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Comparative Effectiveness of Traditional Vs. Novel Dressings in Burn Wound Healing: A Systematic Review

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Keywords
burn wounds; advanced dressings; conventional dressings; wound healing; infection control

Abstract
This study aims to evaluate the efficacy of traditional dressings compared to contemporary dressings (advanced/novel dressings) in healing burns, using the latest scientific information through the Systematic Literature Review (SLR) methodology. Burns are a global health problem that must be properly addressed to avoid infection, speed up healing, and reduce the risk of long-term complications. Gauze, paraffin, and silver sulfadiazine (SSD) are some of the most commonly used dressings for wounds. However, many studies show that these dressings do not always maintain a moist wound environment, may be painful to change, and can slow down the healing process. In addition to biomaterial manufacturing, advanced dressings such as hydrogels, hydrocolloids, foam dressings, nanofibers, honey-based dressings, and biologically engineered leather have been developed to improve the moist wound environment. This study examined 32 publications published from 2016 to 2025 that met the inclusion criteria according to the PICO methodology. The results showed that advanced dressings consistently accelerated healing time, with some meta-analyses demonstrating a substantial reduction in healing time of up to 4 days compared to SSDs. Additionally, some advanced dressings have now been shown to be superior in preventing bacterial growth, reducing the need for debridement, and lowering pain ratings, especially at the beginning of therapy. However, research still indicates that the efficacy in terms of the quality of scar tissue differs. High costs, limited availability, and the requirement for strict control are major challenges associated with advanced dressings. Overall, the data suggest that advanced dressings are superior to standard dressings for clinical use, but their use should be weighed against healthcare costs and available resources.

INTRODUCTION

Burns are one of the most common forms of skin injuries worldwide and pose a major challenge for healthcare. The World Health Organization states that more than 11 million people require medical assistance for burns each year, and about 180,000 people die from burn complications, primarily in low- and middle-income countries (WHO Estimates, 2023). Burns cause significant damage to tissues and initiate a complicated inflammatory process. To prevent infection, speed up healing, and improve the patient's quality of life, proper treatment management is necessary. The healthcare system is under significant pressure because burn care is expensive, and patients often need extended hospital stays (Chukamei et al., 2021). In these situations, selecting the appropriate type of dressing is a crucial part of clinical governance, as it can influence the time it takes for the wound to heal and the likelihood of complications.

In the past, traditional treatments for burns included the use of silver sulfadiazine (SSD), gauze, and paraffin gauze. This approach is quite popular because it is easily accessible, simple to use, and inexpensive (Opriessnig et al., 2023). However, (Ahmad, 2022) noted that traditional dressings have a number of drawbacks, such as requiring frequent changes, causing discomfort during treatment, and potentially slowing down the epithelialization process. Silver sulfadiazine is an effective antibiotic, but it can also delay wound healing because it is toxic to fibroblasts and keratinocytes (Dahm, 2020). This underscores the importance of reevaluating how well conventional dressings work compared to contemporary dressings, which are becoming more widely used in clinical practice.

Biomaterial technology has led to the development of several new and improved dressings, including hydrogels, hydrocolloids, foams, nanofiber-based materials, honey-based dressings, and bioengineered skin replacements. These dressings are designed to maintain wound moisture, which has been shown to accelerate epithelialization, increase tissue perfusion, and reduce the risk of infection (Farahani & Shafee, 2021; Nutila & Eriksson, 2021). Ataide et al. (2022) showed that nanotechnology-based dressings enhance antibacterial efficacy and tissue regeneration through the release of regulated bioactive compounds. Boekema et al. (2024) found that honey-based dressings have strong antibacterial and anti-inflammatory properties, facilitating the healing of mild to severe burns. This variety of outcomes suggests a broad range of potential benefits; however, the comparative efficacy of various contemporary versus traditional dressings remains a topic of ongoing discussion in the literature.

Although many studies examine different forms of dressings, most are not very useful because they focus on only one type of dressing or one level of burn severity. This complicates the ability of healthcare professionals to make thorough, evidence-based clinical assessments. Additionally, previous research has shown methodological diversity, including discrepancies in wound size, treatment protocols, and patient populations, which can lead to bias in evaluating the efficacy of dressings (Norman et al., 2018). These findings suggest that systematic studies are needed that not only collect data but also directly analyze the performance of both traditional and contemporary dressings in various clinical settings.

The rising cost of burn care necessitates competitive studies that assess therapeutic efficiencies and outcomes. Advanced dressings are typically more expensive, but if they can speed up healing and reduce the risk of complications, they may prove to be more cost-effective for the overall healthcare system (Mirhaj et al., 2022). Due to the lack of extensive comparative research, there is a knowledge gap regarding the clinical advantages of contemporary dressings compared to traditional ones. This gap is the main reason why a systematic study is needed to examine, compare, and analyze both methods based on available scientific data.

To help establish clinical practice guidelines, it is important to understand how successful contemporary dressings are in comparison to other treatments. Evidence-based clinical choices are needed now to make burn care safer and more effective in primary care settings and referral hospitals. Given the wide range of study findings and available dressings on the market, healthcare providers need a systematic review that provides a complete picture of what is known and what remains unknown about burn healing outcomes.

This research is important in offering a thorough understanding of the comparative efficacy of traditional versus contemporary dressings in healing burns. An integrative and comprehensive evaluation can address the shortcomings of existing research, which is currently limited to isolated studies or specific dressings. This research is expected to significantly improve clinical practice, health cost planning, and the formulation of operational standards in the treatment of burns. The aim of this study is to conduct a systematic review evaluating the efficacy of standard dressings versus new dressings in healing burns, focusing on the duration of healing, infection rates, and patient discomfort during treatment.

