

Topical corticosteroids in the treatment of acute sunburn: a systematic review

Andre Parmonangan Panjaitan^{1*}, Marina Haroen²

Abstract

Background: Acute sunburn is a prevalent dermatological issue, particularly affecting individuals with fair skin types I-III. It is characterized by erythema, edema, and discomfort due to ultraviolet (UV) radiation exposure. Topical corticosteroids are commonly used for their anti-inflammatory properties, but their efficacy in sunburn treatment is debated due to limited high-quality evidence from randomized controlled trials (RCTs). This study aims to assess the efficacy of topical corticosteroids in relieving symptoms and inflammation of sunburn.

Methods: A systematic review was conducted by searching PubMed, Web of Science, ProQuest, Scopus, and Cochrane Central Register of Controlled Trials (CENTRAL) for studies published up to April 30, 2024. Keywords included combinations of terms related to corticosteroids, topical application, and sunburn. Studies were selected based on PRISMA 2020 guidelines, focusing on adult patients treated with topical corticosteroids compared to placebo. Data extraction and quality assessment were independently performed by two researchers using the Cochrane Collaboration's Risk of Bias tool.

Results: The review included six RCTs with a total of 339 participants, aged 18-68 years, conducted in Europe and the USA. Various topical corticosteroids were studied, including methylprednisolone aceponate, hydrocortisone 17-butyrate, and hydrocortisone-21-acetate. Treatment durations ranged from single applications to twice daily for seven days. The results demonstrated that prolonged treatment with topical corticosteroids significantly reduced sunburn symptoms such as erythema and pain. When applied for seven days, treated areas showed lower sunburn reaction scores and reduced inflammation compared to untreated areas. Early application of corticosteroids, particularly within 6 hours post-exposure, was more effective than later applications. Histological analyses supported these findings, showing improvements in epidermal thickness and reduced dermal inflammation in treated areas.

Conclusion: Topical corticosteroids can effectively alleviate acute sunburn symptoms and aid skin recovery by targeting inflammatory pathways. Their efficacy is enhanced with prolonged and early application. Further research is needed to optimize treatment protocols and assess long-term effects to fully realize the therapeutic potential of corticosteroid therapy in managing acute sunburn.

Keywords: Efficacy, Sunburn, Systematic Review, Topical Corticosteroids, Indonesia

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Background

Acute sunburn represents a significant dermatological challenge, particularly affecting individuals with fair skin types I-III, who are more susceptible to the harmful effects of ultraviolet (UV) radiation [1]. Clinically, sunburn manifests as erythema, edema, and discomfort, often accompanied by sensations of burning and itching [2]. Despite its widespread occurrence and substantial impact on individuals' well-being, there remains a notable gap in our understanding of optimal therapeutic interventions [3]. Topical corticosteroids have emerged as a common treatment for acute sunburn, owing to their potent anti-inflammatory properties and potential to alleviate associated symptoms [2]. Topical steroids offer a distinct advantage in sunburn management due to their ability to mitigate the inflammatory cascade triggered by ultraviolet radiation exposure while also potentially modulating key mediators involved in the pathogenesis of sunburn-associated skin damage [4]. However, the efficacy of topical corticosteroids in this context remains arguable, largely due to the absence of high-quality evidence report derived from randomized controlled trials (RCTs). To improve the management and outcomes of acute sunburn, it is crucial to bridge the existing gap in evidence-based practices. To date, no systematic review has tackled this knowledge gap, suggesting the need for thorough examination of the available

literature concerning the application of topical corticosteroids in managing acute sunburn. This study aims to provide a comprehensive understanding of the efficacy of topical corticosteroids in alleviating symptoms and inflammation associated with sunburn.

Methods

Search Strategy

A computerized systematic literature search of relevant studies was conducted in PubMed, Scopus, Web of Science, ProQuest, and the Cochrane Central Register of Controlled Trials for studies published up to April 30, 2024. The following main keywords were initially established: (Corticosteroid OR Steroid) AND (Topical OR Local OR Ointment) AND (Sunburn OR Solar Erythema OR Solar Dermatitis). In order to create database-specific search terms, a number of Medical Subject Headings (MeSH) and other free-text terms were subsequently added.

Selection of Studies

This systematic review and meta-analysis adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) 2020 guidelines. All search outcomes were compiled and organized using Google Sheets. Following duplicate removal, articles were screened based on their titles and abstracts. Those meeting the inclusion criteria were subsequently sought for full-text retrieval. Studies with published full texts were then evaluated based on the eligibility criteria.

