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# *WOUND HEALING EFFICACY OF MOIST EXPOSED BURN OINTMENT (MEBO) AND SILVER SULFADIAZINE IN PARTIAL-THICKNESS BURNS: A SYSTEMATIC REVIEW*

Aditya Wardhana [a*], Nadya Farhana [a]

[a]Burn Unit, Plastic Reconstructive and Aesthetic Surgery Division, Department of Surgery, Cipto Mangunkusumo Hospital, Faculty of Medicine, Universitas Indonesia, Jakarta, Indonesia

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***Corresponding author*:**
Aditya Wardhana
Email address:
aditya_wrdn@yahoo.com

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ABSTRACT

**Introduction:** Burn injuries are a common global health issue that often require prolonged wound care and can lead to complications such as infections, delayed healing, and surgical interventions. Silver sulfadiazine (SSD) has long been the standard topical treatment for partial-thickness burns, but concerns remain regarding delayed healing and potential side effects. Moist Exposed Burn Ointment (MEBO), a Chinese herbal-based topical agent containing sesame oil, beta-sitosterol, and berberine, has emerged as a potential alternative due to its anti-inflammatory, antimicrobial, and moisture-retaining properties.

**Method:** This systematic review aimed to evaluate the efficacy of MEBO compared to SSD in partial-thickness burn wound healing. A comprehensive search of PubMed, Cochrane, and Science Direct using the terms "MEBO," "SSD," "Burns," and "Wound healing" identified five trials conducted between 2000 and 2008.

**Result:** The results consistently demonstrated that MEBO provided comparable or superior outcomes to SSD, including shorter wound healing time, reduced pain, absence of infection in wound swabs, minimal slough and crust formation, lower complication rates, and reduced need for surgical intervention.

**Conclusion:** These findings suggest that MEBO is an effective and potentially preferable alternative to SSD for managing partial-thickness burn wounds.

**Highlights:**

1. Superior efficacy between MEBO and SSD in burn patients.
2. Improved Clinical Outcomes of wound healing in burn patients.
3. Natural, Plant-Based Alternative for burn patients.

## INTRODUCTION

Moist Exposed Burn Ointment (MEBO), a Chinese-origin topical treatment developed in 1989 in Beijing, has been proposed as an effective therapy to accelerate burn wound healing. [1] MEBO is an oil-based ointment composed of sesame oil, beta-sitosterol, berberine, and other plant-derived ingredients.[1-3] Theoretically, MEBO promotes wound healing by creating a moist environment that supports cellular regeneration, minimizes dehydration, and reduces wound surface temperature, conditions known to facilitate faster re-epithelialization.[2,3] Beta-sitosterol, a key active compound in MEBO, exhibits anti-inflammatory and antioxidant properties that help modulate the wound healing process by reducing inflammation and oxidative stress.[4,5] Additionally, its oil-rich formulation supports moisture retention, which prevents the formation of dry scabs and enhances tissue repair. [4,5] It is widely used in Asia and has shown comparable efficacy to standard therapies like silver sulfadiazine in several clinical studies.

Topical treatment such as silver sulfadiazine (SSD) are commonly used as standard treatment for superficial and partial thickness of burns.[6] Silver sulfadiazine helps maintain a moist wound environment, reduces pain, and exhibits antibacterial properties.[1] Despite its beneficial properties, silver sulfadiazine has some limitations.[6] Several adverse effects have been reported, such as agranulocytosis, aplastic anemia, hemolytic anemia, and leukopenia.[6]

Partial-thickness burns typically heal within two weeks, unless they become infected, which can delay the healing process.[1] While partial-thickness burns generally do not require skin grafts, they still necessitate careful and timely management to avoid complications.[2] Prompt and effective treatment is essential to promote optimal wound healing, minimize the risk of infection, and prevent long-term scarring.[2]

However, despite growing interest in MEBO as an alternative, the current evidence comparing its effectiveness to silver sulfadiazine (SSD) in partial-thickness burns remains inconclusive and scattered across studies. This paper aims to compare the healing outcomes between MEBO and SSD in the treatment of partial-thickness burn wounds.

