Shifting the distribution curve for healthcare resource use through topical oxygen therapy for wound healing

Abstract: The clinical and economic burden associated with hard-to-heal wounds is high and evidence suggests that it continues to increase. Healthcare resources consumed during the provision of wound care can be saved by implementing strategies and actions aimed at promoting wound healing. When these are successful, the frequency distribution curve for time to healing and for the consumption of healthcare resources should 'move to the left' and the extent to which it is 'skewed to the right' would be reduced, resulting in a reduction in the population mean for time to wound healing, and correspondingly, healthcare resources. Not only would this release healthcare resources in the short term, but, if these changes are maintained, would render savings sustainable, thereby contributing to lowering the overall burden of wounds and wound care. In this article, we present evidence that suggests that the adoption of adjunct topical haemoglobin spray can effect these desired changes in the wound healing curve and, due to the nature of the technology, it can be easily and sustainably implemented within relevant whole populations requiring wound care. The ease of adoption and impact is further illustrated by a patient case study.

Declaration of interest: PA and FE are consultants of Mölnlycke Healthcare. GB is an employee of Mölnlycke Healthcare. The remaining authors have no conflicts of interest to declare.

chronic • distribution curve • economic burden • hard-to-heal • haemoglobin spray • healthcare resource • sustainable healthcare • topical oxygen therapy • wound • wound care • wound healing

It is often the case that a relatively small number of patients consume a disproportionately large share of healthcare resources. The distribution of such healthcare resources has been extensively reviewed[1–4] and is invariably 'skewed to the right', with a population mean resource use that is much higher than the median.[1–4] Wound care is one of five examples of 'skewing to the right' highlighted by Briggs and Gray[1] using data from patients with venous leg ulcers (VLUs) receiving standard care. Many wound care publications report on a proportion of patients where wound healing happens faster than the population mean, a proportion of patients where wound healing happens in and around the population mean, and a proportion of patients where would healing happens much slower than the population mean, supporting the notion that the wound care resource utilisation curve is 'skewed to the right'.[5–7]

Lindholm and Searle[5] provided an example of a population where 24% of wounds took six months to heal, while 16% took ≥1 year. Similarly, Milne et al.,[6] quote data where between 35–39% of wounds are termed 'static' and/or 'hard-to-heal', and that these type sof wounds would be typical in most wound care populations. Guest et al.[7] reported that 30% of patients in their study failed to heal within one year, while Fife et al.[8] found that 55–70% of hard-to-heal wounds across a range of studies on best standard care failed to heal within 12 weeks.

The longer the wound healing time, the more healthcare resources tend to be consumed. A study in the UK suggested that >60% of wound care resources were consumed by wounds that were not healed in an average of one year,[9] and, by implication, more than doubling the overall cost of wound treatment.[7] Lindholm and Searle[5] identify the lack of timely wound healing as one of the main drivers of the cost of wound care. Fig 1 illustrates the relationship between wounds healed, frequency distribution of time to healing, and mean cost of healthcare resources per (unhealed) wound.

A setting with better healing outcomes, more wounds healed and faster healing, consumes relatively less of the healthcare resources associated with the provision of wound care, and will have a wound care resource utilisation curve less skewed to the right, with fewer hard-to-heal wounds remaining unhealed, and therefore consuming fewer healthcare resources. Hence, by improving outcomes at the patient level, savings can be effected at the population level, aligning to the Porter