Eligibility Criteria

We employed the Population, Intervention, Comparison, Outcome, and Study Design (PICOS) framework (refer to Table 1) to establish the eligibility criteria for this study. Inclusion criteria comprised studies involving: (1) adult patients with sunburn; (2) the use of a corticosteroid regimen as the sole intervention; and (3) inclusion of a control group. Exclusion criteria encompassed studies with: (1) irrelevant titles; (2) irrelevant abstracts; (3) inaccessible full texts; (4) pre-exposure treatment or other combination therapies; and (5) non-topical corticosteroid use.

Table 1. PICOS framework

Components of PICOS	Definition
Population	Adults with sunburn
Intervention	Topical corticosteroid
Comparison	Topical placebo
Outcome	Outcomes related to the sunburn reaction (erythema, pain, or histological changes)
Study Design	Randomized Controlled Trial

Data Extraction and Quality Assessment

Two researchers independently extracted data extraction from each included study. The extracted data was the primary author, publication year, study location, design, sample size, and participant demographics. Treatment specifics, including regimen, dosage, and duration, were also recorded. The risk of bias for each eligible study was assessed using the Cochrane Collaboration's Risk of Bias (RoB) 2 tool, which consists of six bias domains tailored to evaluate the risk of bias in randomized

trials. Bias within each domain was categorized as low, high, or unclear risk.

Results

Selection of Studies

A PRISMA flow diagram illustrating the overall study selection process is presented in Figure 1. The initial electronic database searches yielded 241 records. Upon the review process, records were excluded based on titles and abstracts, as well as full-text availability. The remaining 10 full texts were thoroughly assessed for eligibility, resulting in the exclusion of 4 studies due to irrelevance in terms of interventions and study type. The overall screening process led to the inclusion of 6 randomized controlled trials (RCTs) in this systematic review.

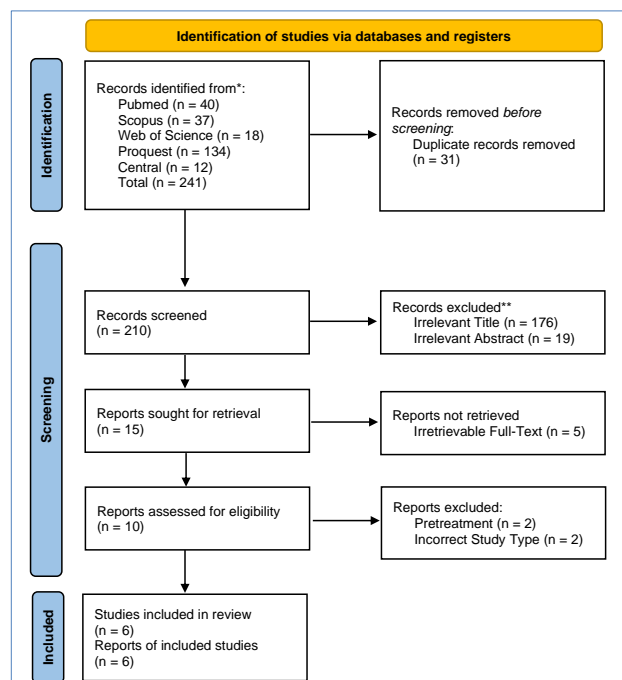


Figure 1. PRISMA Flow Diagram of the Study Selection Process

Characteristics and Outcomes of Included Studies

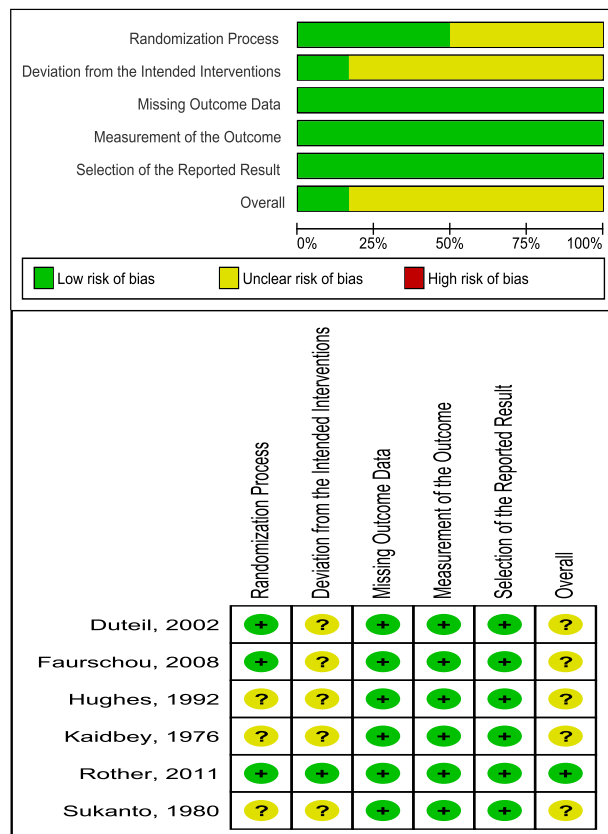
The characteristics of the included studies are summarized in Table 2. The 6 RCTs yielded a total of 339 participants, with ages ranging from 18 to 68 years. Four studies were conducted in Europe and the remaining was conducted in USA. All studies examined healthy volunteers who have irradiated with simulated sunlight in the back area. Studies reported the use of various type of topical corticosteroids (Table 3). The duration was divided to single use or continuous for 7 days before the assessment. Studies reported difference result of sunburn reaction (erythema and pain). One study provided qualitative data of skin biopsy.

