

Hyperbaric Oxygen for Enhancement of Healing in Selected Problem Wounds

A referral guide for emergency and referring physicians in Canada.

Condition: **Enhancement of Healing in Selected Problem Wounds** Open-access studies: **150**

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For referring and emergency physicians in Canada. Enhancement of healing in selected problem wounds is one of the 14 conditions Health Canada recognises for hyperbaric oxygen therapy (HBOT), and it is among the most common non-emergency hyperbaric indications treated at Canadian hospital-based programmes, covered by provincial health insurance. This is an elective outpatient course, not an emergency referral: the candidate is typically a patient with a diabetic foot ulcer or other complex chronic wound that has failed to progress despite weeks of appropriate standard care. This guide summarises when to refer, how to assess the patient before referral, what the evidence supports, the Canadian referral pathway, and contraindications. It closes with the complete list of open-access research published since 2020, each linked to its free full text.

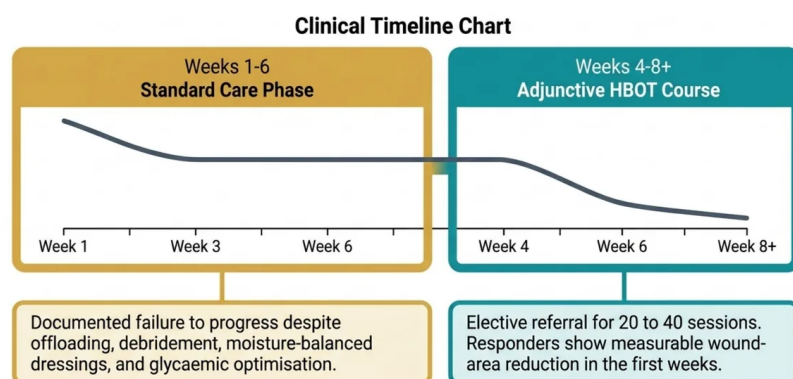
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When to refer

Consider referral for elective hyperbaric assessment when a patient has a chronic wound that has failed to progress through the normal healing process despite four to six weeks of appropriate standard care, and that wound falls into a pattern with a recognised hypoxic component. The strongest candidates are:

Refer when appropriate standard care stalls at four to six weeks



FIGURE

When to refer: consider elective hyperbaric assessment once a chronic wound has failed to progress despite four to six weeks of appropriate standard care, including offloading, debridement, moisture-balanced dressings, and glycaemic optimisation. A typical adjunctive course runs 20 to 40 sessions, and responders generally show measurable wound-area reduction within the first weeks of treatment.

- **Diabetic foot ulcers, particularly deeper Wagner grade 3 or higher lesions** (deep ulcer with abscess, osteomyelitis, or extensive soft-tissue involvement) that persist despite optimised diabetes control, offloading, debridement, and infection management. Diabetic foot ulcers affect roughly 15 percent of people with diabetes over a lifetime, and the deeper grades carry the clearest evidence signal for adjunctive HBOT.
- **Other complex chronic wounds with documented tissue hypoxia**, including venous stasis ulcers, arterial insufficiency ulcers, and chronic post-surgical or post-traumatic wounds that have not responded to comprehensive wound care.

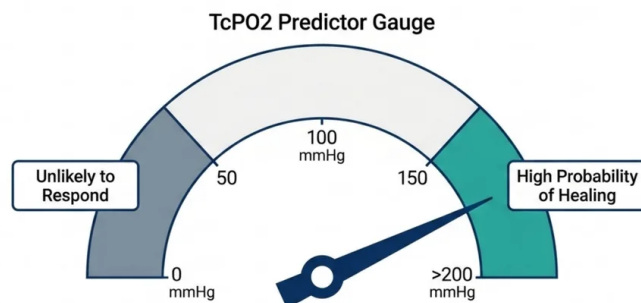
The shared physiological feature that defines a "problem wound" for hyperbaric purposes is local tissue hypoxia, so referral is most appropriate once the wound has demonstrably stalled and reversible factors (offloading, revascularisation candidacy, glycaemic control, infection) have been addressed. HBOT is considered when the wound is hypoxic and not responding, not as a first-line measure.

