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Prophylactic Incisional Negative-Pressure Wound Therapy Versus Conventional Dressings in Emergency Colorectal Surgery: A Systematic Review of Randomized Controlled Trials

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Abstract

Choosing between prophylactic closed-incision negative pressure therapy and conventional sterile dressings remains a complex clinical challenge in emergency abdominal and acute colorectal surgery, where high contamination classes and physiological instability create severe vulnerabilities to incisional breakdown. This study compares how closed-incision negative pressure therapy and standard wound management perform against each other in emergency laparotomies and acute colorectal operations, focusing on primary 30-day surgical site infection rates, secondary abdominal wall complications, adverse safety profiles, and patient-reported outcomes. The literature search covered PubMed/MEDLINE, Scopus, SciELO (Scientific Electronic Library Online), LILACS (Latin America and the Caribbean Literature on Health Sciences), and CENTRAL (Cochrane Central Register of Controlled Trials) up to 2026, targeting prospective randomized controlled trials (RCTs) published between 2021 and 2026 evaluating prophylactic interventions against conventional dressings in adult emergency cohorts, with quality assessment relying on the Cochrane Risk of Bias 2 tool. Five prospective RCTs enrolling 1,221 patients qualified for qualitative analysis. Individual trials displayed distinct outcomes: smaller prospective studies reported notable reductions in superficial infections, whereas the large-scale pragmatic SUNRRISE trial (Single Use Negative pRessure dressing for Reduction In Surgical site infection following Emergency laparotomy) found no statistically significant difference in primary infection rates between groups. Secondary endpoints indicated selective mechanical benefits, such as reduced superficial dehiscence and lower day 7 pain scores, while hospital stay and mortality remained comparable. Prophylactic negative pressure exhibited good local device tolerance, with adverse events restricted to minor cutaneous reactions that resolved spontaneously. Substantial clinical and technical heterogeneity precluded formal quantitative meta-analysis pooling. Ultimately, prophylactic closed-incision negative-pressure therapy does not consistently eliminate primary infection rates across all high-risk emergency cohorts. However, it offers a favorable safety profile and advantages in early patient-reported recovery, warranting further standardized trials to define optimal application parameters and patient selection.

Categories: General Surgery, Emergency Medicine, Gastroenterology
Keywords: colorectal surgery, emergency surgery, negative-pressure wound therapy, randomized controlled trials, surgical site infection

Introduction And Background

National database registries confirm that surgical site infections (SSIs) remain a primary driver of post-operative morbidity, resource utilization, and escalating healthcare expenditures following major abdominal operations [1-3]. While advances in minimally invasive techniques have facilitated notable downward trends in infection rates across elective colorectal cohorts, emergency operations continue to face stagnant clinical outcomes and persistently elevated complication burdens [1]. This disproportionate risk is particularly pronounced in emergency laparotomies and acute colorectal interventions, where high contamination classes and physiological instability create an environment highly vulnerable to incisional breakdown [4]. Consequently, identifying reliable, standard prophylactic interventions to mitigate these risks remains a critical clinical priority.

For several decades, surgeons have relied on conventional sterile dressings as the primary defense to protect closed surgical wounds. However, these passive systems do not actively counteract the mechanical forces acting upon the abdominal wall. Closed-incision negative pressure therapy (ciNPT) emerged to address these limitations by shifting the therapeutic approach from passive absorption to active biomechanical stabilization. Basic and translational research demonstrates that applying negative pressure across closed incisions leads to an immediate and reversible increase in local microvascular cutaneous perfusion [5], while experimental and multidisciplinary consensus data indicate simultaneous reductions in lateral fascial tension and elimination of dead space [6]. Even so, managing high-risk emergency incisions requires careful

consideration, as local patient factors and varying clinical protocols can influence overall device efficacy.

Practicing acute care surgeons and investigators face a cluttered landscape because existing comparative trials and systematic evaluations utilize highly diverse negative-pressure parameters, mixed device configurations (such as single-use vs. continuous systems), and disparate wound classes [7]. Furthermore, emerging systematic evaluations and contemporary comparative studies consistently analyze whether prophylactic negative pressure outperforms standard dressings in high-risk emergency fields. This structural and methodological variation, coupled with contrasting observations between large database analyses and randomized trials, makes it difficult to pinpoint exactly under which clinical thresholds barrier devices offer a definitive advantage over conventional management [4,7].

To address this uncertainty, this systematic review specifically synthesizes prospective randomized controlled trials (RCTs) published between 2021 and 2026 comparing incisional negative-pressure therapy against conventional dressings in emergency colorectal surgery and emergency laparotomies. By focusing strictly on contemporary trials, this review uniquely evaluates modern standardized application protocols, 30-day primary infection endpoints, and secondary abdominal wall complications to provide an updated, non-fragmented breakdown of their comparative prophylactic efficacy and safety profile.

