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Efficacy of Magnesium Sulphate (MgSO_4) Dressing versus Normal Saline Dressing in the Management of Cellulitis: A Randomized Controlled Trial

MgSO_4 versus Normal Saline Dressing in Cellulitis

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ABSTRACT: Background

Cellulitis is a common acute bacterial infection involving the dermis and subcutaneous tissue. Systemic antimicrobial therapy is the cornerstone of treatment, while local measures are frequently used as adjuncts. Magnesium sulfate (MgSO_4) dressings are used in some clinical settings because of their proposed hyperosmolar effect and potential to reduce local tissue edema. However, comparative evidence regarding MgSO_4 dressing versus conventional normal saline dressing in cellulitis is limited.

Aim

To compare the efficacy of magnesium sulfate-soaked dressing with normal saline-soaked dressing as an adjunct to standard antibiotic therapy in patients with uncomplicated cellulitis.

Methods

A prospective, randomized, controlled, parallel-group study was designed at the Department of General Surgery, Saveetha Medical College and Hospital, Thandalam. A total of 200 adult patients with clinically diagnosed uncomplicated limb cellulitis were hypothetically randomized in a 1:1 ratio into two groups. Group A received MgSO_4 -soaked dressing ($n=100$), while Group B received 0.9% normal saline-soaked dressing ($n=100$), in addition to standard systemic antibiotic therapy. The primary outcome was time to clinical resolution. Secondary outcomes included pain score assessed using the Visual Analogue Scale (VAS), length of hospital stay, antibiotic escalation, progression to abscess or surgical intervention, and dressing-related adverse events.

Results

The mean age was 49.2 ± 13.1 years in the MgSO_4 group and 48.6 ± 12.8 years in the normal saline group. Baseline demographic and clinical characteristics were comparable between groups. Mean time to clinical resolution was significantly shorter in the MgSO_4

group than in the normal saline group (5.2 ± 1.5 versus 6.4 ± 1.8 days; mean difference -1.2 days; 95% CI -1.64 to -0.76 ; $p < 0.001$). The day-3 VAS pain score was significantly lower in the MgSO_4 group (3.1 ± 1.2 versus 4.0 ± 1.3 ; $p < 0.001$). Median hospital stay was also shorter in the MgSO_4 group (5 [IQR 4–6] versus 6 [IQR 5–7] days; $p = 0.002$). Antibiotic escalation occurred in 8% and 16% of patients, respectively ($p = 0.08$). Progression to abscess formation or surgical intervention occurred in 3% versus 7% ($p = 0.19$). Dressing-related adverse events occurred in 7% versus 4% of patients ($p = 0.35$).

Conclusion

In this simulated dataset, MgSO_4 dressing used as an adjunct to standard antibiotic therapy was associated with faster clinical resolution, lower day-3 pain scores, and shorter hospital stay compared with normal saline dressing. These findings are hypothesis-generating and require confirmation using prospectively collected clinical data.

1. INTRODUCTION

Cellulitis is an acute bacterial infection involving the dermis and subcutaneous tissues and is characterized clinically by erythema, warmth, edema and tenderness. It represents a common cause of presentation to medical and surgical services. The most frequently implicated organisms include streptococci and *Staphylococcus aureus*.

Systemic antibiotic therapy remains the mainstay of management. Current guidelines recommend selecting antimicrobial therapy according to disease severity and individual risk factors. Limb elevation and management of predisposing factors such as edema and underlying skin disorders are also recommended.¹ The NICE guideline similarly recommends antibiotic therapy for cellulitis and emphasizes assessment and management of underlying predisposing factors.²

In addition to systemic therapy, local wound care is commonly performed in patients with cellulitis. Normal saline is frequently used for local cleansing and dressing because it is isotonic and generally well tolerated.

Magnesium sulfate has been used as a topical dressing in various clinical settings. Its proposed therapeutic rationale is related to its hyperosmolar properties, which may promote movement of fluid from edematous tissue and potentially reduce local swelling. Reduction of tissue edema may theoretically improve local tissue conditions and contribute to resolution of inflammatory changes.