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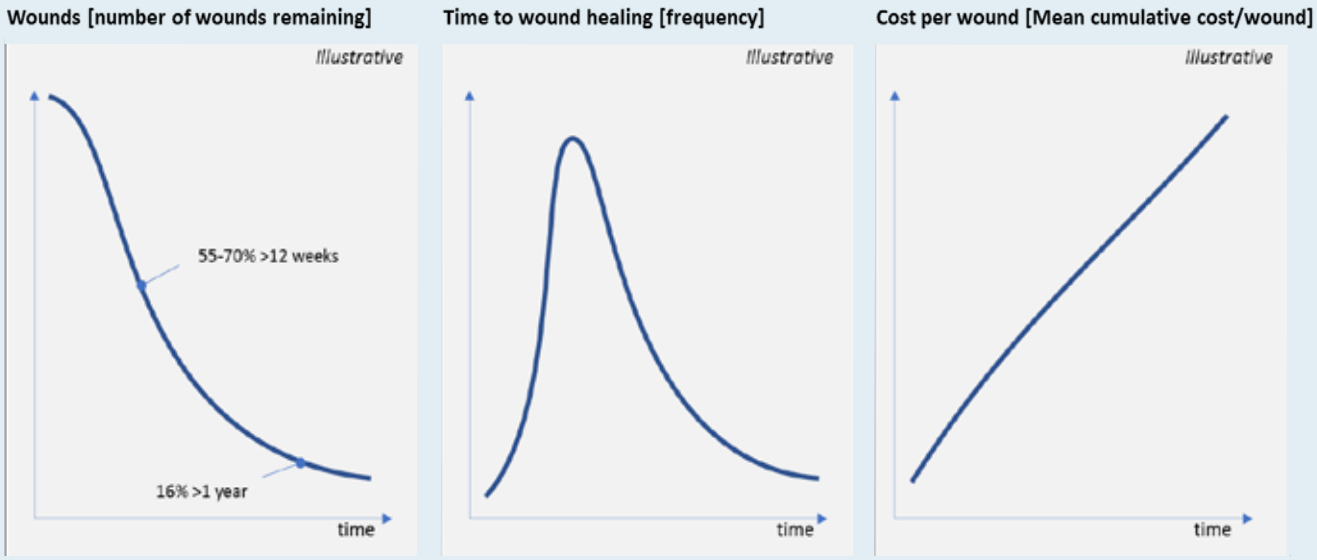
Fig 1. Illustration of relationship between wounds healed, frequency distribution of time to healing, and mean cost of healthcare resources per (unhealed) wound



and Tiesberg[10] definition of value in healthcare, as achievable by improvement of outcomes at the patient level.

Actions taken to move the wound healing curve to the left, thereby reducing the population mean healing time, and/or reduce the extent to which the wound healing curve is skewed to the right, will result in substantial savings of healthcare resources. At a provider level, such actions may include strategies aimed at improving the standard of care, enhancing patient adherence, upskilling caregivers, integrating care pathways, and adopting innovative technologies with proven effectiveness.[11] In wound care, the adoption of technologies with proven effectiveness towards better wound healing outcomes has been shown to support the achievement of the desired effects on the wound healing curve.[5]

Topical oxygen therapy, in the form of an adjunct topical haemoglobin spray, is one of the very few such technologies we have identified that is able to do so cost-effectively. Adjunct topical haemoglobin spray has been extensively studied in terms of its clinical and cost-effectiveness in supporting wound healing across a wide variety of wound types, with observations of significant reductions in average healing times and corresponding reductions in the consumption of associated healthcare resources.[12–21]

It is, therefore, the aim of this evaluation to review and consolidate available published material we have identified and assess the potential of adjunct topical haemoglobin spray (Granulox, Mölnlycke Healthcare, Sweden) to support the shifting of the wound healing curve to the left, and to reduce the extent to which the curve is skewed to the right, thereby supporting the realisation of the benefits of these changes in the time to wound healing curve (Fig 1).

Method

The following sections outline the results of each of the three steps in our evaluation, with the aim of highlighting the impact of an adjunct topical haemoglobin spray on the wound healing curve.

First, we evaluated the overall potential of topical adjunct haemoglobin spray to reduce overall healthcare resource utilisation and reduce median healing times. Secondly, we evaluated the potential of topical haemoglobin spray to improve the healing outcomes in the wounds that have the largest clinical unmet needs, the wounds that are stagnant or worsening—despite the best standard care. Finally, we evaluated, using our own case example, the practical ease of implementation and clinical outcomes.

Ethical considerations and patient consent

This case study and all referenced evaluations were conducted according to the Declaration of Helsinki. The patient authorised the use of photographs and clinical information for this publication. Permission was given by the patient to use all relevant data for educational/research purposes.