## METHODS

### Protocol and Registration

We have registered our systematic review and meta-analysis on the International Prospective Register of Systematic Reviews (PROSPERO) with registered number CRD42025634435. The study is reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[7]

### Inclusion Criteria

This systematic review was conducted from June 2024 to June 2025. The inclusion criteria for this review were studies that compared MEBO and SSD as topical treatments for patients with partial-thickness burns and evaluated wound healing as an outcome measure. Studies that used other topical agents or focused on full-thickness burns were excluded. Only RCT studies were included and articles published in English were considered, with no restrictions on the publication date and no geographical restriction on study location.

### Search Strategy

A systematic review regarding the effect of MEBO and SSD in burn wound healing. Literature review was conducted using the terms of “Moist Exposed Burn Ointment” or “MEBO”, “Silver sulfadiazine” or “SSD”, “Burns”, and “Wound healing” with Pubmed, Cochrane, and Science Direct as the search engine. The review followed PRISMA guidelines and the study selection process is outlined in Figure 1. All included studies were critically appraised and reviewed.

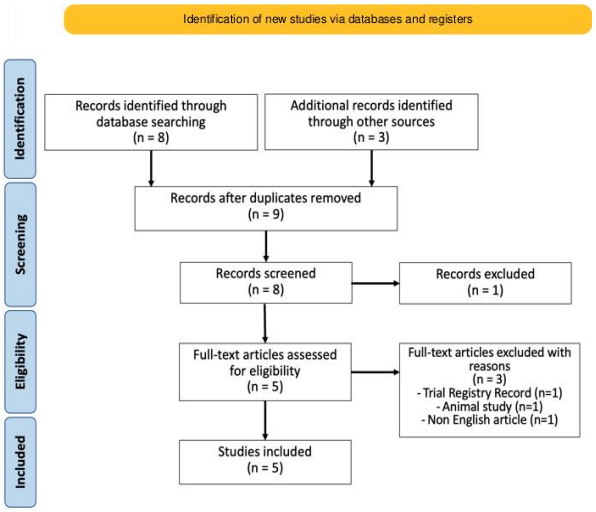


Figure 1. PRISMA Diagram for Study Selection Process

### Data Extraction

The extracted data included the year of the study, study design, number of patients, treatment between the MEBO and SSD groups, reported wound healing outcomes, sign of infection, pain, cost, and burn-related complications. We also evaluated the methodological quality of each trial using Cochrane's criteria. We did a stratified selective method with two independent reviewer and resolved any disagreements between reviewers through discussion.

### Risk of Bias Assessment

The risk of bias assessment for randomized controlled trials (RCTs) was assessed using the RoB2 in Cochrane Collaboration's risk of bias assessment tool (RevMan version 8.13.0, Cochrane Collaboration).[8]

### Descriptive analysis

The analysis focused on summarizing outcomes related to the efficacy of MEBO compared to SSD in treating partial-thickness burn wounds. The primary outcomes considered across the included studies were wound healing time and the presence or absence of infection in wound swabs. Secondary outcomes included pain levels, formation of slough and crust, complication rates, and the requirement for surgical intervention. Each study's findings were reviewed and compared narratively, highlighting trends and consistencies in clinical outcomes. Differences in treatment effectiveness were described qualitatively, and no pooled statistical synthesis was conducted due to variability in study design, outcome reporting, and sample sizes.

## RESULTS

### Included Studies

We identified five trials (332 patients) conducted between 2000 and 2008 that compared MEBO and SSD for the treatment of partial-thickness burns. Of the eleven candidate studies, two were excluded due to duplication. During abstract screening, one study was excluded for ineligible outcome measures, at full-text assessment, three were excluded due to language limitations, one was an animal study, and one was an ongoing trial. The five included studies compared MEBO with SSD as their control treatment for burn wounds. All five randomized controlled trials were critically appraised and reviewed. Table 1 provides a summary of the study design, interventions, and control treatments.

