

Hyperbaric Oxygen for Crush Injury, Compartment Syndrome and Acute Traumatic Ischaemias

A referral guide for emergency and referring physicians in Canada.

Condition: **Crush Injury, Compartment Syndrome and Acute Traumatic Ischaemias** Open-access studies: **3**
 Updated **June 2026** Reviewed **quarterly**

For referring and emergency physicians in Canada. Crush injury, compartment syndrome and acute traumatic ischaemia are among the 14 conditions Health Canada recognises for hyperbaric oxygen therapy (HBOT), and they are treated as a time-critical emergency at Canadian hospital-based hyperbaric programmes, covered by provincial health insurance. HBOT is adjunctive here: it is added after fasciotomy, vascular repair and standard trauma management, never as a substitute for them. 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

Refer for hyperbaric assessment as soon as the patient is haemodynamically stable and the indicated surgery is underway or complete. HBOT is most useful as an adjunct in:

Indication Matrix: The Four Accepted Trauma Presentations

HBOT is strictly adjunctive and must never delay or substitute standard surgical trauma management.	
Severe Crush Injury ● Target = Gustilo Grades IIIB and IIIC ● Primary Threat = Questionable soft-tissue viability	Acute Traumatic Ischaemia ● Surgical Prerequisite = Post-Vascular Repair ● Primary Threat = Reperfusion injury
Compartment Syndrome ● Surgical Prerequisite = Post-Fasciotomy ● Primary Threat = Zone of stasis muscle necrosis	Threatened Flaps & Replants ● Primary Threat = Compromised distal perfusion

FIGURE

The four accepted trauma presentations for HBOT referral. In every case hyperbaric oxygen is adjunctive and must never delay or replace standard surgical trauma management.

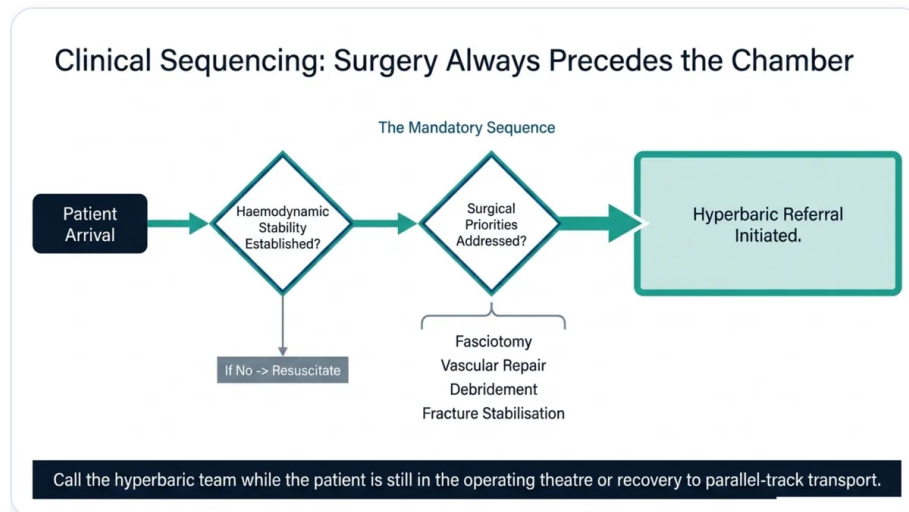
- **Severe crush injury** of an extremity, particularly higher Gustilo grades (IIIB and IIIC) where soft-tissue viability and limb salvage are in question.

- **Compartment syndrome**, after fasciotomy. HBOT does not replace fasciotomy and must never delay it; it is added to post-operative management to support the threatened muscle in the zone of stasis.
- **Acute traumatic ischaemia and reperfusion** following vascular repair or replantation, where re-establishing flow risks reperfusion injury to marginally viable tissue.
- **Threatened flaps, replants or grafts** at risk of failure from compromised perfusion.

Time to the first treatment is critical. The optimal window is within 4 to 6 hours of injury, or as soon as the patient is stable after the index operation, with benefit documented up to 24 hours and beyond. Because earlier treatment is associated with better outcomes, the decision to refer should be made early and in parallel with surgical care, not after it.