RESEARCH METHODS

This study uses a systematic literature review (SLR) methodology to find, assess, and synthesize empirical data on the efficacy of innovative or advanced wound dressings compared to standard dressings for acute burn patients. This SLR examines the stages of planning, implementation, and execution using the PICO (population, intervention, comparator, outcome) framework to develop research questions and determine study selection criteria. The study population consisted of patients of all ages with acute burns (superficial to full-thickness) on either an outpatient or inpatient basis. The interventions studied included advanced/novel wound dressings such as hydrogel, foam, hydrocolloids, silver-impregnated dressings, nanofiber, honey-based dressings, bioengineered skin, and 3D bioprinted dressings, compared to conventional dressings such as gauze, paraffin gauze, non-adherent dressings, and SSD+ gauze.

The primary outcomes evaluated included wound healing time, infection rate, pain score, and the need for surgical intervention, while secondary outcomes included scar quality, length of stay (LOS), cost-effectiveness, and adverse events. The main research question focused on the effectiveness of advanced wound dressings in accelerating the healing of acute burns, lowering infection rates, and reducing the need for surgical intervention. Sub-questions examined the effects on pain control, scar tissue quality, length of hospitalization, implementation challenges, cost limitations, and the risk of side effects.

The search strategy involved searching three main databases—PubMed, Scopus, and ScienceDirect—using keywords formulated based on the PICO framework with Boolean operators: ("burn wound" OR "acute burn") AND ("advanced dressing" OR hydrogel OR foam OR hydrocolloid OR nanofiber OR "bioengineered skin" OR "silver dressing" OR "honey dressing") AND (healing OR infection OR pain OR grafting). This search yielded a total of 1,774 initial articles from all three databases. Inclusion criteria included RCTs, CCTs, and prospective/retrospective cohort studies published between 2016 and 2025, involving acute burn patients with advanced wound dressings compared to conventional dressings, and measuring outcomes such as healing time, infection, pain, LOS, and scar quality. Exclusion criteria included case reports, reviews, editorials, non-burn traumatic injuries, non-bandage therapy, studies without peer groups, publications prior to 2016, and irrelevant outcomes. After a careful screening procedure, as outlined in the PRISMA diagram (Figure 1), a total of 32 papers that met the criteria were included in the final analysis.

The purpose of data analysis was to collect and review data from these studies to answer the research questions systematically, by examining quantitative and qualitative data on development time, infection rate, pain, surgical intervention outcomes, quality parameters, and duration of hospitalization using narrative synthesis methodology in accordance with the RQ and SRQ frameworks.

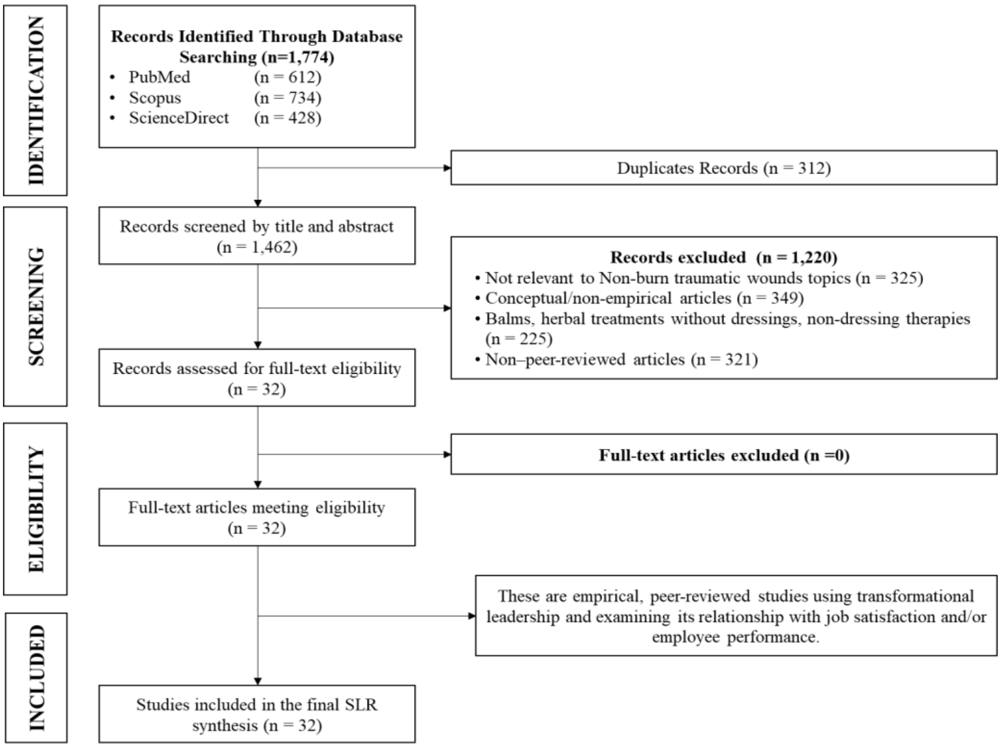

Figure 1. Prism Diagram

RESULTS AND DISCUSSION

Features

A total of 32 articles analyzed in this study showed diversity in terms of year of publication, population characteristics, and the types of interventions and comparators used in the context of burn management.

Table 1. Distribution of Article Frequency Based on Clinical Characteristics

Clinical Features	Criteria	Frequency (N=32)	Percentage
Types of Patients and Burns	Pediatric burns	6	18.80%
	Adult partial-thickness burns	12	37.50%
	Full-thickness burns	4	12.50%
	Burn wound infection	5	15.60%
	Donor-site wounds / graft	3	9.40%
	Pressure ulcers	1	3.10%
	Diabetic ulcers	1	3.10%
Advanced / Novel Dressings	Hydrogel / polyhexanide / biopolymer	6	18.80%
	Foam / silver-foam	5	15.60%
	Nanofiber / nanotechnology	4	12.50%
	Bioengineered / cellular dressings	4	12.50%

	Amniotic membrane	3	9.40%
	Larval / maggot therapy	1	3.10%
	Novel antimicrobials (Peceleganan/PL-5)	2	6.30%
	Enzyme alginogel	2	6.30%
	Antibiotic bone cement	1	3.10%
	Bacteriophage therapy	1	3.10%
	Herbal bioactive (Boswellia, Licorice)	2	6.30%
Conventional Dressings	SSD (silver sulfadiazine)	22	68.75%
	Gauze / paraffin gauze	6	18.75%
	Enzymatic debridement	2	6.25%
	Non-adherent dressings	2	6.25%

Sumber: Bairagi et al. (2021), *Burns, 47*(6), 1225–1240.