The total sample consisted of 163 patients in the MEBO group and 169 in the control group. Control treatments, mainly SSD, varied across studies, with SSD frequently combined with other agents such as paraffin gauze, sofratulle, nitrofurazone, povidone iodine, hydrogen peroxide, and other topical agents, as outlined in Table 1.

### Randomized Study Quality

The Risk of Bias (RoB) assessment in Figure 2 shows that the randomized controlled trials (RCTs) raise some concerns regarding bias.[9]

Table 1. Summary of Eligible Studies

| Study, year | Study Design | Intervention | Intervention (n) | Control | Control (n) |
|---|---|---|---|---|---|
| Hirsch T. et al, 2008[1] | RCT | MEBO covered in sterile compress, cotton, and elastic bandage, changes once daily | 20 | Flammazine (SSD) cream, covered in sterile compress, cotton, and elastic bandage, changes once daily | 20 |
| Allam A. M. et al, 2007[3] | RCT | MEBO applied twice daily, covered in a sterile polyethylene bag | 53 | SSD 1% cream covered in a sterile polyethylene bag, applied daily | 53 |
| Ang E. et al, 2003[4] | RCT | MEBO applied every 4 hours | 54 | Parafin gauze or polyutherane dressing and SSD cream covered in gauze dressing, twice daily | 57 |
| Atiyeh B.S. et al, 2002[5] | RCT | MEBO, no information regarding its application | 19 | Control topical treatment (silver sulfadiazine, sofratulle, nitrofurazone, quadriderm, dexpanthenol, savlon, hydrogen peroxide, povidone iodine) | 17 |
| Ang E. et al, 2000[2] | RCT | MEBO applied every 4 hours | 17 | SSD cream covered in gauze dressing, twice daily | 22 |

*Abbreviation: MEBO=Moist exposed burn ointment; SSD=Silver sulfadiazine; n=number of participants; RCT=Randomized controlled trial*

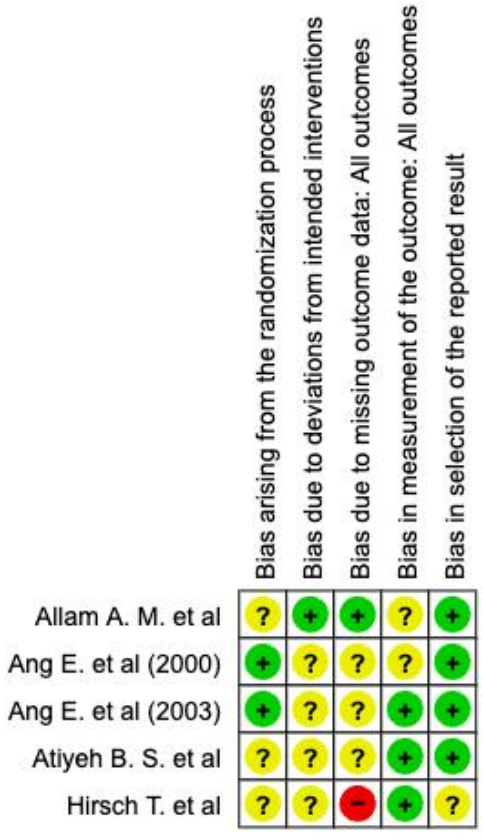


Figure 2. Risk of Bias Assessment

Three studies did not clearly describe their randomization and allocation processes. Although randomization was implemented, smaller studies are generally more vulnerable to poor outcomes due to their limited sample size. Patients were assigned to treatment groups using simple randomization methods. Two studies achieved allocation concealment through sealed envelopes containing patient allocation sheets, but the remaining studies did not specify their allocation concealment methods. Most studies had deviations due to the awareness of participants and personnel regarding the intervention. In terms of missing outcome data, one study reported missing outcome data in the MEBO group due to patient withdrawals, and three studies excluded patient's post-randomization for various reasons. In terms of outcome measurement, bias may have been influenced by knowledge of the intervention. Regarding the selection of reported results, only one study, which had patient withdrawals, raised concerns about bias.

