

TREATMENT RECCOMMENDATIONS FOR FROSTBITE - A NARRATIVE OVERVIEW



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Hypoxia Symposium, Kührointalm
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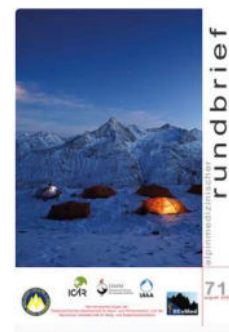
Therapieempfehlungen bei Erfrierungen: Ein narrativer Überblick

Jurij Gorjanc, Rosmarie Oberhammer

Jänner/Feber 2025, Alpinmedizinischer Rundbrief

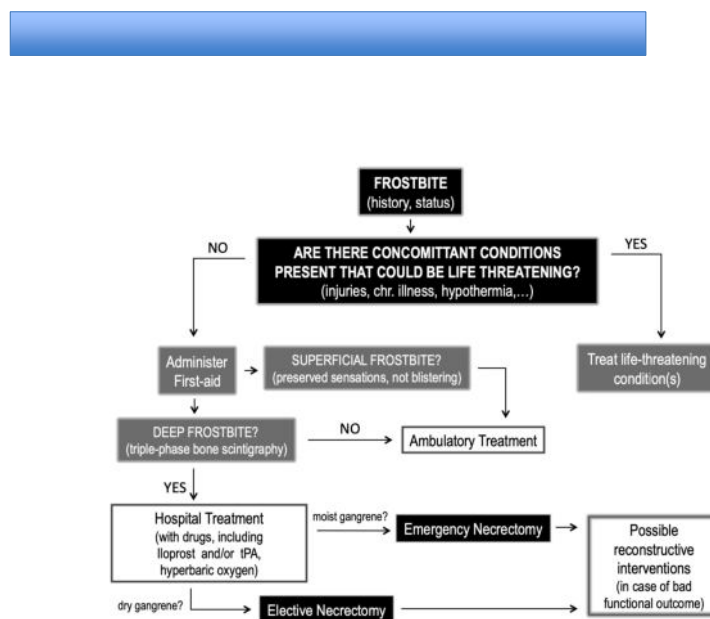
McIntosh SE, Freer L, Grissom CK et al. Wilderness Medical Society Clinical Practice Guidelines for the Prevention and Treatment of Frostbite: 2024 Update. Wilderness Environ Med;2024:183-97.

Wibbenmeyer L, Lacey AM, Endorf FW et al. American Burn Association Clinical Practice Guidelines on the Treatment of Severe Frostbite. J Burn Care Res. 2024;45:541–56.



DISKUSSION:

•DER WEG EINES PAT. MIT ERFRIERUNGEN: PLANICA PROTOKOLL



Emmanuel Cauchy
(1960 – 2018)



> Wilderness Environ Med. 2016 Mar;27(1):92-9. doi: 10.1016/j.wem.2015.11.014.

A New Proposal for Management of Severe Frostbite in the Austere Environment

Emmanuel Cauchy ¹, Christopher B Davis ², Mathieu Pasquier ³, Eric F Meyer ⁴, Peter H Hackett ⁵

Annals of Clinical Case Reports

Case Report
Published: 16 Sep, 2023



The Planica Protocol for Frostbite Management - 3 Case Reports

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Erste Hilfe:

- MEDIKAMENTE BEI ERFRIERUNGEN:
 - ERSTE HILFE: Azetylsalizylsäure oder Ibuprofen (Erste Hilfe),
 - NOTARZT: NMH, Azetylsalizylsäure, Pentoxifylin, NMH, Iloprost, An` bio` kum