Assessing the patient before referral

While arranging hyperbaric assessment, the receiving team should:



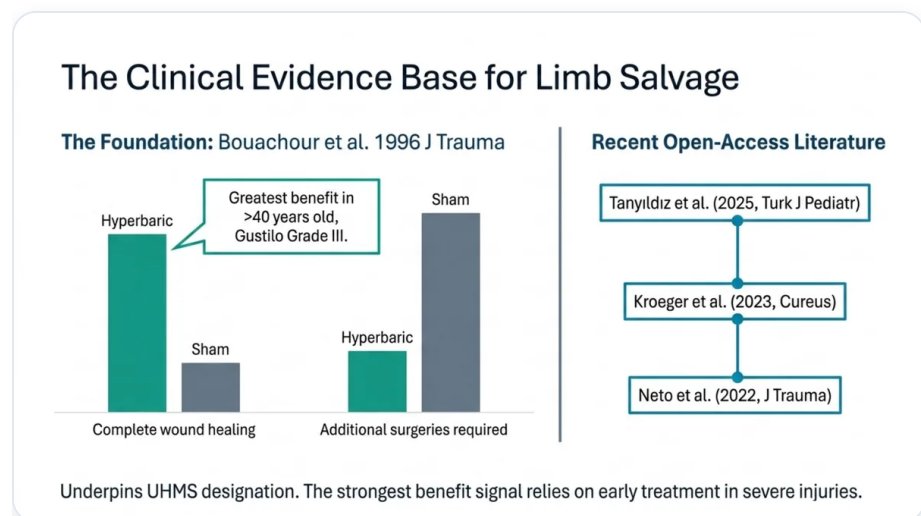
FIGURE

Surgery always precedes the chamber. Confirm haemodynamic stability and complete surgical priorities first, then call the hyperbaric team while the patient is still in theatre or recovery to parallel-track transport.

- Confirm that **surgical priorities are addressed first**. Fasciotomy for established or developing compartment syndrome, vascular repair, debridement and fracture stabilisation all precede HBOT. HBOT is sequenced after these, once the patient is haemodynamically stable.
- Establish and maintain **haemodynamic stability**. Severe instability requiring continuous high-dose vasopressor titration is a relative contraindication, though it rarely overrides the decision in a true limb-salvage scenario.
- **Exclude an untreated pneumothorax** and ensure any pneumothorax is drained with a chest tube before chamber entry, as trapped air expands on decompression.
- Document the **Gustilo grade, ischaemia time, mechanism and time of injury**, since these drive both the urgency and the expected benefit.
- Review the **medication and comorbidity list** for bleomycin and disulfiram exposure, bullous lung disease, and uncontrolled seizure disorder, which the hyperbaric team will weigh.
- For ventilator-dependent or critically injured patients, note that **multiplace chambers** accommodate full ICU monitoring and ongoing ventilation inside the chamber during treatment.

What the evidence supports

The reference clinical trial is the **Bouachour et al. randomised double-blind placebo-controlled trial (J Trauma 1996, 36 patients with severe extremity crush injuries)**, which found significantly more complete wound healing and significantly fewer additional surgical procedures in the hyperbaric group compared with sham. The significant subgroup benefit was in patients older than 40 with Gustilo grade III soft-tissue injury. This remains the most-cited controlled evidence in crush-injury practice, and underpins the UHMS designation of crush injury as an accepted indication.



FIGURE

The evidence rests on one small randomised trial (Bouachour 1996, 36 patients) showing more complete healing and fewer additional surgeries, supported by animal data and more recent open-access reports. It underpins the UHMS designation; the benefit signal is strongest with early treatment of severe injuries.