A review of the 32 articles in table 5 shows that the focus of clinical research is mostly on the management of partial burns in adult patients, which is the largest category (37.50%), as reported in the studies of Schiefer et al. (2022), Chaganti et al. (2019), and Ye et al. (2025). The child population is also quite widely discussed (18.80%), especially related to biological responses and the effectiveness of modern treatments in the healing process (Liu, 2023; Lőrincz et al., 2022). In addition, burn infections emerged as a significant topic (15.60%), reflected in the research of Jault et al. (2019), Wei et al. (2024), and Chen et al. (2023) which emphasized the urgency of antimicrobial therapy innovation to overcome bacterial resistance in burns. Meanwhile, other conditions such as full-thickness burns, donor-site wounds, pressure ulcers, and diabetic ulcers appear in smaller portions, but still show a diversity of modern therapeutic applications in various wound contexts (Oba et al., 2020; Poinas et al., 2019; Cao et al., 2023).

In terms of interventions, the study shows a shift towards the use of advanced wound dressings, with the category of hydrogel/polyhexanide/biopolymer (18.80%) as the most tested technology in the burn and infection population (Razavi et al., 2018; Chen et al., 2023). Foam/silver-foam-based therapy (15.60%) also occupies an important position in accelerating re-epithelialization and lowering the risk of infection (Hundeshagen et al., 2018; Lőrincz et al., 2022). On the other hand, cutting-edge innovations such as nanofiber, bioengineered dressings, amniotic membranes, and bacteriophage therapy expand the spectrum of modern therapies with more precise regenerative and antimicrobial approaches (Bairagi et al., 2021; Wu et al., 2021; Jault et al., 2019). However, most studies still use silver sulfadiazine (SSD) as the main comparator (68.75%), confirming its position as the conventional "gold standard" in burn management, as recorded in various cross-year studies (Saeidinia et al., 2017; Zacharevskij et al., 2018; Moghimi et al., 2024).

RQ1: How effective are advanced wound dressings compared to conventional dressings in accelerating the healing time of acute burns (healing time / re-epithelialization)?

A series of experimental investigations, randomized controlled trials (RCTs), and meta-analyses were conducted to evaluate the efficacy of various advanced dressings in accelerating burn healing compared to traditional therapies. Important thresholds for effectiveness testing are determined by a p-value of less than 0.05, effect measures such as standardized mean difference (SMD), and a 95% confidence interval to guarantee the reliability of the estimates (Polit & Beck, 2017). Heterogeneity among studies is problematic because it can affect the robustness of results in systematic reviews. Interpretation is done objectively, looking at data patterns without making subjective judgments. The summary is shown in the table below.

Table 2 Effectiveness of advanced wound dressings in accelerating burn healing

No	Study & design	Population & types of wounds	Advanced vs conventional	Healing outcomes	Key statistical value	Source
1	Systematic review & meta-analysis RCT	Partial thickness burns & donor sites (anak & dewasa)	Autologous skin cell suspension (ASCS) vs standard care	TTRE is shorter in pediatric partial thickness burns and adult donor sites	Paediatric TTRE: SMD −1.75 (95% CI −3.45 to −0.05); adult donor site SMD −5.71 (95% CI −10.61 to −0.81); evidence *very low certainty*	Bairagi et al. (2021)
2	Eksperimental in vivo (model tikus)	Third-degree, full-thickness burns with skin excision	Hyperdry human amniotic membrane (HD-AM) vs tanpa HD-AM	Faster granulation, angiogenesis and migration of fibroblasts increases; better quality of granulated tissue	Significant increase in the expression of TGF-β1, VEGF, CD31, α-SMA, CD163+ and Iba1+ infiltration; $p<0.05$ (details of numbers not detailed in the summary)	Oba et al. (2020)
3	Systematic review & meta-analysis RCT	Luka bakar partial thickness pediatrik	Variety of biosynthetic, silver foam, amnion membrane vs SSD	Tendency to faster cure times in biosynthetic/silver foam/amnion; Debridement is less frequent	There was no meaningful difference in the main outcome due to heterogeneity; *no significant difference* ($p>0.05$), but the trend of faster healing and fewer complications	Lőrincz et al. (2022)
4	Studi eksperimental 3D-bioprinting + in vivo	Luka bakar deep partial thickness	3D-printed gelatin–alginate hydrogel (75% gelatin: 25% alginate) vs non-printed and standard hydrogels	Faster wound closure, hair follicle regeneration, 7 days moisture retention; Non-traumatic removal	Dressing 75:25 provides the best compromise between modulus, degradation, and cell viability; faster healing (the number of days is not detailed in the summary)	Fayyazbakhsh et al. (2022)
5	Systematic review & meta-analysis RCT	Patients with burns of various degrees	Various alternatives to 1% SSDs (advanced dressings, other topical preparations) vs 1% SSDs	All alternatives show a shorter average healing time than SSDs	Mean difference in cure time −4.26 days (95% CI −5.96 to −2.56; $p<0.00001$) favored alternative therapy	da Silva Maciel et al. (2019)
6	Prospective RCT	DFU patients (not burns, but severe	Antibiotic bone cement + VSD vs SSD cream	Shorter wound healing time, increased local vascularization	Relative blood flow percentage: 44.7±2.0% vs 28.3±1.2%; change rate 129±12% vs 41±8% (both $p<0.05$). Cure time: 47.1±2.9 days vs	Cao et al. (2023)

		chronic wounds)			58.8±2.3 days (t=10.86; p<0.05)	
7	RCT topical herbal vs SSD	Partial-thicknes s burn	Centiderm (ekstrak *Centella asiatica*) vs SSD	Re-epithelialization and complete healing faster with Centiderm	All objective & subjective signs, the time of re-epithelialization and complete healing were significantly different (p<0.05); no infection in the Centiderm group	Saeidinia et al. (2017)
8	RCT tradisional vs advanced biologic	Donor site split-thicknes s skin graft	Biological dressing fetal fibroblast & keratinocyte vs balutan konvensional	Faster time to healing donor site, less initial pain	Acceleration of epithelialization and improvement of wound appearance; The number of days & P is not detailed in the summary, but is reportedly superior to conventional	Poinas et al. (2019)

