

VANDERBILT  UNIVERSITY
MEDICAL CENTER

Guideline: Frostbite Management Guidelines

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I. Definitions

- A. **Frostnip** is associated with pallor, numbness, and pain on rewarming. It is completely reversible with warming and leads to no resulting tissue loss.
- B. **Frostbite** is defined by the actual freezing of the tissues. This leads to intracellular ice crystal formation and cell destruction, associated microvascular occlusion, tissue anoxia and reperfusion injury.
- C. **Frostbite severity**
 - a. **First degree:** hyperemia with significant edema, non-blistered.
 - b. **Second degree:** partial skin thickness necrosis, forms large tense serous blisters.
 - c. **Third degree:** full thickness and possible subcutaneous tissue loss, forms hemorrhagic blisters and/or dark eschar.
 - d. **Fourth degree:** full thickness skin necrosis involving bone, tendon, or muscle.

II. Pre- Hospital Guidelines for Management of Severe Frostbite

- 1. Primary assessment/treatment for ABCs and traumatic injury
- 2. Vital signs, including temperature if possible
- 3. Anticipate/treat/prevent hypothermia
- 4. Protect frostbitten tissue from further cold injury and trauma:
 - a. Protect and cover exposed limbs from wind and cold
 - b. If possible, remove wet or tight-fitting garments (e.g., rings, jewelry, boots) and replace with dry, loose-fitting, bulky, insulating dressings or garments
 - c. Mechanically protect any frozen tissue to prevent further damage with bulky dressings
- 5. Immediate (<1-2 hours) evacuation possible:
 - a. Consider helicopter if anticipate prolonged ground extrication >1-2 hours
 - b. Do not attempt to rewarm frostbitten tissue
 - i. Do NOT rub affected part or apply heat (direct or indirect)
 - c. Motrin (Ibuprofen) 800mg PO (if available and not contraindicated)
 - d. Prevent trauma and direct pressure (blankets, litter straps, etc.) to frostbitten tissues
 - i. Build frame and padded splint around frostbitten limbs during transport
 - ii. Do NOT have patient walk on frostbitten feet or use frostbitten hands unless patient or rescuer in danger
 - e. Elevate frostbitten limbs above level of the heart if possible
- 6. Immediate evacuation (> 1-2 hours) NOT possible:
 - a. Seek nearest warm shelter
 - b. Remove wet clothing, tight fitting garments, rings, jewelry, and boots. Replace with dry, insulating, loose-fitting garments or padded dressings.
 - c. Call the burn center to discuss possible re-warming
 - d. Consider rewarming ONLY if able to prevent refreezing:
 - i. Rapid rewarming with water immersion 104 F (40 C) is preferred method
 - 1. Avoid tissue touching sides or bottom of container
 - 2. Warm for 10-30 minutes (until tips of frostbitten limbs become flushed red or purple, and tissue soft and pliable to gentle touch)
 - 3. Caregiver should test and circulate warm water with hand
 - ii. Slow rewarming (warm tent/hut, adjacent body heat) if only option
 - iii. Avoid using any direct heat: fire, space heaters, oven because risk of thermal injury to non-perfusing tissue (frostbite)
 - iv. Anticipate pain with re-warming
 - v. Do not break or drain blisters that may appear after re-warming

- vi. Apply loose, bulky sterile dressings and avoid pressure points
- vii. Elevate affected areas above level of the heart to help with swelling
- e. Motrin (Ibuprofen) 800mg by mouth (if available and not contraindicated)
- f. When evacuation possible:
 - i. Avoid refreezing of thawed tissue
 - ii. Prevent trauma and direct pressure (blankets, litter straps, etc.) to frostbitten tissues with frame and padded splint around frostbitten limbs during transport
7. Hydration with warm oral fluids (if alert and no nausea/vomiting) or IV hydration
8. Supplemental oxygen if available
9. Maintain non weight bearing status whenever possible to affected tissue
10. Rewarming should not be started if refreezing is expected before definitive care; repeated freeze/thaw cycles are contraindicated for thrombolytics and tend to have worse outcomes