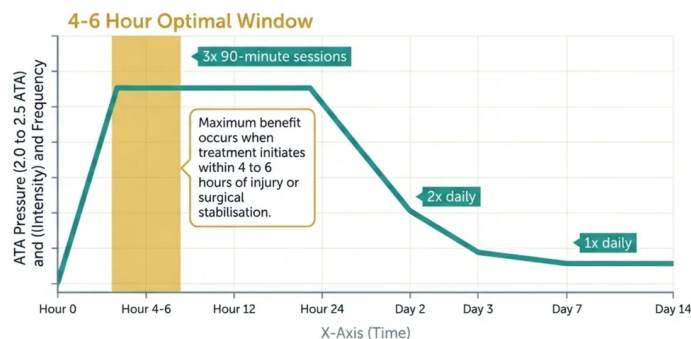
The mechanistic rationale is well established. At 2.0 to 2.5 ATA on 100 percent oxygen, plasma oxygen content rises roughly 10- to 15-fold, raising tissue oxygen tension in the ischaemic zone of stasis from hypoxic levels (often below 20 mmHg) to several hundred mmHg per session. Hyperoxic vasoconstriction reduces capillary permeability and intramuscular oedema without compromising oxygen delivery, while HBOT blunts neutrophil adhesion and lipid peroxidation in the reperfusion cascade. In experimental crush and compartment-syndrome models, the Strauss series reported that early hyperbaric treatment reduced skeletal muscle necrosis and intramuscular oedema, with diminishing benefit as treatment was delayed.

The evidence base is modest in volume. The controlled human data rest largely on the single Bouachour trial supported by animal models and observational series, so the strength of recommendation reflects mechanism and the consistency of the early-treatment signal more than a large trial portfolio. The most consistent observation is that benefit appears greatest when HBOT begins early, in the most severe injuries, and in older patients.

◆ Clinical translation

Refer early and treat surgical needs first. The benefit signal is strongest when hyperbaric treatment begins within the first several hours of injury or of stabilisation after the index operation, so do not wait for delayed complications to declare themselves. A typical course is 2.0 to 2.5 ATA for 90 minutes per session, intensive in the first days (often three sessions in the first 24 hours, then twice daily on days 2 to 3, then once daily) for a total of roughly 7 to 14 sessions, extended for replantation or severe soft-tissue defects. When limb salvage is in doubt, call the hyperbaric team while the patient is still in the operating theatre or recovery.

The Therapeutic Window and Dosing Trajectory



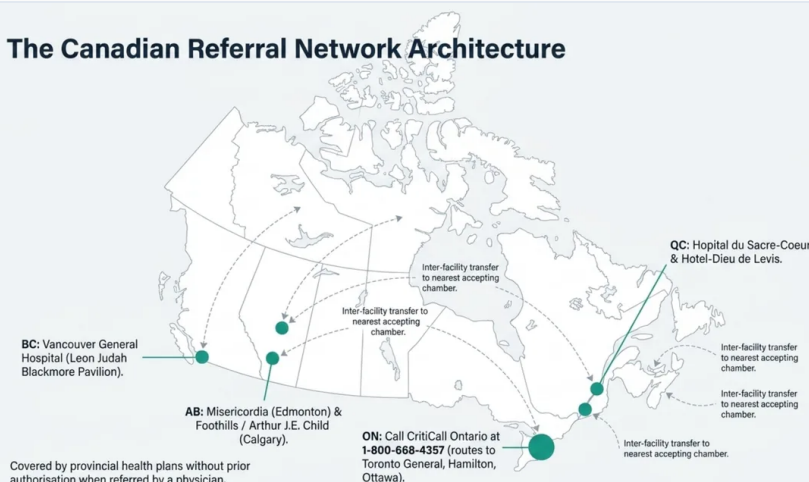
FIGURE

A representative dosing trajectory: treatment ideally begins within 4 to 6 hours, with three 90-minute sessions at 2.0 to 2.5 ATA in the first day, tapering from twice to once daily over the following days.

The Canadian referral pathway

Crush injury, compartment syndrome and acute traumatic ischaemia are treated as adjunctive emergencies at Canadian hospital-based hyperbaric programmes and are covered by provincial plans without prior authorisation when referred by a physician.

The Canadian Referral Network Architecture



FIGURE

Accepting hyperbaric centres by province, with inter-facility transfer to the nearest chamber. Provincial health plans cover treatment when a physician refers; in Ontario, CitiCall coordinates placement at 1-800-668-4357.

