

ORIGINAL RESEARCH

Network Meta-Analysis of Wound Dressings and Their Effectiveness in Promoting Healing



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Abstract

Background: Chronic and acute wounds affect millions of individuals worldwide, placing a substantial burden on patients and healthcare systems. Previous evaluations have often focused on limited types of dressings or specific wound conditions. Therefore, a comprehensive network meta-analysis is essential for comparing various interventions, bridging knowledge gaps, improving healing outcomes, and addressing clinical and economic challenges.

Purpose: This study assessed the comparative effectiveness and safety of advanced wound dressings in promoting healing.

Methods: This network meta-analysis, registered with PROSPERO (CRD42023433268), systematically searched PubMed, ProQuest, Scopus, CINAHL, ScienceDirect, Springer Nature, Wiley, Cochrane Library, and Taylor & Francis from January 2012 to December 2022. Eight reviewers independently assessed and extracted data from randomized controlled trials evaluating different dressings, including placebo, alginate, collagen, gamat, honey, hyaluronic acid, hydrocolloid, hydrogel, mebo, platelet-rich plasma, povidone-iodine, and silver sulfadiazine. Data were synthesized using a random-effects network meta-analysis with SUCRA rankings. Study quality was evaluated using Cochrane RoB2, and certainty of evidence was assessed through CINeMA.

Results: This review included 38 RCTs with a total of 4,049 patients. The largest placebo group comprised 1,628 participants, while the smallest group was mebo with 10 participants. Heterogeneity and consistency analysis showed negligible variation ($\chi^2=1.757$, $p=0.78$). Alginate dressings were the most effective in reducing wound size compared to placebo (OR 0.64; 95% CI 0.38–1.08; SUCRA probability 0.73), whereas hyaluronic acid dressings were the least effective (OR 0.22; 95% CI 0.06–0.79; SUCRA probability 0.08).

Conclusion: Alginate was identified as the most effective primary dressing for wound healing, while hyaluronic acid dressings were the least effective. However, clinical practitioners should carefully weigh the benefits and limitations of each dressing type before selecting the most appropriate treatment for patients.

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1. Introduction

A wound is an injury that interrupts the continuity of skin, mucosa, or deeper tissues, potentially resulting from trauma, chronic diseases, or surgical procedures (Kangal et al., 2025; Nguyen et al., 2023). Different wound forms, such as abrasions, incisions, contusions, lacerations, pressure injuries, and punctures, may advance to sepsis (Iversen et al., 2024). Chronic wounds impact roughly 1–2% of the global population at any moment (López-Jiménez et al., 2025; Sen, 2021). The severity of these wounds, indicated by erythema and healing duration, escalates with age, with those over 60 encountering a significantly greater risk than younger groups (Yao et al.,

2020). Chronic open lesions impact approximately 3% of those aged 65 and beyond. By 2060, it is anticipated that 77 million older persons in the United States will be living with chronic wounds (Sen, 2023). A systematic review and meta-analysis of observational studies indicated a global frequency of chronic wounds ranging from 1.51 to 2.21 per 1,000 individuals (Martinengo et al., 2019). In Asia, a pooled prevalence of chronic wounds was determined to be 32.1% (Burhan et al., 2025). The global prevalence of pressure injuries is estimated at 12.8%, with a hospital-acquired incidence rate of 8.4% (Li et al., 2020).

Non-healing wounds can impede functional rehabilitation, prolong hospitalization, and increase the risk of complications (Saragih et al., 2025). Therefore, nurses must employ evidence-based wound care strategies that maintain a moist environment at near-body temperature to optimize tissue regeneration (Nuutila et al., 2021). Clinical guidelines recommend hydrogel-based and other aqueous dressings to support cellular proliferation and minimize secondary trauma (Nifontova et al., 2024; Ghomi et al., 2019). Moreover, recent reviews emphasize that sustaining a moist wound bed accelerates epithelial migration and prevents desiccation-induced cytotoxicity (Gefen et al., 2024). Despite the availability of contemporary dressings that have been proven to expedite healing process, several nurses still use traditional methods for wound treatment (Ongarora, 2022).

Modern dressings speed tissue recovery and reduce infection risk by maintaining a moist micro-environment that minimises dehydration and stimulates cellular activity (Nuutila et al., 2021). Modern wound dressings mostly utilise synthetic polymers that operate as semi-occlusive or interactive occlusive systems (Talebi et al., 2025; Tudoroiu et al., 2023). These materials sustain a hydrated wound environment favourable for granulation tissue development, offer structural support for regenerating cells, and serve as efficient barriers against microbial infiltration to manage surface infection (Gounden & Singh, 2024; Nguyen et al., 2023).

A recent systematic analysis revealed that modern green and honey dressings can speed wound closure and lower costs (Julika, 2021); however, it did not describe healing trajectories or all dressings. In subsequent network meta-analyses, moist dressings promote epithelialisation following surgical suturing (Sun et al., 2023), advanced biomaterial dressings help diabetic foot ulcers (Chen et al., 2024), and honey-based dressings improve chronic wound outcomes. These data show that there is no one, comprehensive review of dressing technologies across wound etiologies. This implies the existence of a disparity in outcomes among previous investigations. This study sought to bridge the current gap by performing a thorough network meta-analysis (NMA) of randomized controlled trials to evaluate the overall efficacy of different wound dressings in facilitating healing.

While prior studies offer significant insights, the majority were confined to particular wound types or limited dressings, and direct comparative trials are still infrequent. Standardized outcome measurements are reported inconsistently, resulting in ambiguity about the relative efficacy of therapies. Therefore, this study aimed to perform a thorough network meta-analysis (NMA) of randomized controlled trials to assess and rank the efficacy of modern wound dressings in facilitating healing, utilizing SUCRA to provide an evidence-based hierarchy for clinical decision-making.

2. Methods

2.1. Research design

We performed a systematic review and network meta-analysis (NMA) of randomized controlled trials (RCTs) to assess the comparative efficacy of modern wound dressings. Network meta-analysis was used because it facilitates the amalgamation of direct and indirect evidence, yielding a comprehensive assessment of relative effectiveness and permitting the ranking of various interventions within a singular analytical framework. The review adhered to the methodological standards established in the Cochrane Handbook for Systematic Reviews of Interventions and conformed to the PRISMA reporting guidelines, guaranteeing transparency and reproducibility. The study protocol was registered in advance with the International Prospective Register of Systematic Reviews (PROSPERO, CRD42023433268). Ethical approval was obtained from the Health Research Ethics Committee of Universitas Harapan Bangsa (Reference number: B.LPPM-UHB/1686/04/2023). This methodology was chosen to improve methodological rigor, minimize bias, and produce a dependable evidence-based hierarchy of wound dressing alternatives to inform clinical practice.

2.2. Search methods

We conducted a systematic search of PubMed, Scopus, ProQuest, CINAHL, ScienceDirect, Springer Nature, Wiley, Cochrane Library, and Taylor & Francis for papers published in English from January 1, 2012, to December 1, 2022. Search phrases were formulated utilizing the National Library of Medicine's MeSH Browser in MEDLINE, integrating restricted vocabulary with free-text keywords such as "Wounds and Injuries," "Wound Healing," "Wound Care," and "Dressings." Boolean operators and database-specific filters were utilized to enhance sensitivity and specificity across databases. Two separate reviewers performed the searches, which a medical librarian corroborated, and all references were organized and de-duplicated using EndNote version 21 before screening.

2.3. Inclusion and exclusion criteria

Eligible studies comprised RCTs involving participants aged 18 years or older with chronic wounds, regardless of infection status, that compared advanced wound dressings including hydrogel, alginate, collagen, honey, silver sulfadiazine, platelet-rich plasma, mebo, povidone-iodine, hyaluronic acid, and gamat with placebo or standard care. Only full-text articles published in English from 2012 to 2022 were included, contingent upon the evaluation of wound-healing outcomes utilizing validated instruments such as the Bates-Jensen Wound Assessment Tool (BWAT), Surgical Site Infection (SSI) criteria, Visitrak wound measurement, the Wagner scale, or the WIfI classification. Studies were excluded if they were case reports, cohort studies, non-randomized or parallel designs, crossover trials, reviews, or conference abstracts not published as full journal articles; duplicate reports and studies with heterogeneous populations, insufficient analyses, or absent effect sizes were also eliminated.

2.4. Screening of articles

Two independent reviewers (A.B. and I.S.) initially evaluated the titles and abstracts of all obtained records using Rayyan to identify potentially eligible studies, resolving conflicts through consensus or, when necessary, by consulting a senior investigator (V.A.D.). Subsequent full-text screening and eligibility verification were conducted by two additional reviewers (V.K. and R.H.) utilizing EndNote version 21, while content analysis and data consistency checks were executed in pairs (A.B. with I.S., and V.K. with S.M.S.), thereby ensuring methodological rigor and reducing selection bias.

2.5. Data extraction

Data extraction was conducted independently by two pairs of reviewers (A.B. with I.S., and V.K. with S.M.S.) utilizing a standardized, pre-tested spreadsheet to ensure uniformity and reduce bias. The extracted variables encompassed bibliographic facts (author, year, country), study parameters (objectives, conceptual framework, sample size and population, study design), methodological features (kind of instrument utilized to evaluate wound-healing outcomes), and published results. Discrepancies among reviewers were reconciled through consensus or arbitration by a senior investigator (V.A.D.), and the finalized extraction framework served as the foundation for the evidence synthesis detailed in the results section.

2.6. Quality appraisal

The methodological quality of eligible studies was evaluated using the Cochrane Risk of Bias 2 (RoB 2) tool (Sterne et al., 2019), independently assessed by two reviewers, with discrepancies resolved by a senior investigator, thereby ensuring a transparent and rigorous evaluation of randomization, allocation concealment, blinding, completeness of outcome data, and selective reporting. The overall certainty of evidence inside the network was assessed using the CINeMA (Confidence in Network Meta-Analysis) framework (CINeMA, 2022; Salanti et al., 2014), which evaluates within-study bias, reporting bias, indirectness, imprecision, heterogeneity, and incoherence. An audit trail of excluded studies was preserved, with full-text exclusions explained by ineligible designs (e.g., cohort studies, case reports, reviews), heterogeneous populations, insufficient or incomplete analyses, or the lack of extractable effect sizes. This systematic evaluation approach was used to reduce bias, improve reproducibility, and bolster the confidence of the synthesized results.