Study Quality Assessment

According to the Cochrane Risk of Bias (RoB) tool, only one study was rated as low risk in all domains, indicating a low overall risk of bias (Figure 2). The remaining five RCTs were rated as having some concerns. These concerns mainly arose during the randomization process and potential deviation from intended interventions, as there was a potential for influence by the knowledge of intervention status. The random sequence process also did not well mention in three studies.

Table 2. Characteristics of Included Studies

Author, Year	Location	Design	Total Examination		Age (Range)	Female (%)	Patient Characteristics	Sunburn Area
			Intervention	Control				
Duteil, 2002	France	RCT	24 (group I) 24 (group II)	24	18-65	41.67	Healthy volunteers, irradiated with simulated sunlight.	Back
Rother, 2011	Germany	RCT	24	24	18-55	N/A	Healthy volunteers, irradiated with simulated sunlight.	Back
Faurschou, 2008	Denmark	RCT	20 (group I) 20 (group II)	20	23-62	80.00	Healthy volunteers, irradiated with simulated sunlight.	Back
Sukanto, 1980	Netherlands	RCT	28 (group I) 28 (group II)	28	18-68	N/A	Healthy volunteers, irradiated with simulated sunlight.	Back
Hughes, 1992	USA	RCT	24	24	18-57	41.67	Healthy volunteers, irradiated with simulated sunlight.	Back
Kaidbey, 1976	USA	RCT	9 (group I) 9 (group II)	9	21-30	N/A	Healthy volunteers, irradiated with simulated sunlight.	Back

**Figure 2.** Risk of Bias Assessment. (A) Graph, (B) Detailed Summary

Discussion

This systematic review showed different effects of topical corticosteroids on short-term and long-term outcomes. The findings underscore the impact of corticosteroids on mitigating sunburn symptoms and facilitating skin recovery, specifically in the application of topical corticosteroids twice daily for 7 days. This reduction was evidenced by lower sunburn reaction scores and overall mean sum scores, indicative of diminished erythema, pain, and inflammation.

This can be explained by the potency of corticosteroids in suppressing inflammatory pathways, elucidating their ability to mitigate the acute inflammatory response elicited by UV radiation exposure [11]. The duration of treatment emerged as a critical factor influencing its effectiveness. Prolonged treatment over 7 days yielded more therapeutic benefits compared to shorter regimens of 2 days. This prolonged exposure to corticosteroids likely allows for sustained suppression of inflammatory mediators and cytokines, therefore give more resolution of sunburn symptoms [12]. Additionally, the timing of treatment application become a pivotal aspect, with earlier introduction demonstrating superior efficacy. This temporal aspect aligns with the cascade of inflammatory events triggered by UV radiation, highlighting the importance of timely intervention to intercept and attenuate the inflammatory cascade while minimizing tissue damage. Histological analyses of skin biopsies provided valuable insights into the underlying mechanisms of corticosteroid action, they showed an improvement in epidermal thickness, basal cell morphology, and dermal inflammation in treated areas. These histological changes reflect the modulation of cellular processes implicated in the pathogenesis of sunburn, including keratinocyte proliferation, immune cell infiltration, and cytokine production [9]. Furthermore, the observed differential effects across erythema severity highlight the refinement after corticosteroid therapy, with greater benefits observed in milder cases. This study offers comprehensive insights into the efficacy and mechanisms of topical corticosteroids in acute sunburn treatment, synthesizing qualitative assessments. It's important in guiding optimal treatment strategies. However, the heterogeneity of study designs and outcomes poses limitations, affecting the generalizability and comparability of findings. The review encountered a shortage of recent studies, with most published over 20 years ago. This may impact on lack of the current evidence. Additionally, the low quality of the included studies limited the depth of information. Limited data underscores the need for rigorous assessments to address safety concerns and optimize treatment outcomes.