Sumber: Bairagi et al. (2021), *Burns, 47*(6), 1225–1240.

Most studies show that better wound dressings speed up wound healing compared to traditional gauze-based treatments or SSDs. Bairagi et al. (2021) conducted a meta-analysis showing that autologous skin cell suspension (ASCS) reduced epithelial re-epithelialization time (TTRE) in pediatric partial-thickness burns and adult donor locations, although the data were considered to be very low-confidence. Da Silva Maciel et al. (2019) corroborate similar findings, showing that various 1% SSD alternatives (including advanced dressings and other topical preparations) can reduce the average cure time by about -4 days compared to SSDs, with a very significant p<0.00001). These results suggest that, at the population level, replacing traditional SSDs with contemporary dressings may be associated with accelerated re-epitellition.

In vivo experimental research and new technologies provide mechanistic data. Oba et al. (2020) showed that the application of hyperdry human amniotic membrane (HD-AM) in third-degree burns increased granulation, angiogenesis, and fibroblast migration, accompanied by significant improvements in various markers (TGF-β 1, VEGF, CD31, α-SMA), thereby facilitating the acceleration of granulated tissue formation. The 3D bioprinting method using gelatin-hydrogel alginate (Fayyazbakhsh et al., 2022) is associated with faster wound closure and excellent moisture retention, however the exact number of days is not given. In severe cases, chronic wounds, using bone cement antibiotics and drainage vacuum sealing (VSD) together speed up the healing process compared to SSD creams (Cao et al., 2023). This suggests that the drug delivery system and the control of the wound environment are important to speed healing. In addition, therapies using natural components such as Centiderm (Centella asiatica extract) and biological fetal cell dressings have been shown to promote re-epithelialization and facilitate full healing more effectively than standard dressings (Saeidinia et al., 2017; Poinas et al., 2019). The data patterns of the table reveal that sophisticated dressings tend to speed up healing times, but the different amounts and methodologies used mean that the results need to be read carefully.

RQ2: Are advanced wound dressings more effective in reducing infection rates and the need for surgical intervention (grafting/debridement)?

Researchers used the following measures to see how well advanced wound dressings worked to lower the risk of infection and the need for surgery: lowering the number of bacteria, the rate of colonization of pathogenic germs (such as Pseudomonas aeruginosa and Staphylococcus aureus), the time it takes to get enough debridement, and the need for a skin graft. Intervention is considered superior if it shows a significant reduction in the number of bacteria or infection rates ($p<0.05$), accelerated resolution of necrosis, or reduced need for debridement/grafting. In contrast, non-inferior interventions are thought to be able to replace standard therapies without increasing the risk of complications. The quality of the evidence is also influenced by the type of research (RCTs, animal studies, retrospective cohorts) and how well the publication is, as in the case of Wu et al. (2021). The table below shows how advanced wound dressings affect infection and the need for surgery.

Table 3. The effectiveness of advanced wound dressings in lowering infection rates and the need for surgical intervention

Yes	Study & design	Population & types of wounds	Advanced vs conventional	Infection outcomes & surgical interventions	Key statistical value	Source
1	Eksperimental in vivo (nanocarrier)	Burn injuries in animals	Nanoethhogel SSD (ethosomal SSD) vs regular SSD/control	Significant reduction in bacterial load; wound contractions ±96.83% vs 59.41% in control; Indication of a decrease in the need for further debridement	SSD encapsulation 92.03±0.79%; size 206.7 nm; ζ-pot −67.3 mV; Increased significant antimicrobial effects ($p<0.05$)	Razavi et al. (2018)
2	RCT full-thickness (grade III) burns	31 patients with full-thickness burns	Maggot debridement therapy (MDT) vs conventional silver-based regimens (SSD, sharp debride, antibiotics)	Faster resolution necrosis; increased granulation; surgical debridement requirements and shorter time to graft on MDT	g/n ratio 5×, 15×, 13× higher on MDT on days 2, 4, 6 ($p<0.001$); necrosis decreased significantly on day 2 ($p=0.028$), day 4 ($p=0.023$); Time to Debridement & Time to Healing Shorter ($p<0.001$)	Gaffari et al. (2023)
3	Cohort retrospective	Burn patients who are treated conservatively	Polyhexanide hydrogel (Prontosan Gel X) vs alginate-based Flaminal	The decrease in *colonization of P. aeruginosa* and *S. aureus* was greater in polyhexanide; similar healing times did not increase the need for grafts	The proportion of positive cultures *of P. aeruginosa*/*S. aureus* decreased significantly in the polyhexanide group ($p<0.05$); the distribution of the cure time category	De Decker et al. (2024)