Results

Effectiveness of adjunct topical haemoglobin spray in hard-to-heal wounds

We conducted a literature review related to adjunct topical haemoglobin spray and its effect on wound healing in those wounds that were hard-to-heal, but without selecting wounds that were already long-standing wounds. This was to establish a clear view on what may be expected in terms of outcomes should adjunct topical haemoglobin spray be adopted and made available to all new patients with a

Table 1. Identified sources documenting the wound healing impact of adjunct topical haemoglobin in chronic (but not yet static) wounds

Source	Design	Main findings
20,21,23	Cohort-controlled evaluation, 50+50 hard-to-heal wounds, <40% reduction in past four weeks, mean 2.3 months wound persistency (range: 1–8 months, with patients persistent for >6 months typically referred to tertiary care). Patients in the treatment group received standard care plus haemoglobin (Hb) spray with no other adjustments, controls all received standard care	8% of wounds remaining in the Hb group versus 53% in control at six months (p<0.0001)
20,24	Cohort-controlled evaluation, 100+100 sloughy wounds, mean persistency 1.6 months (range: 0.7–18 months)	6% of wounds remaining in Hb group versus 34% in control at 6 months (p<0.0001)

hard-to-heal wound presenting for care in a typical clinical setting. Table 1 highlights publications related to two controlled evaluations identified with broad inclusion criteria for hard-to-heal wounds, with few, if any, exclusions. A controlled study, in 40 patients with a diabetic foot ulcer, evaluating topical haemoglobin spray, was identified that partly met our inclusion criteria;[22] however, this study included stagnant wounds but also excluded the worst wounds (SINBAD>2), and did not provide a subgroup analysis that would enable already long-standing wounds to be meaningfully excluded. Hence, it was not possible to establish the healing curve benefit on a new cohort of wounds from this data, although the results were highly positive.

The results in the two identified controlled evaluations in hard-to-heal wounds,[20,21,23] or wounds with slough, indicative of healing complications,[20,24] showed significantly higher healing rates in the adjunct topical haemoglobin spray groups than in the control groups, with 45% and 28% fewer wounds remaining unhealed, respectively, at the end of the follow-up period (six months in both studies). The median time to healing was also much faster, at just six weeks in the first evaluation in the adjunct topical haemoglobin spray group, versus >26 weeks (less than half of wounds closed at six months) in the control group. In the second evaluation, this was six weeks in the adjunct topical haemoglobin spray group versus 13 weeks in the control group. Both results were highly statistically significant across n=100 and n=200 patients, respectively (p<0.0001). Hence, the time to wound healing curve for the adjunct topical haemoglobin spray group would be situated to the left of the same curve for the control group in these cases. Consolidating the published curves from the two evaluations identified above is illustrated in Fig 2. The graphic also illustrates the cost impact from the adoption of the adjunct topical haemoglobin spray. It shows the cumulative cost of dressings used, initially slightly higher due to the cost of the adjunct topical haemoglobin spray, but then lower from week 10 onwards, as previously published by Elg and Bothma.[21]

Fig 2. Pooled data for wounds unhealed and implied time to wound healing frequency distribution (adapted from Hunt and Elg[22] and Hunt et al.[23]), and cumulative cost of dressings, including the cost of the topical haemoglobin spray, from Elg and Bothma[21] (hard-to-heal wound study only, data reused with permission)