Review

Methods

Study Registration and Protocol

This systematic review was prospectively registered in the International Prospective Register of Systematic Reviews (PROSPERO) under the registration number CRD420261536841 [8].

Study Criteria and Eligibility

The methodological design followed the operational steps mandated by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement [9]. To filter the literature effectively, selection parameters were organized around a dynamic Population, Intervention, Comparator, and Outcomes (PICO) structure [10]:

Population (P): Clinical trial cohorts involving human subjects aged 16 years or older with no restrictions regarding participant sex, who underwent emergency colorectal surgical interventions presenting clean-contaminated, contaminated, or dirty wound classifications (e.g., complicated diverticulitis, bowel obstruction, perforated viscus, or acute trauma requiring emergency laparotomy or laparoscopic conversion with primary fascial closure). Conversely, criteria excluded elective colorectal resections, pediatric cohorts, patients managed strictly with open abdomen configurations or delayed primary closure strategies, and cases presenting active preoperative abdominal wall sepsis or open wound management prior to intervention. Studies including mixed emergency and elective cohorts (such as those with a predominant emergency representation) were selectively retained if they provided extractable emergency subgroup data or contributed necessary outcome metrics for sensitivity analyses.

Intervention (I): The core clinical track demanded the primary application of prophylactic closed-incision negative-pressure wound therapy (ciNPT) systems directly over closed surgical incisions immediately following emergency colorectal operations. Studies evaluating alternative wound management strategies or combining ciNPT with non-standard adjuncts without an isolated comparative arm were excluded.

Comparator (C): Comparative arms had to evaluate standard conventional postoperative wound dressings (e.g., standard gauze, non-adherent pads, or transparent film dressings) applied over closed primary incisions. Investigations dealing solely with non-comparative case series, historical controls, or alternative active interventions without a standard dressing control group were excluded.

Outcomes (O): Matching studies had to provide objective metrics concerning SSI rates (stratified as superficial, deep, or organ/space), while documenting secondary recovery parameters such as wound dehiscence incidence, seroma or hematoma formation, length of hospital stay, and reintervention or readmission rates within 30 days postoperatively.

To maintain real clinical relevance for modern acute care surgery, the search was restricted entirely to prospective randomized controlled trials (RCTs) published between 2021 and 2026. This restricted timeframe was deliberately defined to evaluate contemporary trials reflecting modern standardized negative pressure parameters, contemporary antimicrobial stewardship protocols, and standardized surgical bundles, thereby minimizing clinical heterogeneity from obsolete device iterations or outdated wound care protocols. This timeframe intentionally excluded non-randomized observational cohorts, retrospective case-control designs, case series ($n < 5$), personal editorials, letters to the journal editor, and conference presentations missing complete numerical results.

Information Sources and Search Strategy

The literature retrieval involved systematic queries across PubMed, Medical Literature Analysis and Retrieval System Online (MEDLINE), Scopus, Scientific Electronic Library Online (SciELO), Latin American and Caribbean Health Sciences Literature (LILACS), and the Cochrane Central Register of Controlled Trials (CENTRAL). Our search approach combined text keywords and official medical subject descriptors (MeSH terms for PubMed/MEDLINE) through logical Boolean connectors. The implemented search sequence was designed to capture specific intersections: ("surgical site infection" OR "wound complications" OR "incisional negative pressure wound therapy" OR "ciNPT" OR "vacuum-assisted closure") AND ("emergency colorectal surgery" OR "peritonitis" OR "acute abdomen" OR "colorectal resection") AND ("randomized controlled trial"). Full-text availability was required to ensure thorough data extraction.

The detailed database-specific search strategies, including controlled vocabularies (MeSH), field tags, filters, search dates, and exact Boolean operators for all searched databases, are provided in Table *1*.

Database	Search strategy / syntax	Filters / limits	Search date
PubMed / MEDLINE	("surgical site infection"[Mesh] OR "surgical site infection" OR "wound complications" OR "incisional negative pressure wound therapy" OR "iNPT" OR "vacuum-assisted closure") AND ("emergency colorectal surgery" OR "peritonitis" OR "acute abdomen" OR "colorectal surgery" OR "emergency laparotomy") AND ("randomized controlled trial"[Publication Type] OR "randomized controlled trial" OR "controlled clinical trial")	Humans, Clinical Trial, Randomized Controlled Trial, English, Spanish	October 2026
CENTRAL	(#1 MeSH descriptor: [Surgical Wound Infection] explode all trees OR "surgical site infection":ti,ab,kw) AND (#2 MeSH descriptor: [Negative-Pressure Wound Therapy] explode all trees OR "incisional negative pressure":ti,ab,kw) AND (#3 MeSH descriptor: [Colorectal Surgery] explode all trees OR "emergency laparotomy":ti,ab,kw)	Trials	October 2026
Scopus	TITLE-ABS-KEY ((“surgical site infection" OR "wound complications" OR "incisional negative pressure therapy" OR "ciNPT”) AND (“emergency colorectal surgery" OR "peritonitis" OR "emergency laparotomy”) AND (“randomized controlled trial”))	Article, Article in Press, English, Spanish	October 2026
SciELO	(("surgical site infection" OR "infección del sitio quirúrgico" OR "ciNPT") AND ("colorectal surgery" OR "cirugía colorrectal" OR "laparotomía de urgencia"))	All Indexes	October 2026
LILACS	(("surgical site infection" OR "complicaciones de la herida") AND ("negative pressure wound therapy" OR "terapia de presión negativa") AND ("emergency surgery" OR "cirugía de urgencia"))	Humans	October 2026

TABLE 1: Detailed database-specific search strategies and query strings.

