicinal treatments’ (as per the ‘dimensions of the scope of nursing practice’), under doctor’s orders, to prevent postoperative complications in patients undergoing CR surgery. Examples of common activities were both removing NWPT and other dressings and applying dressings. This raises questions about whether nurses’ scope of practice could be broadened to enact these activities more autonomously, which will be discussed. Additionally, our review highlights that nurses are instructed to undertake these tasks at varying time points. There is a gap in evidence for the optimal timing of these activities, which should be addressed to reduce variation in care. Our review also highlighted that nurses may not be enacting their full scope of practice; there are opportunities to explore nursing activities like ‘patient and family education’ or ‘activities of daily living’ (as per ‘dimensions of the scope of nursing practice’), which nurses can enact independently. Further, the influence of independent nursing activities on outcomes warrants further investigation.

We found that the most frequent activities nurses undertook were wound management activities, however in many countries nurses cannot independently manage wounds. In response to increased medical professional workloads, UK nurses’ scope of practice has increased to include independent wound management, which requires additional education and training for nurses [67]. Training may be critical to ensure nurses practice evidence-based wound management, as 25-61% of nurses across Saudi Arabia and Australia report always following national or international surgical wound care guidelines, and only 22-33% of these nurses reported journal articles were ‘always used’ or ‘highly important’ sources for evidence-based wound management [68, 69]. Another approach could be further developing and revising clinical pathways in collaboration with surgeons and other members of the multidisciplinary team [12]. Clinical pathways provide clear criteria for independent nursing roles and when nurses should escalate decision-making; however, nurses need to be highly-qualified to enact clinical pathways [12]. In this review, authors provided little information about nurses’ education and current roles, thus it was difficult to comment on nurses’ competence. Overall, increasing nurses’ independent decision-making in wound management could enhance interprofessional collaboration, while improving outcomes for patients, however, nurses need appropriate knowledge and skills to act more autonomously.

In our review, nurses were carrying out many activities under doctor orders, it is essential that the timing of these activities are evidence based, rather than being based on doctor preference. For example, one of the most common activities nurses undertook was removing NWPT and conventional dressings. Currently the optimal time for their removal varies [70-72]. However, there is some evidence that removing conventional dressings at 48 hours significantly reduces length of hospital stay and costs related to procedure and hospitalization, but this evidence is at high-risk of

bias [72]. Given the lack of high-quality evidence, it is unsurprising that there is practice variation, with one-third of nurses removing dressings 1–3 days after surgery [68]. Another example we found was nurses' role in administering medications to manage euglycemia, however the timing of this activity was unclear. There is growing evidence that insulin administration in the the intraoperative and postoperative, or postoperative phase only, significantly lowers SSI risk, compared to treatment in intraoperative phase only; however, data are at moderate risk of bias [73]. In summary, it is promising to see that activities delegated to nurses reflect the latest developments in evidence, but more high-quality randomised control trials are required, to ensure nurses positively influence postoperative outcomes for patients.

Overall, the nursing activities identified in our review were delegated and highly technical, suggesting there is scope to investigate independent nursing activities like 'patient and family education'. A recent study showed that patients who perceived they were more engaged in education in hospital, managed their surgical wound better at home [74]. Experts believe that promoting patient and family education could empower patients to manage postoperative wound complications themselves, thus reducing SSI [75]. Additionally, novel interventions are being developed, that train families to actively engage in postoperative care activities, which may reduce rates of complications [76]. However, like our results, others have found that patient and family education is an infrequent, with only 28% of patients receiving surgical wound care education from nurses [13]. Further, when surgical patients do receive discharge education, it is often perceived as inadequate [77]. Overall, this underexplored topic warrants further investigation to establish links between patient and family education and postoperative outcomes [75].

In our review we found evidence of improvements in SSI and length of stay outcomes, however our findings reflect nurses' collaborative role in prevention of wound complications with other healthcare professionals, to move patients through their care trajectory. In 2016, a comprehensive core outcome set for CR surgery was published [78]. In it, there were three groups of outcomes including oncological (such as long-term survival) operative (such as surgical site infection) and quality of life (such as physical function) [78]. Much attention has been paid to interventions surgeons undertake to improve outcomes like SSI [79], however, hospital acquired infection outcomes are also nurse-sensitive [17]. Future researchers who test independent nursing activities, could use CR surgery core outcomes sets to build the evidence base for nursing-sensitive outcomes.

Limitations

This review has limitations. First, the studies included tended to focus on the effectiveness of interventions and quality initiatives, rather than describing the nurses' role within these. Thus, our research team interpreted what activities within the interventions/quality improvements initiatives were within nurses' scope of practice, as per a framework. This may not represent what occurred in the interventions/quality improvements initiatives. In future interventional research, researchers should describe who delivers each intervention component, including their expertise (e.g. nurses' highest level of education and nurses' role/level of practice), background, and any specific training given which aligns with international reporting guidelines [80]. Second, many interventions/quality initiatives were bundles or combined with ERAS, that had activities occurring at various stages of the perioperative journey. We only focussed on postoperative components, thus outcomes reported cannot be attributed to nurses providing postoperative care. Third, we excluded studies that only focused on nursing assessment and risk prediction, unless there was resultant nursing actions based on these assessments. We still identified studies that included nurse assessments, suggesting that this is an important part of the nurses' role, and likely a foundation for many other activities nurses undertake. Finally, the protocol evolved as the research team became immersed in the literature and

discovered that most interventions were multidisciplinary and nurses undertook discrete activities within these. However, scoping reviews allow for protocol changes.