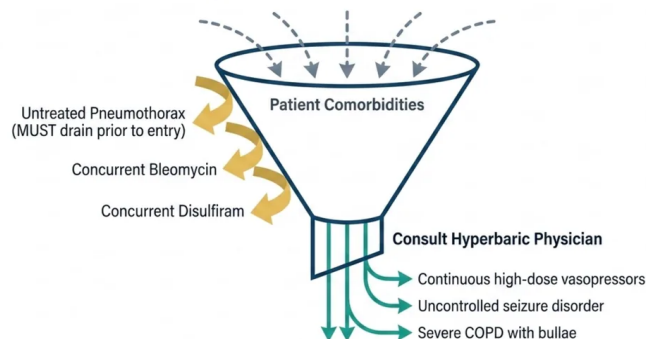
- **Ontario:** call **CitiCall Ontario at 1-800-668-4357**, the 24/7 physician-to-physician coordination line that connects emergency departments and trauma services to the Toronto General (UHN), Hamilton General, and The Ottawa Hospital programmes and arranges transport when needed.
- **British Columbia:** route to Vancouver General Hospital (Leon Judah Blackmore Pavilion), the hospital chamber for the province; covered under MSP.
- **Alberta:** route to Misericordia Community Hospital (Edmonton) or the Calgary programme (Foothills Medical Centre / Arthur J.E. Child Comprehensive Cancer Centre); covered by Alberta Health.
- **Quebec:** RAMQ covers Hopital du Sacre-Coeur de Montreal and Hotel-Dieu de Levis.
- **Provinces and territories without a chamber** (Manitoba, New Brunswick, PEI, Yukon, NWT, Nunavut): inter-facility transfer to the nearest accepting chamber is arranged through provincial networks, usually after the index surgery once the patient is stable for transport.

Multiplace chambers at the larger programmes can accommodate ventilator-dependent, critically injured patients with full ICU monitoring inside the chamber. Programme distribution and verified facility details are summarised on the [crush injury, compartment syndrome and acute traumatic ischaemia condition](#) page.

Contraindications and cautions

The only universally agreed absolute contraindication is an **untreated pneumothorax**, which must be drained before chamber entry. Hyperbaric programmes also treat **concurrent bleomycin** (oxygen-induced pulmonary toxicity risk) and **concurrent disulfiram** (which inhibits superoxide dismutase and can increase the risk of oxygen toxicity) as contraindications to be cleared with the hyperbaric physician before treatment. Relative contraindications include severe haemodynamic instability requiring continuous high-dose vasopressor titration, uncontrolled seizure disorder, severe COPD with bullous lung disease, and uncontrolled claustrophobia. In a severe crush injury or threatened limb-salvage scenario these relative cautions are weighed pragmatically and usually do not override the hyperbaric decision; the hyperbaric physician makes that judgement in collaboration with the trauma team.

Pre-Referral Triage and Contraindication Filter



FIGURE

Screen for contraindications before referral. An untreated pneumothorax must be drained first; bleomycin, disulfiram, high-dose vasopressors, uncontrolled seizures and bullous COPD warrant a discussion with the hyperbaric physician. Multiplace chambers support ICU monitoring and ventilation.

How to use the research list below

The list contains every crush injury, compartment syndrome and acute traumatic ischaemia 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. Because only a small number of open-access studies on this indication exist, the list is intentionally short. 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

3 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.

2025

1. Tanyildiz M et al.. Should we give priority to plasma exchange and hyperbaric oxygen treatment before deciding on amputation for severe crush injuries?. *Turk J Pediatr*.

2023

1. Kroeger MG et al.. Adult-Onset Tics After Being Crushed by an Air Conditioner: A Case Report. *Cureus*.

2022

1. Neto PH et al.. [Hyperbaric oxygen therapy for the treatment of a crush injury of the hand: a case report.](#) *Journal of trauma and injury.*

Canada Hyperbarics, canadahyperbarics.ca. Reviewed each quarter. For clinicians; does not replace individual clinical judgement.