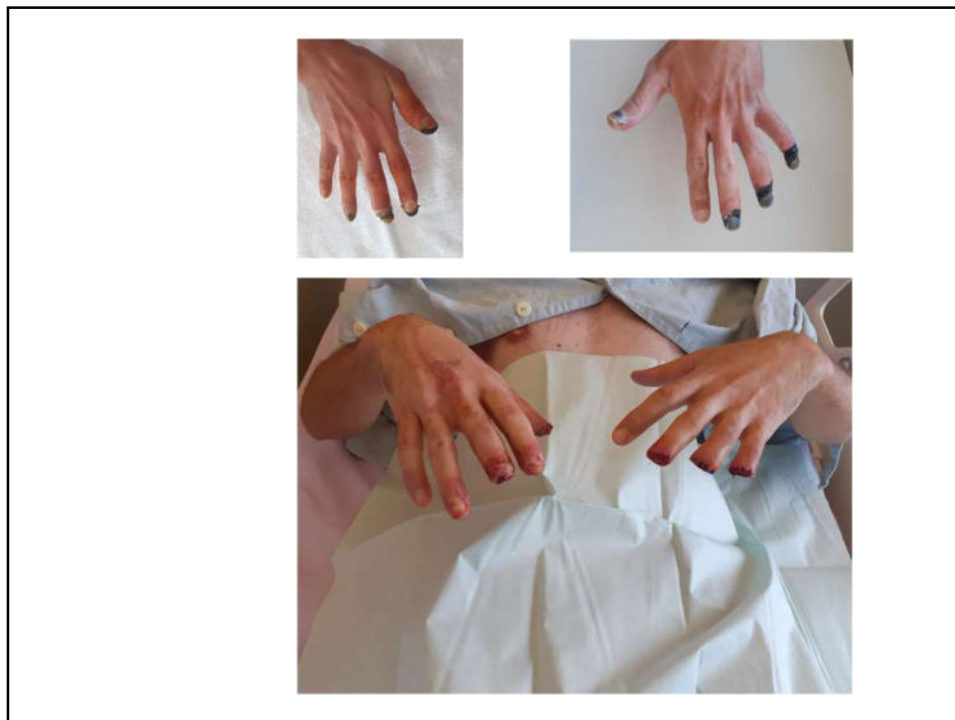
Medication type	Dosage/manner	Duration of treatment
Ibuprofen	2-3 x 400 mg p.os	5 weeks
Pantoprazole	1 x 40 mg p.os	5 weeks
Pentoxifylline	3 x 400 mg p.os	5 weeks
Enoxaparin	40 mg s.c.	5 weeks
Amoxicillin/clav. acid	1,2 g/8h and 1000mg 2x1	1 week i.v, 3 weeks p. os
Iloprost	1-2ng/kgBW/min i.v, (6h/day)	3 weeks
Hyperbaric oxygenation	1x to 2x 90 min/day at 2,5 absolute atmospheric pressure	4 weeks
tPA (tissue Plasminogen-Activator)*	If<24h after Frostbite occurrence: 0.15 mg/kg over 15 minutes, followed by a continuous IV infusion of 0.15 mg/kg per hour for six hours.	1 day

Table 1 – Medication dosages of Planica protocol

tPA Bolus 0.15 mg/kg, dann 0.15 mg/kg/h i.v. langsam über 6 Std. bis max. 100 mg
(Twomey JA et al, 2005).

ÖGAHM – Winterlehrgang 2024





What can we learn from the past?

Year	Conflict	Comments
cca 400 B.C.	Armenia	Approx. 6000 casualties (60%) due to "cold"
218 B.C.	Hannibal crossing Alps	19,000 (50%) survivors of a total army of 38,000
1719	Swedish/Norwegian	3,700 Swedish dead from force of 5,000; 600 permanently crippled from frostbite.
1778	American War of Independence	Up to 10% of casualties in some battles
1812	Napoleonic/Russian campaign	100,000 KIA; 200,000 DNBR (majority from cold injury & hypothermia). 12,000 from the 12th Division. All perished except for 350.
1854-1856	Crimean War	2,000 cold injured out of 50,000
1861-1865	American Civil War	15,000 cold injuries
1870-1871	Franco/Prussian	1,450 cold injuries
1899-1902	Boer War	"Many with cold injuries"
1904-1905	Russo/Japanese	"Staggering numbers"
1912	Balkans	"Many cold injuries"

Golden et al. (2003)

Year	Conflict	Comments
1914-1918	WW I	<p>British: 115,361 French: 79,000 Italian: 38,000 German: ?? - but had special hospitals dedicated to treating cold injuries</p> <p>Distinction between Freezing and Non-freezing (Trench foot) injury first made.</p>