2.7. Data analysis

We obtained continuous outcomes as mean $\pm$ standard deviation and compiled event counts for dichotomous variables. Pairwise meta-analyses conducted in RStudio (v4.3.1) calculated I^2 , τ^2 , and p -values, utilizing a 0.5 continuity correction for studies with zero events (Cochrane, 2011; Hozo et al., 2005). Subsequently, we performed a random-effects network meta-analysis utilizing the netmeta R package to produce network plots, rankograms, netrank statistics, and SUCRA values. The inconsistency between direct and indirect evidence was evaluated using side-splitting and design-by-treatment interaction models (White et al., 2012). Publication bias and small-study effects were assessed using funnel plots in Complete Meta-Analysis (v3.3.037), whereas risk-of-bias domains were analyzed in RevMan (v5.4.1) (Borenstein et al., 2014; Cochrane, 2020; Higgins et al., 2022). These methodologies exemplify contemporary best practices: continuity corrections mitigate variance in sparse data (Cochrane, 2011; Hozo et al., 2005), the netmeta framework facilitates robust mixed-treatment comparisons with formal inconsistency assessment (White et al., 2012), and SUCRA offers an objective ranking of intervention effectiveness (Shim et al., 2019). Funnel plots continue to be a conventional method for identifying bias in meta-analyses (Borenstein et al., 2014).

3. Results

3.1. Description of studies

The PRISMA flow diagram shows that, from an initial collection of 21,898 records ($n = 9$ from databases; $n = 21,889$ from registers), 21,755 were eliminated before screening (duplicates $n = 528$; automated exclusions $n = 19,184$; other reasons $n = 2,043$), resulting in 134 records available for title and abstract evaluation. Out of them, 72 full-text reports were requested, but only 38 were obtained and evaluated (62 were inaccessible). During the eligibility assessment, 31 papers were removed due to methodological deficiencies (non-qualified $n = 2$; heterogeneous populations $n = 11$; inadequate analyses $n = 9$; missing effect sizes $n = 9$), leading to the inclusion of 38 studies in the final systematic review (Figure 1).

The final analysis included 38 randomized controlled studies involving 4,049 patients, who were randomly assigned to receive either current dressings or a placebo, as shown in Figure 1. The participant count in each study varied from 20 to 253, primarily comprising adult demographics. The randomized controlled studies undertaken between 2012 and 2022 encompassed multiple illnesses, including 11 instances of diabetic foot ulcers, 16 post-operative cases, three burn cases, two pressure ulcers, two venous leg ulcers, and four chronic wounds. Additionally, 38 trial papers encompassed a sample of 18 people from Asia. A multitude of European authors have produced a diverse array of works: 10 from Europe, three from Africa, five from the United States, and one from Oceania. A variety of standard measurement instruments were employed, including the Visitrak digital wound measuring device ($n=11$), epithelialization scale ($n=2$), photographic wound assessment tool (PWAT) ($n=1$), University of Texas wound measuring device ($n=2$), wound area evaluation number ($n=6$), Surgical Site Infection ($n=2$), grid film surface ($n=1$), POSE score ($n=1$), Antera 3D camera for skin analysis ($n=1$), Miravex ($n=1$), and Bates-Jensen Wound Assessment Tool ($n=3$), Wound measurement ($n=1$), Camera UNC-15 ($n=1$), Photographic assessment ($n=2$), and Photographic assessment 8 megapixels ($n=1$). Moreover, supplementary assessment techniques encompassed 3D digital infrared imaging technology ($n = 1$), the REEDA scale for evaluating redness, oedema, ecchymosis, discharge, and approximation of perineal tissues ($n = 1$), and wound-edge assessment ($n = 1$) (Table 1, see Appendix).

3.2. Risk of bias assessment

A summary and graph illustrating the danger of bias in the quality evaluation. In the 18 randomised controlled trials, the implementation of double or triple blinding led to a designation of low risk for the blinding of patients, investigators, and assessors. Moreover, a total of 20 randomised controlled trials exhibited a significant degree of risk or uncertainty attributable to the absence of publicly conducted or disclosed blinding techniques, as illustrated in Table 1.

3.3. The outcomes from network meta-analysis of valid comparisons on effectiveness

Figure 2 illustrates the network of direct comparisons among various wound treatment approaches. Wound treatments were classified based on the frequency of dressing changes—every other day or every third day. Modern dressings have undergone at least one placebo-controlled

trial. However, within the agents included in the network meta-analysis, povidone–iodine, gamat, hydrocolloid, hyaluronic acid, and MEBO have not been directly compared. Meanwhile, Figure 3 presents the geometry of atypical comparisons, depicting the degree of commonality between modern dressings and conventional treatments. The data in both figures describe the distribution of network structures, the number of studies evaluating each intervention, the average incidence of risk of bias, and the reliability of limited direct estimates for pairwise comparisons.

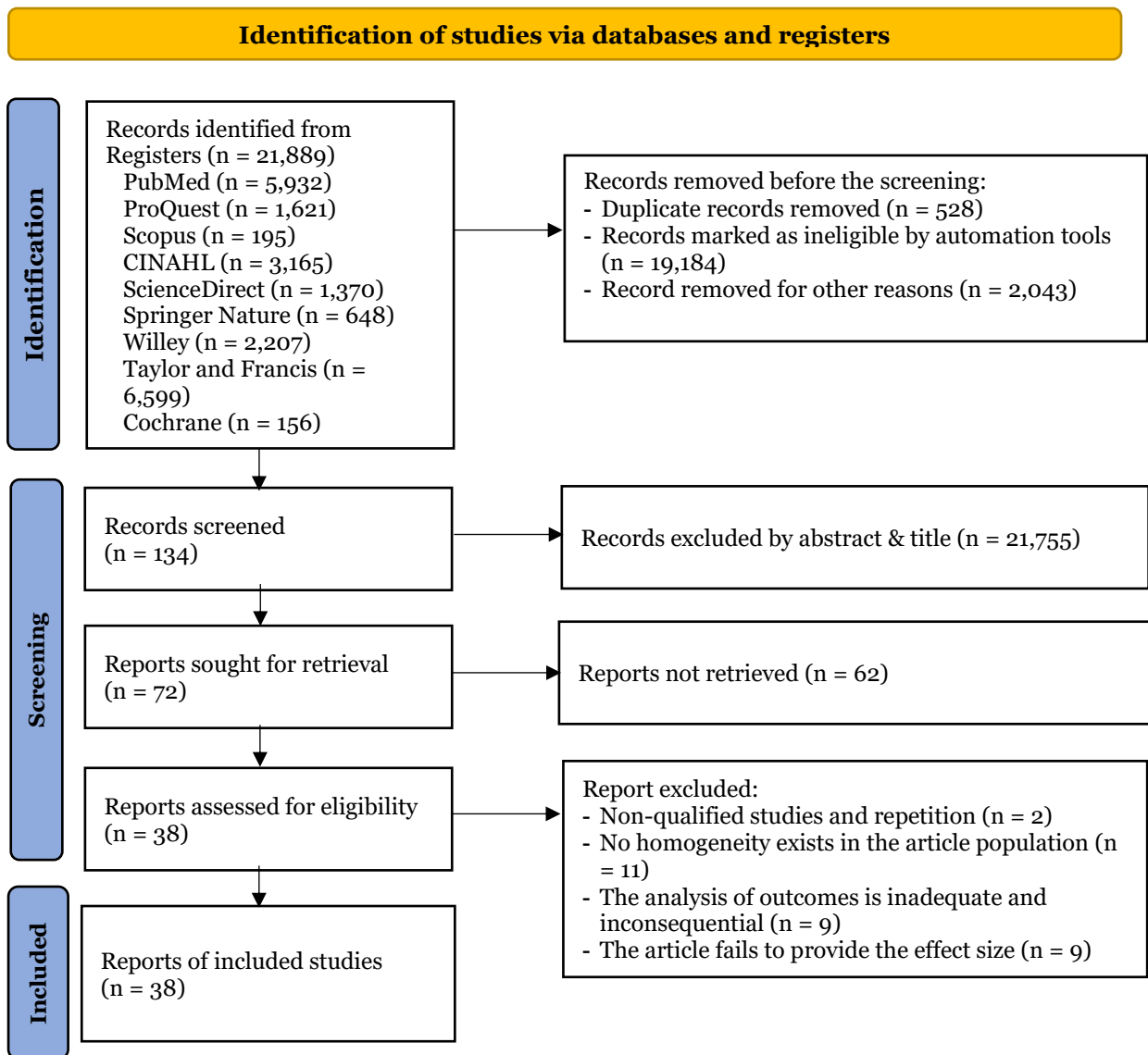


Figure 1. PRISMA flow chart

3.4. Results heterogeneity and consistency

As shown in Figure 4, a pairwise network meta-analysis was conducted for all dressing interventions that were directly compared. The results showed that Alginate vs. placebo ($I^2 = 0\%$), Collagen vs. Placebo ($I^2 = 0\%$), Honey vs. Placebo ($I^2 = 44\%$), Hydrogel vs. placebo ($I^2 = 0\%$), Silver Sulfadiazine vs. Placebo ($I^2 = 27\%$), indicating a low risk of heterogeneity. The consistency of global recommendations was assessed using an inconsistency model based on Figure 3. A design-by-treatment interaction model [$X^2 = 1.757$, $p = 0.780$] was also used to test for inconsistency. However, neither model identified any discrepancy, suggesting complete agreement between direct and indirect comparisons, as illustrated in Figure 3. Findings from meta-analyses involving pairs and networks.

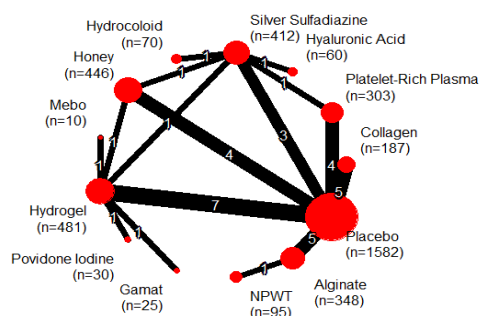


Figure 2. Network of RCTs comparing wound-healing interventions; node size reflects total participants per treatment, and edge width denotes the number of head-to-head trials.