Database-specific search strategies include controlled vocabularies, field tags, Boolean operators, and applied filters used to identify eligible studies published up to October 2026.

CENTRAL: Cochrane Central Register of Controlled Trials; ciNPT: closed-incision negative-pressure therapy; LILACS: Latin American and Caribbean Health Sciences Literature; MeSH: Medical Subject Headings; SciELO: Scientific Electronic Library Online

Study Selection and Data Extraction

Two reviewers independently screened titles and abstracts retrieved from the database search against preset inclusion criteria. Full-text copies of candidate studies were then evaluated for final selection. Disagreements between reviewers were settled by discussion or by consulting a third author. Data were extracted independently into a standardized form to record study characteristics, patient baseline demographics, ciNPT and conventional dressing protocols, primary outcomes (30-day SSI rates), secondary parameters (wound dehiscence, seroma, hematoma, length of stay, and readmissions or reinterventions), and adverse events. Missing data were analyzed as reported without imputation, and no automation tools were used during the screening phase.

Risk-of-Bias Assessment

Methodological quality across included RCTs was appraised independently using the Cochrane Risk of Bias 2 (RoB 2) tool [11]. Outcome-level evaluations distinguished primary objective endpoints (physician-assessed

30-day SSI rates) from secondary measures (wound dehiscence, seroma, hematoma, length of stay, and readmission or reintervention rates). Objective clinical endpoints generally carried a lower risk of detection bias, whereas unblinded open-label trial designs introduced higher performance and measurement concerns for subjective secondary outcomes. Five standardized domains were examined: randomization process, deviations from intended interventions, missing outcome data, outcome measurement, and selection of reported results. Disagreements between evaluators were settled through protocol re-examination and consensus. RoB figures were constructed using the RobVis software [12]. Evidence certainty for main clinical outcomes was categorized via the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) framework across RoB, inconsistency, indirectness, imprecision, and publication bias domains [13].

Data Synthesis

Trial comparability and clinical heterogeneity were evaluated prior to evidence aggregation. While quantitative pooling was initially considered, a formal meta-analysis was omitted due to substantial methodological diversity in ciNPT application parameters (variations in device models, negative pressure levels, and dressing duration) alongside inconsistent outcome definitions and assessment intervals across surgical cohorts. To prevent biased pooled estimates, data were synthesized narratively in accordance with the SWiM (Synthesis Without Meta-analysis) reporting guidelines [14]. Results were systematically categorized by primary prophylactic efficacy regarding 30-day SSIs, secondary abdominal wall recovery parameters (wound dehiscence, seroma, and hematoma incidence), postoperative clinical metrics (hospital length of stay, readmissions, and reinterventions), and documented adverse device profiles.

Results

Study Selection and Screening Flow

Initial electronic database searches yielded a total of 142 records. Following duplicate removal and title/abstract screening, 32 full-text articles were assessed for eligibility. As detailed in the PRISMA flow diagram (Figure *1*), 27 reports were subsequently excluded for failing to meet the predefined inclusion criteria (such as non-prophylactic application, lack of a standard control group, or absent 30-day metrics). Ultimately, five prospective randomized controlled trials satisfied all requirements and were included in the qualitative synthesis [15-19].