Golden et al. (2003)



Year	Conflict	Comments
1939-1945	WW II	<p>Western Europe: British 500 USA 91,000</p> <p>Italian campaign, Winter 1943/44: British 102 cold injured casualties USA 4,560 cold injured casualties</p> <p>First description of "immersion foot" (at sea) and "shelter foot".</p> <p>Russian Front: massive number of casualties among Germans (special cold injury hospitals established)</p> <p>Attu (Aleutians): US Marines 1,200 in 15 day period of conflict. Ratio of 1:1 with battle casualties</p>

Golden et al. (2003)

Year	Conflict	Comments
1950-1952	Korea	UN: 8,000 US Army: 6,300 (25% of all casualties in Winter of 1951/52) Chinese: Tens of thousands (100% in some units) "Paddy foot"
1971	India/Pakistan	Indians: 847 cold injured
1982	Falklands	British: 20% of all hospital casualties. Over 80% troops had residual neuropathy. Argentinians: many cases

Frostbite incidence is a selective term and dependable on methodology – a narrative review

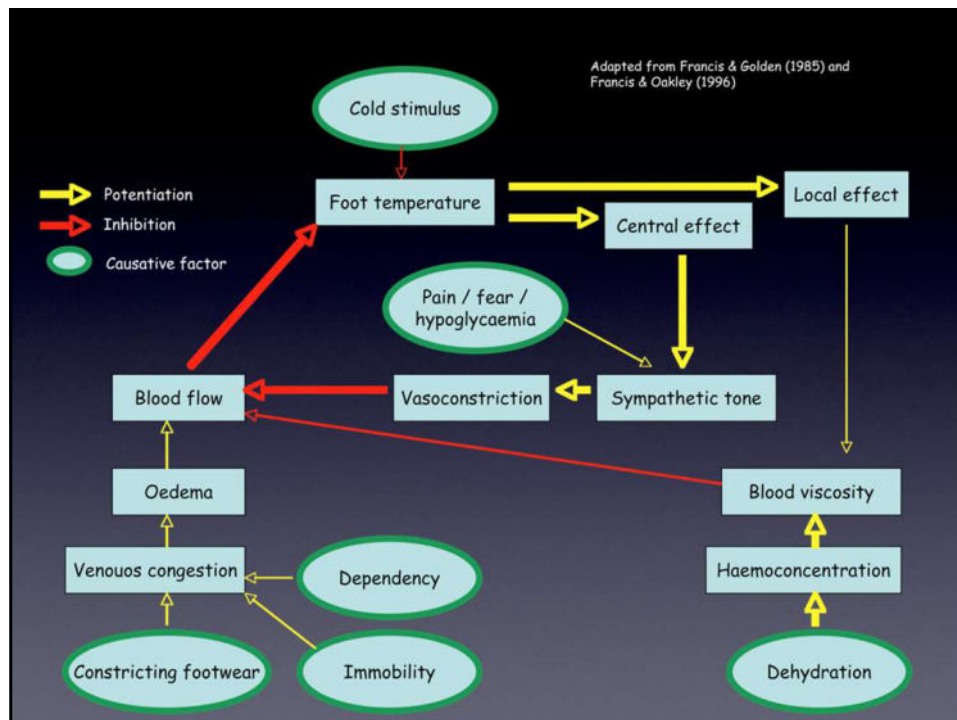
Berenike Schneider^{1 A,F}, Jurij Gorjanc^{2 A,B,F,G}