CONCLUSION

The literature surrounding the activities surgical nurses undertake to prevent postoperative wound complication predominantly focuses on technical procedures and delegated medical care. There is a need to further articulate the independent role nurses play on CR patients' postoperative recovery, such as independently managing surgical wounds. Focusing on areas such as patient and family education and on using nursing sensitive outcomes in future research may help determine nurses' unique contribution to patient outcomes.

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Table 1. Search strategy in Medline (Ovid)

PCC components	**Keywords**	**MeSH**
Population	(colorectal adj2 (surg* OR operation* OR procedure*))	exp colorectal surgery/
Concept and context	Wound* OR (Surg* adj1 (site* OR incision*)) OR Complication* OR infect* OR (nurs* adj1 intervention*)	exp Postoperative complications/ OR exp surgical wound infection/

Table 2. Study characteristics

First author, (year), country	Aim(s)	Study design, setting, sample size	Intervention and control groups
Abadía et al. (2021), Spain	To assess the efficacy of NPWT for SSI in elective CR surgery	**Study design:** Prospective cohort study **Setting:** Public general hospital **Sample size:** 200 patients (100 intervention group, 100 control group)	**Intervention group:** NWPT **Control group:** Occlusive dressing
Ahmad et al. (2019), USA	To evaluate use of Mupirocin dressings compared to standard surgical dressings on SSI	**Study design:** RCT **Setting:** Community hospital **Sample size:** 192 patients (75 intervention group, 75 control group, 42 group not reported)	**Intervention group:** Mupirocin ointment (2%) dressing **Control group:** Standard dressing
Arslan et al. (2020), Turkey	To compare the effects of Jackson-Pratt drain placement in patients with and without drains on incisional SSI after CR resection for cancer	**Study design:** Prospective, randomised, controlled study **Setting:** 2 departments of general surgery at an education and research hospital and university hospital **Sample size:** 182 patients (intervention group 89 , control group 93)	**Intervention group:** Subcutaneous Jackson-Pratt closed suction drain **Control group:** No subcutaneous closed suction drain
Borejsza-Wysocki et al. (2021), Spain	To investigate the efficiency of closed incision NPWT in terms of the incidence rate of SSI after stoma reversal surgery	**Study design:** RCT **Setting:** Not reported **Sample size:** 30 patients (intervention group 15; control group 15)	**Intervention group:** Closed incision NPWT **Control group:** Standard sterile dressing

Carrano et al. (2021), Italy	To assess whether the application of NWPT can improve wound healing compared with conventional wound dressing after stoma reversal in CR surgery	**Study design:** Superiority, open-label, RCT **Setting:** Single tertiary referral centre **Sample size:** 100 patients (50 intervention group; 50 control group)	**Intervention group:** NWPT **Control group:** Conventional dressing
Chadi et al. (2014), Canada	To investigate the role of incisional NWPT in decreasing the rates of perineal SSI	**Study design:** Retrospective cohort study **Setting:** Tertiary care academic institution **Sample size:** 59 patients (intervention group 27, control group 32)	**Intervention group:** NWPT **Control group:** Gauze
Cima et al. (2013), USA	To evaluate the impact of a CR SSI-reduction bundle on SSI rates	**Study design:** Quality improvement, using Lean Six Sigmas approach **Setting:** 2 tertiary care academic hospitals **Sample size:** 729 patients (531 pre intervention; 198 post-intervention)	**Intervention:** CR SSI-reduction bundle **Control:** Pre CR SSI-reduction bundle
Curchod et al. (2022), Switzerland	To compare incisional SSI rates in patients after ostomy closure with and without additional application of a closed wound NPWT dressing	**Study design:** Retrospective comparative study **Setting:** University hospital **Sample size:** 337 patients (intervention group 85, control group 252)	**Intervention group:** NWPT **Control group:** Surgical glue
Curran et al. (2019), USA	To assess the effect of prophylactic closed incision NWPT on the incidence of SSI in a cohort of high-risk patients undergoing open CR surgery.	**Study design:** Retrospective cohort study with nested matched case: control **Setting:** Academic and teaching hospital **Sample size:** 315 patients (intervention group 77, control group 238; matched subset intervention group	**Intervention group:** Closed incision NWPT **Control group:** Standard care

