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**Systematic Review**

# Negative-pressure wound therapy in thoracic and abdominal surgery: meta-analysis of randomized trials

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## Abstract

**Background:** Around 30 000 patients undergo emergency laparotomy in the UK each year, and a similar number of patients undergo open cardiothoracic surgery. Surgical site infection is a common complication associated with increased morbidity, prolonged hospital stay, and higher healthcare costs. Negative-pressure wound therapy has been proposed as a prophylactic strategy to reduce wound complications, but trial evidence has been inconsistent.

**Methods:** This systematic review and meta-analysis was carried out using PRISMA guidelines and was registered prospectively in PROSPERO (CRD420251010516). A literature search was carried out in March 2025 (updated December 2025), and titles and abstracts were screened against predefined inclusion criteria. Trials assessing patients undergoing open thoracic or abdominal surgery for any indication in adult patients assessing the risk of surgical site infection as an outcome were included. Quality assessment was performed using Cochrane's risk-of-bias 2 tool. Summary statistics for outcomes of interest underwent meta-analyses to a confidence interval of 95% and are presented as forest plots.

**Results:** Some 12 427 patients across 45 randomized trials in abdominal and thoracic surgery were included for analysis. Negative-pressure wound therapy significantly reduced surgical site infection compared with standard dressings (odds ratio (OR) 0.53, 95% confidence interval 0.42 to 0.66). The effect was consistent across commercial devices (PICO™ and Prevena™). Negative-pressure wound therapy was associated with shorter hospital stay (mean difference −1.67 (95% confidence interval −3.19 to −0.16) days), but not with reduced risk of organ/space infection (OR 0.92, 0.67 to 1.25), wound dehiscence, or reoperation. Only three studies included thoracic surgery and no significant difference in surgical site infection was found (OR 0.44, 0.00 to 45.25). Publication bias was detected; trim-and-fill analysis attenuated but did not eliminate the benefit (adjusted OR 0.70, 0.54 to 0.90). Adverse events and patient-reported outcomes were reported infrequently, and showed no consistent differences.

**Conclusion:** Negative-pressure wound therapy was associated with a nearly 50% reduction in SSI and shorter hospital stay after open abdominal surgery, with consistent benefit across device types. However, evidence of publication bias, and limited long-term and patient-reported outcome data suggest that effect size may be overestimated. Selective use in high-risk patients is supported.

## Introduction

Almost two million patients undergo laparotomy in the USA each year, and hundreds of thousands undergo sternotomy for various indications, in both the emergency and elective setting[1,2]. These incisions provide surgical access for major thoracic and abdominal surgery. Following a procedure, the wounds require closure, and various techniques have been described to close the thoracic and abdominal wall in layers, to promote wound healing and minimize complications[3,4]. One such adjunct to closure of these wounds is the use of negative-pressure wound therapy (NPWT), which aims to obliterate the dead space in the subcutaneous layers, thus reducing the volume of serous fluid build-up under the skin surface. In theory, this reduces the chance of infection developing at the surgical site.

Surgical site infection (SSI) can be associated with significant morbidity, and may result in wound dehiscence necessitating further surgery, systemic illness such as sepsis, or future risk of incisional hernia[5]. SSIs are one of the top five healthcare-acquired infections, accounting for approximately one-third of the $9.8 billion cost to the US healthcare system, increasing average length of hospital stay by 9.58 days at an additional cost of $38 656[6,7]. Several risk factors exist for the development of SSIs. Patient-related factors include smoking, diabetes, immunosuppression, obesity, and malnutrition[8]. Recognized operative influences include emergency surgery, degree of contamination, revisional surgery, and soft tissue trauma[8,9].

NPWT has been evaluated in a growing number of randomized clinical trials (RCTs) across surgical specialties. Although early studies suggested potential reductions in SSI and wound complications, results have been inconsistent, and previous meta-analyses have been limited by small sample sizes, heterogeneous inclusion of observational designs, or restriction

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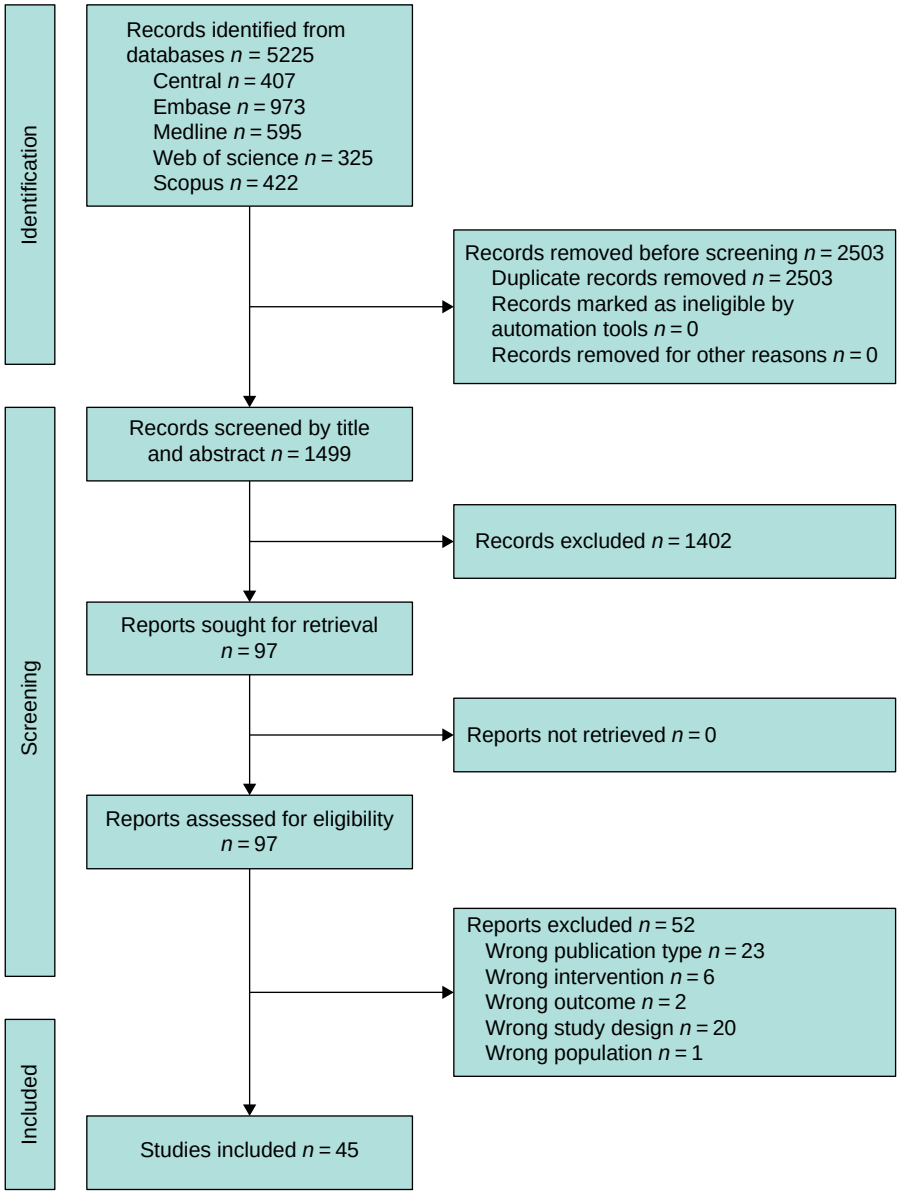