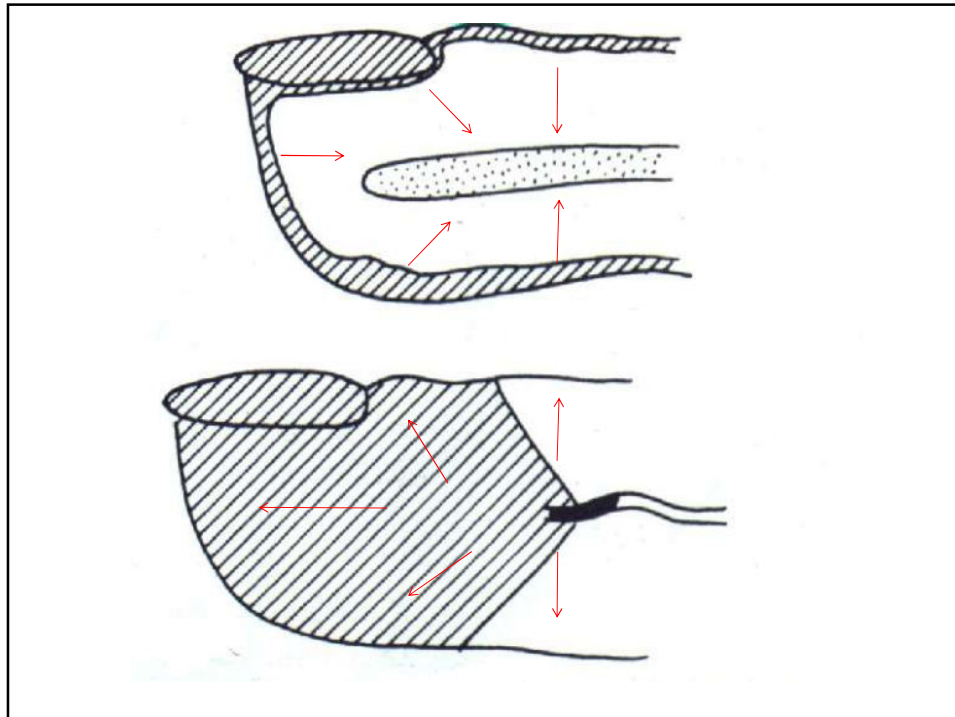
¹ Gesamtschule Kürten, Germany
² Klinikum Klagenfurt am Wörthersee, Klagenfurt, Austria

Results: The comparison of the seven studies shows a great variability of frostbite incidence depending on the population, its size, and the method of data collection. Studies that included civilian populations have significantly lower frostbite incidence rates than studies focusing on individuals who are exposed to temperatures below 0°C for extended periods, such as mountaineers, military personnel, workers in cold storage houses or homeless people. The results highlight different incidence rates for different populations and indicate that retrospectively collected data are insufficiently comparable among studies. Frostbite incidence, expressed as the ratio of injured individuals to non-injured inhabitants, is only comparable in studies using the same

Frequency of cold-related problems in different parts of the body (Finrisk 97study;N=2624)

	Location	5 year incidence (%)
Upper extremities	Fingers	4
	Palms	16
	Arms	6
Lower extremities	Toes	46
	Feet	23
	Thighs	14
	Knees	12
	Ankles	9
	Calves	6
Head	Ears	25
	Cheeks	22
	Nose	22
	Chin	14





“Internal” risk factors for Frostbite

- Footwear
- Immobility
- Dehydration
- Hypoglycaemia
- Genetics
- Military personnel
- Ethnic origin
- (Acclimatisation, Adaptation)
- Smoking
- Gender (slightly higher risk in women)