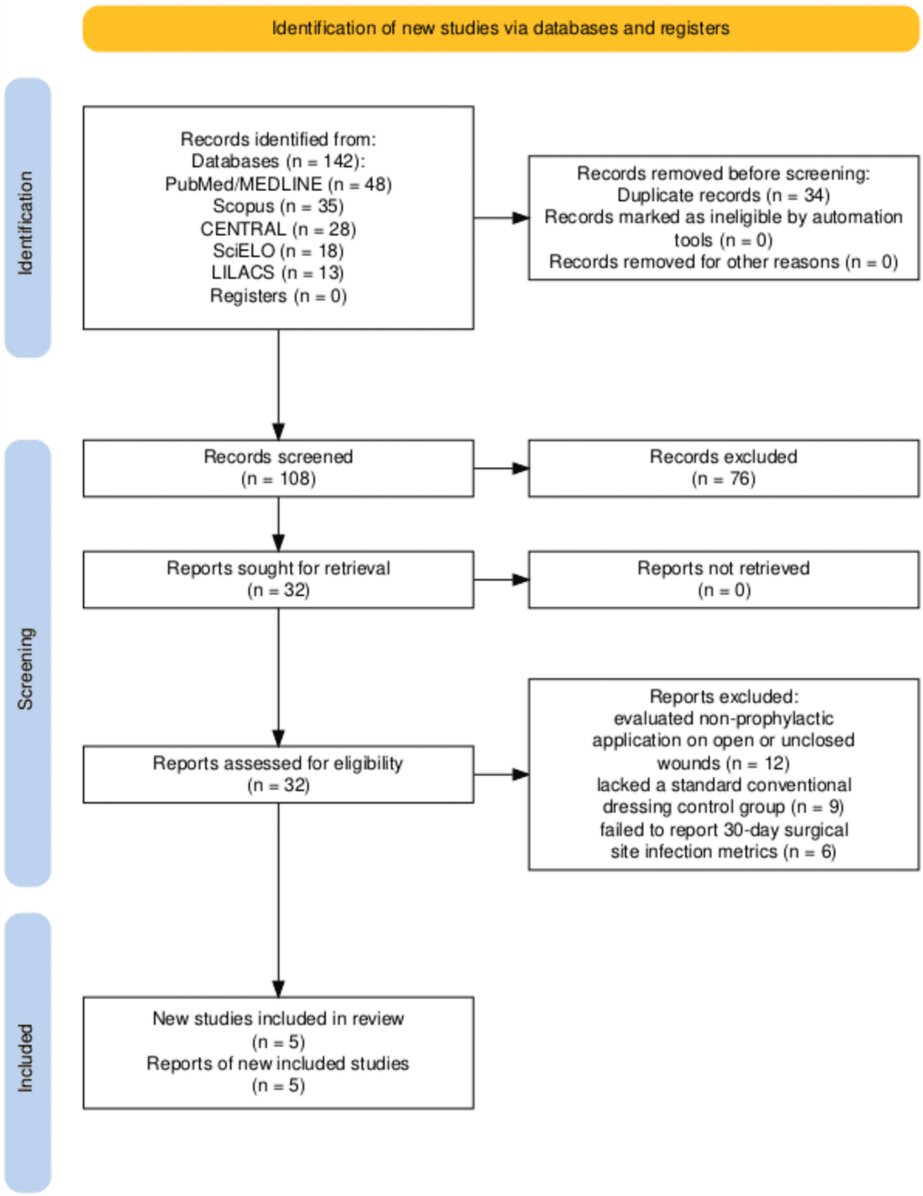


FIGURE 1: PRISMA 2020 flow diagram for the systematic review process

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 flow diagram detailing the identification, screening, eligibility, and inclusion phases of prospective randomized controlled trials evaluating prophylactic incisional negative-pressure therapy in emergency colorectal surgery.

CENTRAL: Cochrane Central Register of Controlled Trials; LILACS: Latin American and Caribbean Health Sciences Literature; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses; SciELO: Scientific Electronic Library Online

Methodological and Population Characteristics

Table *2* outlines the baseline design parameters and clinical setups across the five included RCTs. Treatment regimens spanned five to seven days of continuous negative-pressure application across a combined cohort of 1,221 evaluated patients undergoing emergency laparotomy or urgent colorectal interventions with primary closure. All trials utilized prospective randomized designs, incorporating multicenter pragmatic cohorts, open-label comparative arms, and double-blind protocols [15-19]. Experimental interventions comprised single-use or canister-based prophylactic negative-pressure systems (PICO™ and PREVENA™) set at continuous pressures ranging from -80 mmHg to -125 mmHg, compared directly against standard conventional wound dressings.