**Fig. 1 PRISMA flow chart showing selection of articles for review**

to single surgical specialties[10–14]. Furthermore, questions remain regarding the magnitude of benefit, device-specific efficacy, applicability across surgical populations, and cost-effectiveness in routine practice.

Given the increasing volume, complexity, and multimorbidity of patients presenting for major open thoracic and abdominal surgery, there is a growing need to prevent the development of wound complications, surgical morbidity, and healthcare resource utilization[15]. This systematic review and meta-analysis therefore aimed to assess the efficacy of NPWT in patients undergoing open thoracic or abdominal surgery with closed wounds, providing a comprehensive overview of its application and utility in a pan-specialty manner.

## Methods

This systematic review was conducted using guidance from the *Cochrane Handbook for Systematic Reviews of Interventions*[16]. These findings are reported according to the search extension for PRISMA guidelines[17]. A study protocol was developed on 13 March 2025 before starting this systematic review of the literature concerning the use of NPWT on SSI, with particular focus on RCTs. The protocol was registered with PROSPERO (CRD420251010516) in June 2025[18].

### Search strategy

MEDLINE and Embase on Ovid, as well as the Cochrane Central Database of Controlled Trials, Web of Science Core Collection and Scopus, were searched on 18 March 2025 (last updated 1 December 2025). Each of these databases was searched separately using a combination of free-text keywords and subject headings or Medical Subject Headings terms which were similar to, and adapted from, a search in Ovid MEDLINE (*Table S1*). The search strategies for each database can be found in *supplementary methods* and *Tables S1–S3*.

The total number of records for each database search is summarized in *Fig. 1*. Search filters for RCTs were applied to each search, excluding the search in the Cochrane Central Database of Controlled Trials as it is not recommended to do so[16]. The RCT filters for MEDLINE and Embase were adapted from search filters reported in the *Cochrane Handbook for Systematic Reviews of Interventions*[16]. Published search filters were also applied to the search strategies for Web of Science and Scopus. Any additional limits were applied thereafter using the inclusion and exclusion criteria set out in the protocol. All search strategies were devised and run by the information specialist (H.M.) for this systematic review only and have not been used elsewhere previously. The Ovid MEDLINE search strategy was reviewed and approved by the main author (A.L.) before searches being run on each database.

To deduplicate, all records were exported from each database as Research Information Systems files and uploaded to EndNote™ 21.2 (Philadelphia, PA, USA). The deduplication function in EndNote was used to identify duplicate records. The deduplication process was run several times, with different edited preferences according to steps outlined by Bramer *et al.*[19]. After each subsequent step, each set of duplicate results was examined carefully to identify any false duplicates and ensure that these were not removed.

## Article screening

Each article was assessed by two separate authors using the inclusion criteria outlined below, and any disagreement regarding the eligibility of an article was discussed. Agreement was reached by consensus with a third, independent, reviewer. There were no language or time-period restrictions. Abstract-only publications, editorials, letters, commentaries, case reports/case series with fewer than ten patients, and conference presentations were excluded, as were retrospective studies and non-randomized cohort studies. RCTs that compared wound-related outcomes of patients who underwent open thoracic or abdominal surgery for any elective or emergency indication where the wound was closed primarily were included. Control groups included patients without NPWT, in whom simple wound dressings only were used, such as dry sterile gauze, hydrocolloid, honeycomb or any other standard surgical wound cover. The authors of studies that met the inclusion criteria, but reported ambiguous or missing data for either the population or outcomes of interest, were contacted for further clarification before exclusion.

## Quality assessment

The Cochrane risk-of-bias 2 tool[20] for RCTs was used to evaluate relevant studies identified. Two independent reviewers undertook quality assessment. Any discrepancies were discussed with a third author until consensus was reached. Results are presented in both the standardized format and as a weighted bar plot to aid visualization.

## Data extraction

Data were extracted by two independent authors for each paper using a standardized and predesigned data collection form. Data were extracted, where available, on study design characteristics, cohort information including proportion of patients undergoing elective *versus* emergency surgery, information on underlying surgical pathology, relevant co-morbidities such as smoking, body mass index (BMI), immunosuppression, concurrent antibiotic therapy, hypoalbuminaemia, wound contamination, and presence of diabetes. Outcomes of interest including SSIs, wound dehiscence, Clavien–Dindo complication grade[21], postoperative pain, quality of life (QoL) scored using any validated tool, incisional hernia risk, and length of hospital stay, were also recorded, when reported. Data were recorded on an intention-to-treat basis to preserve the effects of randomization.