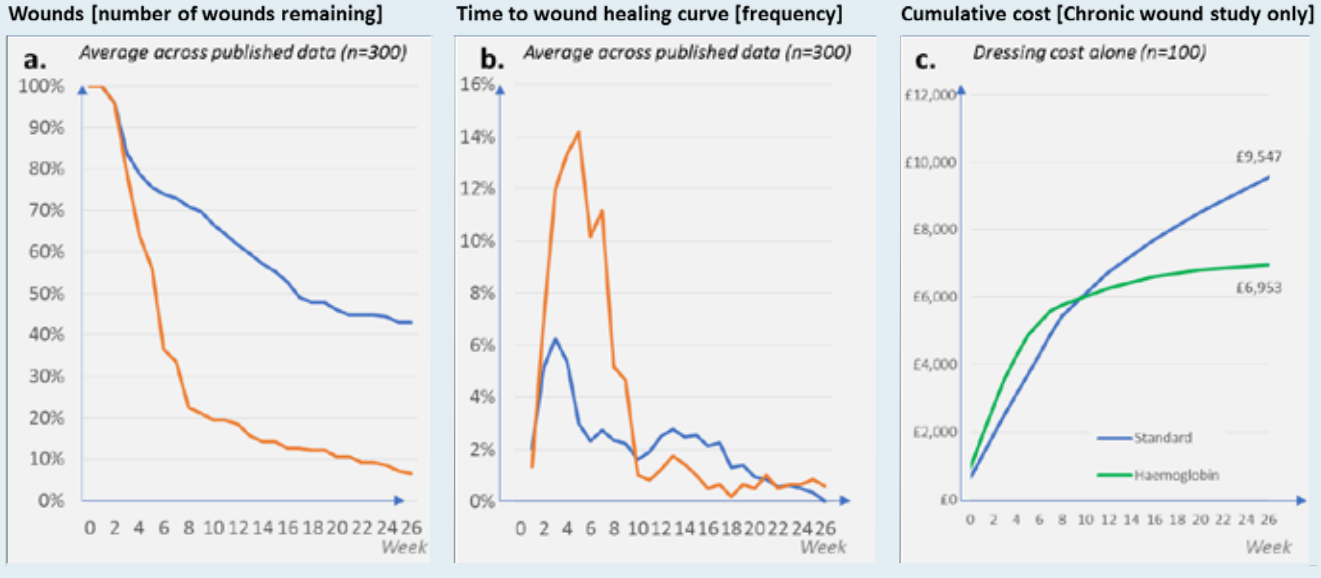


Table 2. Identified sources documenting the wound healing impact of adjunct topical haemoglobin spray in static, non-healing wounds

Source	Design	Main findings
13	RCT, 14+14, lower leg ulcers, topical Hb spray regimen versus standard care (alone), wounds persistent for at least eight months (mean unknown), followed for six months	13/14 in Hb group healed at six months, versus 1/14 in the control group (p<0.0001)
17,25	RCT1, 36+36, non-healing VLUs non-improving for two weeks and persistent on average for 24 months, randomised to standard care plus Hb spray or standard care plus dummy spray (saline); 13 weeks follow-up	53% average wound size reduction at 13 weeks in Hb group versus 22% average size increase (worsening) in controls (p<0.0001); 85% of wounds predicted closed at 12 months with Hb versus 13% with standard care alone
20,30	A cohort of 10 static, hard-to-heal ulcers of mixed aetiologies, prior persistence reported for four wounds; 9, 10, 12 months and 15 years (median: 11 months). Wounds received standard care plus adjunct Hb spray and were evaluated over 2–4 months	Eight wounds completed minimum follow-up; 1/8 wounds healed, 5/8 progressed toward healing
31	A cohort with 17 patients with hard-to-heal VLUs, static or deteriorating, persistent for at least six months, with a mean persistency of 3.4 years (41 months; range: 6–120 months), recruited from across five sites in England, patients receiving standard care plus adjunct Hb spray	14/17 patients completed the four-week evaluation, with wound size reduction achieved in all 14/14 patients, with size reduction of 16–96%. Median reduction of 68% (within 4 weeks)
32,33	A multicentre evaluation of 19 PU patients receiving standard care plus Hb spray, 18 completing. Average wound duration prior to entry to the evaluation was 11 weeks (range: 1–52 weeks), followed for four weeks, a subset continued and 11 patients were followed-up to 12 weeks treatment[28]	18/18 wounds improved over the four-week evaluation and 17/18 reduced in size. In the follow-up, 11 patients followed-up for up to three months (12 weeks). Of three static, non-healing wounds (>6 months), 3/3 (100%) completely healed (overall 9/11 healed (82%), with the remaining two reduced by 77% and 33%, respectively)
34–36	Several large case series in DFUs were identified but may also have included wounds that were not stagnant or long-term, and therefore may not be fully representative of static, non-healing, DFUs. Notably, we found three such case series in 20, 22 (11 on Hb spray) and 17 patients, respectively	In the first study, in 20 wounds, 20/20 progressed towards healing, with 5/20 wounds closed within four weeks. In the second, in the 11 patients treated with the Hb spray, 80% of wounds demonstrated a reduction in size versus 30% in a matched control cohort, with 20% of wounds in the Hb spray group healed within 12–16 weeks, and 0% in the control cohort. In the third study of 17 patients (20 wounds), of the 14 wounds that completed the evaluation, all wounds had a reduction in wound size and by 12 weeks, three wounds (20%) had healed