		77; control group 79)	
D'Souza et al. (2019) Canada	To determine whether there was an additive benefit associated with the sequential implementation of the evidence-based SSI bundle and ERAS protocols	**Study design:** Retrospective cohort study **Setting:** Tertiary referral community hospital **Sample size:** 368 patients (stratified into 3 groups: SSI bundle pre-ERAS 95 patients; SSI bundle post-ERAS 179 patient; control group 94 patients)	**Intervention group:** Group 1: SSI bundle pre-ERAS**,** Group 2: SSI bundle post-ERAS **Control group:** Pre-intervention, pre-ERAS
Forsmo et al. (2016) Norway	To investigate whether an ERAS programme with dedicated ERAS and stoma nurse specialists focusing on counselling and stoma education can reduce the length of hospital stay, re-admission, and stoma-related complications and improve health-related quality of life compared to current stoma education in a traditional standard care pathway	**Study design:** RCT, sub-study of a larger RCT **Setting:** University hospital **Sample size:** 122 patients (61 intervention group, 61 control group)	**Intervention group:** ERAS care with extended stoma education **Control group:** Standard care with conventional stoma education
Gorgun et al. (2018), USA	To evaluate the impact of the SSI prevention bundle on CR SSI rates before and after the bundle implementation	**Study design:** Before and after **Setting:** Specialised CR surgery department **Sample size:** 2250 patients (986 pre-intervention, 1264 post-intervention)	**Intervention group:** SSI prevention bundle **Control group:** Pre-bundle implementation
Han et al. (2021), China	To investigate the effect of continuous negative pressure drainage combined with intermittent irrigation in the presacral space on the perineal SSI following laparoscopic extralevator abdominoperineal excision for low	**Study design:** Retrospective chart audit **Setting:** Department of gastrointestinal surgery, at a university hospital **Sample size:** 99 patients (46 intervention group, 53 control group)	**Intervention group:** Continuous negative pressure drainage combined with intermittent irrigation **Control group:** Conventional drainage

	rectal cancer		
Hewitt et al. (2017), USA	To examine institutional efforts and processes to reduce SSIs through a resident-driven quality initiative	**Study design:** Before and after study **Setting:** Surgical unit at 1 acute care hospital **Sample size:** 701 patients (489 pre-intervention, 212 post-intervention)	**Intervention group:** CR care bundle **Control group:** Pre-bundle implementation
Keenan et al. (2014), USA	To determine the effect of a preventive SSI bundle on SSI rates	**Study design:** Before and after study **Setting:** Academic tertiary referral centre **Sample size:** 559 patients (pre-intervention 346, post-intervention 213)	**Intervention group:** Preventative SSI bundle **Control group:** Pre-bundle implementation
Keenan et al. (2015), USA	To examine the impact of the sequential implementation of the ERP and SSI bundle on short-term outcomes in CR surgery	**Study design:** Retrospective cohort **Setting:** Acute care academic tertiary care facility **Sample size:** 787 patients (165 group 1; 285 group 2; 337 control)	**Intervention group:** 1. ERP, pre-SSI bundle, 2. ERP, post-SSI bundle **Control group:** Pre-implementation of ERP and SSI bundle
León Arellano et al. (2021) Spain	To evaluate the effectiveness of closed incision NWPT on SSI prevention	**Study design:** RCT **Setting:** Multi-centre (4 hospitals) **Sample size:**148 patients (75 intervention, 73 control)	**Intervention group:** Closed incision NWPT **Control group:** Conventional surgical dressing
Martinez et al. (2020), USA	To assess the impact of established protocol on SSI after colon surgery	**Study design:** Before and after study **Setting:** Tertiary university medical centre **Sample size:** 94 patients (intervention group 47 ,	**Intervention group:** Colon SSI bundle protocol **Control group:** Pre-protocol

		control group 47)	implementation
Murphy et al. (2019), Canada	To determine if NPWT reduces SSI in primarily closed incision after open and laparoscopic-converted CR surgery	**Study design:** RCT **Setting:** Two separate sites at single hospital system. **Sample size:** 300 patients (150 intervention group, 150 control group)	**Intervention group:** NPWT **Control group:** Sterile gauze dressing
Ocaña Jiménez et al. (2019), Spain	To evaluate clinical effectiveness of NPWT in the primary prevention of SSI in CR surgery	**Study design:** Prospective case–control study **Setting:** One tertiary hospital **Sample size:** 80 patients (40 intervention group; 40 control group)	**Intervention:** NWPT **Control:** No NWPT
Okuya et al. (2020), Japan	To evaluate the usefulness of preventive NPWT for SSI after ileostomy closure	**Study design:** Prospective pilot study **Setting:** Multi-centre (hospitals) **Sample size:** 50 patients	NWPT
Pan et al. (2015), China	To analyse the risk factors of SSI and to assess the utility of an subcutaneous vacuum drain for preventing SSI in patients undergoing primary closure of ileostomy	**Study design:** Retrospective study **Setting:** Department of CR surgery, university cancer hospital **Sample size:** 254 patients (160 control group, 85 intervention group)	**Intervention group:** Subcutaneous vacuum drain **Control group:** Primary closure without subcutaneous vacuum drain
Park et al. (2020), Korea	To investigate how rates of SSI were changed over 2 years after applying colon SSI bundle in patients who underwent colon surgery	**Study design:** Pre-post design **Setting:** University-affiliated, tertiary referral hospital **Sample size:** 1158 patients (71 pre-intervention; 1087 post-intervention; 480 post-intervention time	**Intervention group:** SSI bundle **Control group:** Pre-implementation of SSI bundle

