Case series on the administration of Topical Oxygen Therapy for wound care management in Malaysia



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This is a series of three case reports on the use of topical haemoglobin spray as topical oxygen therapy (TOT) for wound care management in elderly patients presenting with chronic wounds, and underlying diabetes mellitus. The administration of TOT in the form of topical haemoglobin spray accelerated the wound healing for all three patients in this series of case reports, suggesting that TOT may be a promising treatment option for chronic and non-healing wounds.

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Physiologically, oxygen is required for normal cellular processes in the human body (Stang et al, 2018). Low oxygen levels or mild hypoxia is a common biological response following an injury, with up to 97% of chronic and non-healing wounds shown to have low oxygen levels (Stang et al, 2018). Chronic and non-healing wounds commonly demonstrate low partial pressure of oxygen (PaO^2); usually below the critical hypoxic level (Gottrup et al, 2017). An oxygen-rich environment at the wound site is vital for wound healing as it increases cellular resources and promotes wound healing (Gottrup et al, 2017; Kaufman et al, 2018). Furthermore, oxygen depletion in the wound may lead to colonization by anaerobic bacteria. The increased burden of both aerobic and anaerobic bacterial load can in turn become an infection of varying severity, leading to increased risk of morbidity and mortality (Malone et al, 2016).

Classic treatment options for oxygen deprived wounds are surgical and endovascular re-vascularization procedures (Gordillo et al, 2009). Other adjunctive modalities for chronic wounds with oxygen deprivation are hyperbaric oxygen therapy (HBOT) and topical oxygen therapy (TOT) (Gordillo et al, 2009). TOT has been proven to reduce wound size and accelerate the healing process of chronic wounds. Due to the limited availability and higher cost associated with HBOT, most clinicians may find TOT as a viable and more cost-effective alternative of oxygen therapy.

Case 1: Grade III pressure injury with underlying peripheral vascular disease

Mr A was a 77-year-old male who presented with a one-month-old pressure injury wound on the left heel. The wound was treated initially with normal saline daily dressing for 2 months. However, there was no improvement. He had underlying diabetes mellitus, hepatitis C, Parkinson's disease, hypertension, and ischemic heart disease. He was on oral medication for his Type-II diabetes mellitus and also on medication for his Parkinson's disease. The patient was attached to a community-based nursing home and in terms of his premorbid functioning, he was semi-dependent for activities of daily living (ADL).

Physical examination of the lower limb revealed a palpable pulse which was weaker compared to the contralateral side. The patient also described the 'gloves and stocking' sensation at his lower limb, which was indicative of peripheral neuropathy. His ankle-brachial pressure index (ABPI) was 0.8.

The wound was located at the lateral aspect of the left heel and measured 4×3 cm, with a depth of 2 cm *[Figure 1]*. The wound comprised of more

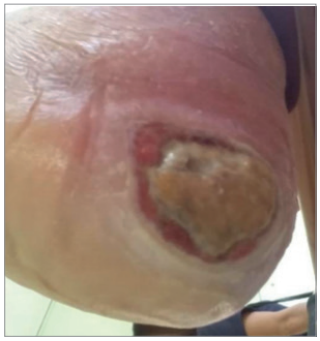

Figure 1. The wound during initial presentation

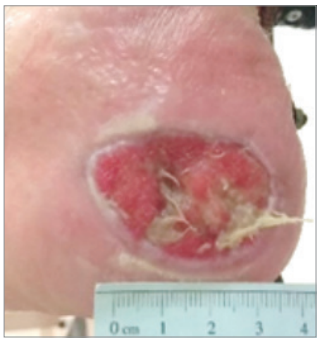

Figure 2a. The wound after 2 weeks of treatment with topical haemoglobin spray

Figure 2b. The wound healed well after 2 months of treatment with topical haemoglobin spray

than 75% of wet sloughy tissue and less than 25% of granulation tissue. The wound was also inflamed with signs of erythema. Additionally, the wound was moist and was producing a moderate to heavy amount of exudate. There were no signs of epithelial advancement but the periwound skin was macerated.

Due to the nature of his wound, and the fact that he was dependent on nursing care, positioning became a crucial aspect of the treatment plan for Mr A. As an additional measure to aid his recovery process, he was prescribed additional supplementation of protein and vitamins. Furthermore, the management of his underlying medical conditions were optimized.

Owing to his multiple comorbidities, revascularization was not feasible. HBOT was an inconvenient option due to the travel distance and support needed as the patient was bound to a nursing home. In this instance, topical haemoglobin spray was the ideal treatment of choice for the patient. The infection at the wound site was managed with bedside mechanical debridement, local and systemic antimicrobial treatment, and pressure relief. In view of there was only presence of signs and symptoms of local infection, no antibiotics was initiated. After an estimated 2 months of modern wound care with topical haemoglobin spray, his wound healed *[Figure 2a, 2b]*.