Assessing the patient before referral

Before or alongside referral, the referring clinician should:

In-chamber transcutaneous oximetry sets realistic clinical expectations

Regional programmes conduct a chamber-side evaluation before confirming a course.
A clear baseline of prior wound care helps contextualise the TcPO₂ response.



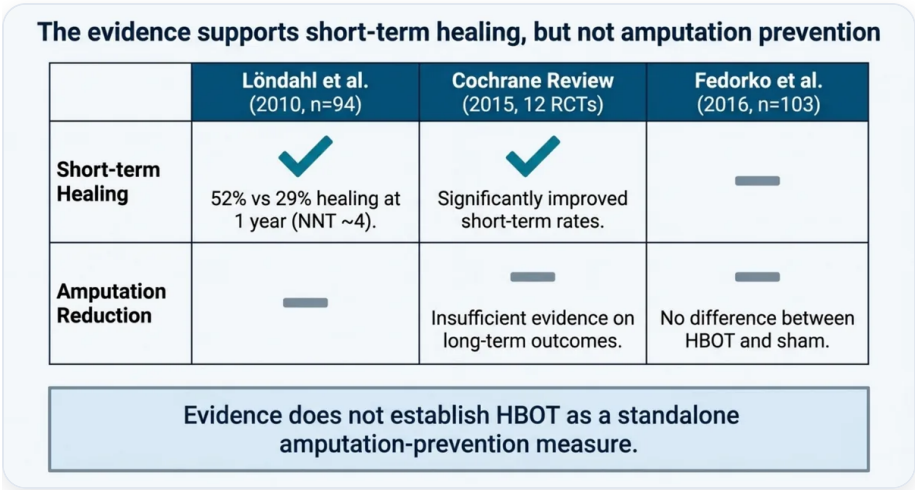
FIGURE

The pre-referral assessment in sequence. Confirm the wound has genuinely stalled despite four to six weeks of optimised standard care, then assess revascularisation candidacy, because a wound failing primarily from correctable large-vessel disease should have inflow restored first and hyperbaric oxygen does not substitute for it. Where tissue hypoxia is documented or the lesion is Wagner grade 3 or higher, refer electively and attach the standard-care history to expedite the chamber-side evaluation.

- **Confirm the wound has failed standard care.** Document four to six weeks of appropriate management: debridement, offloading, moisture-balanced dressings, infection control, and glycaemic optimisation in diabetic patients.
- **Assess perfusion and revascularisation candidacy.** A wound that is failing primarily because of correctable large-vessel arterial disease should be considered for revascularisation first; HBOT does not substitute for restoring inflow.
- **Characterise the wound and its depth.** Record size, depth, Wagner grade where applicable, and the presence of exposed bone, osteomyelitis, or deep infection.
- **Note diabetes status and control.** Recent HbA_{1c} and any peripheral neuropathy or peripheral arterial disease are relevant to both prognosis and the offloading plan that must continue during the course.
- **Provide the wound-care history.** Treatments already tried, duration of non-healing, prior amputations, and current dressing and offloading regimen. The hyperbaric programme uses in-chamber transcutaneous oximetry to help judge likely response, so a clear baseline is useful.

What the evidence supports

For diabetic foot ulcers, the reference randomised evidence is **Löndahl et al. (Diabetes Care 2010, n=94)**, which reported 52 percent complete healing in the HBOT arm versus 29 percent with placebo at one year, a number-needed-to-treat of approximately 4. This trial is among the most-cited positive RCTs for adjunctive hyperbaric oxygen in chronic diabetic wounds and informs much of Canadian practice.



FIGURE

What the evidence supports. The reference randomised trial (Loendahl 2010, n=94) reported 52 percent complete healing with hyperbaric oxygen versus 29 percent with placebo at one year, a number-needed-to-treat of about four. The 2015 Cochrane review found significantly improved short-term healing but insufficient evidence on long-term outcomes, and the Canadian Fedorko 2016 trial (n=103) found no difference from sham for amputation. Taken together the evidence supports accelerated short-term healing of selected diabetic foot ulcers but does not establish hyperbaric oxygen as an amputation-prevention measure, and it does not replace good wound care.