However, there is limited high-quality comparative evidence specifically evaluating MgSO_4 dressing against normal saline dressing as an adjunct in uncomplicated cellulitis. The clinical question therefore remains whether MgSO_4 provides an additional benefit over conventional saline dressing when both are used alongside appropriate antibiotic therapy.

The present study was designed to compare MgSO_4 -soaked dressing with 0.9% normal saline-soaked dressing in adult patients with uncomplicated limb cellulitis.

The study design and reporting structure were based on the CONSORT recommendations for randomized controlled trials.^{3,4}

1.1 Aim

To compare the efficacy of magnesium sulfate dressing with normal saline dressing in the management of uncomplicated cellulitis.

1.2 Objectives

Primary objective

To compare the time to clinical resolution of cellulitis between the MgSO_4 dressing group and the normal saline dressing group.

Secondary objectives

1. To compare pain scores between the two groups.
2. To compare length of hospital stay.

3. To compare the requirement for antibiotic escalation.
4. To compare progression to abscess formation or surgical intervention.
5. To compare dressing-related adverse events.

1.3 Hypothesis

Null hypothesis

There is no difference in time to clinical resolution between patients receiving MgSO_4 dressing and those receiving normal saline dressing.

Alternative hypothesis

There is a significant difference in time to clinical resolution between patients receiving MgSO_4 dressing and those receiving normal saline dressing.

2. MATERIALS AND METHODS

2.1 Study Design and Setting

This was designed as a prospective, randomized, controlled, parallel-group study in the Department of General Surgery, Saveetha Medical College and Hospital, Thandalam, Chennai, Tamil Nadu, India.

The study population consisted of adult patients presenting with clinically diagnosed uncomplicated cellulitis involving the upper or lower limb.

The protocol was structured in accordance with the study template, which specifies a prospective randomized controlled design, 1:1 allocation, and assessment of clinical resolution as the primary outcome.

2.2 Study Period

For the simulated manuscript, a hypothetical study period of **January 2025 to December 2025** was assumed.

Note: This date range is illustrative and must be replaced with the actual study period if a real study is performed.

2.3 Study Population

Adult patients aged ≥ 18 years with clinical features suggestive of uncomplicated cellulitis were considered for inclusion.

Inclusion criteria

1. Age ≥ 18 years.
2. Clinically diagnosed cellulitis of the upper or lower limb.
3. Presence of localized erythema, edema, warmth and tenderness.
4. Duration of symptoms ≤ 7 days.
5. Willingness and ability to provide informed consent.

Exclusion criteria

1. Clinical suspicion of necrotizing fasciitis.
2. Suspected compartment syndrome.
3. Abscess requiring immediate incision and drainage.
4. Diabetic foot ulcer with deep-space infection or bone involvement.
5. Immunocompromised state.
6. Known hypersensitivity to magnesium sulfate.

7. Pregnancy.
8. Peripheral vascular disease with critical limb ischemia.
9. Refusal or inability to comply with follow-up.

These criteria follow the structure of the uploaded study protocol.

2.4 Sample Size

A total sample size of 200 patients was used for the simulated study, with 100 patients allocated to each group.

The sample-size calculation in the protocol is based on comparison of two independent means:

$$n = \frac{2(Z_{\alpha/2} + Z_{\beta})^2 \sigma^2}{\Delta^2}$$

where:

- $Z_{\alpha/2} = 1.96$ for $\alpha=0.05$
- $Z_{\beta} = 0.84$ for 80% power
- σ = assumed standard deviation
- Δ = minimum clinically meaningful difference.

Using an assumed standard deviation of 3.5 days and a clinically meaningful difference of 1.5 days gives approximately 86 patients per group. Allowing for potential attrition, the sample was rounded to 100 patients per group, giving a total sample size of 200.

2.5 Randomization

Participants were hypothetically randomized in a 1:1 ratio into two groups:

- **Group A:** MgSO₄ dressing – 100 patients
- **Group B:** Normal saline dressing – 100 patients

Computer-generated block randomization was assumed. Allocation concealment was planned using sequentially numbered, opaque, sealed envelopes.

The randomization approach was selected in accordance with accepted reporting principles for randomized controlled trials.^{3,4}

2.6 Standard Treatment

All participants received standard-of-care systemic antibiotic therapy according to the clinical severity of cellulitis and institutional antibiotic policy.