*Unless specified, numbers refer to Hb-treated patients; RCT—randomised controlled trial; Hb—adjunct topical haemoglobin spray; VLU—venous leg ulcer; DFUs—diabetic foot ulcers; PU—pressure ulcer

Effectiveness of adjunct topical haemoglobin spray in static, non-healing wounds

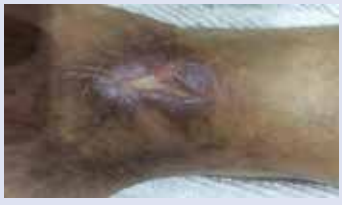
To additionally evaluate the ability of topical adjunct haemoglobin spray to facilitate healing in patients with the highest clinical unmet need, i.e., those with static or worsening wounds, we conducted a literature review of case series and clinical trials involving ≥10 patients with static, non-healing wounds treated with adjunct topical haemoglobin spray that have been published to date, including case series presented at international conferences, to investigate wound healing outcomes. Table 2 summarises the design and main findings from each identified report.

The results across each of the randomised controlled trials (RCTs) and case series in static, non-healing wounds suggested a highly positive healing response to the introduction of the adjunct topical haemoglobin spray. A positive healing response was observed in a majority of wounds in each of the studies, both in the case series and in the RCTs, with 86% more wounds closed in the first RCT, 70% more wounds predicted to close in the second, and 63–82% healed or predicted to heal in the case series in non-healing or stagnant wounds (with several wounds healing quickly once the adjunct topical haemoglobin spray was introduced across hard-to-heal wounds of different aetiologies). In the two RCTs where a statistical analysis of the probability of superior healing outcomes versus standard of care in a separate control cohort was performed, both of these studies reported highly statistically significant differences at p<0.0001[13] and p<0.0001,[17,25] respectively. Hard-to-heal wounds cause a skewing to the right of the time to wound healing curve and, hence, healing these wounds faster will reduce the extent to which such curves are skewed to the right. In addition to the controlled RCTs in static, non-healing, wounds mentioned above, we also identified several large case series in hard-to-heal wounds, and invariably showing progression towards healing across several hard-to-heal indications. Table 2 provides a summary of identified, large case series by wound type.

De novo clinical evaluation

To evaluate ease of adoption and clinical impact, we additionally conducted our own clinical evaluation, in our clinic, involving a patient with a hard-to-heal