					did not differ (p>0.05)	
4	RCT phase 1/2 double-blind	Burns infected *with P. aeruginosa*	Bacteriophage cocktail (PP1131) vs SSD 1%	Reduction of bacterial load as the main endpoint; Effectiveness is limited by low phage titers, but still shows eradication in some cases	Primary endpoint: median time to ≥2-quadrant bacterial load reduction; not better than SSD due to under-dosage (CI wide, some non-significant analyses)	Jault et al. (2019)
5	RCT phase 3 multicenter	Open wound infections (including burns)	0.2% spray vs. 1% SSD	The clinical efficacy rate is higher in the scleroder, but the bacterial clearance is actually higher in the SSD	Clinical efficacy D8: 90.4% vs 78.7% (p<0.001); D5: 59.2% vs 49.2% (p=0.03). Bacterial clearance D8: 24.0% vs 46.0% (p<0.001); D5: 16.5% vs 30.7% (p<0.001)	Wei et al. (2024)
6	RCT fase IIb multicenter	Skin wound infections	PL-5 (antimicrobial peptide) spray (1‰, 2‰, 4‰) vs SSD	All doses of PL-5 show higher clinical efficacy than SSDs, with a good safety profile; Lowering infections without systemic toxicity detected	Efficacy D8: 100%, 96.7%, 96.7% vs 87.5% (p<0.05 between 4 groups); D5: 100%, 93.4%, 98.3% vs 82.5% (p<0.05); the concentration of PL-5 blood is not detected; no SAE related	Wei et al. (2023)
7	Multicenter RCT non-inferiority	Deep partial-thickness burns	HBPs-Ag (hyperbranched polyamide–Ag) vs Atrauman Ag	The total efficacy is almost the same; similar levels of negative bacterial cultures; does not increase the need for grafts	Total efficiency: 98.3% vs 94.7% (p>0.05); there was no significant difference in healing rate, healing time, and negative culture rate (p>0.05); silver was detected in blood/urine in only 3.79% of patients	Ye et al. (2025)
8	RCT (retracted)	Deep II degree burns	Nanosilver burn dressing vs SSD cream	Faster healing, lower positive culture rate in nanosilver	Faster healing and significant decrease in positive bacterial cultures (p<0.05); however the article has been *retracted* so the evidence	Wu et al. (2021)

					should be considered very weak	
9	RCT luka tekan (pressure ulcer)	88 stage II–IV decubitus patients	LPPL + SSD vs LPPL only	Infections are more controlled, cure scores are better, and healing times are shorter on SSD combinations	Infection rate 70.45% early; total effective rate 90.91% vs 70.45%; healing time stage II: 9.76±2.38 vs 13.20±3.76 days; Stage III–IV: 13.19±2.54 vs 18.82±4.17 days (all p<0.05)	Chen et al. (2023)

Sumber: Bairagi et al. (2021), *Burns, 47*(6), 1225–1240.

Table 3 illustrates that some advanced methods or SSD enhancements improve infection prevention and optimize the need for surgical intervention. In preclinical studies, NANOETHOGEL SSDs with an ethosomal system showed a significantly greater reduction in bacterial load and wound contraction compared to controls, while maintaining consistent nanocarrier physical properties and showing considerable improvements in antibacterial efficacy (Razavi et al., 2018). In the clinical setting of full-thickness burns, maggot debridement therapy (MDT) exhibits accelerated necrosis resolution, enhanced granulation, and reduced debridement and grafting duration when compared to traditional silver- and sharp-based debridement methods, with $p<0.001$ values for most endpoints (Gaffari et al., 2023). This suggests that biological debridement methods may reduce the need for continuous surgical intervention in some situations.

Other research shows that not all advanced dressings make a significant difference in healing time, but they still help control colonization. Polyhexanide hydrogel (Prontosan Gel X) significantly reduced the colonization of P. aeruginosa and S. aureus compared to alginate-based Flaminal, although the distribution of healing time and graft requirements was comparable (De Decker et al., 2024). Newer antimicrobials such as bacteriophage cocktail (PP1131), peceleganan, and PL-5 have a wide range of effects. PP1131 does not outperform SSD due to poor phage titration (Jault et al., 2019). In contrast, sclemans and PL-5 had higher levels of clinical effectiveness compared to SSDs ($p<0.05$), though SSDs sometimes showed better bacterial clearance (Wei et al., 2023; 2024). In severe partial-thickness burns, hyperbranched polyamide-Ag (HBPs-Ag) is just as effective as Atrauman Ag, without requiring further grafts or causing infections (Ye et al., 2025). Randomized controlled trials (RCTs) on pressure wounds show that the combination of LPPL and SSD offers superior infection control and shorter healing times compared to LPPL alone (Chen et al., 2023). On the other hand, claims of better results using nanosilver burn treatment compared to SSDs (Wu et al., 2021) should be viewed with caution, as the paper has been discarded.

This pattern of findings objectively suggests that new topical advanced and antimicrobial dressings are at least not inferior to SSDs in infection control. In some cases, they can reduce the bacterial load and speed up the clearance of necrotic tissue, although the benefits for graft needs have not been consistently proven.

SRQ2.1: How do advanced dressings affect pain control during dressing?

Pain management during dressing replacement is a clinically significant outcome, especially in pediatric patients with severe burns. The impact of advanced dressing on pain was evaluated using pain assessments (such as numerical assessment scales or visual analogue scales), duration of analgesia, and frequency of dressing changes. Clinical excellence is often determined by a decrease in pain score and a substantial requirement for analgesics ($p<0.05$), with a preference for dressings that allow for less frequent turnovers without increasing the risk of infection or delaying recovery. The table below shows how advanced bandages can help with pain in partial thickness burns and second-degree burns.