## Data synthesis

Data analyses were undertaken and figures extracted from Microsoft® Excel (Microsoft, Redmond, WA, USA) and the statistical package RevMan version 5.8.0 (Cochrane Collaboration (London, UK)), and further analyses undertaken in R version 4.5.2 for MacOS™ (R Project for Statistical Computing, Vienna, Austria). Funnel plots were used to assess publication bias in studies that reported the primary outcome of interest, and analysed for asymmetry by means of Egger's linear regression, using a mixed-effects meta-regression model, and standard error as the predictor[22]. The trim-and-fill method was used to adjust for missing studies using the inverse-variance method with the L-estimator, and restricted maximum-likelihood estimator for $\tau$. Heterogeneity was assessed for the meta-analyses using the $I^2$ statistic (< 20%, low; 20–40%, moderate; > 40%, high), with the Mantel–Haenszel method and a random-effects model used because of the high expected heterogeneity between the studies included in the meta-analysis. Prediction interval was based on t-distribution (53 degrees of freedom). Summary statistics used to characterize the distribution of prespecified dichotomous outcomes of interest underwent meta-analyses to a confidence interval of 95% and are presented as forest plots for odds ratios (ORs)[23]. For continuous outcomes, the pooled effect size was expressed as the mean difference with a 95% confidence interval, calculated using the inverse-variance method.

For the purposes of meta-analysis, the work of Costa *et al.*[24] was considered as two separate trials, as this study included two intervention arms (control, Prevena™, PICO™), and so outcomes for both types of vacuum-assisted therapy (compared with control) were recorded separately. Fisher's exact test and Pearson's $\chi^2$ test with Yates' continuity correction were used to compare categorical variables in order to assess clinicopathological comparability of randomized cohorts within each included study[25]. Baseline characteristics are, however, reported without formal statistical comparison, in line with item 15 of CONSORT and to avoid $\alpha$ inflation in multiple testing, leading to potentially falsely significant results[26,27].

# Results

A total of 45 RCTs[10,28–68] involving 12 427 patients was included (*Fig. 1* and *Table S4*). The trials spanned from 2010 to 2025, and were conducted across Europe, North America, Asia, and Australasia. The majority of trials enrolled patients undergoing major abdominal surgery, including colorectal, hepatopancreatobiliary, bariatric, and obstetric procedures; a smaller number investigated cardiac surgery. Most trials compared NPWT with standard gauze or adhesive dressings; PICO™ and Prevena™ were the most frequently studied commercial systems (63% of studies). Follow-up was typically 30 days, and longer follow-up beyond 90 days was rare. Thirty-three trials were rated as being at low risk of bias, with only one[24] rated as high risk owing to concerns with the randomization process (*Fig. 2* and *Fig. S1*).

Baseline characteristics of patients included in control and intervention arms were similar, including important risk factors

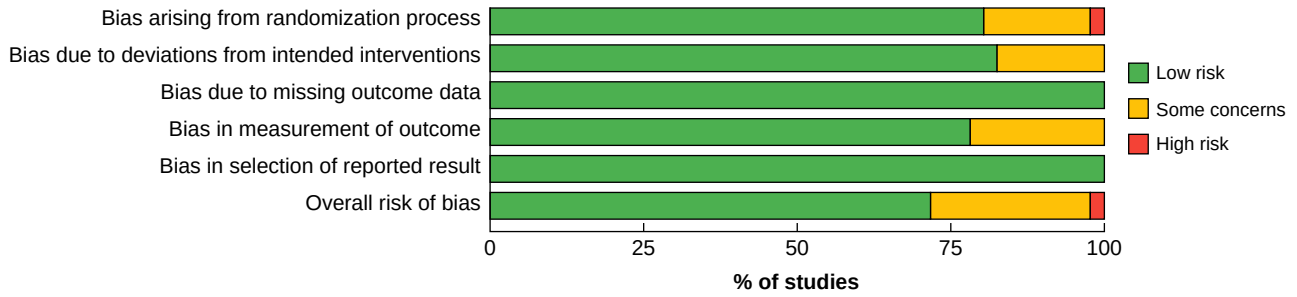


**Fig. 2 Risk-of-bias weighted bar plot**

for wound complication such as smoking, diabetes, and obesity (*Table S5*). Where reported, immunosuppression was similar across groups, as was hypoalbuminaemia, except in one study (AbdelDayam *et al.*) that reported significantly higher rates of low albumin level in the intervention group compared with the control group ($P = 0.001$).

## SSI

Across 45 RCTs, NPWT significantly reduced SSI (OR 0.53, 95% confidence interval (c.i.) 0.42 to 0.66; $I^2 = 50\%$) (*Fig. 3*). Among studies limited to abdominal surgery alone, NPWT reduced SSI (OR 0.52, 0.42 to 0.66; $I^2 = 50\%$), but no difference was found in open cardiac surgery (OR 0.44, 0.00 to 45.25; $I^2 = 66\%$, 3 RCTs).

Device-specific subgroup analyses demonstrated a reduction in SSI with both PICO™ (OR 0.62, 0.44 to 0.89; $I^2$ = 34.9%) and Prevena™ (OR 0.64, 0.43 to 0.93; $I^2$ = 35.3%), (*Fig. 4*). These findings suggest that the observed benefit represents a class effect of NPWT rather than superiority of a specific device. Trials using other proprietary or non-commercial devices were fewer, and limited data precluded meta-analysis.