III. Emergency Department Guidelines for Management of Severe Frostbite

1. Primary assessment/treatment for ABCs and traumatic injury
2. Document vital signs, including core temperature (esophageal or rectal)
3. Assess and treat for hypothermia
4. Provide supplemental oxygen
5. Tetanus prophylaxis as indicated
6. Motrin 800 mg PO (if not contraindicated or previously provided)
7. Establish IV access for hydration and analgesia
8. Circulating water bath:
 - a. Temp 104 F (40 C)
 - b. 10-30 minutes until distal tip of frostbitten limb becomes flushed red or purple, and tissue soft and pliable to gentle touch
 - c. If outerwear (gloves, socks, etc) are adherent and also frozen, do not forcibly remove. Immerse the entire area in the warm water – may take longer than 30-45 minutes to fully rewarm. Once the outerwear can be safely removed, remove and continue rewarming
9. Anticipate pain with re-warming
10. Air dry – do NOT towel dry.
11. Defer aspiration or debridement of clear, cloudy, or tense blisters to burn center consultant. Can occur at referral center.
12. Wrap frostbitten areas in warm dry linens. Defer to application of topical aloe vera and padding between affect digits to burn center consultant. Can occur at referral center.
13. Dry bulky padded dressing to avoid pressure points
14. Avoid tapping, bumping or ambulation on frostbitten tissue
15. Elevate above level of the heart to reduce edema
16. Consult Burn Center for further management and Alteplase (t-PA) eligibility:
 - a. Initiate IV Alteplase (t-PA) prior to transfer if advised by Burn Center consultant and meets Inclusion Criteria:
 - Severe frostbite with clear evidence of frozen tissue and/or decreased perfusion upon rewarming
 - < 24 hours from time of completion of rewarming (warm ischemia time)
 - No contraindications to Alteplase (t-PA)
 - b. Confirm IV Alteplase (t-PA) treatment protocol (see part V. Guidelines for Management)

IV. Inpatient Guidelines for Management of Severe Frostbite

1. Primary and secondary assessments, including a history and physical
 - a. Document time spent outdoors, pictures of the affected areas prior to and following rewarming, and time rewarming was completed,
2. Document vital signs, including temperature, and obtain an accurate weight
3. If patient is hypothermic, continue to treat until normothermic
4. Provide supplementation oxygen
5. Ensure patient has IV access and initiate hydration with warm IV fluids
6. Remove wet or tight-fitting garments (e.g., rings, jewelry, boots) and replace with dry, loose-fitting, bulky, insulating dressings or garments
7. Warm the environment
8. Medications
 - a. Scheduled Ibuprofen
 - b. Consider starting scheduled Gabapentin and/or Tylenol for additional pain management
9. If t-PA eligibility assessment has not been completed, perform assessment
10. If the patient is a candidate, initiate IV Alteplase (t-PA) **(see protocol below)**
11. Prepare and initiate rapid rewarming if not completed prior to admission
12. Daily Wound Care
 - a. Take down all dressings and wash wounds at least once a day
 - b. Allow to air dry
 - c. Blisters may continue to form for 2-7 days following rewarming
 - i. clear/cloudy tense blisters should be unroofed/debrided daily
 - ii. hemorrhagic blisters should be left intact
13. PT/OT consults
 - a. Therapists can assist with off-loading shoes to prevent walking on the injured areas
 - b. Maintain full non-weight bearing status to prevent rupturing of the hemorrhagic blisters for the first 72 hours
 - c. Early ambulation after 72 hours with wound protection

V. Guidelines for Management of Severe Frostbite (3rd or 4th degree) with tPA

Vanderbilt Burn Center Absolute Contraindications for tPA:

If YES to any, do NOT give Alteplase (t-PA)

- | NO | YES |
|--------------------------|--|
| <input type="checkbox"/> | <input type="checkbox"/> Repeated freeze-thaw cycles |
| <input type="checkbox"/> | <input type="checkbox"/> > 24 hours warm ischemia time (defined as passive or active rewarming) |
| <input type="checkbox"/> | <input type="checkbox"/> Concurrent or recent (within 1 month) intracranial hemorrhage, subarachnoid hemorrhage or trauma with active bleeding |
| <input type="checkbox"/> | <input type="checkbox"/> Inability to follow a neurologic exam (intubated and sedated for example, altered mental status) |
| <input type="checkbox"/> | <input type="checkbox"/> Severe uncontrolled hypertension (SBP > 180 mmHg) and/or DBP > 105 mmHg):
Hydralazine and/or labetalol may be used to lower BP to acceptable limits per burn center consultant. Do not begin Alteplase (t-PA) until BP within acceptable limits. |

Relative Contraindications to Alteplase (t-PA):

If yes to any of the following: discuss with the patient and the Burn Attending

- | NO | YES |
|--------------------------|--|
| <input type="checkbox"/> | <input type="checkbox"/> Recent intracranial or intraspinal surgery, serious head trauma (within 3 months) |
| <input type="checkbox"/> | <input type="checkbox"/> History of an active gastrointestinal bleeding |
| <input type="checkbox"/> | <input type="checkbox"/> Pregnancy |

Use Caution and discuss with Burn Attending if YES to any of the following prior to the use of tPA:

- | NO | YES |
|--------------------------|--|
| <input type="checkbox"/> | <input type="checkbox"/> Age >75 |
| <input type="checkbox"/> | <input type="checkbox"/> Prior ICH, known structural intracranial process, intracranial neoplasm |
| <input type="checkbox"/> | <input type="checkbox"/> Non-compressible vascular punctures |
| <input type="checkbox"/> | <input type="checkbox"/> Recent internal bleeding (within 2-4 weeks) |
| <input type="checkbox"/> | <input type="checkbox"/> Dementia |
| <input type="checkbox"/> | <input type="checkbox"/> Remote history of ischemic stroke (> 3 months) |
| <input type="checkbox"/> | <input type="checkbox"/> Recent major surgery (within 3 weeks) |