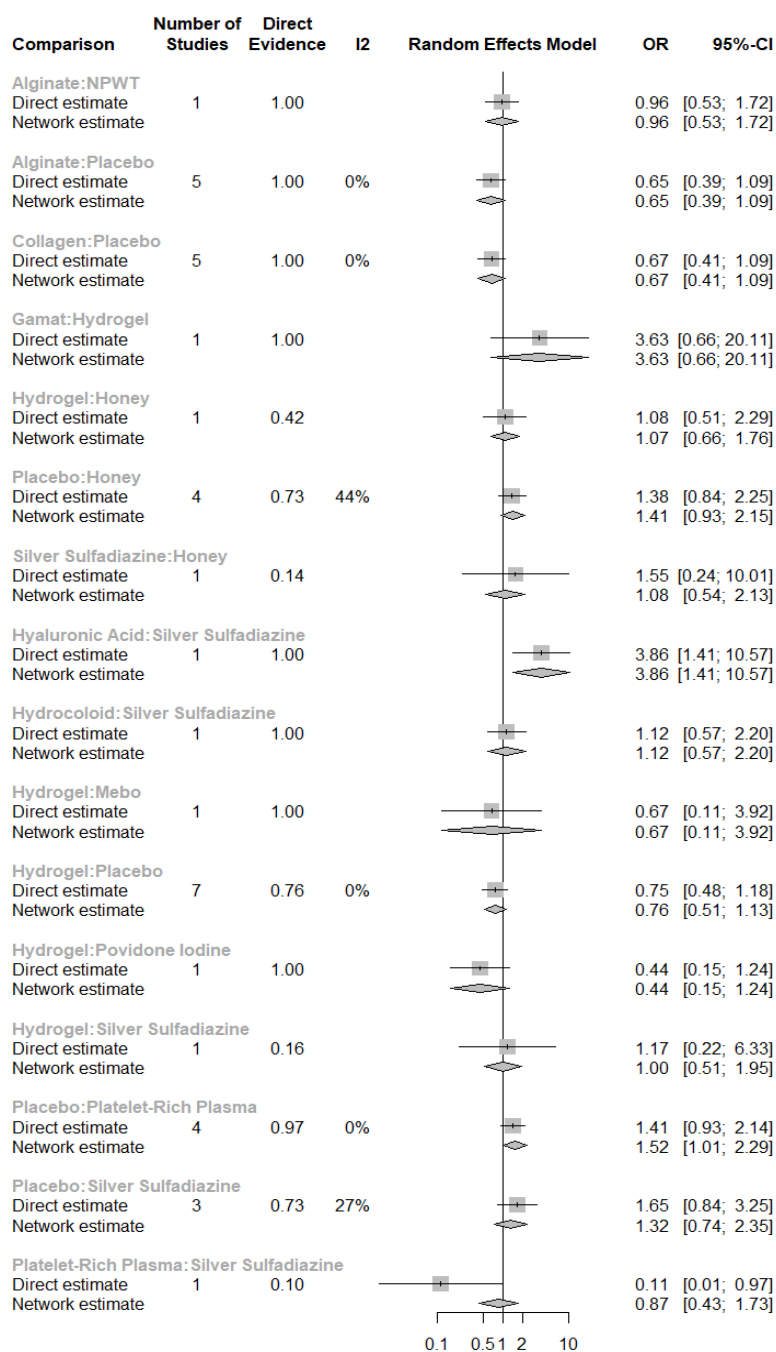


Figure 3. Pairwise direct estimate comparison with I-square (I²), using random-effects model (RE), odds ratio (OR), and confidence interval (CI)

3.5. Primary outcome results

The NMA revealed multiple statistically significant effects among wound dressing therapies. Alginate exhibited enhanced healing efficiency relative to PRP (OR = 0.22, 95%CI = 0.06–0.79), highlighting its potential as a preferred alternative to platelet-rich plasma in clinical applications. In contrast, PRP demonstrated a greater probability of wound healing than placebo (OR = 1.52, 95%CI = 1.01–2.29), indicating a quantifiable therapeutic advantage of biologically active dressings over inert controls. Moreover, the placebo demonstrated considerably lower efficacy compared to PRP (OR = 0.66, 95%CI = 0.44–0.99), hence underscoring the comparative benefit of PRP in facilitating tissue healing. These findings indicate that alginate is the most effective intervention among the studied modalities, although PRP remains clinically significant by surpassing placebo, thus affirming its status as a viable supplementary therapy (Table 2).

Table 2. Pairwise comparisons of wound dressings for complete wound healing (odds ratio [OR], 95% confidence interval [CI])

Reference	Alginate	Collagen	Honey	PRP	SSD	Placebo
Alginate	-	0.65 (0.39–1.09)	0.92 (0.44–1.98)	0.22 (0.06–0.79)*	0.87 (0.43–1.73)	1.41 (0.93–2.14)
Collagen	1.54 (0.92–2.56)	-	0.72 (0.44–1.19)	0.24 (0.04–1.47)	0.88 (0.41–1.88)	1.65 (0.84–3.25)
Honey	1.09 (0.51–2.29)	1.38 (0.84–2.28)	-	0.94 (0.12–7.66)	0.94 (0.47–1.80)	0.99 (0.51–1.91)
PRP	4.52 (1.27–16.1)*	4.10 (0.78–21.5)	1.07 (0.13–9.02)	-	1.32 (0.49–3.42)	1.52 (1.01–2.29)*
SSD	1.15 (0.58–2.29)	1.13 (0.53–2.41)	1.07 (0.55–2.08)	0.76 (0.29–2.01)	-	1.32 (0.65–2.70)
Placebo	0.71 (0.47–1.08)	0.61 (0.31–1.19)	1.01 (0.52–1.93)	0.66 (0.44–0.99)*	0.76 (0.37–1.53)	-

Notes. Abbreviations: -: diagonal = self-comparison; PRP: platelet-rich plasma; SSD: silver sulfadiazine

3.6. Ranking probabilities

Alginate proved to be the most efficacious dressing, achieving the highest SUCRA score (0.73) and acting as the reference (OR=1.00). Platelet-rich plasma (OR=0.99; SUCRA=0.73) and collagen (OR=0.98; SUCRA=0.71) constituted a close second tier, whereas negative-pressure wound therapy and honey exhibited reasonably high SUCRA values (0.68 and 0.67, respectively). Conversely, hyaluronic acid demonstrated significantly reduced healing probabilities relative to alginate (OR=0.22; 95%CI = 0.06–0.79) and was scored lowest on SUCRA (0.09), designating it as the least advantageous choice. The SUCRA curves substantiate these findings, illustrating swift cumulative probability increases for alginate, platelet-rich plasma, and collagen, in contrast to the stable trajectories of hyaluronic acid and gamat (Figure 4 and Figure 5).

As seen in Figure 4, the forest plot indicates that Alginate is most likely ranked first despite significant overlap with other wound healing strategies. The cumulative probability of ranking first through thirteenth is displayed for each wound size reduction: 1 represents alginate, 2 represents platelet-rich plasma, 3 represents collagen, 4 represents NPWT, 5 represents honey, and 6 represents hydrogel. Hyaluronic Acid comprises substances 7 and 13, while Silver Sulfadiazine and Hydrocolloid comprise 8 and 10, respectively. Mebo and 11 are substitutes for Povidone Iodine, Gamat is substance 12, and Hyaluronic Acid is substance 13.

4. Discussion

This network meta-analysis consolidated 38 randomised controlled studies with 4,049 people. Alginate was the most effective in promoting wound closure (OR 0.64; 95% CI 0.38–1.08; SUCRA 0.73), followed by platelet-rich plasma (PRP), collagen, and negative-pressure wound therapy, while hyaluronic acid (HA) rated the lowest (SUCRA 0.08). Effect estimates were derived using a frequentist random-effects model executed in the netmeta R package, which accommodates between-study covariance and clinical heterogeneity. A design-by-treatment interaction test ($\chi^2 = 1.76$; $p = 0.78$) and low pairwise I^2 values validated the coherence between direct and indirect evidence.

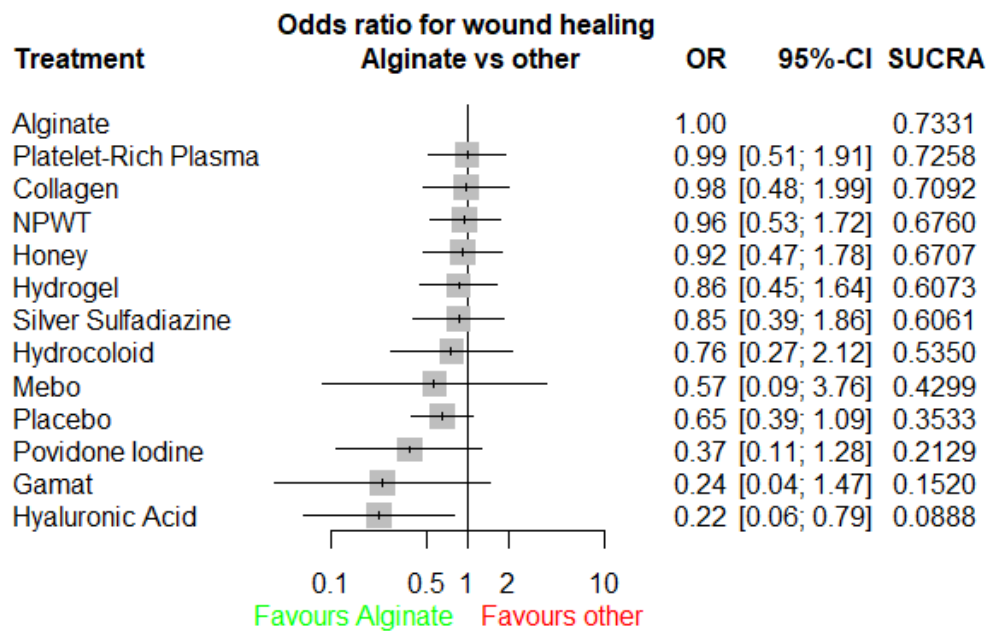


Figure 4. Ranking of wound healing interventions based on cumulative probability from NMA

When placed in the context of previous research, our findings reveal both concordance and discrepancy. In accordance with the Cochrane study (Dumville et al., 2015), alginate dressings showed superior efficacy compared to ordinary gauze in facilitating wound healing, hence affirming their effectiveness in chronic wound management. Conversely, the recent network meta-analysis by Alhindi et al. (2025) on split-thickness skin graft donor-site wounds revealed that alginate was not among the most efficacious dressings, as povidone-iodine-impregnated foam and hydrocolloid exhibited superior re-epithelialization rates.