The systematic-review picture is consistent on short-term healing but more cautious on hard endpoints. The **Cochrane review by Kranke et al. (2015, 12 RCTs, 577 participants)** concluded that HBOT significantly improves short-term healing rates for diabetic foot ulcers, while finding insufficient evidence on long-term outcomes or amputation reduction. The Canadian **Fedorko et al. RCT (Diabetes Care 2016, n=103)** is an important counterpoint: it did not show a difference between HBOT and sham treatment in the indications for amputation. Taken together, the evidence supports accelerated short-term healing of selected diabetic foot ulcers but is mixed and does not establish HBOT as an amputation-prevention measure, and it does not replace good wound care.

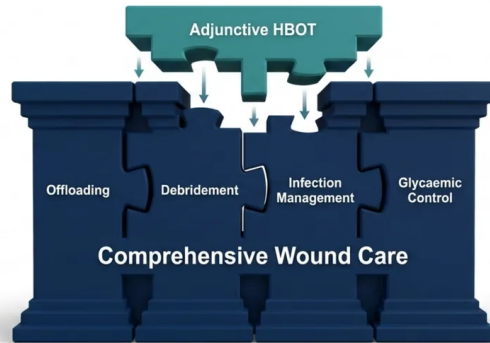
The mechanistic rationale is well established. Hyperbaric oxygen is associated with stimulation of angiogenesis, restoration of neutrophil oxidative-burst activity (the oxygen-dependent mechanism by which neutrophils kill bacteria in infected tissue), enhanced fibroblast proliferation and collagen cross-linking, and improved activity of certain oxygen-dependent antibiotics. These effects address the local tissue hypoxia that defines a problem wound. Read more on the linked [problem-wounds condition page](#).

◆ Clinical translation

Refer the right wound at the right time. The evidence signal is strongest for deeper diabetic foot ulcers that have stalled despite genuine optimisation of standard care, and weakest when a wound has not yet had an adequate trial of offloading, debridement, infection control, and revascularisation where indicated. HBOT is an adjunct to, not a replacement for, comprehensive wound care: the patient must continue offloading, dressings, debridement, and infection management throughout the hyperbaric course. A typical course runs 20 to 40 sessions at 2.0 to 2.4 ATA, 90 to 120 minutes each, five days per week, over roughly four to eight weeks, and responders generally begin to show measurable wound-area reduction within the first weeks of treatment. In-chamber transcutaneous oximetry helps identify likely responders: TcPO2 rising above 200 mmHg in the chamber is associated with a high probability of healing, while a failure to rise above 50 mmHg suggests the wound is unlikely to respond. Setting that expectation with the patient before referral helps frame the course realistically.

Hyperbaric oxygen is an adjunct to, not a replacement for, standard care

Patients must continue their offloading plan, daily dressings, surgical debridement, and infection control throughout the entire hyperbaric course.



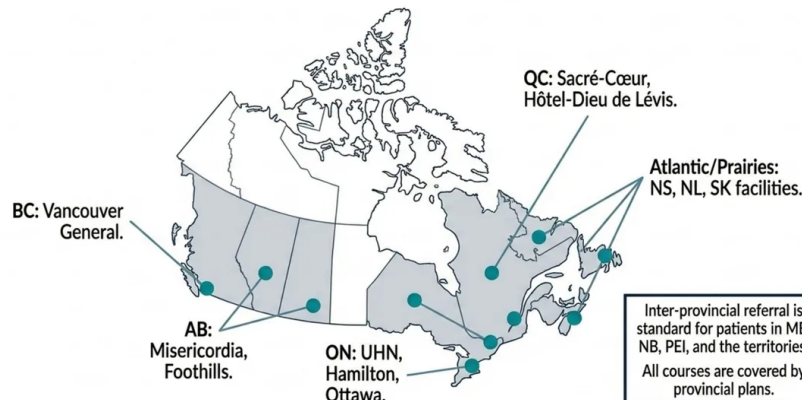
FIGURE

Clinical translation: hyperbaric oxygen is an adjunct to, not a replacement for, comprehensive wound care. Patients must continue offloading, dressings, surgical debridement, infection management, and glycaemic control throughout the entire hyperbaric course. Hyperbaric oxygen supplements these measures and never substitutes for them, or for revascularisation where it is indicated.