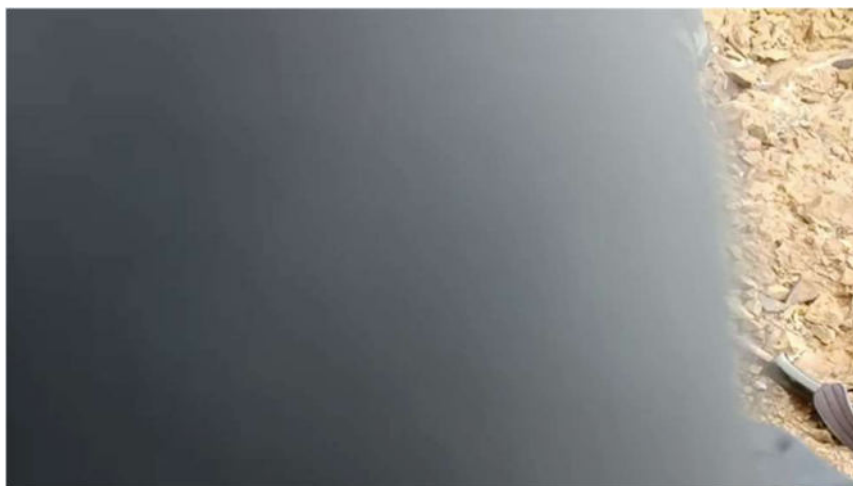


External risk factors for Frostbite

Wind Chill Index

		Wind Speed (km/hr)															
		5	10	15	20	25	30	35	40	45	50	55	60	65	70		
Temperature (°C)	0	-2	-3	-4	-5	-6	-6	-7	-7	-8	-8	-8	-9	-9	-9		
	-5	-7	-9	-11	-12	-12	-13	-14	-14	-15	-15	-15	-16	-16	-16		
	-10	-13	-15	-17	-18	-19	-20	-20	-21	-21	-22	-22	-23	-23	-23		
	-15	-19	-21	-23	-24	-25	-26	-27	-27	-28	-29	-29	-30	-30	-30		
	-20	-24	-27	-29	-30	-32	-33	-33	-34	-35	-35	-36	-36	-37	-37		
	-25	-30	-33	-35	-37	-38	-39	-40	-41	-42	-42	-43	-43	-44	-44		
	-30	-36	-39	-41	-43	-44	-46	-47	-48	-48	-49	-50	-50	-51	-51		
	-35	-41	-45	-48	-49	-51	-52	-53	-54	-55	-56	-57	-57	-58	-58		
	-40	-47	-51	-54	-56	-57	-59	-60	-61	-62	-63	-63	-64	-65	-65		
	-45	-53	-57	-60	-62	-64	-65	-66	-68	-69	-69	-70	-71	-72	-72		

- Wind – chill” (20km/h -15C= - 24C)
- Alpinists, “cold” sports
- Workers in cold
- Homeless people
- Trauma



Aconcagua 6960m (11. Feb. 2024)



Broad Peak (8050m) – 31. 7.. 2012



Pik Lenin, 7134m (9. Aug. 2021)



Aconcagua 6960m (11. Feb. 2024)

• **“Freezing cold injury-FCI”** is not the same as **“ non-freezing cold injury - NFCI”**











- 1 – Coagulation zone
- 2 – Congestion zone
- 3 – Hyperaemic zone

•“Clinical stages of frostbite:

- 3-stages
- 4-stages
- 2 stages

- Clinically we can assess the stage
not sooner than 24-48 h after freezing

Initial frostbite care			
THAWING PROTOCOL			
Immersion in warm water 38°C, 60 min. + ASPIRINE 250 mg Per Os or IV			
CLASSIFICATION			
Disappearance of initial cyanotic lesion	Initial cyanotic lesion on distal phalanx only	Initial cyanotic lesion affects at least 1 DIP joint	Initial cyanotic lesion affects at least 1 MP joint
			
			
Grade 1 Amputation risk: 0%	Grade 2 Amputation risk: 1%	Grade 3 Amputation risk: 23-83% SOS-Frostbite protocol	Grade 4 Amputation risk: 99% SOS-Frostbite protocol

Stages of frostbite



superficial



deep



FIRST AID

Outdoors:

Protection from wind and cold

Ibuprofen 6 mg/kg body weight twice daily (12 mg/kg) (~~aspirin~~).

Allergies?

“Fast rewarming” 37-39 ° C.

Disinfected water. Removal of cuffs, watches, rings, etc.: up to 60 min. warming or until the affected areas are soft.

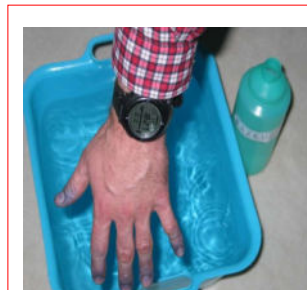


FIRST AID

“Fast rewarming”

Caution!

1. Do not warm the patient if first aid is provided after >24 hours!
2. Do not warm the patient if there is a risk of further frostbite (prolonged transport, etc.)



FIRST AID

Frostbite is a wound (dry carefully and apply a sterile soft dressing. Leave blisters exposed to the air and uncovered (risk of infection).