The dressing solution was the only planned difference between the two intervention groups.

Current cellulitis guidelines emphasize that systemic antimicrobial treatment remains central to management and that treatment should be adapted according to severity and clinical response.^{1,2}

2.7 Intervention

Group A – MgSO₄ dressing

Sterile gauze was soaked with the study magnesium sulfate solution and applied over the affected area, covering the area of erythema and surrounding tissue.

The dressing was changed according to the study protocol until clinical resolution or discharge.

Concentration: [Specify the concentration actually used in the real study.]

Group B – Normal saline dressing

Sterile gauze soaked in 0.9% normal saline was applied to the affected area in an identical manner and with the same dressing frequency.

The uploaded protocol similarly specifies that the MgSO_4 and normal saline dressings should differ only in the soaking solution.

2.8 Outcome Measures

2.8.1 Primary outcome

The primary outcome was **time to clinical resolution**, defined as resolution of erythema, edema, local warmth and tenderness according to the predefined clinical assessment.

2.8.2 Secondary outcomes The secondary outcomes were:

- VAS pain score on day 3.
- Length of hospital stay.
- Antibiotic escalation.
- Progression to abscess formation or surgical intervention.
- Dressing-related adverse events.

The outcome framework follows the uploaded protocol.

2.9 Data Collection

At baseline, demographic and clinical information was recorded, including:

- Age
- Sex
- Diabetes mellitus
- Site of cellulitis
- Duration of symptoms
- Baseline severity score
- C-reactive protein

Patients were assessed daily for clinical improvement, pain, treatment response and adverse events.

2.10 Statistical Analysis

Continuous variables were expressed as mean $\pm$ standard deviation or median with interquartile range according to distribution. Categorical variables were expressed as frequencies and percentages.

The independent-samples t-test or Mann–Whitney U test was used for continuous variables, as appropriate. The chi-square test or Fisher's exact test was used for categorical variables.

A two-sided p-value <0.05 was considered statistically significant.

The statistical approach corresponds to the framework specified in the original study template.

3. RESULTS

3.1 Participant Flow

A total of 238 patients were hypothetically screened for eligibility.

Thirty-eight patients were excluded:

- 24 did not meet the eligibility criteria.
- 9 declined participation.
- 5 were excluded for other predefined reasons.

A total of 200 patients were randomized.

Of these:

- 100 were allocated to the MgSO₄ group.
- 100 were allocated to the normal saline group.

Three patients in the MgSO₄ group and four patients in the normal saline group were hypothetically lost to follow-up or withdrew.

Therefore, 97 patients in the MgSO₄ group and 96 patients in the normal saline group completed the planned follow-up.

3.2 Baseline Characteristics

Table 1. Baseline demographic and clinical characteristics

Characteristic	MgSO ₄ group (n=100)	Normal saline group (n=100)	p-value
Age, years, mean $\pm$ SD	49.2 $\pm$ 13.1	48.6 $\pm$ 12.8	0.74
Male, n (%)	62 (62)	60 (60)	0.77
Female, n (%)	38 (38)	40 (40)	0.77
Diabetes mellitus, n (%)	34 (34)	37 (37)	0.66
Lower-limb cellulitis, n (%)	82 (82)	80 (80)	0.70
Upper-limb cellulitis, n (%)	18 (18)	20 (20)	0.70
Symptom duration, days, median (IQR)	4 (3–6)	4 (3–6)	0.91
Baseline severity score, mean $\pm$ SD	6.8 $\pm$ 1.4	6.7 $\pm$ 1.5	0.62
CRP, mg/L, median (IQR)	58 (42–78)	60 (43–80)	0.71

There were no statistically significant differences between the two groups in terms of age, sex, diabetes status, anatomical site, symptom duration, baseline severity score or CRP.

3.3 Primary Outcome

Table 2. Primary outcome

Outcome	MgSO ₄ group	Normal saline group	p-value
Time to clinical resolution, days	5.2 $\pm$ 1.5	6.4 $\pm$ 1.8	<0.001
Mean difference	–1.2 days	—	
95% CI	–1.64 to –0.76	—	

The mean time to clinical resolution was 5.2 ± 1.5 days in the MgSO_4 group compared with 6.4 ± 1.8 days in the normal saline group.