The Canadian referral pathway

Enhancement of healing in problem wounds is an elective outpatient indication delivered at 11 Canadian hospital-based hyperbaric programmes across seven provinces and covered by the corresponding provincial plans. Unlike an emergency CO referral, this is a scheduled assessment, so refer in writing to the regional programme and expect a chamber-side evaluation (including in-chamber oximetry) before a course is confirmed.

Delivered across 11 hospital-based programmes in 7 provinces



FIGURE

The Canadian referral pathway. Enhancement of healing in problem wounds is an elective outpatient indication delivered at hospital-based programmes across seven provinces and covered by the provincial plans. Ontario routes to the Toronto, Hamilton, and Ottawa programmes, British Columbia to Vancouver General, Alberta to Misericordia or Foothills, and Quebec to the Montreal or Lévis programmes; patients in provinces and territories without a chamber access treatment through inter-provincial referral. Because the course is elective, early referral of a stalled wound with the standard-care history attached shortens the path to treatment.

- **Ontario (OHIP):** Toronto General Hospital (UHN), Hamilton General Hospital, and The Ottawa Hospital programmes accept outpatient wound referrals.
- **British Columbia (MSP):** Vancouver General Hospital (Leon Judah Blackmore Pavilion), the only hospital chamber in the province.
- **Alberta (AHCIP):** Misericordia Community Hospital (Edmonton) or Foothills Medical Centre (Calgary).
- **Quebec (RAMQ):** Hôpital du Sacré-Cœur de Montréal and Hôtel-Dieu de Lévis.
- **Atlantic and Prairies:** Nova Scotia (MSI), Newfoundland and Labrador (MCP), and Saskatchewan also cover hospital-delivered hyperbaric care.
- **Provinces and territories without an in-province chamber** (Manitoba, New Brunswick, PEI, Yukon, Northwest Territories, Nunavut): patients access treatment through inter-provincial referral, most commonly to Misericordia Edmonton for prairie and territorial patients or to the Ontario hospital programmes.

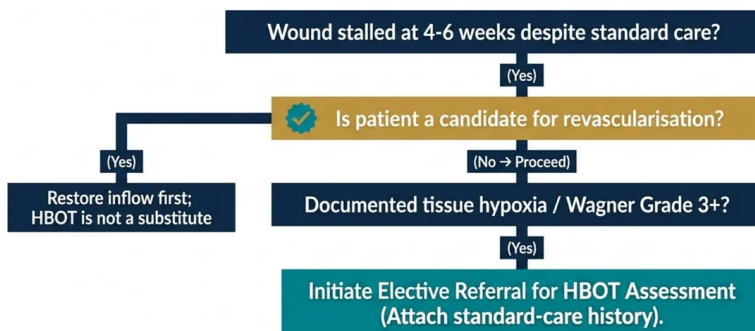
Because this is an elective course rather than an emergency, the practical bottleneck is scheduling and confirming candidacy, so early referral of a stalled wound, with the standard-care history attached, shortens the path to treatment.

Contraindications and cautions

The absolute contraindications are an **untreated pneumothorax**, which must be drained before chamber entry, **concurrent bleomycin chemotherapy**, and **concurrent disulfiram**. Because this is an elective indication, these are firm exclusions rather than risks weighed against an acute threat, and they should be screened for at referral. Relative contraindications that warrant discussion with the hyperbaric programme include severe COPD with bullous disease, an uncontrolled seizure disorder, claustrophobia, recent middle-ear or sinus surgery, untreated dental abscesses, and uncontrolled hypertension. HBOT remains adjunctive throughout: it supplements, and never replaces, offloading, debridement, infection management, and revascularisation where indicated.

The referral algorithm for stalled complex wounds

Early referral with attached standard-care history shortens the path to scheduled treatment.



FIGURE

Contraindications and cautions, screened at referral because this is an elective indication. The absolute exclusions are an untreated pneumothorax, which must be drained before chamber entry, concurrent bleomycin chemotherapy, and concurrent disulfiram. Relative cautions to discuss with the hyperbaric programme include severe COPD with bullous disease, an uncontrolled seizure disorder, claustrophobia, recent middle-ear or sinus surgery, untreated dental abscesses, and uncontrolled hypertension. Hyperbaric oxygen remains adjunctive throughout and never replaces offloading, debridement, infection management, and revascularisation where indicated.