Study (author, year)	Study design	Sample size	Population	Technical arms	Intervention regimens
Herczeg et al., 2025 [15]	Multicenter prospective RCT	N = 90 evaluated (ciNPT: 45, control: 45)	High-risk emergency laparotomy patients (aged 18–80 years, class III–IV wounds)	Experimental arm: ciNPT system (silver mesh, PVA foam, continuous suction. Control arm: Standard dry gauze or absorbent dressings.	Experimental arm: Continuous −90 mmHg for five days without changes. Control arm: Local routine dressing care without negative pressure.
SUNRRISE Trial Study Group, 2025 [16]	Pragmatic international multicenter prospective RCT	N = 788 analyzed (ciNPT: 394, control: 394; initial: 840 randomized)	Adult patients (aged ≥16/18 years) undergoing emergency laparotomy requiring primary fascial and skin closure (≥ 5 cm incision)	Experimental arm: PICO 7 topical negative pressure dressing (Smith & Nephew). Control arm: Surgeon's preference of simple conventional wound dressings (no ciNPT).	Experimental arm: Continuous −80 mmHg applied immediately post-closure in operating room, intended for seven days or until discharge. Control arm: Standard local routine dressing changes.
Di Re et al., 2021 [17]	Prospective, non-blinded, multicenter phase III RCT	N = 124 analyzed (ciNPT: 61, control: 63; initial: 127 enrolled)	Adult surgical cohort (trial inclusion ≥16 years, 49.2% emergency operations)	Experimental arm: PREVENA™ Incision Dressing (KCI) covering entire incision. Control arm: Standard postoperative dressings (Cutiplast™ or Comfeel®).	Experimental arm: Pre-set continuous negative pressure of −125 mmHg applied for five to seven days. Control arm: Standard dressing care left for five to seven days.
Costa et al., 2024 [18]	Single-center prospective open-label multi-arm RCT	N = 123 analyzed (Prevena: 41, PICO: 39, control: 43; initial: 127 randomized)	Adult patients diagnosed in emergency/surgery departments requiring urgent laparotomy	Experimental arm 1: Prevena™ ciNPT system. Experimental arm 2: PICO™ ciNPT system. Control arm: Conventional waterproof sterile dressings.	Experimental arms 1 and 2: ciNPT applied post-closure and maintained for seven days (PICO revised between days three to four). Control arm: Standard dressing changes every two days.
Philip et al., 2024 [19]	Single-center double-blind RCT	N = 96 analyzed (PICO: 47, control: 49; initial: 111 randomized)	Adult patients (aged ≥ 18 years, ASA 1–4) undergoing emergency laparotomy (midline incision < 35 cm) for gastrointestinal indications	Experimental arm: PICO™ 7 single-use ciNPT system (30 x 10 cm or 40 x 10 cm). Control arm: Standard occlusive island dressing + non-functioning dummy PICO device (patient-blinded).	Experimental arm: Pre-set continuous −80 mmHg applied immediately post-skin closure for seven days. Control arm: Standard dressing changes; dummy device removed at day 7.

TABLE 2: Main methodological characteristics and intervention regimens of the included clinical trials.

ciNPT: closed incisional negative pressure therapy; PVA: polyvinyl alcohol; RCT: randomized controlled trial; SSI: surgical site infection; ASA: American Society of Anesthesiologists

Risk of Bias and Quality Assessment Results

Assessment via the Cochrane RoB 2 tool [11] revealed variable methodological quality across the five included RCTs [15-19]. Overall RoB was low to moderate for primary objective outcomes (30-day SSIs), whereas secondary open-label parameters demonstrated greater vulnerability to performance and measurement biases.

Specifically, only the SUNRRISE Trial (Single Use Negative pRessure dressing for Reduction In Surgical site infection following Emergency laparotomy) Study Group (2025) [16] and Philip et al. (2024) [19] achieved a low overall RoB across all appraised domains, supported by rigorous allocation concealment, adequate assessor blinding via matched dummy devices, and robust follow-up procedures. Conversely, Herczeg et al. (2025) [15] introduced a high overall RoB driven primarily by high risk in Domain 3 owing to a substantial 28% attrition rate (90 analyzed from 125 randomized), alongside Domain 2 concerns due to unblinded clinical care. Meanwhile, Di Re et al. (2021) [17] showed Domain 2 concerns stemming from an open-label design. A high overall RoB was identified solely in Costa et al. (2024) [18], driven primarily by Domain 2 high

risk (open-label setting without blinding of patients or surgeons, alongside post-randomization exclusions) and additional Domain 1 and Domain 4 concerns regarding allocation concealment and outcome assessor blinding.

Domain-specific evaluations are summarized in Figure 2. Per the GRADE framework, certainty of evidence for primary SSI reduction was graded as moderate, limited by clinical heterogeneity in negative pressure protocols and performance bias in unblinded cohorts [13]. Given that two trials (Costa et al. [18] and Herczeg et al. [15]) presented a high overall RoB, comparative findings across secondary endpoints are interpreted with appropriate methodological caution.

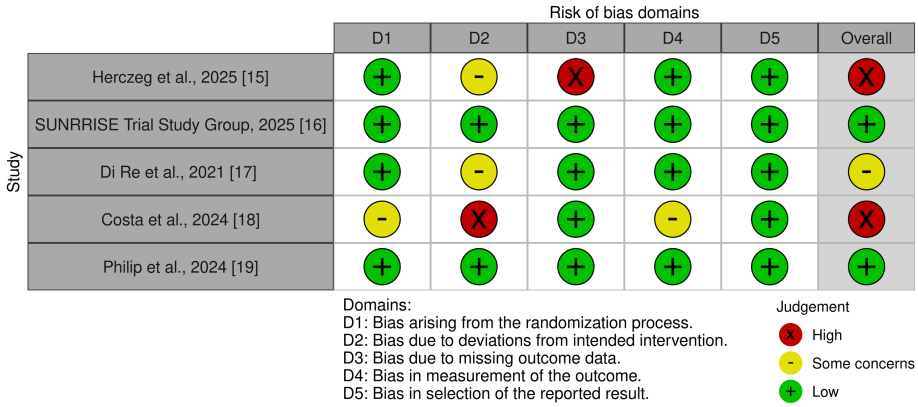


FIGURE 2: Risk-of-bias traffic-light plot for the included randomized controlled trials.