Assessment of publication bias suggested the presence of small-study effects. Visual inspection of the funnel plot revealed asymmetry, with a relative absence of small negative studies (*Fig. 5*). Egger's regression test was statistically significant ($z = -3.9465$, $P < 0.001$), consistent with potential publication bias. Application of the trim-and-fill method suggested that 13 studies (standard error 4.3576) may be missing from the right-hand side of the funnel plot. After adjustment, the pooled OR shifted from 0.53 (0.42 to 0.66) to 0.70 (0.54 to 0.90), indicating that, although NPWT remained associated with a statistically significant reduction in SSI, the magnitude of benefit may be overestimated because of publication bias.

## Further wound complications

Despite significant differences in wound infection rates, use of NPWT had no effect on rates of organ/space infection (OR 0.92, 95% c.i. 0.67 to 1.25; 11 RCTs) (*Fig. S2*) or superficial or deep wound dehiscence (*Fig. 6*). This is perhaps reflective of the definition of SSI in most studies, with use of clinical assessment rather than objective endpoints such as wound culture results (*Table S4*).

## Length of hospital stay

Length of hospital stay was shorter among patients receiving NPWT (mean difference −1.67 (95% c.i. −3.19 to −0.16) days; 8 RCTs), with low heterogeneity (*Fig. 7*).

## Reoperation

Use of NPWT had no impact on reoperation rates (OR 0.96, 95% c.i. 0.68 to 1.36; 11 RCTs), with low heterogeneity (*Fig. 8*).

## Other outcomes

Eight studies reported patient pain scores using a variety of questionnaires and scales, including a visual analogue scale and the patient-specific activity scale. Overall, pain scores were similar at 30 days after operation when reported. Earlier in the recovery period, between 3 and 7 days, pain scores appeared favourable towards use of NPWT (Atherton *et al.*, and Manik *et al.*). However, several studies reported no difference in pain scores, including Ruhstaller *et al.* and Flynn *et al.*

QoL scores were assessed and reported in 6 studies using a variety of questionnaires, including the 12-item Short Form (SF-12®) and EQ-5D-5L™ (EuroQoL Group, Rotterdam, the Netherlands) surveys, and patient and observer scar assessment scale. Overall, there did not appear to be any clear difference between the two groups. For instance, using both SF-12 and® EQ-5D-5L™, Atherton *et al.*[31] found no difference in QoL scores between the two groups. This was supported by similar QoL scores ($P = 0.89$) reported by O'Leary *et al.*, Hyldig *et al.* ($P = 0.319$), and Lopez-Lopez *et al.* ($P = 0.231$). In contrast, Tuuli *et al.* reported significantly higher patient satisfaction scores in the NPWT group at discharge ($P < 0.001$). However, this difference was no longer significant compared with the control group on postoperative day 30 ($P = 0.070$).

# Discussion

This systematic review and meta-analysis has demonstrated the benefit and safety profile of NPWT for closed abdominal surgical wounds. Across 45 RCTs including over 12 000 patients, use of NPWT halved the risk of SSI and shortened hospital stay compared with standard dressings. These findings were consistent across commonly used commercial devices, supporting the potential for broader adoption in abdominal surgery. By contrast, evidence in open cardiothoracic surgery remains limited, and no significant benefit was observed for organ/space infection, fascial dehiscence, or reoperation.

This study has several strengths. First, inclusion was restricted to RCTs, thereby reducing the influence of confounding and selection bias that often complicates observational or retrospective series. Second, the search strategy was comprehensive and the statistical methodology robust, with predefined subgroup analyses by device type and adherence to a prospectively registered protocol. Third, given the heterogeneity of surgical populations and study designs, the use of random-effects modelling was appropriate and increases the generalizability of findings across surgical contexts.