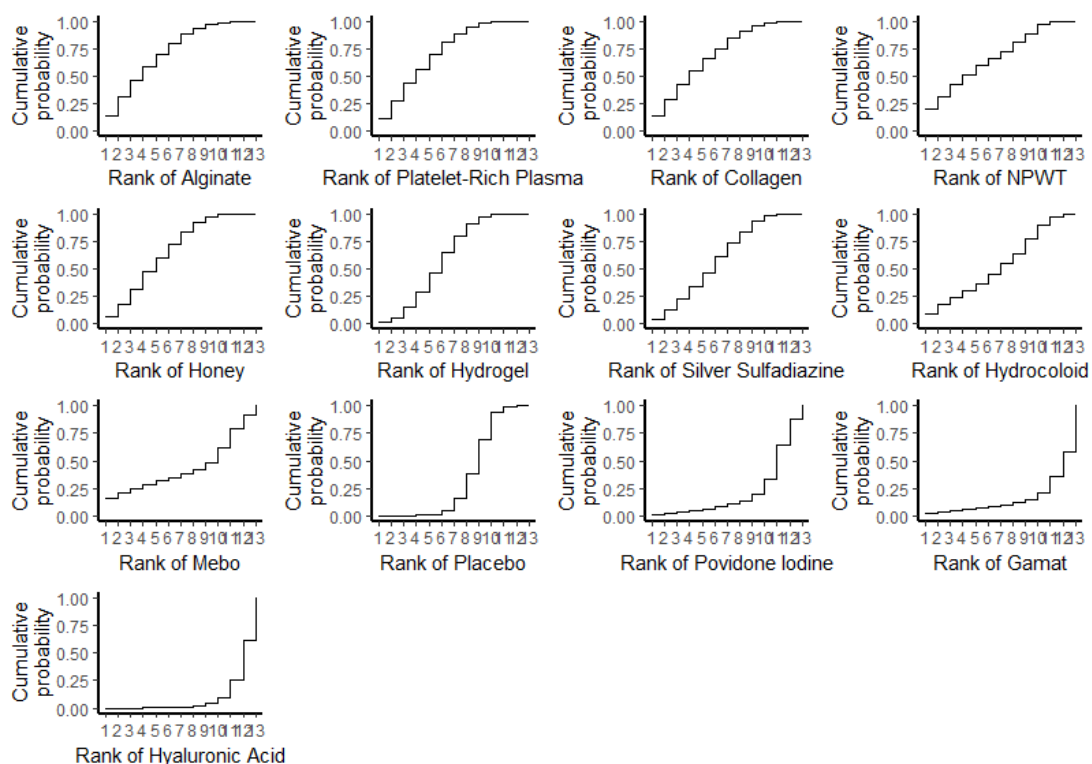


Figure 5. Forest plots of treatments ranked according to SUCRA ranking probability and odds ratio with a Confidence Interval of 95%.

The divergent outcomes indicate that although alginate is advantageous in several chronic wound scenarios, its efficacy may be contingent upon the type of wound and clinical environment, highlighting the necessity of customizing dressing selections for certain patient demographics. The divergent outcomes indicate that although alginate is advantageous in several chronic wound scenarios, its efficacy may be contingent upon the type of wound and clinical environment, highlighting the necessity of customizing dressing selections for certain patient demographics.

Calcium alginate fibers create a gel infused with calcium ions that sustains an ideal moist environment and facilitates hemostasis (Xu et al., 2025). Platelet-rich plasma (PRP) provides essential growth factors, such as PDGF, VEGF, and TGF- β , that promote angiogenesis and tissue regeneration (Everts et al., 2023; Li et al., 2025). Collagen-based scaffolds offer an extracellular matrix framework that facilitates fibroblast adhesion, proliferation, and migration in chronic wounds (Monica et al., 2024). Conversely, low-molecular-weight hyaluronic acid undergoes rapid degradation via enzymatic processes, consequently constraining its therapeutic efficacy unless subjected to chemical modification or crosslinking (Matalqah et al., 2024).

The Risk-of-Bias 2 assessment categorised 18 studies as low risk due to double or triple blinding, while 20 studies were deemed to have moderate to high risk due to incomplete blinding (Sterne et al., 2019). Sensitivity analyses that excluded high-risk trials did not change the intervention hierarchy, highlighting the robustness of the findings. Exploratory meta-regression indicated that a baseline wound area above 10 cm² and the presence of diabetes comorbidity may diminish the efficacy of PRP ($p \approx 0.05$), suggesting residual confounding (Salanti et al., 2014). Strengths encompass a comprehensive intervention network and the application of CINeMA to assess evidence certainty, whereas weaknesses consist of inconsistent study counts per node, diverse care protocols (e.g., frequency of dressing changes), and inadequate reporting of patient-centered outcomes such as pain and quality of life.

Alginate is clinically recognized as a primary choice for managing acute and chronic wounds with moderate to heavy exudate due to its excellent effectiveness, cost-efficiency, and user-friendliness. PRP or collagen may act as supplementary treatments for non-healing wounds when biological resources allow, but HA should be utilized only when more substantial proof is available. The choice of dressing should consider debridement, infection management, metabolic condition, and patient preference (Schaper et al., 2023). Future research should perform direct comparative trials of alginate, PRP, and collagen; standardize digital wound-area endpoints; include cross-national cost-effectiveness assessments; and investigate long-term effects on quality of life.

5. Implication and limitation

Our network meta-analysis of 38 randomized controlled trials with 4,049 patients identifies alginate dressings as the most efficacious choice for facilitating wound healing. By ranking 13 modern dressings using SUCRA probabilities, we provide clinicians with an evidence-based hierarchy to guide first-line choices, especially in resource-limited environments where optimizing healing time can minimize costs and complications. The comparable efficacy of platelet-rich plasma and collagen indicates their potential as viable alternatives in situations where alginate is contraindicated or unavailable.

Nonetheless, several limits necessitate prudence. The trials exhibited variability in wound types, application procedures, and endpoint criteria, resulting in heterogeneity that could influence indirect comparisons. Direct comparative studies were restricted to specific dressing pairs, diminishing the accuracy of certain SUCRA calculations. The majority of randomized controlled trials concentrated on short-term healing metrics, with few data about patient-reported outcomes (such as pain and quality of life) and economic implications. Ultimately, publication bias and varying reporting standards highlight the necessity for larger, meticulously designed studies with standardized outcomes to confirm and expand these findings.

6. Conclusion

This extensive network meta-analysis of 38 randomized trials indicates that alginate dressings have the highest likelihood of healing among 13 contemporary alternatives, as evidenced by their superior SUCRA probability. Platelet-rich plasma and collagen are intimately aligned, with honey also exhibiting significant advantages. In contrast, hyaluronic acid demonstrates the least efficacy. Our evidence-based rating directs doctors to the most effective

first-line dressings and highlights the necessity for future head-to-head trials with standardized outcomes to enhance wound-care regimens.

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Author contribution

AB: Conceptualization; Search strategy design; Methodology; Formal analysis; Statistical meta-analysis and meta-regression; Risk-of-bias assessment; PRISMA 2020 reporting; PROSPERO registration; Writing-original draft; Supervision; Project administration. IS: Database searching; Deduplication; Title/abstract and full-text screening (duplicate); Data extraction (duplicate); Risk-of-bias assessment; Writing-review & editing. VABDS: Expertise, Validation; Writing-review & editing. VK: Software; Data management; Effect size calculations; Validation; Writing-review & editing. DTKCi: Screening (duplicate); Data extraction; Resources; Data curation, Validation; Writing-review & editing. RH: Supervision; Writing-review & editing (provided clinical wound-care expertise). SMS: Database searching; Deduplication; Title/abstract and full-text screening (duplicate); Data extraction (duplicate); Risk-of-bias assessment; Writing-review & editing. HH: Supervision; Funding acquisition; Writing-review & editing. AB serves as guarantor and accepts full responsibility for the integrity of the work, had full access to all data, and controlled the decision to publish. All authors approved the final manuscript and accepted accountability for all aspects of the work.

Conflict of interest

There were no conflicts of interest disclosed by the authors.

References

- Adhya, A., Bain, J., Ray, O., Hazra, A., Adhikari, S., Dutta, G., Ray, S., & Majumdar, B. K. (2015). Healing of burn wounds by topical treatment: A randomized controlled comparison between silver sulfadiazine and nano-crystalline silver. *Journal of Basic and Clinical Pharmacy*, 6(1), 29-34. <https://doi.org/10.4103/0976-0105.145776>
- Ahmed, S. F., Memon, I., Rajpar, Z. H., Asim, M., Anwar, A., & Elahi, W. (2019). Management of Fournier's gangrene; A randomized controlled trial at high volume center comparing the efficacy of honey and eusol dressing in wound healing. *Journal of Liaquat University of Medical & Health Sciences*, 18(01), 06-11. <https://doi.org/10.22442/jlumhs.191810593>
- Akin, T., Kendirci, M., Akgün, A. E., Çetinkaya, E., Er, S., Akin, M., & Yasti, A. Ç. (2022). Applying a silver-containing dressing to the incision site and its effect on the development of surgical site infection after ostomy closure: A prospective randomized clinical pilot study. *Wound Management & Prevention*, 68(4), 34-43. <https://doi.org/10.25270/wmp.2022.4.3443>
- Alhindi, N., Aldossary, S., Alhindi, N., Alturki, B., Alhindi, F., & Alsinawi, L. (2025). Dressing influence on re-epithelialization rate following split-thickness skin graft donor-site dressing: A network meta-analysis. *Plastic & Reconstructive Surgery – Global Open*, 13(5), e6748. <https://doi.org/10.1097/GOX.0000000000006748>
- Armstrong, D. G., Orgill, D. P., Galiano, R. D., Glat, P. M., Kaufman, J. P., Carter, M. J., DiDomenico, L. A., & Zelen, C. M. (2022). Use of a purified reconstituted bilayer matrix in the management of chronic diabetic foot ulcers improves patient outcomes vs standard of care: Results of a prospective randomised controlled MULTI-CENTRE clinical trial. *International Wound Journal*, 19(5), 1197-1209. <https://doi.org/10.1111/iwj.13715>
- Asgari, P., Zolfaghari, M., Bit-Lian, Y., Abdi, A. H., Mohammadi, Y., & Bahramnezhad, F. (2022). Comparison of hydrocolloid dressings and silver nanoparticles in treatment of pressure ulcers in patients with spinal cord injuries: A randomized clinical trial. *Journal of Caring Sciences*, 11(1), 1-6. <https://doi.org/10.34172/jcs.2022.08>