		point 1; 606 post-intervention time point 2)	
Pellino, Sciaudone, Candilio, De Fatico, et al. (2014), Italy	To assess the efficacy of NPWT by means of a pocket device in preventing surgical site event (SSE) compared with conventional dressings in patients undergoing surgery with primary wound closure for breast and for CR diseases	**Study design:** Prospective controlled trial **Setting:** A surgical unit **Sample size:** 100 patients; 50 were CR patients (25 intervention group, 25 control group)	**Intervention group:** NPWT **Control group:** Conventional dressing
Pellino, Sciaudone, Candilio, Campitiello, et al. (2014), Italy	To compare a portable device for NWPT to conventional gauze dressings in patients undergoing surgery for stricturing Crohn's disease	**Study design:** Prospective, nonrandomized, controlled pilot study **Setting:** Not reported **Sample size:** 30 patients (13 intervention group; 17 control group)	**Intervention group:** NWPT **Control group:** Conventional dressing
Poehnert et al. (2017), Germany	To investigate the impact of incisional NWPT on wound healing processes and its potency to prevent superficial SSI after reversal of a double loop ileostomy	**Study design:** Prospective, controlled observational study **Setting:** University, tertiary referral hospital **Sample size:** 49 patients (intervention group 24 , control group 25)	**Intervention group:** Incisional NWPT **Control group:** Standard dressing
Reese et al. (2020), USA	To develop, implement and sustain a colon SSI prevention bundle and determine which bundle components are most strongly associated with prevention of SSI	**Study design:** Quality improvement **Setting:** Level 1 trauma hospital **Sample size:** 280 patients	**Intervention:** SSI bundle
Ruiz-Tovar et al. (2015),	To compare three methods of wound dressings for their ability to prevent	**Study design:** A prospective, randomized study	**Intervention groups:** 1. Ionic silver-containing dressing, 2.

Spain	SSI in patients with CR cancer undergoing elective open surgery	**Setting:** Unclear **Sample size:** 147 patients (49 in each group (2x intervention groups, 1x control group))	Mupirocin ointment dressing **Control group:** Conventional dressing
Ruiz-Tovar et al. (2019), Spain	To compare the effect of conventional wound dressings with vitamin E and silicone dressings on incisional SSI in patients undergoing elective CR laparoscopic surgery	**Study design:** Prospective randomized study **Setting:** Unclear **Sample size:** 120 patients (60 intervention group, 60 control group)	**Intervention group:** Vitamin E and silicone dressing **Control group:** Conventional dressing
Selvaggi et al. (2014), Italy	To compare the effects on surgical site complication of a portable device for NWPT with gauze dressings after elective surgery for Crohn's Disease	**Study design:** Prospective, open-label, controlled trial **Setting:** Department of surgery **Sample size:** 50 patients (intervention group 25 patients, control group 25 patients)	**Intervention group:** NWPT therapy **Control group:** Conventional dressing
Shakeshaft et al. (2020), Australia	To evaluate the effect of postoperative glycaemic control using an insulin infusion on SSI in CR surgery	**Study design:** Cohort design **Setting:** CR surgery unit **Sample size:** 199 patients (pre-intervention 100 patients, 99 post-intervention)	**Intervention group:** Insulin infusion for glycaemic control **Pre-intervention group:** No insulin infusion for glycaemic control
Siah and Yatim (2011), Singapore	To compare the efficacy of total occlusive ionic silver containing dressing combination versus no dressing after CR surgery	**Study design:** RCT **Setting:** Acute ward, at general hospital **Sample size:** 166 patients (83 control, 83 intervention)	**Intervention group:** Occlusive ionic silver-containing dressing **Control group:** Standard practice
Tanner et al. (2016), UK	1) Does implementation of the Department of Health's High Impact	**Study design:** Prospective cohort study	**Intervention group:** SSI bundle **Control group:** Standard care pre-

	Intervention bundle reduce SSIs following open CR surgery? 2) Is compliance with the entire bundle associated with a lower rate of SSI than incomplete compliance?	**Setting:** 2 teaching hospitals **Sample size:** 293 patients (control group 127, intervention group 166)	bundle implementation
Uchino et al. (2016), Japan	To evaluate the efficacy and safety of NWPT during ileostomy closure	**Study design:** RCT **Setting:** Not reported **Sample size:** 59 patients (intervention group 28; control group 31)	**Intervention group:** NWPT **Control group:** Conventional dressing
Watanabe et al. (2017), Japan	To evaluate the clinical benefits of using a subcutaneous closed-suction Blake drain in patients undergoing CRS	**Study design:** RCT **Setting:** department of surgery, at 1 hospital **Sample size:** 240 patients (112 intervention group, 117 control group)	**Intervention group:** Subcutaneous closed-suction drain **Control group:** Did not receive subcutaneous closed-suction drain
Webb et al. (2019), Canada	1) To analyse rates of SSI between incisional NWPT and standard dressings in CR surgery 2) To compare rates of seroma/hematoma formation, wound separation, morbidity, mortality, disposition destination, and HLOS	**Study design:** Prospective cohort **Setting:** Not reported **Sample size:** 689 patients (intervention group 145, control group 544)	**Intervention group:** Incisional NWPT **Control group:** Standard sterile dressing
Wierdak et al. (2021), Poland	To assess the usefulness of protective NPWT in the reduction of wound healing complications and SSI after diverting ileostomy closure in patients	**Study design:** Randomized controlled, superiority trial	**Intervention group:** NPWT **Control:** Sterile wound dressing

	who underwent surgery for CR cancer	**Setting:** Tertiary referral academic surgical centre **Sample size:** 75 patients (intervention group 38, control group 37)	

CR= colorectal; NWPT= negative wound pressure therapy; RCT= randomized control trial; SSI= surgical site infection.