Table 4. The effect of advanced dressings on pain control

No	Study & design	Population & wounds	Advanced vs conventional	Main findings of pain/analgesia	Key statistical value	Source
1	Prospektif, intra-individual RCT	20 pasien partial-thickness burns	Bacterial nanocellulose epicitehydro vs SUPRATHEL	Both dressings reduce pain; significant difference is only the 1st day, after which it is similar; No need to change the wrap repeatedly	Wound healing 15–16 days; Day 1 pain was different in meaning ($p<0.05$), then no different; no infection	Schiefer et al. (2022)
2	Systematic review RCT	Partial thickness burns	Silver-containing foam dressings vs SSD + gauze	Foam lowered pain at the initial dressing change (±day 7), but there was no difference in pain at the end of treatment	Pain scores of the first visit favored foam (p significant, CI not reported); on day 28 there was no difference in pain or healing time (RR healing CI passed 1)	Chaganti et al. (2019)
3	Two-group RCT	Superficial partial-thickness burn ≤15% BSA	Collagen sheet dressing vs paraffin gauze + SSD	95.5% of collagen patients need analgesia ≤2 days; 90.9% of the conventional group needed analgesia ≥6 days; Much less frequency of dressing changes	Healing 5–7 days (59%) vs 8–12 days (66.7%); The need for analgesia and the amount of dressing change are significantly different ($p<0.05$)	Singh & Bhatnagar (2020)
4	Prospective RCT	Pediatric & adult partial-thickness burns	Suprathel vs Mepilex Ag	Lower pain the first 5 days in Suprathel, especially in children; Low dressing change load in both groups	Time to re-epithelialization 12 days, P=0.75; pain ratings 1–5 days were lower in Suprathel ($p=0.03$ all patients; $p<0.001$ pediatric subgroup)	Hundeshagen et al. (2018)
5	RCT open-label	Second-degree burns	Human amniotic membrane (hAM) vs	Pain scores, analgesia needs, and length of stay	Wound epithelization, scar, pigmentation, pain, analgesia, and LOS at day 30 were consistently	Moghimi et al. (2024)

			SSD ointment	were lower in hAM	better (lower) in the hAM group; all p<0.05; higher costs (see SRQ2.3)	
6	Double-blind RCT herbal	Second-degree burns	Licorice root hydrogel vs hydrogel placebo	Pain and burning sensation of wounds were lower in the licorice group, along with milder inflammation and erythema	Pain (day 3) and burning (days 3–15) were significantly lower (p<0.05); faster healing process (number of days not specified)	Zabihi et al. (2023)

Sumber: Bairagi et al. (2021), *Burns, 47*(6), 1225–1240.

Table 4 shows that advanced dressings typically reduce pain, especially during the initial recovery phase. They also lower the need for painkillers and the number of times the dressings need to be changed. An intra-individual study by Schiefer et al. (2022) showed that the nanocellulose bacteria episitehydro and SUPRATHELIAL both reduced pain, with noticeable variations only visible on the first day. Recovery occurred in 15-16 days without infection. Chaganti et al. (2019) conducted a systematic study that showed foam pads containing silver reduced pain during the first pad change compared to SSD+ gauze. However, by day 28, the difference in pain and healing time was less noticeable. This suggests that the main benefits of certain advanced dressings are more noticeable at first, before the skin heals completely.

Other studies more clearly highlight how important it is for patients to feel comfortable and pain-free. For burns with superficial partial thickness, collagen sheet dressings usually need to be used for only two days to relieve discomfort. In contrast, the majority of individuals in the paraffin + SSD gauze group required six days of pain treatment. There is a considerable difference in the frequency of dressing changes and the need for pain relievers (Singh & Bhatnagar, 2020). Suprathel was also shown to be less painful than Mepilex Ag in the first five days, with a very clear benefit in the pediatric group (p<0.001). The time required for skin recovery was approximately the same (Hundeshagen et al., 2018). Human amniotic membrane (hAM) significantly reduced pain levels, analgesic needs, and length of hospitalization in cases of second-degree burns, with all clinical parameters showing significant improvement (Moghimi et al., 2024). In herbal medicine, licorice root hydrogel reduced wound pain and burning sensation compared to placebo hydrogels, along with a decrease in inflammation and erythema.

The findings in the table show a clear trend: advanced dressings that retain wound moisture, minimize the frequency of treatment, and incorporate bioactive chemicals or pain relievers tend to make patients more comfortable without slowing down the healing process.

SRQ2.2: How do advanced dressings impact scar tissue quality (VSS, POSAS) and length of stay (LOS)?

When assessing how well long-term burn therapy works, it's important to think about how long it takes to heal, how good the scar tissue is, and how long the patient stays in the hospital. The Vancouver Scar Scale (VSS) and the Patient and Observer Scar Assessment Scale (POSAS) are two ways to measure the quality of scars. Other objective measures include skin viscoelasticity, transepidermal water loss (TEWL), and pigmentation. The intervention showed superiority by producing a lower VSS/POSAS score (preferred) or a measure of elasticity more similar to normal skin, without prolonging healing time or length of stay, with a statistically significant difference ($p<0.05$). Some studies still have methods that look at scar and cost/QoL as secondary outcomes. The table below illustrates how advanced dressings change the quality of scars and LOS.

Table 5. The impact of advanced dressings on scar tissue quality and length of stay

No	Study & design	Population & wounds	Advanced vs conventional	Scar outcome / LOS	Key statistical value	Source
1	RCT 4-arm	Deep partial-thickness hand burns	Hydrocolloid dressing; mekanik debridement + SSD; collagenase + gauze; SSD + gauze (kontrol)	Hydrocolloids provide the fastest epithelialization and better VSS scores; hand function (DASH) is also better	Epithelialization time 15.7 days (hydrocolloids; p<0.05 vs. other groups); 6-month VSS and DASH scores better (significant p-value, details not detailed)	Zacharevskij et al. (2018)
2	RCT multicenter	Partial thickness burns	Flaminal Forte (enzyme alginogel) vs Flamazine (SSD)	There was no significant difference in scar tissue quality up to 12 months (POSAS, melanin/pigmentation, elasticity)	Median time to healing was 18 vs 16 days (p=0.24); colonization more frequently in Flaminal (78% vs 32%, p<0.001) without increased infection; POSAS, DermaSpectrometer, Cutometer scores are meaningless	Rashaan et al. (2019)
3	Protocol RCT (FLAM study)	Partial thickness burns dewasa	Flaminal vs Flamazine	Plan scar evaluation (POSAS), graft needs, number of dressing changes, and HRQoL for up to 12 months	Outcome scar and cost/QoL are secondary endpoints; There are no numbers yet because this is a protocol	Rashaan et al. (2016)
4	Phase I/II trial design	Deep second-degree burn	Allogeneic cultured keratinocyte sheets vs autograft + konvensional	Endpoints include time to wound closure as well as scar assessment (VSS and POSAS) at 3 & 6 months; expected to improve the quality of the scar with less donor need	Studies are still design; There are no numerical results yet, but keratinocyte sheets are positioned as a regenerative dressing that improves functional and aesthetic outcomes	Farzanbakhsh et al. (2024)
5	RCT donor site	Split-thickness skin graft donor site	Biologic fetal-cell dressing vs balutan tradisional	It is expected to accelerate the healing of the donor site, reduce initial pain, and improve the appearance of scars	Studies target reduction in pain duration, use of analgesics, and improvement of scar appearance; Detailed figures are not detailed in the summary	Poinas et al. (2019)