Table 2. Patient's Baseline Characteristics

| Study, year | Age | TBSA | Depth of Burn | Burn Etiology | Anatomy Region |
|---|---|---|---|---|---|
| Hirsch T. et al, 2008[1] | 20-65 | <20% TBSA | Partial thickness burn | Thermal | Whole burned area |
| Allam A. M. et al, 2007[3] | 30-40 | <25% TBSA | Partial thickness burn | Thermal | Hand |
| Ang E. et al, 2003[4] | 6-80 | <40% TBSA | Partial thickness burn | Thermal | Whole burned area |
| Atiyeh B.S. et al, 2002[5] | 5-54 | 5-20% in adult<br>5-15% in pediatric | Superficial-partial thickness Burns | Thermal | Whole burned area |
| Ang E. et al, 2000[2] | 6-80 | <40% TBSA | Partial thickness burn | Thermal | Face |

*Abbreviation: TBSA=Total body surface area*

Table 3. Wound Healing between MEBO and SSD in Partial-Thickness Burn

| Author, year | Outcome | Result | |
|---|---|---|---|
| | | MEBO | SSD |
| Hirsch T. et al, 2008[1] | TEWL | 13.1 ± 16.9* | 10.8 ± 19.5* |
| | WCI | 83 ± 33* | 70 ± 42* |
| Ang E. et al, 2000[2] | Wound healing rate by day 10 | 14/17 patient | 17/22 patients |
| Allam A. M. et al, 2007[3] | Wound local findings: | | |
| | Maceration | 50 (94.34%) | 46 (86.79%) |
| | Crustation | 0 (0%) | 37 (69.81%) |
| | Easy assessment | 53 (100%)2 | 23 (43.39%) |
| | Healing period (days): | | |
| | Superficial partial thickness burn (p<0.001) | 10.48 ± 2.66* | 14.53 ± 3.83* |
| | Deep partial thickness burn (p<0.001) | 30.50 ± 5.10* | 36.6 ± 5.08* |

*Abbreviation: TEWL=Trans epidermal water loss; WCI=Wound closure index*
**Data are presented as mean ± standard deviation*

## Patient's Baseline Characteristics

The patients' characteristics are shown in Table 2. The age distribution varied across the studies. Three studies included pediatric patients as their participants, while other two studies only included adult as their participants. There is no statistical analysis was performed to assess this imbalance.

The percentage of Total Body Surface Area (TBSA) was higher in two studies, but the remaining studies reported similar TBSA percentages, all under 20-25%. Most studies included partial-thickness burn as part of their inclusion criteria, while one study included superficial-partial-thickness burn. All burn etiologies included in these studies were thermal. Two studies specifically focused on burns in the hand and face regions, while the other three studies included whole burned body area.

## Outcome: Wound healing

Three studies evaluated wound healing between MEBO and SSD in partial-thickness burn shown in Table 3. Hirsch T. et al. evaluated wound healing epithelialization using Trans Epidermal Water Loss (TEWL) and Wound Closure Index (WCI) as parameters.[1] It was shown that there was a difference of 2.3 gr/m$^2$/h between MEBO and SSD in terms of TEWL. [1] However, in terms of WCI, there was no difference between the MEBO and SSD groups.[1] Ang E. et al. (2000) reported the wound healing rates by day 10 for the MEBO and SSD groups.[2] In the MEBO group, 14 out of 17 patients had healed by day 10, compared to 17 out of 22 patients in the SSD group.[2] This resulted in 82.3% patients in MEBO group healed faster compared to 77.2% patients in SSD group.[2] Allam A. M. et al. evaluated local wound findings and the healing period for partial-thickness burns between the MEBO and SSD groups.[3] Maceration was more common in the MEBO group (94.34%) compared to the SSD group (86.79%).[3]