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Table 3. Intervention activity characteristics

First author (year)	Postoperative intervention activities	Characteristics of the nurses delivered the intervention activity?	Other collaborating personnel delivered the intervention?	When was the intervention activity delivered?	Where was the intervention activity delivered?	What was the nursing activity in the intervention?
Abadía et al. (2021)	NWPT until POD 7, or earlier if SSI identified	Not reported	Not reported	Postoperative or post-hospitalisation	Not reported or outpatient clinic if patient discharged prior to POD 7	Dressing removal[#]
Ahmad et al. (2019)	Island dressing removal on POD 5, or earlier if SSI suspected	Not reported	Not reported	Postoperative	Not reported	Dressing removal[#]
Arslan et al. (2020)	Subcutaneous closed suction drain until after POD 3 if drainage output <30 ml. If drainage >30 ml, drain kept in place until output reduced	Not reported	Not reported	Postoperative	Not reported	Drain removal[#]
Borejsza-Wysocki et al. (2021)	Closed incision NPWT dressing changed every 3 days or earlier in the case of an unsealed system or insufficiency of the soaking pad. Usually, the dressing was changed twice postoperatively	Not reported	Not reported	Postoperative	Not reported	Dressing change[#]
	At the time of discharge, a third change of NPWT was routinely done	Not reported	Not reported	Postoperative	Not reported	Dressing change[#]
Carrano et al. (2021)	NWPT removal on POD 7 or if wound infection suspected NWPT removal to allow visual inspection	Not reported	Not reported	Postoperative	Not reported	Dressing removal[#]
Chadi et al. (2014)	NWPT removal on POD 5	Not reported	Not reported	Postoperative	Not reported	Dressing removal[#]

Cima et al. (2013)	Patient and hand hygiene: - Practice good hand hygiene - Patient shower with Hibiclens® after dressing removal - Hand cleansing agent readily available - Signage encouraging hand hygiene - Purell® hand wipes made available to patients	Not reported	Patient	Postoperative	Not reported	Showering[#] and hand hygiene[#]
	Dressing removal by the end of POD 2	Not reported	Not reported	Postoperative	Not reported	Dressing removal[#]
	Discharge patient with 4 oz bottle of Hibiclens®	Not reported	Not reported	Postoperative	Not reported	Showering[#]
	Staff education	Not reported	Not reported	Pre-intervention	Not reported	Nurse education[#]
Curchod et al. (2022)	NWPT removal on POD 5 or day of discharge if earlier	Not reported	Not reported	Postoperative	Not reported	Dressing removal[#]
Curran et al. (2019)	NWPT removal on POD 5-7	Not reported	Not reported	Postoperative	Hospital or outpatient setting	Dressing removal[#]
D'Souza et al. (2019)	Maintain patient as normothermia in post anaesthesia recovery	Ward nurses, enterostomal therapists, clinical practice educators	Surgeons, patient care coordinators, other allied health care professionals	Postoperative	Post anaesthesia recovery unit	Normothermia maintenance[#]
	Administration of high-flow oxygen for 1 hour	Ward nurses, enterostomal therapists, clinical practice	Surgeons, patient care coordinators, other allied	Postoperative	Not reported	Administration of supplementary oxygen[#]

		educators	health care professionals			
	Blood glucose measurement	Ward nurses, enterostomal therapists, clinical practice educators	Surgeons, patient care coordinators, other allied health care professionals	Postoperative	Not reported	Glucose monitoring[#]
	Standardised wound care	Ward nurses, enterostomal therapists, clinical practice educators	Surgeons, patient care coordinators, other allied health care professionals	Postoperative	Not reported	Wound care[#]
	Dressing removal on POD 2	Ward nurses, enterostomal therapists, clinical practice educators	Surgeons, patient care coordinators, other allied health care professionals	Postoperative	Not reported	Dressing removal[#]
Forsmo et al. (2016)	Daily education	Stoma nurse specialist	Not reported	Postoperative	Not reported	Patient education[#]
Gorgun et al. (2018)	Dressing removal on POD 2	Not reported	Not reported	Postoperative	Not reported	Dressing removal[#]
Han et al. (2021)	Continuous negative pressure drainage combined with intermittent irrigation in the presacral space, NWPT removal when drainage volume is less than 10 ml for 2 consecutive days and the drainage tube remains unobstructed	Not reported	Not reported	Postoperative	Not reported	Drain removal[#]
	Drainage tube connected to drainage bag for natural drainage	Not reported	Not reported	Postoperative	Not reported	Drain monitoring and maintenance[#]