- Barbosa, M., Carvalho, V., & Paggiaro, A. (2022). Hydrogel enriched with sodium alginate and vitamins a and e for diabetic foot ulcer: A randomized controlled trial. *Wounds: A Compendium of Clinical Research and Practice*, 34(9), 229–235. <https://doi.org/10.25270/wnds/20103>
- Borenstein, M., Hedges, L., Higgins, J., Rothstein, H., & Englewood, N. (2014). *Comprehensive meta analysis version 3* [Software manual]. <https://meta-analysis.com/download/Meta-Analysis%20Manual%20V3.pdf>
- Burhan, A., Syafiqah, N., Ruangdet, K., MacLeod, R., Roy, A. D., Norrström, E. M., & Susanti, I. (2025). Hidden wounds: Prevalence of chronic wounds in Asia, A systematic review and meta-analysis. *Java Nursing Journal*, 3(2), 221–235. <https://doi.org/10.61716/jnj.v3i3.117>
- Cardenosa, E.M., Domínguez-Maldonado, G., & Córdoba-Fernández, A. (2017). Efficacy and safety of the use of platelet-rich plasma to manage venous ulcers. *Journal of Tissue Viability*, 26(2), 138–143. <https://doi.org/10.1016/j.jtv.2016.11.003>
- Casanova, D., Guerreschi, P., Sinna, R., Bertheuil, N., Philandrianos, C., Chignon-Sicard, B., Brix, M., Herlin, C., Bourgeois, M., Durand, S., Rochlin, D., Vairel, B., Blanchet, N., Lantieri, L., Parry, J.-P., Marcelli, M., Behr, M., Zouani, O., Benjoar, M., & Revol, M. (2020). ALGINATE versus NPWT in the preparation of surgical excisions for an STSG: ATEC trial. *Plastic and Reconstructive Surgery – Global Open*, 8(3), e2691. <https://doi.org/10.1097/GOX.0000000000002691>
- Chen, A. C.-Y., Hsieh, Y. L., Chi-Ying, Chen, Y.-S., Chang, K.-C., & Chang, D.-H. (2024). Advanced biomaterials and topical medications for treating diabetic foot ulcers: A systematic review and network meta-analysis. *Advances in Wound Care*, 13(2), 97–113. <https://doi.org/10.1089/wound.2023.0024>
- CINeMA. (2022). *CINeMA (Confidence in Network Meta-Analysis)*. Campbell Collaboration. <http://cinema.ispm.ch/>
- Cochrane. (2011). *The Cochrane collaboration. Cochrane handbook for systematic reviews of interventions (version 5.1.0)*. <https://training.cochrane.org/handbook>
- Cochrane. (2020). *Welcome to RevMan 5.4*. Cochrane Review. https://training.cochrane.org/system/files/uploads/protected_file/RevMan5.4_user_guide.pdf
- Cwajda-Białasik, J., Mościcka, P., Szewczyk, M. T., Hojan-Jezierska, D., Kawalkiewicz, W., Majewska, A., Janus-Kubiak, M., Kubisz, L., & Jawień, A. (2022). Venous leg ulcers treated with fish collagen gel in a 12-week randomized single-centre study. *Advances in Dermatology and Allergology*, 39(4), 714–722. <https://doi.org/10.5114/ada.2021.108424>
- Dumville, J. C., Stubbs, N., Keogh, S. J., Walker, R. M., & Liu, Z. (2015). Hydrogel dressings for treating pressure ulcers. *Cochrane Database of Systematic Reviews*, 2, CD011226. <https://doi.org/10.1002/14651858.CD011226.pub2>
- Eisenbeiß, W. (2012). Prospective, double-blinded, randomised controlled trial assessing the effect of an Octenidine-based hydrogel on bacterial colonisation and epithelialization of skin graft wounds in burn patients. *International Journal Burn Trauma*, 2(2), 9. <https://pmc.ncbi.nlm.nih.gov/articles/PMC3462524/>
- Everts, P. A., Lana, J. F., Onishi, K., Buford, D., Peng, J., Mahmood, A., Fonseca, L. F., van Zundert, A., & Podesta, L. (2023). Angiogenesis and tissue repair depend on platelet dosing and bioformulation strategies following orthobiological platelet-rich plasma procedures: A narrative review. *Biomedicines*, 11(7), 1922. <https://doi.org/10.3390/biomedicines11071922>
- Gallelli, G., Cione, E., Serra, R., Leo, A., Citraro, R., Matricardi, P., Di Meo, C., Bisceglia, F., Caroleo, M. C., Basile, S., & Gallelli, L. (2020). Nano-hydrogel embedded with quercetin and oleic acid as a new formulation in the treatment of diabetic foot ulcer: A pilot study. *International Wound Journal*, 17(2), 485–490. <https://doi.org/10.1111/iwj.13299>
- Gefen, A., Alves, P., Beeckman, D., Cullen, B., Lázaro-Martínez, J. L., Lev-Tov, H., Najafi, B., Santamaria, N., Sharpe, A., Swanson, T., & Woo, K. (2024). How should clinical wound care and management translate to effective engineering standard testing requirements from foam dressings? Mapping the existing gaps and needs. *Advances in Wound Care*, 13(1), 34–52. <https://doi.org/10.1089/wound.2021.0173>
- Gerosa, D., Santagata, M., Martinez De Tejada, B., & Guittier, M.-J. (2022). Application of honey to reduce perineal laceration pain during the postpartum period: A randomized controlled trial. *Healthcare*, 10(8), 1515. <https://doi.org/10.3390/healthcare10081515>

- Ghoraba, S. M., Mahmoud, W. H., Hammad, S. M., & M. Ayad, H. (2016). Clinical safety and efficacy of platelet-rich plasma in wound healing. *International Journal of Clinical Medicine*, 07(12), 801–808. <https://doi.org/10.4236/ijcm.2016.712086>
- Gold, M. H., Biron, J., & Rn, B. T. (2019). Randomized, single-blinded, crossover study of a novel wound dressing vs current clinical practice after percutaneous collagen induction therapy. *Journal of Cosmetic Dermatology*, 18(2), 524–529. <https://doi.org/10.1111/jocd.12872>
- Gould, L. J., Orgill, D. P., Armstrong, D. G., Galiano, R. D., Glat, P. M., Zelen, C. M., DiDomenico, L. A., Carter, M. J., & Li, W. W. (2022). Improved healing of chronic diabetic foot wounds in a prospective randomised controlled multi-centre clinical trial with a microvascular tissue allograft. *International Wound Journal*, 19(4), 811–825. <https://doi.org/10.1111/iwj.13679>
- Gounden, V., & Singh, M. (2024). Hydrogels and wound healing: Current and future prospects. *Gels*, 10, 43. <https://doi.org/10.3390/gels10010043>
- Hassan, A., Ahmed, E., Ghalwash, D., & Elarab, A. E. (2021). Clinical comparison of MEBO and hyaluronic acid gel in the management of pain after free gingival graft harvesting: A randomized clinical trial. *International Journal of Dentistry*, 2021, 2548665. <https://doi.org/10.1155/2021/2548665>
- Hersant, B., SidAhmed-Mezi, M., Bosc, R., & Meningaud, J.-P. (2017). Autologous Platelet-rich plasma/thrombin gel combined with split-thickness skin graft to manage postinfectious skin defects: A randomized controlled study. *Advances in Skin & Wound Care*, 30(11), 502–508. <https://doi.org/10.1097/01.ASW.0000524399.74460.87>
- Higgins, J. P. T., Chandler, J., Cumpston, M., Li, T., Page, M. J., & Welch, V. A. (Eds.). (2023). *Cochrane handbook for systematic reviews of interventions version 6.4* (updated August 2023). The Cochrane Collaboration. <https://www.training.cochrane.org/handbook>
- Hozo, S. P., Djulbegovic, B., & Hozo, I. (2005). Estimating the mean and variance from the median, range, and the size of a sample. *BMC Medical Research Methodology*, 5, 13. <https://doi.org/10.1186/1471-2288-5-13>
- Hwang, C. S., Al Sharhan, S. S., Kim, B. R., Kim, S. I., Kim, J. W., Cho, H.-J., Yoon, J.-H., & Kim, C.-H. (2018). Randomized controlled trial of steroid-soaked absorbable calcium alginate nasal packing following endoscopic sinus surgery: Steroid-soaked nasal packing after ESS. *The Laryngoscope*, 128(2), 311–316. <https://doi.org/10.1002/lary.26871>
- Imran, M., Hussain, M. B., & Baig, M. (2015). A randomized, controlled clinical trial of honey-impregnated dressing for treating diabetic foot ulcer. *Journal of the College of Physicians and Surgeons Pakistan*, 25(10), 721–725. <https://doi.org/10.2015/JCPSP.721725>
- Iversen, A. K. S., Lichtenberg, M., Fritz, B. G., Díaz-Pinés Cort, I., Al-Zoubaidi, D. F., Gottlieb, H., Kirketerp-Møller, K., Bjarnsholt, T., & Jakobsen, T. H. (2024). The chronic wound characterisation study and biobank: A study protocol for a prospective observational cohort investigation of bacterial community composition, inflammatory responses and wound-healing trajectories in non-healing wounds. *BMJ Open*, 14(10), e084081. <https://doi.org/10.1136/bmjopen-2024-084081>
- Julika, H. (2021). Modern wound care dress for acceleration of foot ulcer healing process in diabetes patients: A systematic review. *Jurnal Surya Medika (JSM)*, 7(1), 146–155. <https://doi.org/10.33084/jsm.v7i1.2650>
- Kangal, M. K. O., & Kopitnik, N. L. (2025). *Physiology, wound healing*. StatPearls Publishing. <https://www.ncbi.nlm.nih.gov/books/NBK535406/>
- Kjær, M., Frederiksen, A. K. S., Nissen, N. I., Willumsen, N., van Hall, G., Jørgensen, L. N., Andersen, J. R., & Ågren, M. S. (2020). Multinutrient supplementation increases collagen synthesis during early wound repair in a randomized controlled trial in patients with inguinal hernia. *The Journal of Nutrition*, 150(4), 792–799. <https://doi.org/10.1093/jn/nxz324>
- La Monica, F., Campora, S., & Gherzi, G. (2024). Collagen-based scaffolds for chronic skin wound treatment. *Gels*, 10(2), 137. <https://doi.org/10.3390/gels10020137>
- Li, Y., Cheng, B., & Tian, J. (2025). Platelet-rich plasma may accelerate diabetic wound healing by modulating epithelial/endothelial-mesenchymal transition through inhibiting reactive oxygen species-mediated oxidative stress. *Frontiers in Bioengineering and Biotechnology*, 13, 1623780. <https://doi.org/10.3389/fbioe.2025.1623780>
- Li, Z., Lin, F., Thalib, L., & Chaboyer, W. (2020). Global prevalence and incidence of pressure injuries in hospitalised adult patients: A systematic review and meta-analysis. *International Journal of Nursing Studies*, 105, 103546. <https://doi.org/10.1016/j.ijnurstu.2020.103546>