Risk-of-bias assessment generated using the Cochrane RoB 2 tool via the robvis application. Domains: D1 (randomization process); D2 (deviations from intended interventions); D3 (missing outcome data); D4 (measurement of the outcome); D5 (selection of the reported result).

Citation: [15-19]

Primary Prophylactic Efficacy: Surgical Site Infections

The protective effect of ciNPT against 30-day SSIs varied across trials (Table 3). Significant reductions in primary SSI incidence were documented by Herczeg et al. [15], where overall SSI rates reached 22.2% (10/45) in the ciNPT arm compared to 44.4% (20/45) in standard controls ($p = 0.025$), driven predominantly by a decline in superficial SSIs (20.0% vs. 40.0%, p = 0.038). Similarly, Costa et al. [18] demonstrated marked reductions in overall surgical site occurrences (26.8% Prevena vs. 20.5% PICO vs. 53.5% control, $p < 0.01$) and clinical SSI rates (12.2% Prevena vs. 7.7% PICO vs. 30.2% control, $p = 0.02$). In Philip et al. [19], a downward trend in 30-day SSI was observed with PICO (4.3% [2/47] vs. 14.3% [7/49]), though this did not reach statistical significance ($p = 0.09$).

Study (author, year)	Follow-up	Evaluation metrics / outcomes	Key findings	Documented adverse events	Withdrawals
Herczeg et al., 2025 [15]	Follow-up: 30 days postoperatively (assessments at day 5 and day 30)	Primary endpoint: Superficial surgical site infection (SSI) requiring suture removal and open wound management (Clavien-Dindo 2+) within 30 days. Secondary endpoints: Full-thickness abdominal wall dehiscence requiring re-operation, superficial vs. deep SSI rates, and mortality.	Overall SSI: 22.2% (10/45) in ciNPT vs. 44.4% (20/45) in control (p = 0.025). Superficial SSI: 20% (9/45) in ciNPT vs. 40% (18/45) in control (p = 0.038). Deep SSI: 4.4% (2/45) in ciNPT vs. 4.4% (2/45) in control ($p = 1.0$). Abdominal dehiscence: 2.2% (1/45) in ciNPT vs. 4.4% (2/45) in control ($p = 0.513$). Mortality: 15.6% (7/45) in ciNPT vs. 11.1% (5/45) in control ($p = 0.535$).	No device-related adverse events or severe complications directly attributed to ciNPT were reported; minor wound pain was managed by adjusting negative pressure to −70 mmHg.	Out of 125 randomized patients, 35 were excluded or withdrawn prior to final evaluation due to protocol violations or incomplete 30-day follow-up, leaving N = 90 fully analyzed cases.