	for 24 hours. When no obvious bleeding in the drainage tube, the drainage tube was connected to a silicone negative pressure drainage ball and kept at negative pressure state					
	When drainage fluid became turbid, a flexible infusion set tube was connected, and 200 ml of normal saline was syringed into the wound cavity 3-5 times/day	Not reported	Not reported	Postoperative	Not reported	Drain irrigation[#]
Hewitt et al. (2017)	Glucose control, with a goal of less than 180 mg/dL	Not reported	Endocrinology consultation (in case hyperglycaemia persisted beyond treatment with standard sliding scale insulin)	Postoperative	Not reported	Glucose control[#]
	All dressings removal by the end of POD 2	Not reported	Not reported	Postoperative	Not reported	Dressing removal[#]
	Wound care service consultation was obtained for all ostomies and complex wounds	Not reported	Not reported	Postoperative	Not reported	Wound care consultation[#]
	Perioperative antibiotics were discontinued by the end of POD 1	Not reported	Not reported	Postoperative	Not reported	Administration of antibiotics[#]
Keenan et al. (2014)	Removal of dressing within POD 2	Not reported	Not reported	Postoperative	Not reported	Dressing removal[#]
	Daily cleansing of wound with chlorhexidine	Not reported	Not reported	Postoperative	Not reported	Daily wound cleanses[#]
	Patient education to continue daily and chlorhexidine wash until the	Not reported	Not reported	Postoperative	Not reported	Patient education[#]

	end of POD 7					
	Maintenance of euglycemia	Not reported	Not reported	Postoperative and intraoperative	Not reported	Glucose control[#]
	Maintenance of normothermia	Not reported	Not reported	Postoperative and intraoperative	Not reported	Normothermia maintenance[#]
Keenan et al. (2015)	Maintenance of euglycemia	Not reported	Not reported	Postoperative	Not reported	Glucose control[#]
	Maintenance of normothermia	Not reported	Not reported	Postoperative	Not reported	Normothermia maintenance[#]
	Removal of sterile dressing by the end of POD 2	Not reported	Not reported	Postoperative	Not reported	Dressing removal[#]
	Daily cleansing of incision with chlorhexidine for one week	Not reported	Not reported	Postoperative	Not reported	Wound cleansing[#]
León Arellano et al. (2021)	Assess dressing without any manipulation on days 1 through 6	Not reported	Not reported	Postoperative	Not reported	Wound assessment[#]
	Removal of dressing on POD 7	Not reported	Not reported	Postoperative	Not reported	Dressing removal[#]
	Staples removal on POD 10	Not reported	Not reported	Postoperative	Not reported	Staple removal[#]
Martinez et al. (2020)	Strict glucose control	Not reported	Not reported	Unclear	Not reported	Glucose control[#]
	IV cefoxitin administered an hour within incision time and every 8 hours postoperatively for 24 hours	Not reported	Not reported	Postoperative	Not reported	Administration of antibiotics[#]
Murphy et al. (2019)	NPWT until POD 5 / date of hospital discharge (whichever came first)	Not reported	Not reported	Postoperative	Not reported	Dressing removal[#]
Ocaña Jiménez et al. (2019)	NWPT until 1 week POD (unless medical complications occurred)	Not reported	Not reported	Postoperative	Not reported	Dressing removal[#]
Okuya et al. (2020)	NPWT removal on POD 3	Not reported	Not reported	Postoperative	Not reported	Dressing removal[#]
	Administration of antibiotic (1 g of cefmetazole as prophylaxis) up to	Not reported	Not reported	Postoperative	Not reported	Administration of antibiotics[#]

	24 hours postoperatively every 8 hours					
	Patients followed-up daily during hospitalised, 30 days postoperatively and at every follow-up examination	Not reported	Physician	Postoperative	Not reported	Wound assessment[#]
Pan et al. (2015)	Wounds observed on POD 3 and at discharge	Nurse practitioner	Attending surgeons	Postoperative	Not reported	Wound assessment
	Adhesive dressing change to keep wound and subcutaneous vacuum drain clean and dry	Not reported	Not reported	Postoperative	Not reported	Dressing change[#]
	Additional education course for patients before discharge	Nurse	Not reported	Postoperative	Not reported	Patient education
	The drainage tubing was milked daily to remove clots and avoid occlusion. The bulb was emptied every 24 h or when it was half full, and the amount of fluid was recorded	Not reported	Not reported	Postoperative	Not reported	Drain monitoring and maintenance[#]
	Subcutaneous vacuum drain until drainage was <10 ml for 24 hours	Not reported	Not reported	Postoperative	Not reported	Drain removal[#]
	Skin sutures or staples removal on POD 7–14, according to the surgeon's discretion	Not reported	Surgeon	Postoperative	Not reported	Staple or suture removal[#]
	After discharge, patients were asked to report signs of SSI	Not reported	Not reported	Postoperative	Not reported	Patient education[#]
Park et al. (2020)	Dressing applied using chlorhexidine within 48 hours from the time of surgery	Ward nurses	Note reported	Postoperative	Not reported	Dressing applied[#]
	Staff hand hygiene: prior to direct contact with patients; prior to invasive or nursing activities regardless of whether gloves are	Ward nurses	Not reported	Postoperative (and intraoperative)	General ward	Hand hygiene