Table 3. History of patient case

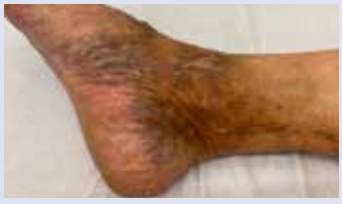
Day/date	Image	Wound characteristics	Wound care regimen
Unknown		Injury caused by abrasion on internal malleolus of the right foot	—
Day 0 (7/12/2018)		Mixed aetiology leg ulcer 10x10mm presented to care (internal malleolus right foot)	Unknown primary care regimen. Details not recorded
Day 31 (7/1/2019)		First photograph taken - on presenting to the specialty team	Unknown primary care regimen. Details not recorded
Day 41 (17/1/2019)		Referred to specialist care. Presenting to wound clinic with yellow fibrinous tissue in the wound bed, size 25x6mm, 12mm deep	Cleansing (in warm running water) Prontosan gel for 15–20 minutes; silver-containing foam dressing
Day 43		Reduction of fibrinous tissue; dry wound bed; signs of infection (pain, redness, swelling, stagnation, high perilesional skin temperature and odour)	Cleansing (warm running water); Prontosan gel 15–20 minutes; saline wash after gel; silver-containing foam dressing
Day 45		Presence of fibrinous tissue (no change); dry wound bed; signs of infection (pain, redness, swelling, stagnation, high perilesional skin temperature and odour)	As above
Day 49		No change	Cleansing in warm running water; Cadexomer iodine powder; foam secondary dressing
Day 52		Presence fibrinous tissue (no change); moderate exudate; signs of infection (pain, redness, swelling, stagnation, high perilesional skin temperature and odour)	As above
Day 54		No change	Debridement (scalpel and curette); antimicrobial DACC dressing; foam dressing (secondary)
Day 55		Fibrinous tissue absent; decreased wound area; more superficial wound	Clean with warm saline; antimicrobial DACC dressing; foam secondary dressing
Day 56		Granulation tissue; decreased wound area; more superficial wound	As above
Day 57		Decreased wound area and depth	As above
Day 58		Decreased wound area and depth	As above
Day 60		Decreased wound area and depth	As above
Day 62		Decreased wound area and depth	As above
Day 66		Stagnated no change; dry wound bed; signs of infection	Clean with warm saline; silver-containing alginate dressing; foam secondary dressing
Day 71		No change	As above
Day 74		No change	As above
Day 76		Increased wound area, stagnation	As above

DACC— dialkylcarbamoylchloride

Table 3. History of patient case (continued)

Day/date	Image	Wound characteristics	Wound care regimen
Day 78		Stagnated no change; low exudation	Cleansing with warm saline; foam dressing
Day 82		No wound size change; moderate exudate	As above
Day 85		No change	As above
Day 91		No change	As above
Day 94		No change	As above
Day 97		No change	As above
Day 100		No change	As above
Day 104		No change	As above
Day 106		Size reduction, but very slow	Cadexomer iodine powder; foam dressing (secondary)
Day 109		Size reduction, but very slow	Cadexomer iodine powder; foam dressing (secondary)
Day 114		Size reduction, but very slow	Cadexomer iodine powder; foam dressing (secondary)
Day 118		Stagnation, increased exudate, peri-wound maceration (from exudate)	Cadexomer iodine powder; Hydrofiber dressing; foam dressing (secondary)
Day 119		No change	Cleansing (warm saline); Cadexomer iodine powder; Hydrofiber dressing; foam dressing (secondary); compression
Day 121		No change	As above
Day 125		No change	As above
Day 128		No change	As above
Day 131		No change	As above
Day 134		Increased wound area, granulation tissue - no slough	Hydrogel, Hydrofiber dressing; gauze, compression
Day 136		Increased wound area, granulation tissue - no slough	As above
Day 138		Increased wound area, granulation tissue - no slough	As above
Day 142		Exudate, periwound maceration	Cadexomer iodine powder; Hydrofiber dressing (primary); foam dressing (secondary)
Day 143/1 (29/4/2019)		No change	Haemoglobin spray; Hydrofiber dressing (primary); foam dressing (secondary); compression
Day 145/3		Decreased wound area. Exudate reduction, moist not wet, wound edge contraction	As above
Day 146/4		Size measured 15x15mm; (2.3cm^2, 34% size reduction)	As above
Day 148/6		Decreased wound area; exudate reduction; dry wound border; granulation tissue	Honey on wound edges; haemoglobin spray; Hydrofiber dressing; foam dressing (secondary); compression

Table 3. History of patient case (continued)