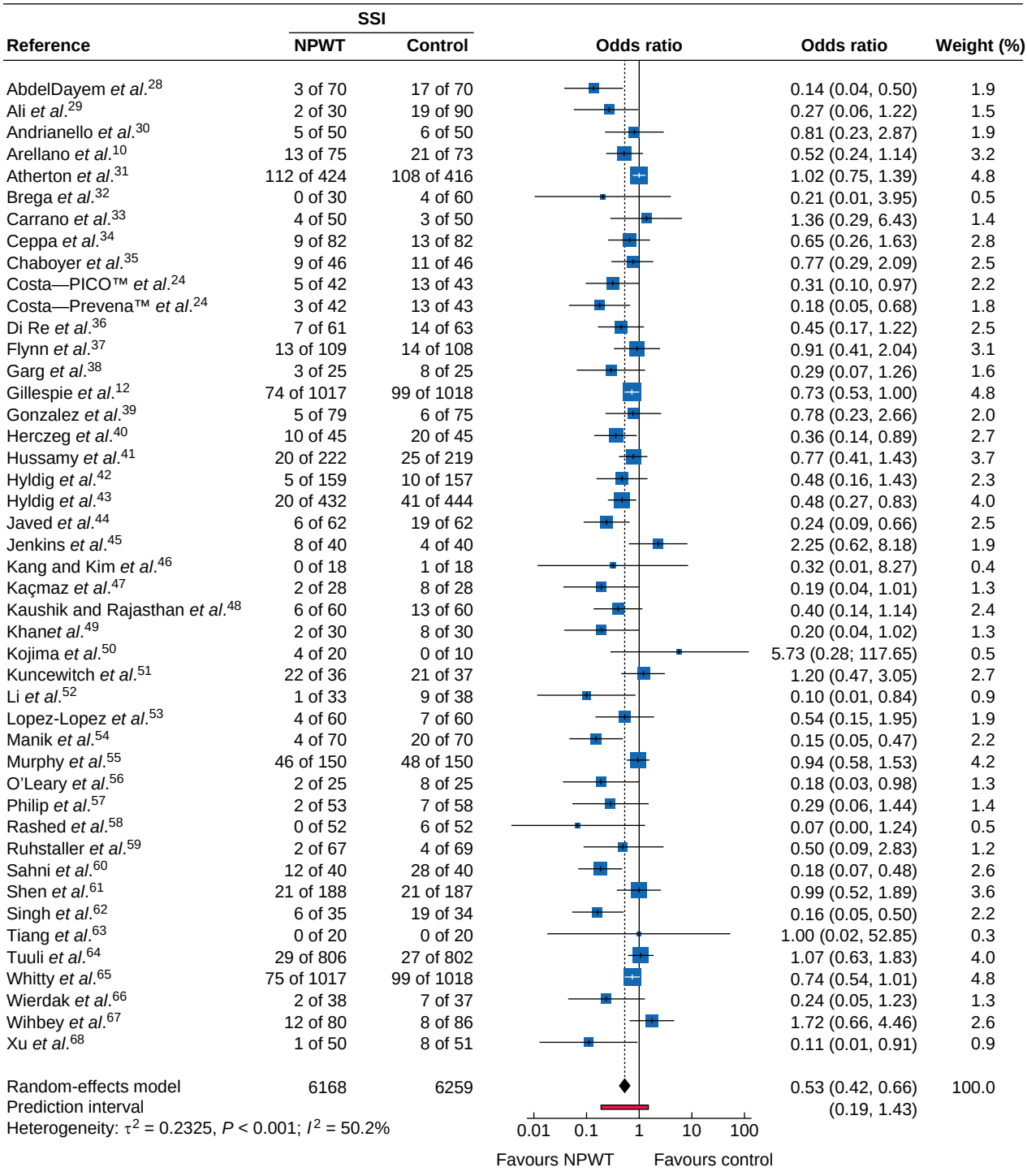


**Fig. 3 Forest plot showing meta-analysis of impact of NPWT on SSI**

Odds ratios are shown with 95% confidence intervals. SSI surgical-site infection; NPWT, negative-pressure wound therapy.

Finally, given the findings published by Groenen *et al.* (2023), assessing all RCTs in prevention of SSI across all surgical specialties, the present study reports results favouring NPWT for SSI prevention, with the additional components of publication bias assessment, and device-specific subgroup analyses.

Publication bias for the primary outcome ($P < 0.001$) suggests that smaller studies reported larger beneficial effects of NPWT than larger studies, perhaps reflecting selective publication of positive findings (or suppression of negative results) from smaller trials. This could mean the pooled OR of 0.53 may be overestimated owing to under-reporting of negative trials. To further explore this, the trim-and-fill method was applied, which estimated that 13 studies may be missing from the right side of the funnel plot. After imputing these hypothetical trials, the pooled OR decreased from 0.54 (95% c.i. 0.43 to 0.69) to 0.70 (0.54 to 0.90). Importantly, the association between NPWT and reduced odds of SSI remained statistically significant, but the magnitude of benefit was reduced, indicating that the effect size