(Aloe vera gel applied topically, sterile)

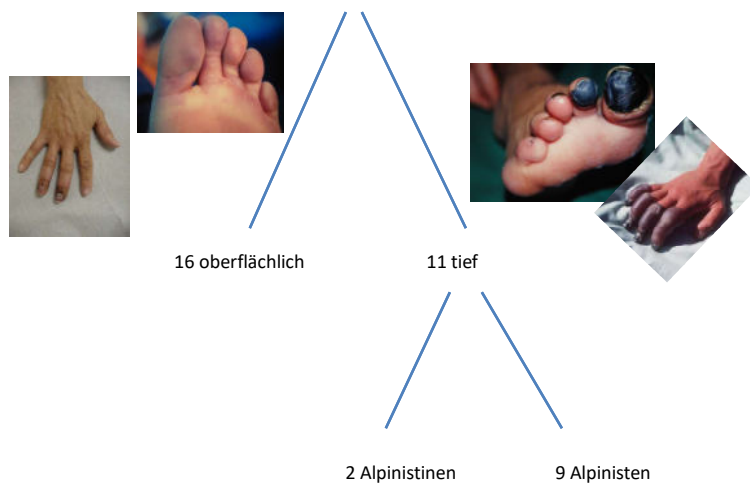
**FIRST AID**

SPLINTING



FIRST AID**5. Transport****Fristbite is an emergency!****📞 Emergency call****ANALYSE von 27 alpinisten**

Zwischen 2000 in 2010: 27 Alpinisten mit Erfrierungen



IN THE HOSPITAL

- Rewarming, if not already done
 - Clinical examination
 - Scintigraphy?
 - Debridement
 - Dressing change Aloe vera twice daily
 - Tetanus prophylaxis
 - Ibuprofen 12 mg/kg body weight
- Which medications?
- Antibiotics for suspected infected wounds
 - Hydration
 - Thrombolysis?
 - Iloprost?
 - HBO?

**IN THE HOSPITAL****3. Scintigraphy?**

superficial? / deep?



Imaging Frostbite:
 A. Positive for distal digit ischemia (#3-5).
 B. Negative for ischemia.
 C. Angiogram correlating with image A.
 D. Positive for ischemia (markers used).

IN THE HOSPITAL

Debridement:

-blister removal under
sterile conditions



IN THE HOSPITAL

Change the dressing with aloe
vera gel twice a day under
sterile conditions.



IN THE HOSPITAL

6. Tetanusprophylaxis



IN THE HOSPITAL

7. Ibuprofen 12mg/kg BW



IN THE HOSPITAL

Other medications?

Medication type	Dosage/manner	Duration of treatment
Ibuprofen	2-3 x 400 mg p.os	5 weeks
Pantoprazole	1 x 40 mg p.os	5 weeks
Pentoxifylline	3 x 400 mg p.os	5 weeks
Enoxaparin	40 mg s.c.	5 weeks
Amoxicillin/clav. acid	1,2 g/8h and 1000mg 2x1	1 week i.v, 3 weeks p. os
iloprost	1-2ng/kgBW/min i.v. (6h/day)	3 weeks
Hyperbaric oxygenation	1x to 2x 90 min/day at 2,5 absolute atmospheric pressure	4 weeks
tPA (tissue Plasminogen-Activator)*	If<24h after Frostbite occurrence: 0.15 mg/kg over 15 minutes, followed by a continuous IV infusion of 0.15 mg/kg per hour for six hours.	1 day

IN THE HOSPITAL

9. Hidration



IN THE HOSPITAL

10. HBO?



1 to 2 times 90 min/day at 2.5 ATA and intermittent ventilation with 100% oxygen (and air) every 10 minutes

And other studies...?

A controlled trial of a prostacyclin and rt-PA in the treatment of severe frostbite.

Cauchy E, Cheguillaume B, Chetaille E.