Day/date	Image	Wound characteristics	Wound care regimen
Day 151/9		Decreased wound area; exudate reduction; granulation tissue	Haemoglobin spray; Hydrofiber dressing; foam dressing (secondary); compressive therapy
Day 154/12		Decreased wound area; exudate reduction; dry borders; granulation tissue; size measured 4x6mm (0.24cm^2, 93% reduction versus baseline)	Honey on wound edges; haemoglobin spray; Hydrofiber dressing; foam dressing (secondary); compressive therapy
Day 159/17		Decreased wound area; exudate reduction	Haemoglobin spray; Hydrofiber dressing; foam dressing (secondary); compressive therapy
Day 161/19		Decreased wound area; exudate reduction	As above
Day 162/20		Decreased wound area; exudate reduction	As above
Day 165/23		Decreased wound area; exudate reduction	As above
Day 168/26		Decreased wound area; exudate reduction	Haemoglobin spray; foam dressing (secondary); compressive therapy
Day 172/30		Decreased wound area; exudate reduction	Foam dressing/compressive therapy (socks)
Day 176/34 (1/6/2019)		Wound closure	Moisturiser; compressive therapy (socks)
Day 446/304 (26/2/2020)		Follow-up, no lesion	Compressive therapy (socks)

wound of 20 weeks' duration and which was stagnant, despite 14 weeks of specialist care in our wound care facility. This involved multiple changes of regimen that included hydrogel treatment, silver dressings, alginate silver dressings and cadexomer iodine, without clinically meaningful improvements. Following the initiation of the adjunct topical haemoglobin spray, the wound showed an immediate response, with a reduction in wound area at the first follow-up visit on day 3. By day 6 there was also a marked reduction in wound exudate and the appearance of granulation tissue in the wound, with the wound progressing to healing without any complications. Wound closure was achieved 34 days after starting the adjunct topical haemoglobin spray. Full case details are outlined below and in Table 3.

Case study

A 69-year-old female patient presented with a non-healing wound that had been caused by a

Table 4. The impact of adjunct topical haemoglobin spray on wound healing time and number of dressings consumed. Data from Elg and Bothma[21]

	Adjunct topical haemoglobin	Control	Difference, %
Average time to complete wound closure, weeks	6.6	11.4	42
Wound dressings used (including any use after complete wound closure), n	2575	6520	60

superficial abrasion of the skin on the internal malleolus of the right foot. Upon visiting our clinic, she was diagnosed with a leg ulcer (10×10mm in size) with arterial and venous pathology.

The patient was not able to determine when the initial abrasion occurred. The patient had a history of an exposed fracture on the right tibiotarsal joint when she was 30 years old and which was difficult to heal. At age 35 years she had varicose vein surgery, also with difficulties in healing, and with a need to resuture the vein stripping incision wound. She additionally had a history of depression, hypertension and dyslipidaemia, with a drug regimen of amlodipine, candesartan cilexetil, sertraline, pentoxifylline, atorvastatin, lercanidipine, clopidogrel and micronised flavonoids (Daflon, Laboratoires Servier, France).

After six weeks of primary care treatment, in a community health unit, the patient was referred to our wound care specialist team, comprising a physician and a wound specialist nurse, and a revised wound treatment regimen was introduced. Initially, the wound stabilised and even showed signs of improving. However, the wound started to deteriorate, despite multiple adjustments to therapy. However, following the introduction of the adjunct topical haemoglobin spray, the wound healed within 34 days. Table 3 details the evolution of the wound.

The addition of the adjunct topical haemoglobin spray to the treatment regimen did not require any complex training, did not require any other changes to the treatment regimen and did not negatively impact the patient experience. The findings on ease of adoption were in line with previously adopted studies reporting ease of use and high patient satisfaction.

Discussion

We have discussed the benefits of moving the wound healing curve to the left and, similarly, the benefits of reducing the extent to which wound healing resources are skewed toward wounds that take a disproportionately long time to heal; we call it 'the wound healing curve being skewed to the right'. When a shift to the left is achieved, through reducing the median and the mean time to wound healing, healthcare resources required for the provision of wound care should also be reduced.

We have presented results that support the potential of adjunct topical haemoglobin spray to effect such desired changes in the wound healing curve, both in terms of affecting change across all hard-to-heal wounds presenting to care, as well as those wounds with the largest clinical unmet needs. We have also discussed a specific case study, highlighting the impact of the adjunct topical haemoglobin spray on the healing of a wound that showed sustained stagnation and deterioration, while also noting the ease of adoption of the adjunct haemoglobin spray.