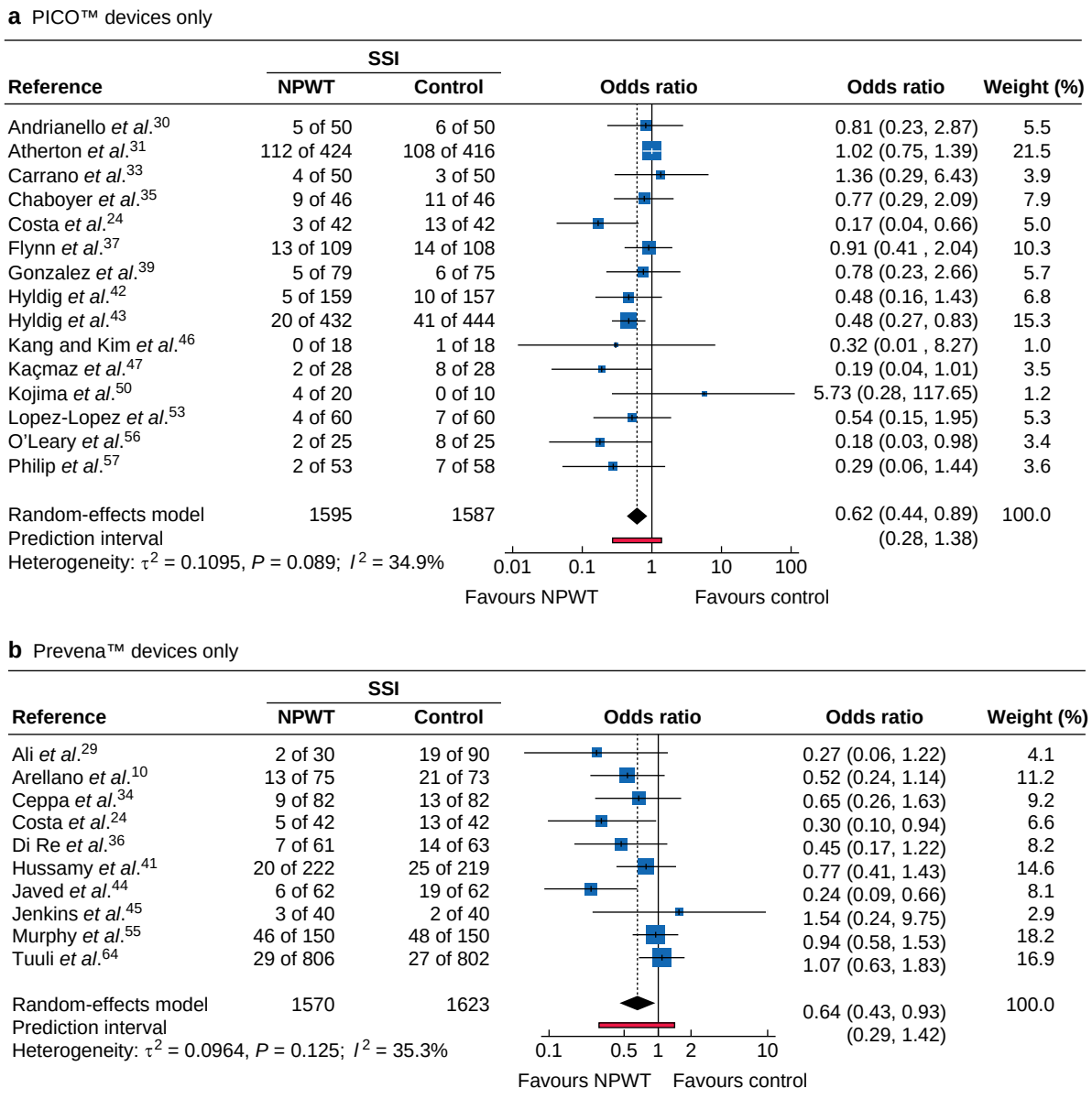


**Fig. 4 Forest plot showing meta-analysis of impact of NPWT on SSI according to specific device type**

**a** PICO™ devices only, **b** Prevena™ devices only. Odds ratios are shown with 95% confidence intervals. SSI surgical-site infection; NPWT, negative-pressure wound therapy.

reported in the unadjusted analysis is likely to be somewhat overestimated. The pooled results must therefore be interpreted with caution, as negative trials may remain unpublished.

Different types of abdominal surgery (for example colorectal, hepatobiliary, bariatric, obstetric) have different baseline risks of SSI. However, meta-analyses of individual surgical subspecialties can make it difficult to assess whether hospital boards should invest in such technology to be used across surgical specialties, rather than limiting a technology to one or a few specialties[69]. Although subspecialty-specific analyses can be informative, decisions regarding investment in NPWT technology are often made at the hospital or health system level, necessitating pooled evaluation across surgical types.

Furthermore, NPWT effectiveness may vary by type of incision (midline, Pfannenstiel, bisubcostal), contamination level, or patient co-morbidities. However the present meta-analysis included a range of incision types and procedure- or patient-related confounders. Over half of the studies used US Centers for Disease Control and Prevention criteria for diagnosis of SSI. The remainder utilized clinical assessment and subjective diagnosis, perhaps also relying on biochemical and/or clinical parameters. However, the absence of wound culture results from the studies may suggest an overestimation of the prevalence of SSI.

The present analysis necessarily combined a wide range of incision types and patient-related factors, which may have diluted signals of benefit in subgroups at highest risk. There was also variation in definition of SSI, follow-up duration, type of NPWT device used, control dressing use, and adherence to NPWT protocol as advised by the manufacturer. Finally, trial follow-up was generally limited to the early postoperative period. One of the longer-term complications of a SSI in the late postoperative phase is the development of incisional hernia[70]. However, limited follow-up duration in the trials analysed precluded the detection and reporting of this important long-term outcome.

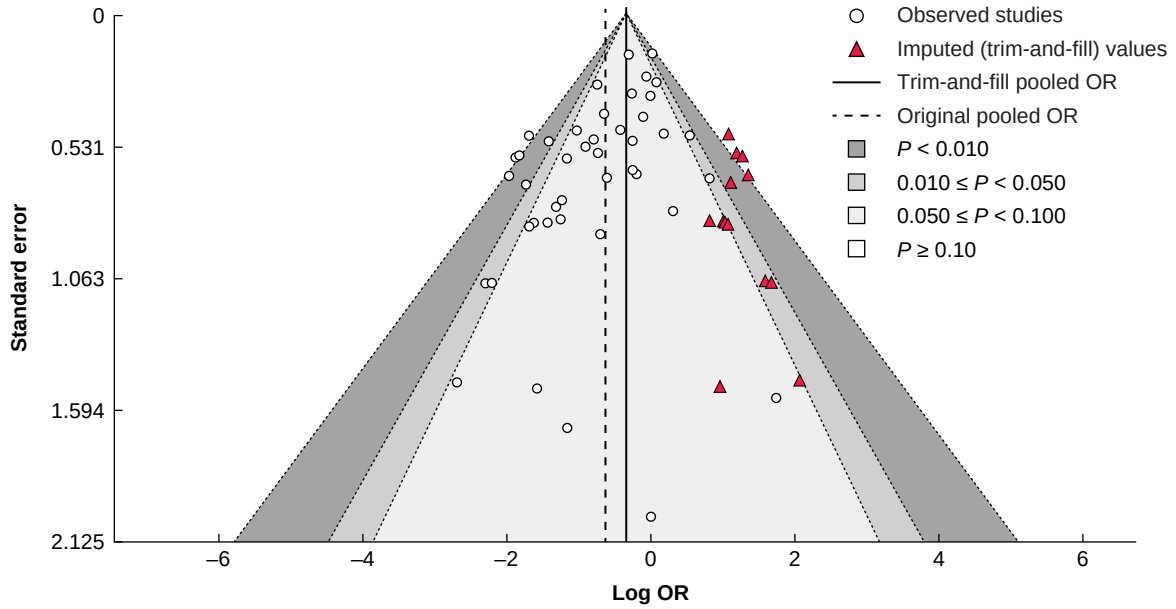


**Fig. 5 Funnel plot: original *versus* trim-and-fill method**

Contour lines show significance levels. Original pooled odds ratio (OR) 0.53; trim-and-fill pooled OR 0.70.