	used or not; prior to contact with catheters, drains, and equipment parts directly in contact with patient's tissues; and prior to contact with blood, body fluids, and operation site before wound dressing. The infection control office educated about accurate method about hand hygiene, particularly regarding brushing and the duration and extent of rubbing					
	Prophylactic antibiotics discontinued within 24 hours after surgery end time	Ward nurses	Not reported	Postoperative	Not reported	Administration of antibiotics[#]
	Staff education	Scrub and ward nurses	Not reported	Pre-intervention	Not reported	Nurse education
Pellino, Sciaudone, Candilio, De Fatico, et al. (2014)	NWPT removal on POD 7	Not reported	Not reported	Postoperative	Not reported	Dressing removal[#]
	Gauzes were changed when too wet or after 3 days during the follow-up	Not reported	Not reported	Postoperative	Not reported	Dressing change[#]
Pellino, Sciaudone, Candilio, Campitiello, et al. (2014)	Special gauze connected to NWPT changed when too wet or after 3 days	Not reported	Not reported	Postoperative	Not reported	Dressing change[#]
	NWPT removal on POD 7 or when complication occurred	Not reported	Not reported	Postoperative	Not reported	Dressing removal[#]
	Additional NWPT cycle administered to selected patients, evaluated for removal at 4 POD	Not reported	Not reported	Postoperative	Not reported	Dressing applied[#]
	Antibiotics continued postoperatively as needed	Not reported	Not reported	Postoperative	Not reported	Administration of antibiotics[#]
Poehnert et al. (2017)	NWPT removal on POD 5	Not reported	Not reported	Postoperative	Not reported	Dressing removal[#]

Reese et al. (2020)	Maintain euglycemia	nurses	Not reported	Postoperative	"Floor"	Glucose control
	Dressing removal by the end of POD 2	nurses	Not reported	Postoperative	"Floor"	Dressing removal
	Daily wound cleansing	nurses	Not reported	Postoperative	"Floor"	Daily wound cleansing
	Chlorhexidine bath before discharge	Floor nurses	Not reported	Postoperative	"Floor"	Bathing
Ruiz-Tovar et al. (2015)	Dressing removal on POD 5 or earlier if SSI was suspected	Not reported	Surgeon	Postoperative	Not reported	Dressing removal[#]
Ruiz-Tovar et al. (2019)	Dressing removal on POD 5 or earlier if SSI was suspected	Not reported	Not reported	Postoperative	Not reported	Dressing removal[#]
Selvaggi et al. (2014)	NWPT removal on POD 7	Not reported	Not reported	Postoperative	Not reported	Dressing removal[#]
	Gauze changed when too wet on POD 3	Not reported	Not reported	Postoperative	Not reported	Dressing change[#]
	Additional NWPT cycle administered in selected patients	Not reported	Not reported	Postoperative	Not reported	Dressing applied[#]
Shakeshaft et al. (2020)	Glycaemic control with an insulin infusion for 48 hours	Not reported	Not reported	Applied intraoperative, continued postoperative	Operating theatre	Glucose control[#]
	BSL performed on admission to recovery ward and 60 minutes later	Not reported	Not reported	Postoperative	Recovery ward	Glucose control[#]
	On POD 3 diabetic patients returned to their usual diabetic medication regime	Not reported	Not reported	Postoperative	Not reported	Glucose control[#]
	On POD 3, hyperglycaemic patients who were able to eat commenced a low sugar diet	Not reported	Not reported	Postoperative	Not reported	Glucose control[#]
Siah and Yatim (2011)	Ionic silver containing dressing removal on discharge, which is POD 7	Not reported	Not reported	Postoperative	Surgical ward	Dressing removal[#]
	Dressing changed when bleeding was present or wound inspection	Ward nurse	Not reported	Postoperative	Surgical ward	Dressing change

	necessary (pictorial illustration provided to staff on how to apply the wound dressing)					
	Sutures removal and appropriate dressing applied if purulent exudate was trapped beneath the sutures	Not reported	Not reported	Postoperative	Surgical ward	Suture removal[#] and dressing applied[#]
Tanner et al. (2016)	Administration of supplementary oxygen	Not reported	Not reported	Postoperative (early postoperative phase)	Recovery and not reported	Administration of supplementary oxygen[#]
	Glucose control for diabetic patients	Not reported	Not reported	Postoperative (preoperative and intraoperative as well)	Not reported	Glucose control[#]
Uchino et al. (2016)	NWPT removal after 2 weeks of hospitalisation, after surgery, with exchange every 3-4 days	Not reported	Not reported	Postoperative	In hospital	Dressing change and removal[#]
Watanabe et al. (2017)	Drain removal on POD 5	Not reported	Not reported	Postoperative	Not reported	Drain removal[#]
Webb et al. (2019)	NWPT removal on POD 3-5	Not reported	Not reported	Postoperative	Not reported	Dressing removal [#]
Wierdak et al. (2021)	NWPT removal POD 3 and 3 steri-strips placed between sutures and standard sterile dressing applied	Not reported	Not reported	Postoperative	Not reported	Dressing removal[#], dressing applied[#]
	Daily dressing every 24 hours until sutures removal on POD 7	Not reported	Not reported	Postoperative	Ward	Daily dressing[#], sutures removal[#]