Often, achieving improvements in the way care is provided is complex and requires significant changes in how people act within the care delivery chain, the processes and procedures that support the delivery of care, and the use of associated technologies. However, adoption of adjunct topical haemoglobin spray appears to be remarkably simple. This is also supported when considering criteria widely used in implementation science. These criteria are:

- Relative advantage—Is there evidence of a gained benefit?
- Compatibility—Is it easy to integrate into daily actions?
- Complexity—Is it easy to learn how to use?
- Trialability—Can it be experimented with?
- Observability—Can the innovation (and benefits) be clearly identified within a treatment regimen?[26]

As an adjunct, this topical haemoglobin spray can be adopted into practice without any additional change to current wound care regimens and protocols with a very fast learning curve. This renders the spray highly compatible due to its relative simplicity to use. Hunt and Elg[23,24,27] reported significantly better wound healing outcomes, with the only significant difference between the treatment and control arms being the addition of the topical haemoglobin spray. As a standalone technology, the adjunct topical haemoglobin spray is highly trialable and observable, as outlined above. Therefore, within the context of implementation science, the sustained uptake of adjunct topical haemoglobin spray should be achievable, increasing the probability of obtaining population-level benefits.

Guidelines on the use of adjunct topical haemoglobin spray have already been developed in the UK for hard-to-heal wounds,[28] and for diabetic foot ulcers in Scotland, specifically.[29] Both of these guidelines state that all wounds predicted not to have substantially healed within 2–4 weeks should be offered topical haemoglobin spray as adjunct therapy. It is important to note the distinction between 'not healed within 2–4 weeks', and 'predicted not to heal within 2–4 weeks'—if a wound is presenting with healing complications or with risk factors associated with delayed healing, such as advanced age, vascular insufficiency, or uncontrolled diabetes, there is no need to wait for 2–4 weeks and risk further complications, and instead the adjunct topical haemoglobin spray should be initiated immediately.

The reduction in the population mean shown in Table 4 aims to emphasise the benefit achievable from the adoption of adjunct topical haemoglobin spray in terms of attaining a shift in the wound healing curve to the left, resulting in a noteworthy decrease in the overall consumption of wound care dressings used. Additional evidence has been published suggesting that these benefits far outweigh the additional cost of the adjunct topical haemoglobin spray, with the health economic assessment conducted in Scotland suggesting its adoption is more effective and less costly than standard care alone.[20] Elg and Bothma[21] estimated that overall cost savings from consumables alone would be achieved from week six of adoption onwards, with a break-even within 10.2 weeks from adoption.

Limitations

This research did not specifically attempt to model the impact on the healing curve in each specific wound sub-type and patient risk category, but focused on the impact in clinics seeing a variety of hard-to-heal wounds. DFUs are often seen in specialist podiatry clinics and it is likely that a similar benefit may be achieved in podiatry clinics treating DFUs and, therefore, a similar exercise to evaluate the impact on the healing curve for DFUs may be appropriate.

Conclusion

Healthcare resources consumed during the provision of wound care can be saved by implementing strategies and actions aimed at promoting wound healing. When these are successful, the wound healing curve will move to the left and the extent to which it is skewed to the right will be reduced, resulting in a reduction in the population mean for time to wound healing.

The evidence we have summarised suggests that the adoption of adjunct topical haemoglobin spray can effect these desired changes in the wound healing curve and, due to the nature of the technology, it can be easily and sustainably implemented within relevant whole populations seeking wound care, and to all patients presenting with a wound that is at risk of not healing within 2–4 weeks, in line with recommendations published elsewhere. **JWC**

Reflective questions

- In which patients should adjunct topical haemoglobin spray be offered?
- What are the benefits of offering advanced wound care at an early stage to patients at high risk of wound complication and stagnation, and not waiting until the wound has reached this stage?
- With resources released due to more wounds healing more quickly, how can this released resource be used to improve quality of care overall?
- What easy to implement changes can be made to shift the healing curve to the left for hard to heal wounds?

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