6	RCT outpatient partial-thickness	Pediatric & adult partial-thickness burns	Suprathel vs Mepilex Ag	Objective scar parameters (viscoelasticity, TEWL, hydration, pigmentation) and 1-month POSAS score were better on Suprathel	Suprathel patients reported better POSAS scores (2 vs 4.5; p<0.001); viscoelasticity of burned skin increased vs normal skin on Mepilex Ag; Same epithelialization time (12 days)	Hundeshagen et al. (2018)

Sumber: Bairagi et al. (2021), *Burns, 47*(6), 1225–1240.

The data shows that not all advanced dressings have a significant impact on scar tissue outcomes; however, some varieties show different advantages. In the case of hand burns with deep partial thickness, the hydrocolloid dressing achieved the fastest epithelialization time (about 15.7 days) and superior VSS scores compared to mechanical debridement + SSD, collagenase + gauze, and SSD+ mesh combination as controls. Notably, there was a significant improvement in hand function (hyphen) at six months (Zacharevskij et al., 2018). This suggests that dressings that retain moisture in the area and reduce the pain of pad changes can speed up epithelialization and also improve the appearance and functionality of the results.

In contrast, Flaminal Forte (enzyme alginogel) and Flamazine (SSD) for burns with partial thickness showed no significant difference in scar quality for up to 12 months, as evidenced by POSAS scores and objective measurements of skin elasticity and pigmentation. However, the rate of bacterial colonization increased in Flaminal without a corresponding increase in the incidence of infection (Rashaan et al., 2019). Several other studies, such as the design of the allogeneic keratinocyte sheet clinical trial (Farzanbakhsh et al., 2024) and the donor site research with biological fetal cell dressings (Poinas et al., 2019), are still in the planning and design stages of scar evaluation as important results, so there are no numbers yet.

Suprathel for burns with partial thickness was shown to provide superior POSAS ratings (median 2 vs. 4.5) and viscoelasticity characteristics more similar to normal skin compared to Mepilex Ag, whereas epithelialization duration lasted about 12 days (Hundeshagen et al., 2018). The data in the table shows that the most advanced dressings can improve the quality and function of the scar to some extent without extending the hospital stay. However, the evidence remains limited and mixed.

SRQ2.3: What are the implementation challenges, cost constraints, and risk of side effects of advanced dressings?

In addition to clinical efficacy, the choice of advanced dressings is also heavily influenced by how well they work in the field, such as their availability, direct and indirect costs, and side effect (AE) profiles. Cost-effectiveness studies typically look at differences in total cost and quality-adjusted life years (QALY). Safety is measured by looking at local/systemic AE frequencies and specific levels of toxicity, such as silver levels in blood or urine. Interventions were considered more advantageous when they demonstrated minimal clinical outcomes associated with only a slight increase in cost, or when additional costs were offset by substantial improvements in Quality-Adjusted Living Years (QALY) and patient comfort, accompanied by statistically significant differences ($p<0.05$) or the likelihood of high cost-effectiveness. The table below shows the problems of using advanced pads, their cost, and the danger of side effects.

Table 6. Implementation challenges, cost limitations, and risk of side effects of Advanced Dressings

Yes	Study & design	Focus on implementation/cost/AE	Key findings	Key statistical values (cost/AE/effectiveness)	Source
1	National consensus	Pediatric management of deep partial-thickness burns, including dressing selection, infection & scarring prevention	Emphasizing the need to choose dressings based on depth, risk of infection, child comfort, and availability; Advanced dressings are beneficial but are limited in cost & access	There are no specific numbers; more in the form of practice recommendations and clinical algorithms	Liu & Chinese Burn Association (2023)
2	Narative review	Hydrogel dressings & scaffolds for burn care	Review the advantages of hydrogels (moist, analgesic, drug/cell loadable) as well as challenges: production costs, stability, regulation, and clinical translation	Does not present p-values; underscore the need for cost-effective and compatible design with burn center practices	Yao et al. (2021)
3	Double-blind RCT	Boswellia topical vs SSD 1%	The healing effect is equivalent to SSD, but the potential for contact dermatitis in some Boswellia patients needs to be watched out for	Mean healing time was 10.94 (95% CI 9.03–12.85) vs 10.73 (95% CI 9.23–12.23) days; p=0.71 (no different); all Boswellia patients recovered on the 17th day; AE: possible contact dermatitis	Badr et al. (2023)
4	RCT cost-effectiveness	Enzyme alginogel vs SSD pada partial thickness burns	There is no significant difference in QALY; costs tend to be higher in alginogels; SSDs have a greater cost-effective probability	ΔQALY −0.03 (95% CI −0.09 to 0.03; p=0.30); Δhealth costs €3,210 (95% CI −1,247 to 7,667; p=0.47); Δsocial costs €3,377 (95% CI −6,229 to 12,982; p=0.49); Flaminal cost-effectiveness probability <25%	Rashaan et al. (2020)
5	RCT open-label	hAM vs SSD for second-degree burns	hAM provides better healing & pain, but the cost is much higher so cost-effectiveness issues arise	Average cost of hAM ±US$170 vs SSD ±US$71 (p<0.001); all clinical parameters (epithelialization, pain, scar, LOS) were better in hAM (p<0.05)	Moghimi et al. (2024)
6	Phase IIb/III RCT	PL-5 & Acceleration vs SSD	Both show high clinical efficacy and good safety profiles; no systemic concentrations detected, SSD-like AE – indicating	PL-5 efficacy up to 100% vs 87.5% SSD (p<0.05); 90.4% vs. 78.7% (p<0.001); AE is similar;	Wei et al. (2023; 2024)