- López-Jiménez, M. M., Romero-García, M., Adamuz, J., Berbis-Morelló, C., Pons-Prats, M., Tapia-Pérez, M., Pastor-Valero, M. A., García-Vallejo, M., Martínez-Monzón, C., Fernández-Ruiz, M., Cañadas-Román, A., Castejón-Castejón, M., Camacho-Moreno, M. J., Granell-Molina, M. E., Baena-García, L., Rodríguez-Calero, M. A., & González-Samartino, M. (2025). Prevalence of chronic wounds in hospitalised patients in Catalonia, Spain: A multicentre cross-sectional descriptive observational study. *BMJ Open*, 15(5), e095542. <https://doi.org/10.1136/bmjopen-2024-095542>
- Malizos, K., Blauth, M., Danita, A., Capuano, N., Mezzoprete, R., Logoluso, N., Drago, L., & Romanò, C. L. (2017). Fast-resorbable antibiotic-loaded hydrogel coating to reduce post-surgical infection after internal osteosynthesis: A multicenter randomized controlled trial. *Journal of Orthopaedics and Traumatology*, 18(2), 159–169. <https://doi.org/10.1007/s10195-017-0442-2>
- Martinengo, L., Olsson, M., Bajpai, R., Soljak, M., Upton, Z., Schmidtchen, A., Car, J., & Järbrink, K. (2019). Prevalence of chronic wounds in the general population: Systematic review and meta-analysis of observational studies. *Annals of Epidemiology*, 29, 8–15. <https://doi.org/10.1016/j.annepidem.2018.10.005>
- Matalqah, S., Lafi, Z., & Asha, S. Y. (2024). Hyaluronic acid in nanopharmaceuticals: An overview. *Current Issues in Molecular Biology*, 46(9), 10444–10461. <https://doi.org/10.3390/cimb46090621>
- Meekul, J., Chotirosniramit, A., Himakalasa, W., Orrapin, S., Wongthanee, A., Pongtam, O., Kulprachakarn, K., & Rerkasem, K. (2017). A randomized controlled trial on the outcome in comparing an alginate silver dressing with a conventional treatment of a necrotizing fasciitis wound. *The International Journal of Lower Extremity Wounds*, 16(2), 108–113. <https://doi.org/10.1177/1534734617701051>
- Megahed, M., Rageh, T., Nassar, A., & Abdel Razek, M.-S. (2019). The role of autologous platelet-rich plasma in healing of gaping and chronic wounds. *Menoufia Medical Journal*, 32(2), 723. https://doi.org/10.4103/mmj.mmj_57_18
- Miner, S. A., Lee, J., Protzman, N. M., & Brigido, S. A. (2022). The effect of a silver hydrogel sheet dressing on postsurgical incision healing after foot and ankle surgery. *Scars, Burns & Healing*, 8, 205951312211223. <https://doi.org/10.1177/20595131221122303>
- Mohamadi, S., Norooznezhad, A. H., Mostafaei, S., Nikbakht, M., Nassiri, S., Safar, H., Moghaddam, K. A., Ghavamzadeh, A., & Kazemnejad, A. (2019). A randomized controlled trial of effectiveness of platelet-rich plasma gel and regular dressing on wound healing time in pilonidal sinus surgery: Role of different affecting factors. *Biomedical Journal*, 42(6), 403–410. <https://doi.org/10.1016/j.bj.2019.05.002>
- Moon, K.-C., Suh, H.-S., Kim, K.-B., Han, S.-K., Young, K.-W., Lee, J.-W., & Kim, M.-H. (2019). Potential of allogeneic adipose-derived stem cell–hydrogel complex for treating diabetic foot ulcers. *Diabetes*, 68(4), 837–846. <https://doi.org/10.2337/db18-0699>
- Nguyen, H. M., Ngoc Le, T. T., Nguyen, A. T., Thien Le, H. N., & Pham, T. T. (2023). Biomedical materials for wound dressing: Recent advances and applications. *RSC Advances*, 13(8), 5509–5528. <https://doi.org/10.1039/D2RA07673J>
- Nifontova, G., Safaryan, S., Khristidis, Y., Smirnova, O., Vosough, M., Shpichka, A., & Timashev, P. (2024). Advancing wound healing by hydrogel-based dressings loaded with cell-conditioned medium: A systematic review. *Stem Cell Research & Therapy*, 15, 371. <https://doi.org/10.1186/s13287-024-03976-x>
- Noorbala, M. T., Noorbala, M., Dashti-Rahmatabadi, M. H., Noorbala, M., Noorbala, R., & Mozaffary, B. (2016). Comparison of hydrogel produced by radiation as applied at the Research Center (Yazd Branch) with MaxGel and routine dressing for second-degree burn repair in Yazd Burn Hospital. *Iranian Red Crescent Medical Journal*, 18(8), e24384. <https://doi.org/10.5812/ircmj.24384>
- Nuutila, K., & Eriksson, E. (2021). Moist wound healing with commonly available dressings. *Advances in Wound Care*, 10(12), 685–698. <https://doi.org/10.1089/wound.2020.1232>
- Ongarora, B. G. (2022). Recent technological advances in the management of chronic wounds: A literature review. *Health Science Reports*, 5(3), e641. <https://doi.org/10.1002/hsr2.641>
- Park, K. H., Kwon, J. B., Park, J. H., Shin, J. C., Han, S. H., & Lee, J. W. (2019). Collagen dressing in the treatment of diabetic foot ulcer: A prospective, randomized, placebo-controlled, single-

- center study. *Diabetes Research and Clinical Practice*, 156, 107861. <https://doi.org/10.1016/j.diabres.2019.107861>
- Parmar, P. D., Dhamija, R., Tewari, S., Sangwan, P., Gupta, A., Duhan, J., & Mittal, S. (2019). 2D and 3D radiographic outcome assessment of the effect of guided tissue regeneration using resorbable collagen membrane in the healing of through-and-through periapical lesions – A randomized controlled trial. *International Endodontic Journal*, 52(7), 935–948. <https://doi.org/10.1111/iej.13098>
- Rasul, R., Akram, B., Abidin, Z. U., Khalid, F. A., Raza, S., & Khalid, K. (2022). Evaluation of amnion versus calcium alginate as split-thickness skin graft donor site dressing: A randomised controlled trial. *Journal of Fatima Jinnah Medical University*, 16(1), 7–11. <https://doi.org/10.37018/OUAN1021>
- Rezvani Ghomi, E., Khalili, S., Nouri Khorasani, S., Esmaeely Neisiany, R., & Ramakrishna, S. (2019). Wound dressings: Current advances and future directions. *Journal of Applied Polymer Science*, 136(27), 47738. <https://doi.org/10.1002/app.47738>
- Russo, R., Carrizzo, A., Barbato, A., Rasile, B. R., Pentangelo, P., Ceccaroni, A., Marra, C., Alfano, C., & Losco, L. (2022). Clinical evaluation of the efficacy and tolerability of Rigenase® and polyhexanide (Fitostimoline® Plus) vs. hyaluronic acid and silver sulfadiazine (Connettivina® Bio Plus) for the treatment of acute skin wounds: A randomized trial. *Journal of Clinical Medicine*, 11(9), 2518. <https://doi.org/10.3390/jcm11092518>
- Salanti, G., Del Giovane, C., Chaimani, A., Caldwell, D. M., & Higgins, J. P. T. (2014). Evaluating the quality of evidence from a network meta-analysis. *PLoS ONE*, 9(7), e99682. <https://doi.org/10.1371/journal.pone.0099682>
- Salehi, V., Yavari Barhaghtalab, M. J., Mehrabi, S., Iraj, A., Sadat, S. A., Yusefi, S. H., & Malekzadeh, J. M. (2022). Does application of honey improve surgical outcome in pilonidal cyst excision with secondary intention healing? A prospective randomized placebo-controlled clinical trial. *Perioperative Medicine*, 11, 1. <https://doi.org/10.1186/s13741-021-00237-w>
- Saragih, D.I., Susanto, H., Lin, H.-C., & Lee, B.-O. (2025). Vibration therapy for patients with hard-to-heal wounds: A systematic review and meta-analysis of experimental studies. *Journal of Tissue Viability*, 34(1), 100852. <https://doi.org/10.1016/j.jtv.2024.100852>
- Schaper, N. J., van Netten, J. J., Apelqvist, J. A., Bus, S., Fitridge, R., Game, F., Monteiro-Soares, M., Senneville, E., & IWGDF Editorial Board. (2023). Practical guidelines on the prevention and management of diabetes-related foot disease (IWGDF 2023 update). *Diabetes/ Metabolism Research and Reviews*, 40(3), e3657. <https://doi.org/10.1002/dmrr.3657>
- Sen, C. K. (2021). Human wound and its burden: Updated 2020 compendium of estimates. *Advances in Wound Care*, 10(5), 281–292. <https://doi.org/10.1089/wound.2021.0026>
- Sen, C. K. (2023). Human wound and its burden: Updated 2022 compendium of estimates. *Advances in Wound Care*, 12(12), 657–670. <https://doi.org/10.1089/wound.2023.0150>
- Siavash, M., Shokri, S., Haghighi, S., Shahtalebi, M. A., & Farajzadehgan, Z. (2015). The efficacy of topical royal jelly on healing of diabetic foot ulcers: A double-blind placebo-controlled clinical trial. *International Wound Journal*, 12(2), 137–142. <https://doi.org/10.1111/iwj.12063>
- Sterne, J. A. C., Savović, J., Page, M. J., Elbers, R. G., Blencowe, N. S., Boutron, I., Cates, C. J., Cheng, H.-Y., Corbett, M. S., Eldridge, S. M., Emberson, J. R., Hernán, M. A., Hopewell, S., Hróbjartsson, A., Junqueira, D. R., Jüni, P., Kirkham, J. J., Lasserson, T., Li, T., ... Higgins, J. P. T. (2019). RoB 2: A revised tool for assessing risk of bias in randomised trials. *BMJ*, 366, l4898. <https://doi.org/10.1136/bmj.l4898>
- Sun, W., Chen, M., Duan, D., Liu, W., Cui, W., & Li, L. (2023). Effectiveness of moist dressings in wound healing after surgical suturing: A Bayesian network meta-analysis of randomised controlled trials. *International Wound Journal*, 20(1), 69–78. <https://doi.org/10.1111/iwj.13839>
- Talebi, M., Ghale, R. A., Asl, R. M., & Tabandeh, F. (2025). Advancements in characterization and preclinical applications of hyaluronic acid-based biomaterials for wound healing: A review. *Carbohydrate Polymer Technologies and Applications*, 9, 100706. <https://doi.org/10.1016/j.carpta.2025.100706>
- Tsang, K.-K., Kwong, E. W.-Y., To, T. S.-S., Chung, J. W.-Y., & Wong, T. K.-S. (2017). A pilot randomized, controlled study of nanocrystalline silver, manuka honey, and conventional