The mean difference was -1.2 days, with a 95% confidence interval of -1.64 to -0.76 days. This difference was statistically significant ($p < 0.001$).

3.4 Secondary Outcomes

Table 3. Secondary outcomes

Outcome	MgSO_4 group (n=100)	Normal saline group (n=100)	p-value
VAS pain score on day 3, mean $\pm$ SD	3.1 ± 1.2	4.0 ± 1.3	<0.001
Hospital stay, days, median (IQR)	5 (4–6)	6 (5–7)	0.002
Antibiotic escalation, n (%)	8 (8)	16 (16)	0.08
Abscess/surgical intervention, n (%)	3 (3)	7 (7)	0.19
Dressing-related adverse events, n (%)	7 (7)	4 (4)	0.35

The MgSO_4 group had significantly lower pain scores on day 3 and a significantly shorter median duration of hospitalization.

Although antibiotic escalation and progression to abscess/surgical intervention were numerically lower in the MgSO_4 group, these differences did not reach statistical significance.

3.5 Adverse Events

Table 4. Dressing-related adverse events

Adverse event	MgSO_4 group	Normal saline group
Mild local irritation	5	2
Contact dermatitis	1	1
Maceration	1	1
Severe adverse event	0	0
Total	7 (7%)	4 (4%)

There was no statistically significant difference in the overall rate of dressing-related adverse events between the two groups ($p = 0.35$).

4. DISCUSSION

The present simulated randomized controlled trial compared MgSO_4 -soaked dressing with normal salinesoaked dressing as an adjunct to standard antibiotic therapy in patients with uncomplicated cellulitis.

The principal finding was that the MgSO_4 group demonstrated a shorter time to clinical resolution. The mean time to resolution was 5.2 days compared with 6.4 days in the normal saline group, corresponding to a simulated mean reduction of 1.2 days.

The management of cellulitis is primarily based on appropriate antimicrobial therapy. The IDSA guideline recommends systemic antibiotics for cellulitis according to clinical severity and emphasizes treatment of predisposing factors such as edema.¹ Similarly, NICE recommends antibiotic therapy and management of underlying predisposing conditions.²

The rationale for evaluating a topical MgSO_4 dressing is therefore as an **adjunct**, rather than an alternative to antimicrobial treatment.

Magnesium sulfate has hyperosmolar properties. A possible explanation for the simulated improvement is that the hyperosmolar dressing could facilitate movement of fluid from edematous tissue and reduce local swelling. However, this mechanism should be considered a biological hypothesis rather than established clinical evidence for cellulitis.

The reduction in pain score observed in the simulated MgSO_4 group is potentially clinically relevant. The day-3 VAS score was 3.1 compared with 4.0 in the normal saline group. Earlier reduction in edema and inflammatory changes could theoretically contribute to improvement in local discomfort.

The simulated hospital stay was also shorter in the MgSO_4 group. The median stay was 5 days compared with 6 days in the normal saline group. However, hospital length of stay is influenced by multiple factors, including clinical severity, response to systemic antibiotics, comorbidities and local discharge practices. Therefore, the finding requires confirmation in a real-world prospective study.

Antibiotic escalation occurred in 8% of patients receiving MgSO_4 dressing compared with 16% receiving normal saline dressing. Although this represents a numerically lower rate, the difference did not achieve statistical significance ($p=0.08$). Therefore, the simulated study does not establish that MgSO_4 dressing reduces antibiotic escalation.

Similarly, progression to abscess formation or surgical intervention occurred in 3% versus 7% of patients, respectively. This difference was not statistically significant.

Dressing-related adverse events were uncommon. Seven patients in the MgSO_4 group and four patients in the normal saline group developed a dressing-related adverse event. The difference was not statistically significant.

Importantly, a literature search identified strong evidence and guidelines regarding **standard cellulitis treatment**, but substantially less high-quality evidence specifically supporting MgSO_4 dressings for uncomplicated cellulitis. Therefore, the present simulated results should be considered hypothesisgenerating rather than confirmatory.

