WHAM evidence summary: potassium permanganate (Condy's crystals)

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CLINICAL QUESTION

What is the best available evidence for potassium permanganate for treating wounds?

SUMMARY

Potassium permanganate (also known as Condy's crystals) is an antiseptic solution with astringent properties that are leveraged to reduce exudate.[1] The solution is used to manage skin conditions and a range of wounds including diabetic foot ulcers (DFUs), venous leg ulcers (VLUs), traumatic wounds and wound-related cellulitis. However, the evidence for the efficacy of potassium permanganate to treat wounds is very limited, primarily coming from low level evidence and studies at high risk of bias. *Level 1* evidence[2, 3] showed reduction in wound size for DFUs associated with using a commercially prepared 5% potassium permanganate solution, but the research was at moderate-to-high risk of bias. Research on potassium permanganate crystals/tablets prepared at a very dilute concentration was primarily *Level 4* evidence[4-9] at high risk of bias and did not provide sufficient evidence of its efficacy. Use of potassium permanganate for treating wounds should be evaluated with consideration to the risk of adverse events and to the other antimicrobial solutions that are available in the clinical and geographic context.

CLINICAL PRACTICE RECOMMENDATIONS

All recommendations should be applied with consideration to the wound, the person, the health professional and the clinical context.

There is insufficient evidence to make a recommendation on the use of potassium permanganate to promote wound healing.

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SOURCES OF EVIDENCE: SEARCH AND APPRAISAL

This summary was conducted using methods published by the Joanna Briggs Institute.[10-13] The summary is based on a systematic literature search combining search terms related to potassium permanganate, and wound care. Searches were conducted for evidence reporting use of potassium permanganate for treating human wounds published from 01 January 1980 up to 31 May 2024 in English in the following databases: Cumulative Index to Nursing and Allied Health Literature (CINAHL), Medline (Ovid), Google Scholar, Embase (Ovid), AMED, Health Internetwork Access to Research Initiative (Hinari, access via Research4Life) and Cochrane Library. Levels of evidence for intervention studies are in Table 1.

BACKGROUND

Potassium permanganate (also known as Condy's crystals) is an early antiseptic solution dating to the 1850s.[1] It has been used in skin and wound care for its antimicrobial qualities and astringent properties that reduce exudate.[1, 2, 6, 21, 22, 24] However, the antimicrobial efficacy of potassium permanganate has been questioned in the literature, and it is reported to be low and short-lived,[20, 22, 23, 25] with some bench research demonstrating no significant effect in reducing bacteria after application of 0.015% concentration solution for 15 minutes.[26]

CLINICAL EVIDENCE ON POTASSIUM PERMANGANATE FOR TREATING WOUNDS

Studies reporting clinical outcomes for potassium permanganate used in wound management are summarised in Table 2. The research included evidence on a 5% potassium permanganate solution commercially available in some countries, and on potassium permanganate tablets or crystals dissolved in water to a very dilute solution. The best available clinical evidence includes the studies below.

5% potassium permanganate commercial solution

- A small (n = 25) single-blinded RCT[2] at high risk of bias explored 5% potassium permanganate (n = 15, treatment group) for treating Wagner stage I or II DFUs compared with standard treatment that included topical super oxidised solution (Microdacyn™; n = 10, control group). Wounds in both groups were cleansed daily with potable

water and an antiseptic treatment (type not reported) and then either potassium permanganate or super oxidised solution was applied to the entire wound surface area. No rinsing was conducted after application, but excess solution was removed with gauze from deeper wounds. Wound dressings were not reported. Wounds were assessed weekly and debrided if required. At baseline, significantly more DFUs in the treatment group had signs of local infection (64% versus 20%, p = 0.03). Wound surface area was measured weekly using acetate tracings and a digital area calculator. After 3 weeks, the treatment group showed a 78% reduction in wound surface area, which was statistically significantly greater than the 38% surface area reduction observed in the control group (p < 0.009). Four DFUs in the treatment group completely healed by 21 days compared to none in the control group. The number needed to treat (NNT) with potassium permanganate to achieve 50% or greater reduction in DFU size at 21 days was 2.18 (95% confidence interval [CI]: 1.26 to 8.25)[2] (*Level 1*).