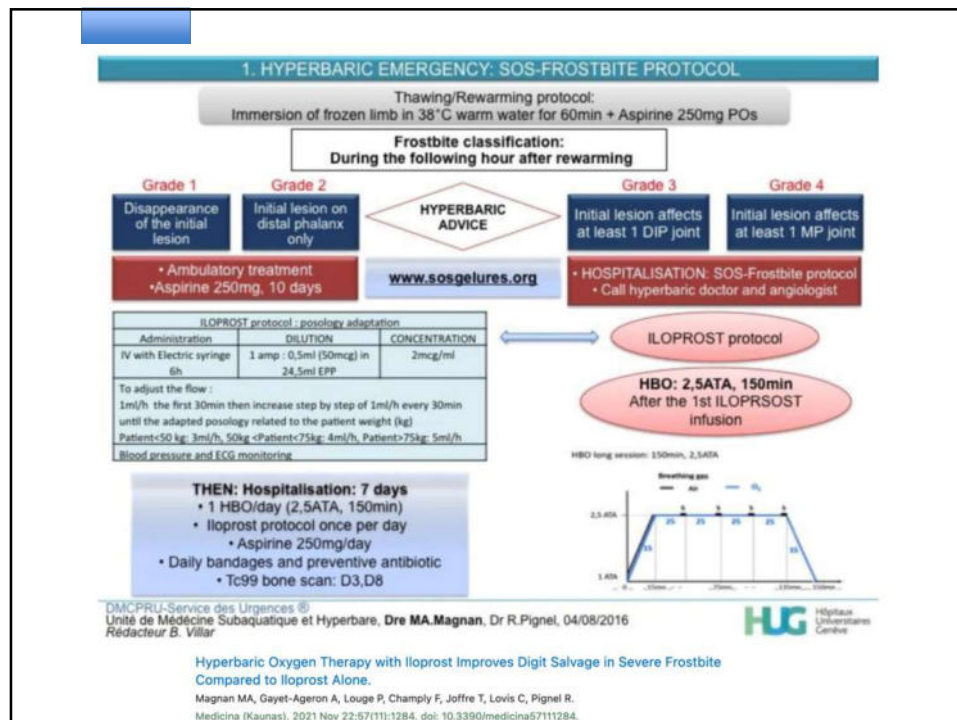
N Engl J Med. 2011 Jan 13;364(2):189-90. doi: 10.1056/NEJMc1000538.

And other studies...?

Hyperbaric Oxygen Therapy with Iloprost Improves Digit Salvage in Severe Frostbite Compared to Iloprost Alone.

Magnan MA, Gayet-Ageron A, Louge P, Champly F, Joffre T, Lovis C, Pignel R.

Medicina (Kaunas). 2021 Nov 22;57(11):1284. doi: 10.3390/medicina57111284.



Thirty patients from the historical cohort were eligible and satisfied the inclusion criteria, and **28 patients were prospectively included**. The number of preserved segments per patient was significantly higher in the prospective cohort (mean $13 \pm \text{SD}, 10$) compared to the historical group ($6 \pm 5, p = 0.006$); the **odds ratio** was significantly higher by 45-fold (95%CI: 6-335, $p < 0.001$) in the prospective cohort compared to the historical cohort after adjustment for age, gender and delay between signs of freezing and treatment start.

Hyperbaric Oxygen Therapy with Iloprost Improves Digit Salvage in Severe Frostbite Compared to Iloprost Alone.

Magnan MA, Gayet-Ageron A, Louge P, Champly F, Joffre T, Lovis C, Pignel R. Medicina (Kaunas). 2021 Nov 22;57(11):1284. doi: 10.3390/medicina57111284.

Conclusions: This study demonstrates **that the combination of HBO and iloprost was associated with higher benefit in patients with severe frostbite. The number of preserved segments was two-fold higher** in the prospective cohort compared to the historical group (mean of 13 preserved segments vs. 6), **and the reduction of amputation was greater in patients treated by HBO + iloprost** compared with the iloprost only.

Hyperbaric Oxygen Therapy with Iloprost Improves Digit Salvage in Severe Frostbite Compared to Iloprost Alone.

Magnan MA, Gayet-Ageron A, Louge P, Champly F, Joffre T, Lovis C, Pignel R. Medicina (Kaunas). 2021 Nov 22;57(11):1284. doi: 10.3390/medicina57111284.

?

A Photographic Case of **Frostbite** Treated with Delayed Hyperbaric Oxygen Therapy.

Davis A, Sinopoli B, Mann N, Stenbit AE.

High Alt Med Biol. 2022 Jan 10. doi: 10.1089/ham.2021.0047. Online ahead of print.



NAKED PROSTHETICS



<https://www.npdevices.com/>



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