- dressing in healing diabetic foot ulcer. *Evidence-Based Complementary and Alternative Medicine*, 2017, 5294890. <https://doi.org/10.1155/2017/5294890>
- Tudoroiu, E.-E., Albu Kaya, M. G., Titorencu, I., Dinu-Pîrvu, C. E., Marin, M. M., Roşca, A.-M., & Ghica, M. V. (2023). Design and evaluation of new wound dressings based on collagen-cellulose derivatives. *Materials & Design*, 236, 112469. <https://doi.org/10.1016/j.matdes.2023.112469>
- Verdú-Soriano, J., de Cristino-Espinar, M., Luna-Morales, S., Dios-Guerra, C., Caballero-Villarraso, J., Moreno-Moreno, P., Casado-Díaz, A., Berenguer-Pérez, M., Guler-Caamaño, I., Laosa-Zafra, O., Rodríguez-Mañas, L., & Lázaro-Martínez, J. L. (2022). Superiority of a novel multifunctional amorphous hydrogel containing *Olea europaea* leaf extract (EHO-85) for the treatment of skin ulcers: A randomized, active-controlled clinical trial. *Journal of Clinical Medicine*, 11(5), 1260. <https://doi.org/10.3390/jcm11051260>
- Wang, Y.-C., Lee, H.-C., Chen, C.-L., Kuo, M.-C., Ramachandran, S., Chen, R.-F., & Kuo, Y.-R. (2021). The effects of silver-releasing foam dressings on diabetic foot ulcer healing. *Journal of Clinical Medicine*, 10(7), 1495. <https://doi.org/10.3390/jcm10071495>
- Wen, P.Y.A., Halim, A. S., Mat Saad, A. Z., Mohd Nor, F., & Wan Sulaiman, W. A. (2018). A prospective study evaluating wound healing with sea cucumber gel compared with hydrogel in treatment of skin graft donor sites. *Complementary Therapies in Medicine*, 41, 261–266. <https://doi.org/10.1016/j.ctim.2018.10.006>
- White, I. R., Barrett, J. K., Jackson, D., & Higgins, J. P. T. (2012). Consistency and inconsistency in network meta-analysis: Model estimation using multivariate meta-regression. *Research Synthesis Methods*, 3(2), 111–125. <https://doi.org/10.1002/jrsm.1045>
- Wu, B., Zhang, F., Jiang, W., & Zhao, A. (2021). Nanosilver dressing in treating deep II degree burn wound infection in patients with clinical studies. *Computational and Mathematical Methods in Medicine*, 2021, 3171547. <https://doi.org/10.1155/2021/3171547>
- Xu, F., Gao, Y., Xin, H., Cao, C., Ma, W., Sun, W., & Ma, Q. (2025). A review on multifunctional calcium alginate fibers for full-time and multipurposed wound treatment: From fundamentals to advanced applications. *International Journal of Biological Macromolecules*, 290, 139133. <https://doi.org/10.1016/j.ijbiomac.2024.139133>
- Yao, Z., Niu, J., & Cheng, B. (2020). Prevalence of chronic skin wounds and their risk factors in an inpatient hospital setting in Northern China. *Advances in Skin & Wound Care*, 33(9), 1–10. <https://doi.org/10.1097/01.ASW.0000694164.34068.82>

Appendix

Table 1. Characteristics and interventions of included studies

Study	Design	Area, Continent	Sample Size	Mean Age	Settings, Diagnosis	Intervention, Frequency	Timing	Tools	Findings	RoB2
Adhya et al., 2015	RCT	India Asia	58	29.60	Hospital Burn	Hydrogel 1 (day) SSD (1 day)	2 weeks	Photographic wound assessment tool (PWAT)	In partial-thickness burn wounds, nano-crystalline silver attained $\geq 50\%$ healing in 80.6% of cases, compared to 48.1% with silver sulfadiazine at four weeks, indicating higher efficacy.	M
Ahmed et al., 2019	RCT	Pakistan Asia	44	54.93	Hospital Diabetic Foot Ulcer	Honey (2 days) Placebo (2 days)	6 weeks	BWAT	Honey dressings improved wound-healing in Fournier's gangrene by removing slough faster, requiring fewer debridements (3 vs. 5), and reducing hospital stays to 10 days vs. 14 days with Eusol.	M
Akin et al., 2022	RCT	Turkey Asia	32	59.52	Hospital Post-Operative	SSD (3 days) Placebo (3 days)	4 weeks	Surgical Site Infection	Post-ostomy closure, a silver-hydrofiber dressing entirely inhibited surgical-site infections (0% compared to 26.7% with gauze; $P = 0.043$), hence affirming its preventative efficacy.	M
Armstrong et al., 2022	RCT	USA America	80	62.90	Hospital Diabetic Foot Ulcer	Alginate (3 days) Placebo (3 days)	12 weeks	Wagner Scale University of Texas 1A	In non-healing diabetic foot ulcers, a purified reconstructed bilayer matrix achieved closure of 83% of wounds by 12 weeks, compared to 45% with standard care, and reduced the mean healing period from 62 to 42 days (both $p < 0.01$).	L
Asgari et al., 2022)	RCT	Iran Asia	70	69.29	Hospital Pressure ulcer	SSD (3 days) HD (3 days)	2 weeks	BWAT	Hydrocolloid and silver-nanoparticle dressings improved pressure ulcer scores in spinal cord injury patients equally, confirming treatment comparability.	H
Barbosa et al., 2022	RCT	Brazil America	26	63.10	Hospital Diabetic Foot Ulcer	Hydrogel (3 days) Placebo (3 days)	12 weeks	Photographic evaluation	A sodium alginate-based hydrogel supplemented with vitamins A and E did not enhance wound area, PUSH scores, or collagen deposition compared to normal dressings for diabetic foot ulcers.	L
Cardenosa et al., 2017	RCT	Spain Europe	58	64.15	Hospital Venous Leg Ulcer	PRP (3 days) Placebo (3 days)	24 weeks	Visitrak Digital Planimetry Wound Measurement System	Platelet-rich plasma expedited venous ulcer closure (mean healed area 67.7% vs 11.2%; $p = 0.001$) and alleviated pain without side consequences.	M

Table 1. Continued

Study	Design	Area, Continent	Sample Size	Mean Age	Settings, Diagnosis	Intervention, Frequency	Timing	Tools	Findings	RoB2
Casanova et al., 2020	RCT	France Europe	95	52.85	Hospital Post-Operative	Alginate (3 days) Placebo (3 days)	4 weeks	Measure Wound	Calcium-alginate dressings demonstrated non-inferiority to negative-pressure wound care in attaining graft-ready granulation tissue (about 20 days in both cohorts) and resulted in significantly fewer treatment-related side events.	L
Cwajda-Białasik et al., 2022	RCT	Polandia Europe	97	63.40	Hospital Venous Leg Ulcer	Collagen (1 day) Placebo (1 day)	12 weeks	Visitrak Digital Planimetry Wound Measurement System	Fish-collagen gel improved venous leg ulcer healing over 12 weeks, closing 37–55% of ulcers compared to 28–34% with usual therapy and reducing discomfort and improving quality of life.	M
Eisenbeiß, 2012	RCT	Germany Europe	41	41.70	Hospital Post-Operative	Hydrogel (3 days) Placebo (3 days)	1 week	Epitelisasi Scale	In burn victims, an Octenidine-based hydrogel significantly reduced bacterial colonisation of skin-graft donor sites without prolonging epithelial closure.	M
Gallelli et al., 2020	RCT	Italy Europe	56	68.50	Hospital Chronic Wound	Hydrogel (7 days) P.I (7 days)	8 weeks	BWAT	A nano-hydrogel containing quercetin and oleic acid dramatically reduced the healing time of diabetic foot ulcers compared to a hyaluronic acid control, with no side events connected to the treatment.	M
Gerosa et al., 2022	RCT	Switzerland Europe	60	33.35	Hospital Post-Operative	Collagen (1 day) Hydrogel (1 day)	6 weeks	REEDA for redness, edema, ecchymosis, discharge, and approximation of the perineal tissues.	Topical honey did not significantly reduce early postpartum perineal laceration discomfort compared to normal care, but users reported great pleasure and some improvement.	M
Ghoraba et al., 2016	RCT	Egypt Africa	80	28.60	Hospital Chronic Wound	PRP (7 days) Placebo (7 days)	12 weeks	Visitrak digital wound measuring device	Platelet-rich plasma gel accelerated epithelialisation and reduced pain at split-thickness skin graft donor sites without increasing sequelae, proving its safe use in acute wound therapy.	H
Gold et al., 2019	RCT	USA America	20	48.45	Hospital Post-Operative	Collagen (1 day) Placebo (1 day)	1 week	Antera 3D Camera for skin analysis - miravex	A silicone-based bandage following microneedling reduced erythema and other initial inflammatory symptoms compared to Aquaphor, and all wounds healed without problems.	L