How to use the research list below

The list contains every problem-wound and diabetic-foot-ulcer study in the Canada Hyperbarics database that was published in 2020 or later **and** has a freely available full-text version, each linked directly to that full text. Paywalled and abstract-only studies are excluded, and retracted studies are removed. This is a reference list, not a set of summaries. Counts and the open-access set refresh each quarter.

Open-access research, 2020 to present

150 studies with a free full-text version, grouped by year, newest first. Each title links to the full text. Retracted and paywalled studies are excluded; the set refreshes quarterly.

2026

1. Adi S et al.. Adjunctive hyperbaric oxygen therapy for chronic diabetic foot ulcer unresponsive to standard care: A case report. *BioMedicine*.
2. Shao W et al.. Advances in clinical management of acute severe ulcerative colitis. *Zhejiang Da Xue Xue Bao Yi Xue Ban*.
3. Zheng X et al.. Gas Therapies for Chronic Wounds: Comparative Effectiveness, Safety, and Evidence Certainty-A Systematic Review and Network Meta-Analysis. *J Clin Med*.
4. Nikolić D et al.. Hyperbaric Oxygen Therapy for Chronic Venous Leg Ulcers: A Prospective Randomised Controlled Trial. *Int Wound J*.

5. González Flores JE et al.. Hyperbaric Oxygen Therapy in Modern Surgical Practice: Mechanistic Basis and Clinical Applications Across Specialties. *Cureus*.
6. González Flores J et al.. Hyperbaric Oxygen Therapy in Surgical Wound Healing and Tissue Salvage: A Structured Narrative Review. *Cureus*.
7. Gupta A et al.. Management of heel ulcers in diabetes. *Indian journal of thoracic and cardiovascular surgery*.
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9. Mulders L et al.. Hyperbaric oxygen therapy alters bowel perfusion and improves outcomes in patients with treatment-refractory ulcerative colitis: a prospective pilot trial. *J Crohns Colitis*.
10. Zhang W et al.. The Adjunctive Role of Hyperbaric Oxygen Therapy in Microbial Infection-Related Conditions. *Int J Med Sci*.
11. Epelde F. Hyperbaric oxygen in the artificial intelligence era: integration and innovation. *Med Gas Res*.
12. Jreije S et al.. Diabetes and Delayed Wound Healing: Molecular Mechanisms and Dermatological Interventions. *Int Wound J*.
13. Weiss D. Hyperbaric Oxygenation for Ulcerative Graft-Versus-Host Disease: A Case Report. *Clin J Oncol Nurs*.
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15. Duong-Quy S et al.. Hyperbaric Oxygen Therapy and Its Physio-Mechanical Effects on Sleep Breathing Disorder: A Systematic Review. *Pulmonary therapy*.
16. Astasio-Picado Á et al.. Comparative Evidence on Negative Pressure Therapy and Hyperbaric Oxygen Therapy for Diabetic Foot Ulcers: A Systematic Review of Independent Effectiveness and Clinical Applicability. *Medicina (Kaunas)*.
17. Kostyliev M et al.. Hyperbaric Oxygenation of an Ozone-Containing Steam-Water Mixture as Treatment of Infected Combat Wounds of the Limbs With Antibiotic-Resistant Microflora. *Int Wound J*.
18. Mondal NS et al.. Unraveling the Mechanisms of Diabetic Wounds: Insights into Pathogenesis and Advanced Treatment Strategies. *Current diabetes reviews*.
19. Muroya D et al.. The Effects of Hyperbaric Oxygen Therapy in Postoperative Patients with Ulcerative Colitis: A Retrospective Study. *Kurume Med J*.