Table 4. Pain between MEBO and SSD in Partial-Thickness Burn

| Author, year | Outcome | Result | |
|---|---|---|---|
| | | MEBO | SSD |
| Hirsch T. et al, 2008[1] | Pain scale (VAS) by day 0 | 5 | 5 |
| | Pain scale (VAS) by day 12 | 3.8 | 3.5 |
| Allam A. M. et al, 2007[3] | Pain Score 0-3 (during dressing change) | 1 (47.17%) | 1 (41.51%) |
| | Comfort Score 0-3 | 3 (28.30%) | 3 (24.53%) |
| Ang E. et a,l 2003[4] | Pain scale (Mean NRS) in the morning | 2.974 | 2.991 |
| | Pain scale (Mean NRS) after dressing | 2.892 | 3.580 |
| | Pain scale (Mean NRS) in the evening | 2.651 | 2.602 |

*Abbreviation: VAS=Visual analog scale; NRS=Numerical rating scale*

Table 5. Cost between MEBO and SSD in Partial-Thickness Burn

| Author, year | Outcome | Result | |
|---|---|---|---|
| | | MEBO | SSD |
| Allam A. M. et al, 2000[3] | Daily cost (EGP) | 9.00 ± 0.00 | 2.17 ± 0.16 |
| Atiyeh B. S. et al, 2002[5] | Daily cost (EGP) | 34.06 ± 5.38 | 28.20 ± 4.99 |

*Abbreviation: EGP=Egyptian Pound*

However, the MEBO group had no crust formation, which facilitated easier wound assessment (100%) compared to the SSD group (43.39%).[3] Regarding the wound healing period, the MEBO group showed a shorter healing time for both superficial and deep partial-thickness burns compared to the SSD group.[3]

**Outcome: Signs of Infection**

Hirsch T. et al. and Ang E. et al. (2000) both assessed signs of infection as an outcome measure.[1,2] Hirsch T. et al. reported no signs of infection in either the MEBO or SSD groups, while Ang E. et al. (2000) observed minimal slough in the MEBO group but did not mention any signs of infection in the SSD group.[1,2]

**Outcome: Pain**

Three studies assessed pain in the MEBO and SSD groups for partial-thickness burns, as shown in Table 4. Hirsch T. et al. compared pain scores on days 0 and 12 using the Visual Analog Scale (VAS).[1] Pain scores were similar between the MEBO and SSD groups on both days (5 vs. 5 on day 0 and 3.8 vs. 3.5 on day 12).[1] Allam A. M. et al. also evaluated pain and comfort scores.[3] Pain was assessed during dressing changes, while comfort scores reflected comfort related to odor and the appearance of the wound.[3] Pain scores ranged from 0 to 3, indicating mild to severe pain, while comfort scores ranged from 0 to 3, indicating discomfort or refusal of dressing change to comfort during dressing changes.[3] Pain and comfort scores were similar between the groups.[3] Ang E. et al. (2003) evaluated pain using the Numerical Rating Scale (NRS) in the morning, after dressing changes, and in the evening.[4] They found a lower mean NRS score during dressing changes in the MEBO group compared to the SSD group (2.89 vs. 3.58).[4]

**Outcome: Burn-related Complication**

Two studies reported burn-related complications. Ang E. et al (2000) found that none of the participants in either the MEBO or SSD groups required surgery after treatment.[2] Allam A. M. et al. assessed post-burn deformities and found fewer deformities in the MEBO group (15 out of 53) compared to the SSD group (37 out of 53).[3] The post-burn deformities reported in the study included hypertrophic scars, contractures of the metacarpophalangeal and interphalangeal joints, wrist joint

contractures, post-burn syndactyly, and post-burn nail retraction. [3]