SUNRRISE Trial Study Group, 2025 [16]	30 days postoperatively (assessments at days 7–10 and day 30)	Primary endpoint: 30-day surgical site infection (SSI) per CDC criteria. Secondary endpoints: hospital LOS, 30-day wound complications, readmissions, wound pain (VAS), quality of life (SF-12, EQ-5D-5L), and mortality.	Primary SSI: 28.4% (112/394 analyzed patients) in ciNPT vs. 27.4% (108/394) in control (RR = 1.03, 95% CI 0.83–1.28, p = 0.78). Wound pain (day 7): lower in ciNPT (2.6 vs. 3.0 points, mean diff -0.41, p = 0.01). Hospital LOS and readmissions: No significant differences between groups (p > 0.05). Mortality (30-day): 2.4% (10/411 randomized safety cohort) in ciNPT vs. 3.4% (14/410) in control.	Serious adverse events (SAEs) occurred in 38% (ciNPT) vs. 40% (control); specific complications like enterocutaneous fistulae and skin reactions were comparable.	52 post-randomization exclusions/withdrawals prior to primary analysis (leaving N = 788 analyzed patients).
Di Re et al., 2021 [17]	30 days postoperatively (assessments at days 5–7 and day 30)	Primary endpoint: Superficial SSI rate at day 30 per CDC criteria. Secondary endpoints: Early superficial SSI (days 5–7), deep/organ-space SSI, hospital length of stay, fascial dehiscence, cosmetic outcomes, and complications.	Superficial SSI (Day 30): 9.8% (6/61) in ciNPT vs. 20.6% (13/63) in control (p = 0.10, OR 2.41 for control). Superficial wound dehiscence: 0% (0/61) in ciNPT vs. 9.5% (6/63) in control (p = 0.03). Hospital length of stay: Median 13 vs. 15 days (p = 0.42). Deep/organ-space SSI: No significant differences between arms.	Four dressing-related adverse events (6.6%) in ciNPT group (superficial blistering around incision in one patient with undocumented silver allergy) vs. zero in control; resolved without intervention.	Three patients dropped out or were excluded prior to final analysis (leaving N = 124 analyzed cases).
Costa et al., 2024 [18]	30 days postoperatively	Primary endpoint: Surgical site infection (SSI) per clinical/laboratory signs and wound discharge. Secondary endpoints: Surgical site occurrences (SSOs: seroma, hematoma, wound dehiscence), fascial dehiscence, hospital LOS, reinterventions, readmissions, and mortality.	Overall SSOs: 26.8% (Prevena) vs. 20.5% (PICO) vs. 53.5% (control) (p < 0.01). Surgical site infection: 12.2% (Prevena) vs. 7.7% (PICO) vs. 30.2% (control) (p = 0.02). Wound dehiscence (superficial): 4.9% (Prevena) vs. 0% (PICO) vs. 9.3% (control) (p = 0.15). General morbidity / LOS / mortality: No significant differences among groups (p > 0.05).	Not explicitly detailed beyond specific wound complications (seroma, hematoma, and dehiscence).	Four patients excluded post-randomization due to protocol non-compliance (leaving N = 123 analyzed cases).
Philip et al., 2024 [19]	30 days postoperatively (assessments at days 3, 7, 14, and 30)	Primary endpoint: 30-day surgical site infection (SSI) rate per CDC criteria. Secondary endpoints: Seroma, wound dehiscence, hospital LOS, dressing duration, patient-reported wound experience (satisfaction, pain, odor, pulling), and burst abdomen.	SSI (Day 30): 4.3% (2/47) in PICO vs. 14.3% (7/49) in control (p = 0.09). Wound dehiscence: 10.6% (5/47) in PICO vs. 26.5% (13/49) in control (p = 0.066). Seroma: 23.4% (11/47) in PICO vs. 40.8% (20/49) in control (p = 0.083). Dressing duration: 9.78 ± 10.20 days (PICO) vs. 17.78 ± 16.46 days (control) (p < 0.001). Patient satisfaction: 80% (PICO) vs. 57.1% (control) very satisfied (p = 0.031).	Minimal minor complaints reported in PICO group (infrequent itching, pulling sensation, or mild pain/anxiety during dressing removal). Burst abdomen occurred in two control cases (required relaparotomy) vs. one PICO case (managed non-operatively).	15 post-randomization dropouts (eight deaths, five defaulted follow-up, two relaparotomies for non-SSI causes), leaving N = 96 analyzed cases.

TABLE 3: Clinical outcomes, efficacy variables, and safety profiles of the analyzed studies.

Statistically significant difference (p < 0.05).

CDC: Centers for Disease Control and Prevention; ciNPT: closed incisional negative pressure therapy; LOS: length of stay; OR: odds ratio; RCT: randomized controlled trial; RR: relative risk; SAE: serious adverse event; SSI: surgical site infection; SSO: surgical site occurrence; VAS: visual analog scale

Conversely, the large-scale, pragmatic SUNRRISE trial [16] found no significant difference in the 30-day primary SSI per CDC criteria between ciNPT (28.4%, 112/394) and conventional dressings (27.4%, 108/394; RR = 1.03, 95% CI: 0.83-1.28, p = 0.78). Di Re et al. [17] likewise recorded statistically comparable superficial SSI rates at 30 days (9.8% ciNPT vs. 20.6% control, p = 0.10), with deep/organ-space SSIs showing no significant divergence between intervention and control cohorts across all five evaluated trials [15-19].

Secondary Abdominal Wall Complications and Recovery Parameters

Secondary wound endpoints demonstrated selective mechanical advantages for negative-pressure configurations. Superficial wound dehiscence was significantly lower in ciNPT cohorts in Di Re et al. [17] (0% vs. 9.5%, p = 0.03). Philip et al. [19] noted reductions in both wound dehiscence (10.6% PICO vs. 26.5% control, $p = 0.066$) and seroma formation (23.4% PICO vs. 40.8% control, $p = 0.083$), alongside a statistically significant decrease in total dressing application duration (9.78 ± 10.20 days in PICO vs. 17.78 ± 16.46 days in control, $p < 0.001$). Full-thickness fascial dehiscence requiring re-operation remained rare and statistically similar across arms in Herczeg et al. [15] (2.2% vs. 4.4%, $p = 0.513$) and Philip et al. [19] (one burst abdomen in PICO vs. two in control).

Across all five trials [15-19], systemic clinical recovery metrics, specifically total hospital length of stay, 30-day unplanned readmission rates, reintervention incidence, and 30-day post-operative mortality, showed no statistically significant differences between ciNPT and conventional dressing groups ($p > 0.05$).