**a** Superficial wound dehiscence

| Reference | Superficial wound dehiscence NPWT | Control | Odds ratio | Odds ratio | Weight (%) |
|---|---|---|---|---|---|
| Costa - Prevena™ *et al.*[24] | 5 of 42 | 3 of 43 | | 1.80 (0.40, 8.07) | 14.1 |
| Costa- Pico™ *et al.*[24] | 5 of 42 | 3 of 43 | | 1.80 (0.40: 8.07) | 14.1 |
| Di Re *et al.*[36] | 0 of 63 | 6 of 64 | | 0.07 (0.00, 1.29) | 4.0 |
| Flynn *et al.*[37] | 6 of 109 | 8 of 108 | | 0.73 (0.24, 2.17) | 24.5 |
| Herczeg *et al.*[40] | 1 of 45 | 2 of 45 | | 0.49 (0.04, 5.59) | 5.6 |
| Kaushik and Rajasthan *et al.*[48] | 3 of 60 | 7 of 60 | | 0.40 (0.10, 1.62) | 15.9 |
| Khan *et al.*[49] | 2 of 30 | 8 of 30 | | 0.20 (0.04, 1.02) | 11.8 |
| Shen *et al.*[61] | 2 of 188 | 3 of 187 | | 0.66 (0.11, 3.99) | 10.0 |
| Random-effects model | 579 | 580 | | 0.64 (0.30, 1.37) | 100.0 |
| Prediction interval | | | | (0.26, 1.59) | |
| Heterogeneity: $\tau^2$ = 0.0566, $P$ = 0.300; $I^2$ = 16.5% | | | | | |



**b** Fascial dehiscence

| Reference | Fascial dehiscence NPWT | Control | Odds ratio | Odds ratio | Weight (%) |
|---|---|---|---|---|---|
| AbdelDayem *et al.*[28] | 0 of 70 | 0 of 70 | | 1.00 (0.02, 51.10) | 6.1 |
| Costa—Pico™ *et al.*[24] | 0 of 42 | 4 of 43 | | 0.10 (0.01, 1.98) | 10.0 |
| Costa—Prevena™ *et al.*[24] | 2 of 42 | 4 of 43 | | 0.49 (0.08, 2.82) | 21.6 |
| Di Re *et al.*[36] | 2 of 63 | 1 of 64 | | 2.07 (0.18, 23.37) | 13.7 |
| Flynn *et al.*[37] | 1 of 109 | 1 of 108 | | 0.99 (0.06, 16.04) | 11.1 |
| Shen *et al.*[61] | 1 of 188 | 0 of 187 | | 3.00 (0.12, 74.11) | 8.8 |
| Singh *et al.*[62] | 3 of 31 | 15 of 34 | | 0.14 (0.03, 0.53) | 28.6 |
| Random-effects model | 545 | 549 | | 0.47 (0.15, 1.51) | 100.0 |
| Prediction interval | | | | (0.06, 3.89) | |
| Heterogeneity: $\tau^2$ = 0.4747, $P$ = 0.308; $I^2$ = 16.0% | | | | | |



**Fig. 6 Forest plot showing meta-analysis of impact of NPWT on superficial wound dehiscence and fascial dehiscence**

**a** Superficial wound dehiscence, **b** fascial dehiscence. Odds ratios are shown with 95% confidence intervals. NPWT, negative-pressure wound therapy.

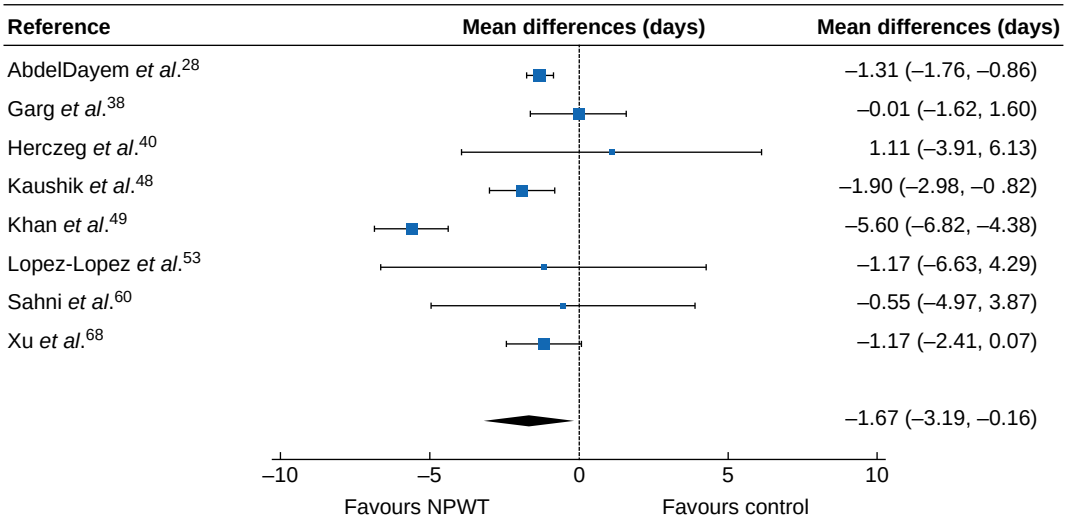


**Fig. 7 Forest plot showing meta-analysis of impact of NPWT on length of hospital stay**

Mean differences between negative-pressure wound therapy and control are shown with 95% confidence intervals. A random-effects model was used for meta-analysis.