Only postoperative intervention components were extracted, some interventions also had components in the pre and intra operative stages and some interventions were combined with ERAS. [#]Authors interpreted that these were activities within nurses' scope of practice, although not reported explicitly reported in the manuscript that nurses were responsible for these activities

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Table 4. Summary of outcomes

Intervention	Outcomes	Positive effect on outcome(s)
NPWT n=17 studies	SSI	(Chadi et al., 2014) (Curran et al., 2019)* (Wierdak et al., 2021) (Ocaña Jiménez et al., 2019) (Pellino, Sciaudone, Candilio, Campitiello, et al., 2014) (Abadía et al., 2021) (Pellino, Sciaudone, Candilio, De Fatico, et al., 2014) (Okuya et al., 2020)# (Webb et al., 2019)*
	LOS	(Pellino, Sciaudone, Candilio, De Fatico, et al., 2014) (Selvaggi et al., 2014) (Chadi et al., 2014) (Poehnert et al., 2017)# (Pellino, Sciaudone, Candilio, Campitiello, et al., 2014)
	Seroma	(Pellino, Sciaudone, Candilio, De Fatico, et al., 2014) (Selvaggi et al., 2014) (Pellino, Sciaudone, Candilio, Campitiello, et al., 2014) (Okuya et al., 2020)#
	Haematoma	(Wierdak et al., 2021)# (Okuya et al., 2020)#
	Wound complications	(Selvaggi et al., 2014) (Curran et al., 2019) (Wierdak et al., 2021)
	Readmission	(Selvaggi et al., 2014)
SSI bundle n=10 studies	SSI	(Keenan et al., 2015)* (Cima et al., 2013)* (Keenan et al., 2014)* (Martinez et al., 2020) (Park et al., 2020)# (D'Souza et al., 2019) (Hewitt et al., 2017)* (Gorgun et al., 2018)* (Reese et al., 2020)#
	LOS	(Keenan et al., 2015) (Keenan et al., 2014) (Martinez et al., 2020) (D'Souza et al., 2019)
	Return to theatre	(Keenan et al., 2015)
	Readmission	(Keenan et al., 2015)
Wound drain n=4 studies	SSI	(Arslan et al., 2020) (Han et al., 2021) (Pan et al., 2015) (Watanabe et al., 2017)
	LOS	(Han et al., 2021)
Mupirocin ointment dressing n=2 studies	SSI	(Ruiz-Tovar et al., 2015)
Vitamin E ointment dressing n=2 studies	SSI	(Ruiz-Tovar et al., 2019)*
	LOS	(Ruiz-Tovar et al., 2019)
Stoma nurse counselling n=1 study	LOS	(Forsmo et al., 2016)
Insulin infusion n=1 study	SSI	(Shakeshaft et al., 2020)

*Positive result was dependent on type of SSI reported #Descriptive statistics suggested a downward trend. Positive effects indicate a statistically significant finding, unless otherwise stated.

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Table 5. Results of mapping to the 'Dimensions of the scope of nursing practice'

Dimensions	Number of activities mapped to dimension	Number of studies
Technical procedure and delegated medical care	63	36
Application of medicinal treatments	11	10
Patient assessment	5	4
Activities of daily living	3	3
Patient and family education	3	3
Quality of care and patient safety	2	2
Knowledge updating and utilization	2	2
Communication and care coordination	1	1
Care planning	0	0
Integration and supervision of staff	0	0
Miscellaneous/non-care	0	0
Personal time	0	0
Relational care and non-medication interventions	0	0

Table 6. PAGER framework

Pattern	Advances	Gaps	Evidence for practice	Research recommendations
Nurses enacting activities under doctor's orders.	There is a growing body of literature that suggests nurses need technical skills to enact activities under doctor's orders. Technical skills can be complex and include nurses managing and removing dressings and equipment, and administering medications.	There is limited evidence on postoperative nurses' independent contribution to preventing wound complications in patients undergoing CR surgery. There is variation in the timing of activities that are delivered by nurses, under doctor's orders.	Ongoing education/training is required for postoperative nurses to keep pace with new technologies (e.g. managing NWPT). Regular assessment of nursing skills is needed to ensure safe nursing actions (i.e. administration of medications).	Research is needed to understand and measure the full scope of nurses' practice in the provision of postoperative care to prevent wound complications in patients undergoing CR surgery. For example, while there is a large focus on technical nursing activities, other nursing activities like 'patient and family education' or 'quality of care and patient safety (such as hand hygiene)' are possible avenues for exploration to improve postoperative wound complications. Future research is needed to identify the optimal timing for nurses to enact doctors' orders such as dressing removal.
Independent nursing activities and clinical	There is emerging evidence that NWPT and SSI bundles may reduce SSI and length	There is no evidence of outcomes that can be attributed to independent nursing activities. Outcomes found reflect collaborative	Outcomes can be used to assess the quality of nursing care. Regular audits of outcomes sensitive to nursing care can help to identify areas to improve	Research to identify the extent to which core outcomes for CR surgery are sensitive to independent nursing care.

outcomes.	of stay.	interventions.	prevention of wound complications in patients undergoing CR surgery.	