Table 3. Main Results from Included Studies

Author, Year	Regimen & Dose	Duration	Result
Duteil, 2002[5]	0.1% methylprednisolone aceponate milk	Twice daily for 7 days	Treated areas had significantly lower sunburn reactions than untreated areas (median[range] 17.0 [7.5-23.0] vs. 18.5 [11.5-25.5]; $p = 0.01$; respectively). Treated areas had significantly reduced overall mean sum scores by the end of treatment ($p = 0.01$).
	0.1% hydrocortisone 17-butyrate emulsion	Twice daily for 7 days	Treated areas had significantly lower sunburn reactions than untreated areas (median[range] 16.8 [8.5-21.5] vs. 18.5 [11.5-25.5]; $p = 0.05$; respectively). Treated areas had significantly reduced overall mean sum scores by the end of treatment ($p = 0.05$).
Rother, 2011[6]	0.25% hydrocortisone-21-acetate	Twice daily for 2 days	There was no significant difference in heat pain threshold between treated and untreated areas in various MEDs (MED 1: 278.0 ± 13.8 vs. 274.5 ± 16.7 ; $p > 0.1$, MED 2: 268.1 ± 17.9 vs. 268.4 ± 18.2 ; $p > 0.1$, MED 3: 265.2 ± 20.8 vs. 264.7 ± 14.4 ; $p > 0.1$). There was no significant difference in erythema between treated and untreated areas in various MEDs (MED 1: 10.4 ± 2.9 vs. 10.3 ± 2.5 ; $p > 0.1$, MED 2: 16.0 ± 2.3 vs. 16.1 ± 2.1 ; $p > 0.1$, MED 3: 17.8 ± 1.9 vs. 17.3 ± 1.9 ; $p > 0.1$). There was no significant difference in temperature between treated and untreated areas in various MEDs (MED 1: 203.0 ± 2.6 vs. 201.9 ± 3.7 ; $p > 0.1$, MED 2: 204.0 ± 2.9 vs. 204.4 ± 2.9 ; $p > 0.1$, MED 3: 204.8 ± 3.0 vs. 205.0 ± 2.4 ; $p > 0.1$).
Faurischou, 2008[7]	hydrocortisone-17-butyrate	Single	Treated areas had significantly higher sunburn improvement factor than untreated areas ($p < 0.05$) if used 6 hours after exposure. There was no significant difference in sunburn improvement factor between treated and untreated areas, if used 23 hours after exposure.
	clobetasol propionate	Single	There was no significant difference in sunburn improvement factor between treated and untreated areas, if used 6 or 23 hours after exposure.
Sukanto, 1980[8]	0.05% betamethasone dipropionate	Single	There was no significant difference in blanching scores between treated and untreated areas in various MEDs.
	0.01% hydrocortisone 17-butyrate	Single	There was no significant difference in blanching scores between treated and untreated areas in various MEDs.
Hughes, 1992[9]	0.05% betamethasone dipropionate	Single	Treated areas had significantly reduction of skin blood flow than untreated areas in 8 hours. Qualitative results from skin biopsy in treated areas (1) the epidermis resembled the control; (2) perivascular cuffing of dermal vessels was noted; and (3) extravascular neutrophils were not observed; compared to untreated areas (1) epidermal thinning (due to reduction in the thickness of the stratum spinosum because of scattered hyperchromatic shrunken 'sunburn' cells); (2) reactive changes in the basal cells (irregularity in size and shape and poorly aligned in an indistinct basement membrane); (3) infrequently present intra- and subepithelial neutrophils; and (4) a slightly edematous papillary dermis and the superficial dermal vasculature showing prominent lymphocytic cuffing.
Kaidbey, 1976[10]	0.01% betamethasone valerate	Single	There was no significant difference in mean erythema scores between treated and untreated areas in various MEDs.
	0.05% betamethasone valerate	Single	Treated areas had significantly reduction in mean erythema scores than untreated areas in MED 1, but not in MED 2 and 3.

Conclusion

This study highlights the potential benefits of topical corticosteroids in alleviating acute sunburn symptoms and aiding skin recovery. By targeting crucial inflammatory pathways and cellular mechanisms, corticosteroids offer an approach to reducing sunburn-related inflammation and facilitating tissue healing.

However, the efficacy of topical corticosteroids appears limited when used late, as a single application, or for moderate to severe sunburn (MED > 2). Therefore, optimizing treatment protocols and conducting further research into long-term effects are essential to fully realizing the therapeutic potential of corticosteroid therapy in managing acute sunburn.

Abbreviation

MeSH: Medical Subject Headings; PICOS: Population, Intervention, Comparison, Outcome, and Study Design; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analysis; RCT: Randomized Controlled Trials; RoB: Risk of Bias; UV: Ultraviolet Services Administration

Declaration

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Availability of data and materials

Data will be available by emailing andreparam2@gmail.com

Authors' contributions

All authors equally participated in conceptualization, methodology, formal analysis, project administration, writing the original draft, writing, review, editing and revised the manuscript. All authors read and approved the final manuscript.

Ethics approval and consent to participate

We conducted the research following the declaration of Helsinki. However, the systematic review needs no ethical approval.

Consent for publication

Not applicable

Competing interest

The authors declare that they have no competing interests.

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