4.1 Comparison with Existing Evidence

Current evidence-based guidelines emphasize systemic antimicrobial therapy as the principal treatment for cellulitis.^{1,2}

The present study does not challenge this principle. Instead, it evaluates whether a locally applied dressing may provide an additional benefit.

The absence of strong comparative evidence specifically examining MgSO_4 dressing in uncomplicated cellulitis represents an important evidence gap. A properly conducted randomized controlled trial with standardized MgSO_4 concentration, standardized dressing frequency and objective clinical endpoints would help determine whether the observed simulated effect is reproducible.

4.2 Strengths

The strengths of the proposed study include:

1. Randomized parallel-group design.
2. Equal allocation between treatment groups.
3. Sample size of 200 participants.

4. Standardized assessment of clinical outcomes.
5. Assessment of both efficacy and safety.
6. Inclusion of patient-centered outcomes such as pain and hospital stay.
7. Reporting structure based on CONSORT recommendations.^{3,4}

4.3 Limitations

Several limitations should be considered.

First, the present manuscript uses simulated data and therefore does not constitute evidence of treatment efficacy.

Second, the study is designed as a single-center study, which may limit generalizability.

Third, complete blinding may be difficult because the dressing solutions may have different physical characteristics.

Fourth, patients with severe or complicated cellulitis were excluded, limiting applicability to these populations.

Fifth, the exact concentration and frequency of MgSO₄ dressing application require standardization before a real clinical trial.

Finally, the present study does not provide sufficient evidence regarding microbiological outcomes or longterm recurrence.

4.4 Clinical Implications

The simulated findings suggest that MgSO₄ dressing may warrant further clinical investigation as an adjunctive intervention for uncomplicated cellulitis.

However, it should not be considered a substitute for appropriate antibiotic therapy.

A future multicenter randomized controlled trial should use a predefined MgSO₄ concentration, standardized dressing frequency, objective resolution criteria, blinded outcome assessment where feasible, and prospective trial registration.

5. CONCLUSION

In this simulated randomized controlled trial, MgSO₄-soaked dressing used as an adjunct to standard antibiotic therapy was associated with a significantly shorter time to clinical resolution compared with normal saline dressing.

MgSO₄ dressing was also associated with lower day-3 pain scores and a shorter hospital stay. However, no statistically significant differences were demonstrated in antibiotic escalation, progression to abscess/ surgical intervention or dressing-related adverse events.

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TABLES

Table 1. Baseline demographic and clinical characteristics

Variable	MgSO ₄ (n=100)	Normal saline (n=100)	p-value
Age, years	49.2 ± 13.1	48.6 ± 12.8	0.74
Male	62 (62%)	60 (60%)	0.77
Diabetes mellitus	34 (34%)	37 (37%)	0.66
Lower-limb cellulitis	82 (82%)	80 (80%)	0.70
Symptom duration, days	4 (3–6)	4 (3–6)	0.91
Severity score	6.8 ± 1.4	6.7 ± 1.5	0.62
CRP, mg/L	58 (42–78)	60 (43–80)	0.71

Table 2. Primary outcome

Variable	MgSO ₄	Normal saline	p-value
Time to clinical resolution, days	5.2 ± 1.5	6.4 ± 1.8	<0.001
Variable	MgSO ₄	Normal saline	p-value
Mean difference	–1.2	—	
95% CI	–1.64 to –0.76	—	

Table 3. Secondary outcomes

Variable	MgSO ₄	Normal saline	p-value
Day-3 VAS	3.1 ± 1.2	4.0 ± 1.3	<0.001
Hospital stay, days	5 (4–6)	6 (5–7)	0.002
Antibiotic escalation	8 (8%)	16 (16%)	0.08
Abscess/surgery	3 (3%)	7 (7%)	0.19
Adverse events	7 (7%)	4 (4%)	0.35

Table 4. Dressing-related adverse events

Adverse event	MgSO ₄	Normal saline
Mild local irritation	5	2
Contact dermatitis	1	1
Maceration	1	1
Severe adverse event	0	0
Total	7 (7%)	4 (4%)