Case 2: Grade III sacral pressure injury precipitated by minor trauma

Ms B was an 80-year-old female who presented with a 3-week-old wound over the gluteal area *[Figure 3]*. She has living in a nursing home and had underlying dementia and diabetes mellitus. Standard of care for pressure injury had been initiated. Yet, the wounds had not been improving. Subsequently, standard care and topical haemoglobin spray were initiated as an adjunctive management. Her wound showed signs of healing after 1 month of treatment with standard care and TOT *[Figure 4]*.

Case 3: Post-below-knee amputation stump with wound breakdown

Mr X was a 70-year-old male who presented with necrotising fasciitis of the left lower limb, which had been surgically treated with below-knee amputation. He had underlying diabetes mellitus with peripheral vascular disease. Post-amputation, his wound was complicated with postoperative wound breakdown and required secondary healing *[Figure 5]*.

Due to peripheral vascular disease, the wound had not healed 3 months post the last

Figure 3. The wound during initial presentation

Figure 4. The wound healed well after 1 month of treatment with topical haemoglobin spray

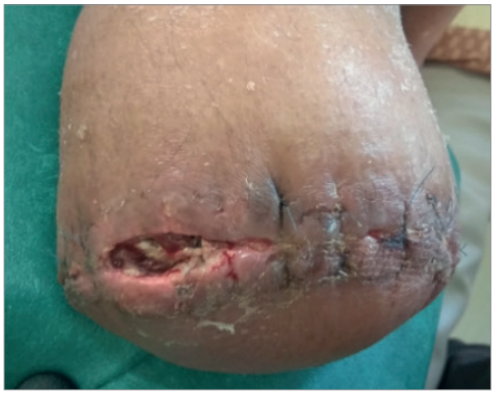

Figure 5. The wound during initial presentation

Figure 6. The wound healed after 2 months of treatment with topical haemoglobin spray

surgical debridement despite standard of care in wound management. Treatment options of vascular surgical interventions and systemic hyperbaric oxygen were offered to patient yet not agreed by patients. Due to the logistics and access issues, the patient was unable to attend to hyperbaric oxygen therapy, the patient was started on topical haemoglobin spray treatment. Eventually, his wound healed after 2 months of treatment *[Figure 6]*.

Discussion

Complex and chronic wounds which are slow to heal or have complications such as recurrent infection and requires multiple wound debridement, severely impact the patients' quality of life and restrict their routine daily function (Elg et al, 2018). Wound healing is also influenced and complicated by various factors and comorbidities such as, diabetes mellitus, immobility (primary cause of pressure ulcers), and peripheral vascular diseases (Rao et al, 2016). The primary causes of chronic wounds should be identified thus to manage accordingly. Complications impact wound healing by causing blood vessels to occlusion and stenosis, thus leading to low or no supply of oxygen to the wound site (Rao et al, 2016). Low levels of oxygen at the wound site is the primary risk factor of slow wound healing and is a vital predictor of clinical outcomes (Elg et al, 2018). Thus, the delivery of the oxygen via the TOT spray has increased the local oxygen availability with limited blood supply from the peripheral arterial system. This will ensure optimal levels of oxygen to the tissues at the wound site have been shown to accelerate wound healing (Rao et al, 2016). The role of oxygen in wound healing are as follows (Kaufman et al, 2018):

- Angiogenesis and revascularization
- Cell metabolism and energy production
- Antibacterial activities
- Promotes growth factor signalling transduction
- Collagen synthesis
- Cell proliferation and reepithelialization.

Moist wound healing has been introduced and reinforced as a standard of care in local wound care management. Treatment of wounds in a moist or wet environment have been shown to be advantageous in terms of promoting the reepithelialization rate and reducing scar formation; henceforth resulting in improved healing outcome of the wound, compared to treatment in a dry environment (Junker et al, 2013). Topical haemoglobin spray is a TOT that facilitates moist wound healing. Topical haemoglobin spray is an aqueous solution containing purified haemoglobin as the oxygen carrier. When applied to the wound, the haemoglobin in the spray acts as an oxygen transporter, facilitating the diffusion of oxygen to the wound bed (Dissemond et al, 2015).

Clinical studies have shown that TOT is efficacious in accelerating the healing process and markedly healed difficult-to-heal wounds which did not demonstrate improvement even after 4 weeks of standard treatment (Arenberger et al, 2011; Arebergerova et al, 2013; Hunt, 2016). Particularly, studies have shown that the administration of topical haemoglobin spray as an adjunct to standard care in the management of chronic non-healing wounds, are substantially beneficial to promote and accelerate wound healing (Elg et al, 2018). TOT is proven to provide wounds with complementary oxygen and thus promote wound healing particularly in hypoxic wounds with suboptimal wound improvement.

Conclusion

TOT in the form of topical haemoglobin spray is a treatment modality that has been proven to be effective in the treatment of wounds, especially in oxygen-deprived chronic and non-healing wounds. However, the underlying aetiology must be established and standard of care given before the initiation of TOT treatment. WAS

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