**Outcome: Cost**

Two studies compared the daily costs of MEBO and SSD treatments for partial-thickness burns, as shown in Table 5. Both studies found that MEBO was more expensive than SSD.[3,5] Allam A. M. et al. reported higher daily costs for the MEBO group, while Atiyeh B. S. et al. also found higher costs for the MEBO group. [3,5]

## DISCUSSION

This review aimed to compare MEBO with SSD in the treatment of partial-thickness burns, focusing specifically on wound healing outcome. Other outcomes assessed in this review included signs of infection, pain, burn-related complications, and treatment costs.

Five randomized controlled trials (RCTs) involving 332 patients were identified, all conducted between 2000 and 2008. While these studies provide valuable insights into the comparative efficacy of MEBO and SSD, several concerns regarding potential biases were noted, as indicated by the Risk of Bias (RoB) assessment. In terms of baseline patient characteristics, the age distribution varied across the studies, with some including pediatric patients and others focusing on adults. Additionally, the percentage of TBSA also varied, although most patients had burns covering less than 25% of their body. Two studies specifically focused on burns to the hands and face, while the other studies did not specify particular anatomical regions. These differences highlight the potential for variability in treatment responses and the need for further analysis to account for these factors. Including more homogeneous study populations and conducting a more rigorous evaluation of bias will strengthen the evidence base for MEBO as a standard treatment option for burn wounds.

In these trials, both MEBO and SSD are used as interventions and controls. However, it is important to note that there is no information available regarding the specific dosage for the application of MEBO and SSD. Despite this limitation, we provide the method of application for both MEBO and SSD in Table 1, based on each trial.

The heterogeneity in application frequency, outcome measures, and patient populations across studies underscores the lack of standardization in topical burn treatment protocols, which this review attempts to address.

The primary outcome in this review was wound healing. Three studies showed a general advantage for MEBO. Hirsch T. et al. found that MEBO performed better in terms of Trans Epidermal Water Loss, with a difference of 2.3 $gr/m^2/h$ compared to SSD, suggesting better skin epithelialization with MEBO.[1] Ang E. et al. (2000) reported that 82.3% of patients in the MEBO group had healed by day 10, compared to 77.2% in the SSD group, indicating a slightly faster healing rate for MEBO.[2] Allam A. M. et al. observed that the MEBO group had a shorter healing time for both superficial and deep partial-thickness burns, despite experiencing more maceration (94.34% vs. 86.79%).[3] However, the absence of crust formation in the MEBO group facilitated easier wound assessment, suggesting that MEBO might offer better manageability for clinicians.[3]

We analyzed signs of infection as our secondary outcome in this review. Hirsch T. et al. and Ang E. et al. (2000) found no significant difference between the two treatments.[1,2] Hirsch T. et al. reported no signs of infection in either group, while Ang E. et al. observed minimal slough in the MEBO group but did not note any infections in the SSD group, implying that both treatments were effective in preventing infection. [1,2]

Pain assessments across three studies revealed generally similar results between the groups. The studies used different

outcome measures to assess pain scores. Hirsch T. et al. employed the Visual Analog Scale (VAS) for pain assessment, while Ang E. et al (2023) used the Numerical Rating Scale (NRS). [1,2] Additionally, Allam A. M. et al. used their own subjective pain scoring system.[3] These differences in pain measurement methods may introduce a risk of bias in the outcomes. Hirsch T. et al. found no significant difference in pain scores at day 0 and day 12, while Allam A. M. et al. reported similar pain and comfort scores for both treatments.[1,3] However, Ang E. et al (2003) found that the MEBO group had a lower pain score during dressing changes, suggesting that MEBO may offer some pain relief benefits during treatment.[2]

Burn-related complications were less frequent in the MEBO group. Ang E. et al (2000) found that none of the participants in either group required surgery, while Allam A. M. et al. observed fewer post-burn deformities in the MEBO group (15 out of 53) compared to the SSD group (37 out of 53).[2,3] The lower incidence in the MEBO group suggests it may offer some advantage in preventing long-term complications.