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1. Sahay S et al.. The Efficacy of Adjuvant Hyperbaric Oxygen Therapy in Chronic Wound Management: A Narrative Review. *Cureus*.
2. Zwoliński M et al.. The Supporting Role of Hyperbaric Oxygen Therapy in Atopic Dermatitis Treatment. *Journal of clinical medicine*.
3. Mackay K et al.. The role of hyperbaric oxygen therapy in the treatment of diabetic foot ulcers - A literature review. *Journal of diabetes and its complications*.
4. Research group. RETRACTION: Effect of Hyperbaric Oxygen Treatment on Diabetic Foot Ulcers: A Meta-Analysis. *International wound journal*.
5. Research group. RETRACTION: Quality of Evidence Supporting the Role of Hyperbaric Oxygen Therapy for Diabetic Foot Ulcers. *International wound journal*.
6. Research group. RETRACTION: Application of Hyperbaric Oxygen Therapy in Diabetic Foot Ulcers: A Meta-Analysis. *International wound journal*.
7. Hu X et al.. Comparison of the efficacy of 12 interventions in the treatment of diabetic foot ulcers: a network meta-analysis. *PeerJ*.
8. Research group. RETRACTION: Efficacy and Safety of Hyperbaric Oxygen Therapy in the Management of Diabetic Foot Ulcers: A Systematic Review and Meta-Analysis. *International wound journal*.
9. Zotikov D et al.. Biological Nanoparticles for Enhancing Chronic Wound Regeneration. *Cells*.
10. Kasha S et al.. Gas-based therapies in chronic wounds: A scoping review of preclinical and clinical data. *Eur J Pharm Biopharm*.
11. Oley M et al.. A descriptive retrospective study on the various uses of hyperbaric oxygen therapy. *Int Marit Health*.
12. Wu Z et al.. Prodigiosin Loaded SN-PB@PG NPs-Based Multimodal Therapy for the Healing of Bacterial Infected Chronic Wounds. *Advanced healthcare materials*.
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16. Sun R et al.. Update on the impact of lipid and glucose control on diabetic wound healing. *Metabolism open*.
17. Siewe N et al.. Modeling treatment of diabetic wounds with oxygen therapy and senolytic drug. *Sci Rep*.
18. Yang J et al.. Comparative efficacy of gas therapy for diabetic foot ulcers using network meta-analysis. *PeerJ*.
19. Pasek J et al.. Comparison of the therapeutic effects in patients with venous leg ulcers treated with routine therapy supplemented by topical hyperbaric oxygen therapy or routine therapy only, basing on the measurement of selected inflammatory markers and blood coagulation parameters: a retrospective study. *Postepy dermatologii i alergologii*.
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21. Iida A et al.. Successful Treatment of Refractory Bilateral Leg Ulcers With an Adsorptive Blood-Purification Device. *Plastic and reconstructive surgery. Global open*.
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29. Sharma S et al.. Evaluating the Effectiveness and Safety of Theruptor Novo Dressing Pad in Managing Diabetic Foot Ulcer: A Prospective Study. *Cureus*.
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31. Nguyen N et al.. Results of treating patients with diabetic foot ulcers with hyperbaric oxygen. *Int Marit Health*.
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33. Pelly T et al.. Systematic review: The management of unhealed wounds and persistent perineal sinuses following proctectomy in inflammatory bowel disease. *Techniques in coloproctology*.
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4. Ulusoy S et al.. Analysis of wound types and wound care methods after the 2023 Kahramanmaraş earthquake. *Joint diseases and related surgery*.

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3. Gonzalez CG et al.. The Host-Microbiome Response to Hyperbaric Oxygen Therapy in Ulcerative Colitis Patients. *Cellular and molecular gastroenterology and hepatology*.
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2021

1. Chen P et al.. Systematic review with meta-analysis: effectiveness of hyperbaric oxygenation therapy for ulcerative colitis. *Therapeutic advances in gastroenterology*.
2. Lindenmann J et al.. Survey of Molecular Mechanisms of Hyperbaric Oxygen in Tissue Repair. *International journal of molecular sciences*.
3. Luo L et al.. Efficacy and safety of hyperbaric oxygen therapy for moderate-to-severe ulcerative colitis: a protocol for a systematic review and meta-analysis. *BMJ open*.
4. Laranjo A et al.. The Effect of Hyperbaric Oxygen Therapy on Rectal Ulcers after Argon Plasma Coagulation. *GE Portuguese journal of gastroenterology*.
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