- A second small (n =30 randomised, n = 23 analysed) non-blinded RCT[3] at moderate risk of bias reported use of 5% potassium permanganate for Wagner stage I or II DFUs. In this study, participants attended their own wound care daily in a home setting. The treatment group participants (n = 12) washed the DFU with soap and water and applied the potassium permanganate solution topically to the ulcer while avoiding healthy skin (method of application and wound dressing not reported). The control group participants (n = 11) used soap and water, topical and systemic antibiotics (types not reported) and no wound dressing. There was a statistically significant (p = 0.005) reduction in the number of DFUs exhibiting signs of local wound infection in the treatment group versus the control group within the first 7 days of treatment, and no DFUs in either group were clinically infected after 21 days. The treatment group ulcers were statistically significantly smaller in length than the control group at baseline (p = 0.012), 7 days (p = 0.02), 14 days (p = 0.024) and 21 days (p = 0.006). Four DFUs in the treatment group completely healed by 21 days compared to none in the control group[3] (*Level 1*).
- A non-randomised comparative study[14] (n = 40) at moderate risk of bias explored potassium permanganate soaks for managing cellulitis associated with grazes, cuts, skin conditions, trauma and ulcers. The treatment group (n = 20) received twice daily, 15–minute 5% potassium permanganate solution-soaked wraps for 7 days and the control group (n = 20) received non-defined daily standard care. Outcomes were measured using a cellulitis observational checklist that was developed and tested for the study and reported to have high content validity and inter- and intra-reliability. The checklist included percent of erythema, pain severity, swelling and local temperature. Statistically significant (p < 0.05) improvements were shown between baseline and one week for intervention group versus control group for all outcomes on the checklist[14] (*Level 2*).

Potassium permanganate crystals/tablets

- A non-randomised comparative study[15] (n = 30) at high risk of bias explored potassium permanganate skin soaks for managing cellulitis. Participants had at least two anatomical areas affected by cellulitis and acted as their own controls. One anatomical location received twice daily 15–minute potassium permanganate-soaked wraps and the second anatomical location received twice daily 15–minute super-oxidised solution (type not reported) soaked wraps. Outcomes were measured after 7 days and included extent of reduction of erythema and other clinical signs of cellulitis. Reduction in erythema was greater in the control group versus the treatment group after 7 days (72.10% reduction versus 59.05% reduction, p = 0.045). There were no statistically significant differences between groups for other measures, including total cellulitis severity score[15] (*Level 2*).
- A case series (n = 48) at high risk of bias described the use of potassium permanganate (1:5,000) for continuous irrigation of significant, open trauma injuries in the context of gas gangrene. In these cases, effectiveness of the treatment was not clearly reported[4] (*Level 4*).
- Several case reports at high risk of bias are also available. The reports provide minimal detail about the use of potassium permanganate, but universally report positive wound outcomes. In many of the reports, multiple different treatments were used for a duration before introducing potassium permanganate to the regimen or were used concurrently. This made it difficult to evaluate the role the potassium permanganate solution may have played in achieving healing. The case reports include use of potassium permanganate to treat:

Table 1: Levels of evidence for clinical studies

Level 1 evidence	Level 2 evidence	Level 3 evidence	Level 4 evidence	Level 5 evidence
Experimental designs	**Quasi-experimental designs**	**Observational – analytic designs**	**Observational – descriptive studies**	**Expert opinion/ bench research**
1.c Randomised controlled trial (RCT)[2, 3]	2.c Quasi-experimental prospectively controlled study[14, 15]	None	4.c Case series[4, 16] 4.d Case study[5-9, 17-19]	5.a Narrative literature review[20] 5.b Opinion[1, 21-25] 5.c Bench[26]

Table 2. Summary of the primary evidence for potassium permanganate for wound management

Study	Country	Potassium permanganate treatment and comparators	Type of wounds	Outcome measures	Level of evidence
5% potassium permanganate solution					
Abdelhamed et al (2022)[14]	Egypt	• 5% potassium permanganate solution wet wrap applied for 15 minutes, twice daily for 7 days (n = 20) • Routine skin care, no details (n = 20)	Class 1 and 2 cellulitis of lower limb associated with open wounds	Reduction in erythema, pain severity, swelling and local warmth	2
Delgado-Enciso et al (2018)[2]	Mexico	• Daily potable water cleanse, antiseptic wash, 5% potassium permanganate solution left *insitu* (n = 15) • Daily potable water cleanse, antiseptic wash, super oxidised solution (Microdacyn™) left *insitu* (n = 10)	DFUs	• Reduction in wound area • Complete healing	1
Haghoost et al (2024)[3]	Iran	• Daily soap and water wash, 5% potassium permanganate solution (n = 12) • Daily soap and water wash, topical and systemic antibiotics (undefined) (n = 11)	DFUs	• Reduction in clinical signs of local infection • Reduction in ulcer length	1
Potassium permanganate crystals/tablets					
Avijgan et al (2016)[6]	Iran	Potassium permanganate rinse for 2 weeks until exudate ceased, then used alternatively (every 12 hours) with aloe vera gel for 2 weeks (n = 1)	Necrotic, dermal ulcers following trauma	• Reduction in wound exudate • Complete healing	4
Biswas et al (2011)[7]	UK	Potassium permanganate soak for 20 minutes daily together with intravenous antibiotics, topical antimicrobials, and Prontosan® gel and solution (n = 1)	Chronic VLU and varicose eczema	• Reduction in wound exudate	4
Brown et al (1993)[5]	USA	Potassium permanganate and topical silver sulfadiazine applied daily, and systemic antibiotics (n = 1)	Pyoderma gangrenosum	Complete healing	4
Frowen (2009)[8]	Wales	Potassium permanganate soak for undefined time, corticosteroid cream, topical silver sulfadiazine, anti-microbial dressing, compression bandaging; attended daily for 2 weeks (n = 1)	Chronic VLU and varicose eczema	No wound outcomes reported	4
Hu et al (2015)[4]	China	• Potassium permanganate continuous irrigation (n = 48)	Traumatic open wounds	No wound outcomes reported	4
Lara-Esqueda et al (2023)[9]	Mexico	• Potassium permanganate applied twice daily for 2 weeks, systemic antibiotics (n = 1)	Ulcer arising from contact with an insect	Reduction in wound breakdown	4
Wahab et. al. (2021)[15]	Malaysia	• Potassium permanganate wet wraps for 15 minutes twice daily for 7 days (n = 30) • Super oxidised hydrogel wet wraps for 15 minutes twice daily for 7 days (n = 30)	Class 1 and 2 cellulitis	Reduction in erythema, tenderness, oedema, ulceration, exudate and fluctuance	2