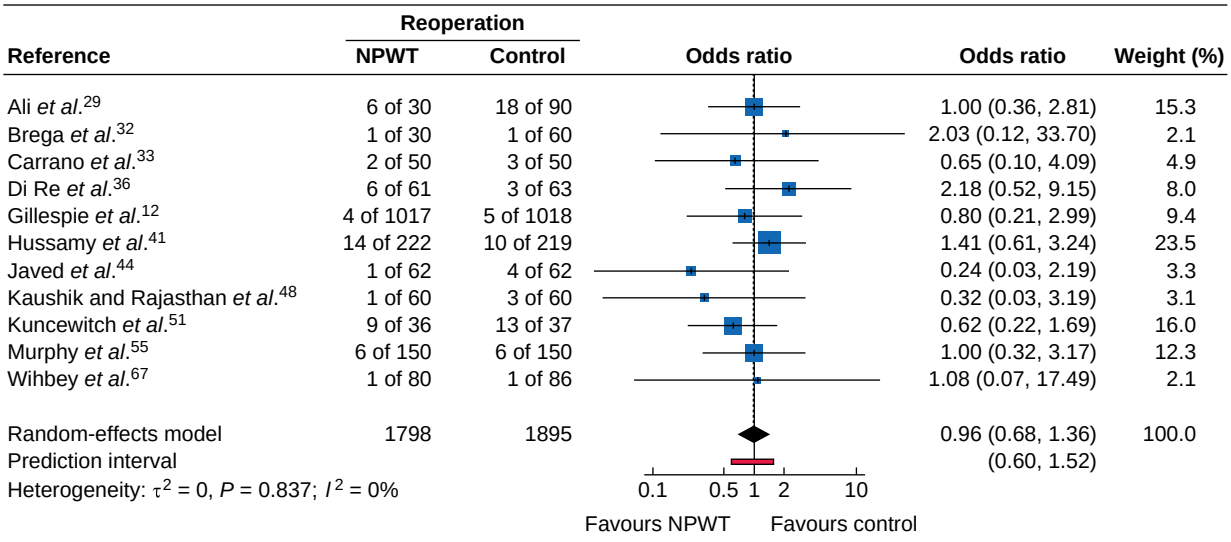


**Fig. 8 Forest plot showing meta-analysis of impact of NPWT on reoperation rate**

Odds ratios are shown with 95% confidence intervals. NPWT, negative-pressure wound therapy.

Industry funding was common among the included trials, particularly for proprietary systems such as Prevena™ and PICO™. Although device-specific analyses demonstrated consistent benefit, the role of manufacturer sponsorship raises concerns regarding selective publication, reporting bias, and emphasis on device-specific outcomes. Indeed, an analysis of 332 historical RCTs by Bhandari *et al.*[71] in 2004 showed that industry funding was directly associated with a statistically significant (pro-industry) result (OR 1.9, 95% c.i. 1.3 to 3.5). Independent, investigator-led trials remain critical to confirming these findings in routine practice. Trials in this study also showed variation in the control dressing utilized. There was limited investigator blinding, and no patient blinding, for example through the use of a placebo or sham device. The control dressings used were referred to as 'standard' or 'surgeon's preference' or 'simple gauze' in most trials. Advanced non-suction dressings such as the Smith & Nephew honeycomb dressing was used in one trial (Jenkins *et al.*).

Guidelines for SSI prevention have been cautious historically in recommending NPWT for closed incisions, largely because trial evidence was limited[69]. The present findings, showing a clear reduction in SSI across a broad range of abdominal procedures, strengthen the rationale for guideline endorsement of NPWT in high-risk patients. At present, many centres adopt a selective approach, targeting NPWT to patients with high-risk characteristics or complex procedures. This aligns with the present findings that the greatest benefit is likely to accrue in such populations, and reflects the need for judicious resource allocation given the higher upfront cost of NPWT devices. Information on the cost-effectiveness of these devices in scarce in the literature. According to PICO™ base-case economic modelling, PICO™ dressings are cost-saving by around £101 per patient compared with standard dressings[72].

Commercially available systems such as Prevena™ are marketed for use in patients with multiple risk factors and broad definitions of high surgical risk. Suitability criteria commonly include at least two of the following: BMI > 35 kg/m$^2$, diabetes mellitus, active smoking, malignancy or chemotherapy, immunodeficiency, chronic kidney disease, chronic obstructive pulmonary disease, advanced age (≥ 75 years), or malnutrition. High-risk procedures include emergency or revisional surgery, prolonged operating time, contaminated or traumatic wounds, incisions under high tension, or multiple simultaneous incisions. These thresholds broadly align with the populations represented in the present meta-analysis and may help guide rational deployment of NPWT in practice. Such risk categories are also replicated in national guidance. For instance, the UK National Institute for Health and Care Excellence Medical Technology Guidance 43[73] reflects this, and goes further to recommend PICO™ dressings for closed surgical wounds, citing reduction in SSI and cost-effectiveness compared with conventional wound dressings alone.

Future research should focus on several areas. First, adequately powered, pragmatic RCTs across selected surgical populations are required to validate efficacy in real-world settings and quantify the absolute risk reduction across baseline SSI observation, especially in the eclectic emergency setting. Second, independent health economic analyses are urgently needed, as the incremental cost-effectiveness of NPWT remains uncertain outside high-risk subgroups. This is essential in informing the use of this resource in the public sector, such as in the National Health Service. Third, longer follow-up is essential to determine whether early reductions in SSI translate into fewer late complications such as incisional hernia. Finally, comparative trials between different NPWT systems, and between NPWT and enhanced conventional dressings, would clarify whether benefits are device-specific or generalizable to the class.

The present analysis has shown that NPWT halves the risk of SSI following open abdominal surgery and modestly reduces hospital stay, with consistent benefits across commercial devices. Evidence for other outcomes remains inconclusive, and the signal of publication bias underscores the need for independent confirmatory studies. These findings support the selective use of NPWT in high-risk patients and procedures, while highlighting the importance of cost-effectiveness analyses and longer-term outcome data in guiding routine implementation.

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## Author contributions

Adil Lakha (Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Validation, Visualization, Writing—original draft, Writing—review & editing), Salma Neves (Data curation, Investigation, Visualization, Writing—original draft), Younis Alemour (Data curation, Investigation, Visualization, Writing—original draft), Hannah McGivern (Conceptualization, Data curation, Methodology, Resources, Software, Writing—original draft), and Alex Gordon-Weeks (Conceptualization, Investigation, Methodology, Project administration, Supervision, Validation, Writing—review & editing)

## Disclosure

The authors declare no conflict of interest.

## Supplementary material

*Supplementary material* is available at *BJS Open* online.

## Data availability

All data are available publicly in the original published article.

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