Table 1. Continued

Study	Design	Area, Continent	Sample Size	Mean Age	Settings, Diagnosis	Intervention, Frequency	Timing	Tools	Findings	RoB2
Gould et al., 2022	RCT	USA America	200	60.30	Hospital Diabetic Foot Ulcer	Alginate (3 days) Placebo (3 days)	12 weeks	3D Digital Infrared imaging technology	A processed microvascular tissue allograft increased the 12-week closure rate of diabetic foot ulcers to 74% from 38% for collagen-alginate alone and decreased healing time by ten days.	L
Hassan et al., 2021	RCT	Egypt Africa	30	37.53	Hospital Post- Operative	Mebo (3 days) Placebo (3 days)	3 weeks	UNC-15	Topical MEBO ointment provided better postoperative pain relief and colour matching than 0.2% hyaluronic acid gel or routine care after free gingival graft harvesting, although all groups reduced wound size similarly.	H
Hersant et al., 2017	RCT	France Europe	34	56.25	Hospital Post Operative	PRP (3 days) SSD (3 days)	4 weeks	Epitelisasi Scale	Adding autologous PRP/thrombin gel to split-thickness skin grafts lowered healing time to 37.9 ± 14.3 days, compared to 73.7 ± 50.8 days, without increasing post-infectious skin defect issues.	H
Hwang et al., 2018	RCT	South Korea Asia	44	42.05	Hospital Post- Operative	Alginate (3 days) Placebo (3 days)	12 weeks	POSE Score	Triamcinolone-impregnated absorbable calcium-alginate packing following endoscopic sinus surgery improved mucosal healing and reduced early polypoid transformation compared to traditional packing.	H
Imran et al., 2015	RCT	Arab Saudi Asia	233	54.00	Hospital Diabetic Foot Ulcer	Honey (1 day) Placebo (1 day)	1 week	Wagner Scale Visitrak digital wound measuring device	Honey-impregnated dressings healed 75.97% of diabetic foot ulcers and shortened median healing time compared to saline dressings.	M
Kjaer et al., 2020	RCT	Denmark Europea	20	54.95	Hospital Post- Operative	Collagen (1 day) Placebo (1 day)	2 weeks	Visitrak Digital Planimetry Wound Measurement System	Peri-operative treatment with arginine, glutamine, vitamin C, and zinc enhanced early collagen-type I synthesis in wound fluid following inguinal hernia repair, while the control group exhibited no such increase.	H
Malizos et al., 2017	RCT	Italy Europe	253	60.55	Hospital Post- Operative	Hydrogel (3 days) Placebo (3 days)	2 weeks	Surgical Site Infection ASEPSIS score	In fracture fixation, a rapidly resorbable antibiotic-embedded hydrogel coating eradicated early surgical-site infections (0% vs to 4.7% in the control group) and resulted in no implant-associated adverse effects.	H

Table 1. Continued

Study	Design	Area, Continent	Sample Size	Mean Age	Settings, Diagnosis	Intervention, Frequency	Timing	Tools	Findings	RoB2
Meekul et al., 2017	RCT	Thailand Asia	39	61.32	Hospital Post-Operative	Alginate (1 day) Placebo (1 day)	8 weeks	Wound Area	In cases of necrotising fasciitis, silver-alginate dressings diminished pain and shown a non-significant reduction of 10 days in wound-bed preparation time compared to saline gauze.	L
Megahed et al., 2019	RCT	Egypt Africa	28	39.68	Hospital Chronic Wound	PRP (7 days) Placebo (7 days)	24 weeks	Visitrak digital wound measuring device	Autologous platelet-rich plasma reduced the average healing duration of chronic non-healing ulcers to 49.8 ± 22.2 days compared to 108.7 ± 5.6 days with conventional treatment ($P < 0.001$), thereby affirming its superior, safe, and easily applicable efficacy.	H
Miner et al., 2022	RCT	USA Americ	40	48.42	Hospital Post Operative	Hydrogel (3 days) Placebo (3 days)	12 weeks	Wound Area	A silver-impregnated hydrogel sheet dressing improved scarring and pain/itch scores at 6–12 weeks after foot-and-ankle surgery without incision issues compared to petroleum gauze.	M
Mohamadi et al., 2019	RCT	Iran Asia	110	28.65	Hospital Post-Operative	PRP (3 days) Placebo (3 days)	12 weeks	Wound Dimension	Platelet-rich plasma gel significantly reduced the mean healing time following pilonidal-sinus surgery (4.8 ± 0.9 weeks versus 8.7 ± 1.2 weeks) and increased the rate of wound closure by 37 times compared to conventional dressings.	M
Moon et al., 2019	RCT	South Korea Asia	39	63.60	Hospital Diabetic Foot Ulcer	Hydrogel (3 days) Placebo (3 days)	12 weeks	Visitrak Digital Planimetry Wound Measurement System	Weekly allogeneic adipose-derived stem-cell hydrogel treatment closed 73% of diabetic foot ulcers by week 8 (compared to 47% in the control group) and halved median healing time with no major side effects.	L
Noorbala et al., 2016	RCT	Iran Asia	55	60.00	Hospital Burn	Hydrogel (1 day) Placebo (1 day)	2 weeks	Wound Area	Irgel, a radiation-produced hydrogel, healed second-degree burns faster than MaxGel or ordinary gauze by day 13 without side effects.	M
Park et al., 2019	RCT	South Korea Asia	30	57.90	Hospital Diabetic Foot Ulcer	Collagen (1 day) Placebo (1 day)	12 weeks	Visitrak Digital Planimetry Wound Measurement System	A porcine collagen bandage closed 82.4 percent of diabetic foot ulcers, compared to 38.5 percent with standard foam, and cut the median time to 50% size reduction in half, indicating faster healing.	L

Table 1. Continued

Study	Design	Area, Continent	Sample Size	Mean Age	Settings, Diagnosis	Intervention, Frequency	Timing	Tools	Findings	RoB2
Parmar et al., 2019	RCT	India Asia	30	28.57	Hospital Post Operative	Collagen (4 days) Placebo (4 days)	12 weeks	Visitrak Digital Planimetry Wound Measurement System	In cases of extensive periapical lesions, the incorporation of a resorbable collagen membrane provided no radiographic healing benefit compared to traditional endodontic surgery at 12 months.	M
Rasul et al., 2022	RCT	New Zealand Oseania	60	31.26	Hospital Post-Operative	Alginate (1 day) Placebo (1 day)	2 weeks	Photographic evaluation	Amnion dressings expedited the healing of split-thickness skin-graft donor sites by three days compared to calcium alginate (11 days versus 14 days; p = 0.000), while also marginally decreasing discomfort and infections.	M
Russo et al., 2022	RCT	Italy Europea	60	58.50	Hospital Chronic Wound	SSD (3 days) H.A. (3 days)	6 weeks	The wound edges (margins)	The polyhexanide hydrogel (Fitostimoline® Plus) diminished wound area more rapidly than the hyaluronic-acid/silver-sulfadiazine comparison (Connettivina® Bio Plus) in acute superficial skin lesions, exhibiting comparable tolerability.	M
Salehi et al., 2022	RCT	Iran Asia	48	25.41	Hospital Diabetic Foot Ulcer	Honey (7 days) Placebo (7 days)	1 week	Wound Dimension	Topical honey shortened healing time and accelerated daily activities after pilonidal cyst excision, but it increased postoperative discomfort and painkiller use compared to placebo gel.	L
Siavash et al., 2015	RCT	Iran Asia	60	60.30	Hospital Diabetic Foot Ulcer	Honey (1 day) Placebo (1 day)	3 weeks	Texas University Wound Classification System for Diabetic Foot Ulcers	A 5% topical royal jelly formulation did not yield any notable enhancement in the decrease of size or healing time of diabetic foot ulcers compared to placebo.	L
Tsang et al., 2017	RCT	Hongkong Asia	31	65.02	Hospital Diabetic Foot Ulcer	Honey (1 day) SSD (1 day)	12 weeks	Visitrak Digital Planimetry Wound Measurement System	In diabetic foot ulcers, nanocrystalline-silver dressings attained complete healing in 81.8% of cases, compared to 50% with Manuka honey and 40% with conventional dressings, demonstrating better efficacy.	L

Table 1. Continued

Study	Design	Area, Continent	Sample Size	Mean Age	Settings, Diagnosis	Intervention, Frequency	Timing	Tools	Findings	RoB2
Verdú-Soriano et al., 2022	RCT	Spain Europe	195	78.75	Hospital Pressure ulcer	Hydrogel (3 days) Placebo (3 days)	8 weeks	Photographic evaluation 8 megapixels	The Olea-leaf extract hydrogel EHO-85 achieved a twofold increase in median wound-area reduction compared to a reference hydrogel in cases of pressure, venous-leg, and diabetic-foot ulcers.	L
Wang et al., 2021	RCT	Singapore Asia	120	65.00	Hospital Diabetic Foot Ulcer	SSD (2 days) Placebo (2 days)	5 weeks	Visitrak Digital Planimetry Wound Measurement System	Silver-releasing foam dressings reduced Wagner grade 1–2 diabetic foot ulcer area by 76% after four weeks, compared to 27% with 1% silver-sulfadiazine cream, indicating faster healing.	H
Wen et al., 2018	RCT	Malaysia Asia	50	45.30	Hospital Post- Operative	Hydrogel (3 days) Gammat (4 days)	9 weeks	Grid film surface	Hydrogel sea-cucumber exhibited healing, analgesic, and anti-pruritic effects statistically comparable to a commercial hydrogel on split-thickness skin-graft donor sites, with no safety concerns.	H
Wu et al., 2021	RCT	China Asia	212	40.64	Hospital Burn	SSD (12 days) Placebo (12 days)	2 weeks	Wound Area	Nanosilver dressings for deep partial-thickness burns accelerated healing and pigmentation resolution, enhanced wound-healing rates, and reduced bacterial-culture positive in comparison to silver-sulfadiazine cream.	H

Notes:

Alginate: Calcium-alginate; HA: Hyaluronic acid, HD: Hydrocolloid, P.I: Povidone-iodine; PRP: Platelet-rich plasma gel; RCT: Randomized controlled trial; RoB2: Risk of Bias 2 (L=low risk, M=moderate risk, H=high risk); SSD: Silver sulfadiazine cream.