Safety Profile, Device Tolerance, and Patient Experience

Prophylactic negative-pressure interventions exhibited favorable overall safety, with adverse events restricted to localized, non-severe tissue reactions. Herczeg et al. [15] reported no severe device-related complications, with minor incisional pain effectively managed by reducing negative pressure levels to -70 mmHg. Di Re et al. [17] recorded four dressing-related cutaneous events (6.6% in ciNPT), consisting of superficial blistering or localized silver contact reactions that resolved spontaneously. SUNRRISE trial reported comparable serious adverse event rates between ciNPT (38%) and controls (40%), including similar rates of enterocutaneous fistulae and skin reactions [16].

Regarding patient-reported outcomes, the SUNRRISE trial documented significantly lower wound pain scores at day 7 in the ciNPT group (2.6 vs. 3.0 points on the VAS scale, mean difference -0.41, $p = 0.01$) [16]. Furthermore, Philip et al. [19] demonstrated superior patient satisfaction, with 80% of PICO patients reporting high satisfaction compared to 57.1% in the conventional dressing group ($p = 0.031$), despite minor complaints of transient itching or pulling sensations during device removal.

Discussion

Principal Findings

SSIs remain a frequent clinical challenge following emergency laparotomies and acute colorectal procedures [4]. When analyzing the available randomized trials, the overall findings present varied outcomes regarding absolute infection prevention across different patient cohorts [15-19]. Rather than displaying universal superiority, clinical outcomes tend to vary depending on the specific contamination level of the incision and individual patient risk factors [4,15-19]. ciNPT functions primarily by reducing lateral tension across closed skin edges and assisting in the drainage of accumulated subcutaneous fluid, a mechanism evaluated in ex vivo biomechanical abdominal wall models [20]. Conventional dry dressings, although simpler to apply, lack this active mechanical mechanism [7,15-19].

Contextualizing With Existing Literature

The individual prospective trials evaluated in this review suggest local benefits associated with ciNPT, although these findings require careful interpretation due to differences in sample sizes and study designs [15-19]. While smaller or moderate-scale multicenter studies (such as those by Herczeg et al. [15] and Costa et al. [18]) contrast with the large-scale pragmatic findings of the SUNRRISE trial [16], together they highlight the clinical variability inherent to emergency abdominal surgery, where factors such as fecal contamination and urgent operational timelines influence wound healing [4,15-19]. These findings align with recent secondary literature: the meta-analysis by Manasrah et al. [21] confirms an overall reduction in infection risk using negative-pressure systems (RR = 0.61), while simultaneously noting substantial statistical heterogeneity ($I^2 = 66\%$). Consequently, the clinical utility of these devices depends heavily on careful patient selection [4,7], strict adherence to international infection control protocols [22], and standardized emergency surgery management algorithms [23].

Clinical Implications and Application Parameters

From a broader clinical perspective, refining application parameters such as maintaining consistent negative-pressure levels between -70 mmHg and -125 mmHg for a standard five-to-seven-day duration remains essential to maximize the performance of ciNPT [15-19], supported by guidelines [23]. Decision-analytic economic models suggest that prophylactic ciNPT is cost-effective at reducing SSI rates across varying risk profiles [24], although further evaluations are warranted in resource-constrained healthcare settings.

Limitations

Several methodological limitations affect the generalizability of these findings. First, RoB evaluation via the Cochrane RoB 2 tool identified variable methodological quality, with two of the included trials exhibiting an overall high RoB driven by unblinded open-label protocols, high attrition rates, lack of outcome assessor blinding, and post-randomization exclusions, alongside additional trials raising some concerns. Second, trial protocols showed noticeable clinical heterogeneity in negative pressure delivery, including differences in device configurations (single-use PICO vs. canister-based PREVENA systems), continuous negative pressure levels (-80 mmHg to -125 mmHg), and varying degrees of wound contamination across emergency laparotomy cohorts. Additionally, secondary outcome reporting varied across studies, incorporating subjective secondary endpoints that were more vulnerable to performance and measurement biases. Furthermore, inherent methodological limitations of this review must be explicitly acknowledged: the literature search was intentionally restricted to studies published from 2021 to 2026, full-text availability was required for inclusion, the final qualitative synthesis was based on a selective pool of eligible RCTs (n = 5, N = 1,221), and substantial clinical or technical heterogeneity precluded formal quantitative meta-analysis pooling while reinforcing the methodological limitations that constrained the certainty of evidence assessment. Finally, potential language restrictions limiting records to English and Spanish studies introduced a minor source of selection bias.

Conclusions

While individual trials demonstrate selective mechanical and local benefits, prophylactic ciNPT does not consistently eliminate primary surgical site infection rates across all high-risk emergency abdominal and colorectal cohorts. Nevertheless, prophylactic negative-pressure therapy exhibits a favorable safety profile with tangible improvements in early patient-reported recovery parameters, without compromising deep visceral healing or systemic outcomes. Systematically applying active negative-pressure protocols may offer clinical advantages in selected surgical populations, although further large-scale, low-bias investigations are required to establish definitive superiority. Ultimately, standardizing application parameters and refining patient selection remain critical priorities to optimize clinical efficacy and healthcare value in acute care surgery.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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