			a low risk of toxicity but cost & availability are not yet clear	PL-5 is undetectable in the blood	
7	Multicenter RCT non-inferiority	HBPs-Ag vs Atrauman Ag	Both silver dressings are safe; silver was detected in 3.79% of patients only; no significant differences in local/systemic AE	Total efficiency: 98.3% vs 94.7% ($p>0.05$); all safety indicators (irritation, skin discoloration, swelling, pain, AE) were not different ($p>0.05$); silver blood/urine in only 5 patients	Ye et al. (2025)
8	Protocol RCT	Flaminal vs Flamazine	Include HRQoL endpoints and costs as outcomes; highlighting the need to consider the economic and burden aspects of the patient in the selection of dressings	There are no numerical results (protocol studies), but the cost/QoL framework has been integrated as part of the selection of therapies	Rashaan et al. (2016)
9	RCT (retracted)	Nanosilver vs SSD	Reporting better clinical outcomes and lower infections, but article retraction highlights issues of data quality and interpretation safety	$P<0.05$ for shorter healing time and decreased inflammatory markers; However because it is retracted, the evidence is very unreliable	Wu et al. (2021)

Sumber: Bairagi et al. (2021), Burns, 47(6), 1225–1240

It suggests that advanced dressings generally have problems with cost and access, despite offering certain therapeutic benefits. The pediatric national consensus compiled by Liu and the Chinese Burn Association (2023) states that when choosing a dressing, factors such as the depth of the wound, the risk of infection, the comfort of the dressing, and its availability should be considered. They also noted that the use of advanced dressings is limited by their cost and availability. A narrative review of hydrogel dressings underscores the difficulties associated with production costs, product stability, regulation, and integration into standard clinical practice, despite its advantages in maintaining wound moisture and facilitating treatment or cell loading.

Rashaan et al.'s (2020) study on cost-effectiveness showed that alginogel enzymes did not provide a substantial QALY difference relative to SSDs in partial-thickness burns. However, the overall health and social costs increased, and the likelihood of Flaminal's cost-effectiveness was indicated to be minimal.

In terms of the combination of cost and clinical outcomes, human amniotic membrane (HAM) is better than SSDs for healing, discomfort, scarring, and length of stay (LOS), but it costs more than twice as much (Moghimi et al., 2024). This raises concerns about whether it is feasible to use in many health systems that lack financial resources. Phase IIb/III trials using PL-5 and its selection demonstrated superior or, at a minimum, not inferior clinical effectiveness compared to SSDs, accompanied by a good safety profile and negligible systemic concentrations (Wei et al., 2023; 2024). However, data on cost and availability remains insufficient.

In non-inferiority multi-center RCTs, branched polyamide-Ag (HBPs-Ag) showed a rate of local and systemic adverse events comparable to Atrauman Ag, with silver identified in only a small percentage of patients (Ye et al., 2025), indicating minimal systemic toxicity risk. The

Flaminal vs. Flamazine test procedure (Rashaan et al., 2016) combines quality of life and cost outcomes, which indicates a higher focus on economic assessment. On the other hand, the recall of the nanosilver versus SSD RCTs (Wu et al., 2021) serves as a reminder that superior efficacy and safety statements must be supported by high-quality data before being used in policy formulation.

The chart shows that the main issue with today's advanced dressings is often attributed to cost and availability. When evaluated in a controlled RCT setting, the security profile is typically similar to that of an SSD.

CONCLUSION

This comprehensive study shows that advanced wound dressings provide significant therapeutic benefits compared to standard dressings in terms of healing, infection reduction, and pain management. A reviewed meta-analysis and randomized controlled trials demonstrated that some contemporary dressings can accelerate re-epithelialization, reduce colonization of pathogenic bacteria, and decrease the need for surgical procedures such as debridement or grafting. Advanced dressings, including hydrocolloids, nanofibers, amniotic membranes, and peptide-based antimicrobials, have shown efficacy in reducing pain during the first phase of therapy and lowering the frequency of dressing replacements. However, their effect on scar tissue quality is still inconsistent, meaning that not all contemporary dressings provide better scar outcomes.

These results have significant implications for clinical practice, financial management, and the formulation of burn treatment protocols. Advanced dressings can make the healthcare system more efficient by shortening the duration of therapy, lowering the risk of complications, and enhancing patient comfort. However, because these dressings are more expensive and not always available, healthcare institutions should choose them based on their clinical needs and budget.

In addition, the findings of this study may inform revisions to clinical practice recommendations to better accommodate biomaterial advances and the diverse needs of patients with varying burn characteristics. Future research will need to address the challenges posed by different study designs by conducting standardized clinical trials that directly compare various types of advanced dressings across specific demographics and burn severities. A more thorough cost-effectiveness analysis is also needed to determine whether current dressings can be used across different healthcare funding systems. Additionally, there is a need for long-term investigations into scar tissue outcomes, quality of life, and systemic safety, especially regarding new biomaterials such as nanofibers, bioengineered skin replacements, and 3D bioprinted dressings, in order to provide robust data for the wider clinical community.

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