- upper limb necrotic ulcers arising from pyoderma gangrenosum in a person with diabetes mellitus, used in combination with topical silver sulfadiazine and systemic antibiotics to achieve complete healing after 4–6 weeks[5].
- traumatic, necrotic ulcers of dermal thickness, used in combination with aloe vera gel to reduce wound exudate[6].
- VLUs and venous eczema in a critically ill person with Cushing's syndrome, used in combination with Prontosan® gel and solution, antibiotics and topical corticosteroids and graduated compression bandaging to achieve eventual healing[7].
- a sloughy VLU and venous eczema in a person with early lymphoedema, used in combination with

corticosteroids, an antimicrobial dressing[8], and compression therapy of various sorts over different time periods to achieve eventual healing.

- severe ulceration from contact with a *Paederus* sp. insect that failed to respond to corticosteroid treatment, to achieve reduction in wound breakdown within 48 hours[9].

CONSIDERATIONS FOR USE

Wound clinicians should consider local policies, procedures, and licensing before implementing wound treatments.

Preparation and clinical use

- In clinical use, skin and wounds are soaked in potassium permanganate for up to 20 minutes.
- Potassium permanganate can be prepared by using crystals or tablets dissolved in lukewarm water to a very dilute solution (e.g. 1:10,0000[21, 22]). When available, one 400mg tablet is dissolved in four litres of water.[1, 21] If crystals are used, the resulting solution should be a very pale pink.
- Commercially available 5% solution potassium permanganate is available in some geographic locations.
- When practical, the wound is soaked in a bucket/basin of diluted potassium permanganate solution for 10–15 minutes[1, 7, 22]. When this is not possible, gauze can be soaked in the solution and applied to the wound, with re-soaking of the gauze every 3–4 minutes to maintain the wetness for 10–15 minutes[1].

Adverse events

- **Care is required with dilution because the solution is corrosive and can cause burns if prepared and applied inappropriately.[1,19]**
- A risk of toxicity when used on large areas of skin is reported.[2, 21, 22] Caution is recommended for people with heart or renal comorbidities due to this risk.[21].
- Skin irritation and pain on application has been reported[2, 3, 21-23]. In one study included in this summary, one participant withdrew due to intolerable pain on application of potassium permanganate to a DFU.[2]
- Several cases of severe gastric ulceration arising from accidental ingestion are reported in the literature[16-18]. In these cases, people mistook tablets or crystals for other medications. People storing potassium permanganate at home should receive education on this risk[17].
- Potassium permanganate is a dye that could stain the skin and nails brown[1, 22]; this can be somewhat minimised by reducing the soaking duration and protecting nails with paraffin or varnish[21].

CONFLICTS OF INTEREST

The author declares no conflicts of interest in accordance with International Committee of Medical Journal Editors (ICMJE) standards.

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The author received no funding for this study.

ABOUT WHAM EVIDENCE SUMMARIES

WHAM evidence summaries provide a summary of the best available evidence on specific topics and make suggestions that can be used to inform clinical practice. Evidence contained within this summary should be evaluated by appropriately trained professionals with expertise in wound prevention and management, and the evidence should be considered in the context of the individual, the professional, the clinical setting and other relevant clinical information.

WHAM evidence summaries are developed using methodology consistent with that published by Joanna Briggs Institute[10-13]. Evidence underpinning a WHAM recommendation is identified via a PICO search strategy, assigned a level of evidence and evaluated for risk of bias. All WHAM evidence summaries are peer-reviewed by an international Expert Reference Group. For more information on the methods and the WHAM Expert Reference Group, visit the website: www.WHAMwounds.com.

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