The final secondary outcome assessed in this review was treatment cost. The cost between MEBO and SSD consistently showed that MEBO is more expensive. Allam A. M. et al. reported daily costs of 9.00 ± 0.00 for the MEBO group versus 2.17 ± 0.16 for the SSD group, while Atiyeh B. S. et al. found similar results (34.06 ± 5.38 vs. 28.20 ± 4.99), indicating that MEBO is a less cost-effective option compared to SSD.[3,5] The daily cost for topical agents depends on factors such as the total dosage required for daily application, the patient's length of stay, and the wound healing rate. Atiyeh B. S. et al. reported that MEBO was associated with a shorter length of hospital stay, while Allam A. M. et al. noted that the MEBO group had a faster wound healing rate.[3,5] Allam A. M. et al. also mentioned that MEBO was applied every four hours, totaling six applications per day, although Atiyeh B. S. et al. did not specify the application frequency for MEBO.[3,5] Additionally, Ang E. et al. (2000) noted that MEBO is easier to apply than SSD, as SSD requires bulkier dressings, which are also more costly.[2] Despite its higher cost, MEBO may still be considered cost-effective due to its shorter healing period, even though it requires more frequent application.

MEBO appears to offer some advantages in wound healing, pain reduction, and prevention of burn-related complications, its higher cost must be considered. MEBO's benefits in terms of wound healing rate and long-term outcomes may justify its higher cost in some clinical settings.

Given its benefits in healing acceleration and complication prevention, MEBO may be integrated into clinical guidelines for partial-thickness burn management, especially in tertiary care centers. However, policymakers in low-resource settings must weigh these benefits against its higher cost, possibly reserving MEBO for selected patient populations where rapid recovery is critical.

To our knowledge, this is the first systematic review synthesizing clinical outcomes of MEBO and SSD specifically in partial-thickness burn injuries. This research has several limitations, including the small number of available trials and limited sample sizes, which may reduce the internal validity and increase the risk of bias in the pooled conclusions. As a result, the generalizability of these findings to broader patient populations or different healthcare settings, especially those outside of Asia should be interpreted with caution. Despite these limitations, the review provides valuable preliminary insights and highlights the potential of MEBO as an alternative topical agent in burn management. Future high-quality randomized controlled trials with larger sample sizes are recommended to validate these findings and further explore long-term outcomes, including cost-effectiveness, patient satisfaction, and aesthetic results. From a clinical and policy standpoint, the findings may offer practical guidance for low- and middle-income

countries seeking cost-effective burn treatment alternatives, but definitive recommendations should await further research.

## CONCLUSION

This systematic review demonstrates that MEBO is comparable in efficacy to silver sulfadiazine (SSD) in promoting wound healing in partial-thickness burns. Across the reviewed studies, MEBO showed similar or better outcomes in terms of healing time, infection prevention, pain reduction, and scar formation. These findings suggest that MEBO may serve as a safe and effective alternative topical treatment for partial-thickness burn injuries, particularly in settings where conventional agents such as SSD may not be ideal due to side effects or availability.

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## CONFLICT OF INTEREST

We declare that there are no conflicts of interest or financial disclosures related to this paper.

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No external funding or grants were received for this study, and the authors have no personal or professional affiliations that could have influenced the research or its outcomes.

## AUTHOR CONTRIBUTION

AW contributed to the article review, data collection, manuscript preparation, and final approval of the manuscript. NF contributed to the article review and data collection, and participated in the manuscript preparation. All authors have read and approved the final manuscript for publication.

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