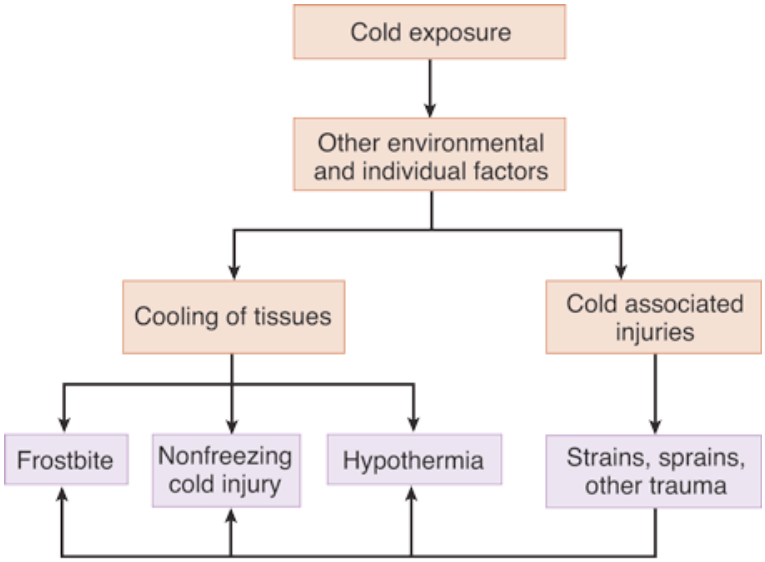
FROSTBITE & COLD INJURIES



Frostbite is the prototypical freezing injury, seen only when ambient temperatures are well below freezing.

Non-freezing cold injuries result from exposure to wet conditions when temperatures are above freezing (eg. trench-foot & chilblains).

NON-FREEZING COLD INJURIES.

TRENCH-FOOT.

- Largely remain a problem in military operations or hikers/campers.
- Direct injury to soft tissues (from prolonged cooling).
- Initially reversible.

Cold/wet conditions → vasoconstriction → RBC/PLT plugging → oedema → nerve & small-vessel injury

Clinically...

- Tingling & numbness of affected tissue.
- Foot is pale, mottled, anaesthetic, pulseless & immobile.
    - Initially does *NOT* respond to rewarming.
- Hyperaemic phase occurs *hours* after rewarming.
    - Assoc. severe burning pain & return of sensation.
- Oedema (± bullae) form over 2-3 days.
- Hyperhidrosis & cold sensitivity persist for months to years.

Treatment...

- Supportive [vasodilator drugs may be tried].
- Keep warm, dry, bandaged & elevated.
- Closely observe for infection.

CHILBLAINS (or PERNIO).

- Mild but uncomfortable inflammatory lesions of the skin.
- Results from long-term intermittent exposure to damp, non-freezing ambient temperatures.
- Most commonly affected areas are hands, ears, lower legs & feet.

Clinically...

- Tingling → numbness of affected tissues.
- Cutaneous manifestations appear ~ 12 hours after acute exposure.
    - Localised oedema, erythema, cyanosis, plaques & nodules.
    - Rarely; ulcerations, vesicles & bullae.
- Assoc. burning & pruritis
- Rewarming may result in formation of tender blue nodules.

Treatment...

- Supportive.
- Rewarm, gently bandage, elevation.
- Medications trialled incl. nifedipine, prostaglandin E1 & topical steroids.

PANNICULITIS.

- Mild degrees of necrosis of subcutaneous fat tissue (following prolonged exposure to temperatures just-above freezing).
- Mild inflammation, adipose fibrosis → cosmetic defects.
- No effective treatment.

COLD URTICARIA.

- Hypersensitivity to cold air or water.
    - Rarely leads to fatal anaphylaxis.
- Most cases are idiopathic.
- Treatment = antihistamines or mast cell stabilisers.

FREEZING COLD INJURIES.

Frostbite most often occurs at temperatures -20*C, with exposure times varying from hours to several days (depending on magnitude & degree of protective clothing etc).

- ↑ altitude & windspeed accelerate convective loss ∴ ↑ risk of frostbite.

Factors influencing likelihood of Frostbite			
Environmental - Temperature - Wind & Wetness - Duration of exposure - Hypoxia - Altitude	**Behavioural** - Cold acclimatisation - Alcohol + smoking - Fatigue - Inappropriate clothing - Constrictive clothing	**Physiologic Problems** - Raynaud's - Peripheral vascular disease - Diabetes - Peripheral neuropathies - Medications (vasoconstrictors) - Psychiatric illnes	**Individual** - Physical characteristics - Age & gender - Race

Pathophysiology.

The most affected areas are head, hands & feet.

- As cooling reaches 10*C cutaneous blood flow is negligible.
- Temperatures < 0*C = formation of ice crystals in ECS.
    - Cellular dehydration & hyperosmolarity.
    - Proteins are denatured, enzymes destroyed & cell membranes altered.
- Intracellular ice then forms.
    - Endothelial damage (mechanical & biochemical).
    - Leakage ++ (upon thawing)
- Inflammatory cascade → further vasoconstriction → PLT aggregation & sluggish flow.
    - Perpetuates ischaemia, necrosis & dry gangrene.

Three zones of frostbite.

1. Zone of coagulation
    - Most severe. Most distal.
    - Damage is irreversible.
2. Zone of hyperaemia
    - Most superficial. Typically proximal.
    - Least cell damage.
    - Expected to recover.
3. Zone of stasis.
    - “middle ground”
    - Benefits the most from treatment → “possibly reversible”

Clinical Features.

Visual determination of tissue viability is difficult during the 1st few weeks of injury.

- Viable tissue identified only after gangrenous tissue has demarcated & sloughed.

Classification of Frostbite Injuries	
First degree	Numbness, erythema, swelling, desquamation, dysaesethesia.
Second degree	Blisters of skin
Third degree	Tissue loss involving entire thickness of skin
Fourth degree	Tissue loss involving entire thickness of the part (incl. deep structures) result in amputation.

Second degree

Fourth degree frostbite w/ amputation

Treatment.

In the field;

- Prevention of further cold injury, hypothermia & dehydration.
- *AVOID* heating the frozen area (may cause further injury).
- *AVOID* thawing & then further *refreezing.*
- Analgesia.
- Immobilisation & elevation of frozen extremities.

In the Emergency Department;

- ***Rewarming is crucial.***
- Place injured extremity in ***gently circulating warm water (40-42*C)*** for 20-30mins.
    - Continue until skin is pliable & erythematous.
    - Cover affected face w/ warm compresses.
- ***Analgesia ++***
- ***ADT*** booster
- ***Topical aloe vera cream*** to blisters q6h (both clear & haemorrhagic).
- Separate affected digits by cotton. Wrap in sterile, dry gauze.
- Burns/Plastics referral.

Later management;

- Watch for signs of infection.
    - Prophylactic ABx are controversial.
- Pain control.
- Early surgical intervention *not indicated.*
    - May result in unnecessary tissue loss.
    - Typically observe for 3-4 weeks (for full demarcation).

Little evidence for heparin & hyperbaric O2 therapy. Similarly, sympathectomy of no benefit.

Sequelae.

- Hypersensitivity to cold
- Pain.
- Ongoing numbness
- Arthritis, bony deformities & scars can occur.