Document the risks and benefits discussion with the patient in their chart

Alteplase (t-PA) Treatment Protocol

- Accurate patient weight
- 2-3 large-bore peripheral IVs. One line dedicated to Alteplase (t-PA)
- Baseline labs (CBC, BMP, Mg, P, ionized-Ca, PT/TT, CK, and HCG if indicated)
- Complete 2-person skin assessment
- Obtain baseline vital signs and neurological examination
- Insert invasive tubes or lines before Alteplase (t-PA). Avoid NT suction if possible.
- Limit arterial, venous, muscular, and subcutaneous punctures during infusion. Avoid puncture of non-compressible sites. Provide Tdap before initiating therapy.
- Alteplase (t-PA) bolus 0.15mg/kg over 2 min, then
- Alteplase (t-PA) drip 0.15 mg/kg/hr over 6 hours
- Total dose Alteplase (t-PA) not to exceed 100mg
- Flush tubing with NS to ensure that entire does of Alteplase (tPA) administered
- Lovenox therapeutic dose of 1 mg/kg SQ immediately following (within 10 minutes) the completion of Alteplase (tPA) infusion. Continued Lovenox Q12 hours for 1 week.
- Patient to remain on bedrest during infusion

Note: A bone scan does not need to be completed prior to t-PA initiation. The Healthcare Provider may order t-PA based on a physical assessment.

VI. Patient care considerations during thrombolytic therapy:

- a. Complete skin assessment and monitor patient for bleeding or hematomas every 2 hours.
 - i. Notify the Healthcare Provider immediately for new hematoma or bleeding.
- b. Monitor vital signs every 15 minutes x 4, then every 30 minutes x 2, then every 1 hour x 22 hours.
 - i. BP should remain less than 180 systolic and 105 diastolic during Alteplase (t-PA) infusion.

- ii. This may be achieved with administration of hydralazine and/or labetalol as ordered.
- iii. Notify the Healthcare Provider if blood pressure cannot be maintained within the above parameters.
- c. Basic Neurological checks should be completed approximately every 15 minutes x 4, then approximately every 30 minutes x 2, then approximately every 1 hour x 22 hours.
 - i. In case of any acute change in mental or neurological status (including but not limited to unresponsiveness, pupillary changes, headache, nausea, vomiting or seizure):
 - 1. Stop the Alteplase (t-PA) infusion.
 - 2. Call the Healthcare Provider.
 - 3. Prepare for emergent head CT.
- d. Complete neurovascular checks to the affected extremity every 1 hour x 8 hours.
- e. Limit arterial, venous, muscular and subcutaneous punctures. Avoid puncture of non-compressible sites.
- f. Avoid discontinuing peripheral IV or arterial access sites during infusion, if possible.
- g. Activity restrictions:
 - i. During Alteplase (t-PA) infusion, patient should remain on bedrest.
 - ii. Active and functional range of motion is important to help improve circulation and should be encouraged.

VII. Patient care considerations post-thrombolytic therapy:

- a. Continue to monitor patient for superficial bleeding at IV, arterial, and venous puncture sites.
- b. Continue to monitor vital signs approximately every hour x 18 hours, or for a minimum of 24 hours after initiating Alteplase (t-PA) infusion.
- c. Continue basic neurological checks approximately every hour x 18 hours, or for a minimum of 24 hours after initiating Alteplase (t-PA) infusion. Ambulation should be promoted starting 90 minutes after Alteplase (t-PA) infusion is complete, unless otherwise contraindicated.
- d. The patient should remain ICU Status for 24 hours after initiation of Alteplase (t-PA) infusion.
- e. Activity restrictions:
 - i. Patients with frostbite to their feet should remain on bedrest for at least 90 minutes post thrombolytic infusion, and the patient's activity restrictions are changed by the Healthcare Provider.
 - ii. Appropriate footwear/ splints may be ordered and fitted by therapy.
 - 1. Appropriate footwear/ splints should be applied at all times during ambulation until otherwise ordered.
 - iii. Patients with frostbite injury to their upper extremity(ies) should be educated to restrict all activity of that extremity until edema and blistering are resolved and the patient's activity restrictions have been changed by the Healthcare Provider. They should avoid bumping the injured extremity as this may cause further tissue damage.
 - 1. Appropriate splints may be ordered by the Healthcare Provider and applied to prevent contractures.

VIII. Imaging in Frostbite:

1. Plain Radiography (X-rays)

- a. Role of x-ray in acute frostbite management is limited. Initial radiographs may show soft tissue swelling acutely and underlying traumatic injuries, which provides limited prognostic information.
- b. Later concerns for osteomyelitis – may show distal tuft acro-osteolysis, and phalanx bone changes post-frostbite.

2. CT & MRI

- a. CT: Rarely used for frostbite but valuable for ruling out deep tissue injury and fractures.
- b. MRI: May help demarcate ischemic soft tissue and evaluate deep damage (e.g., muscle, tendon).
- c. Particularly useful when clinical exam and X-ray don't provide clarity on soft tissue viability.
- d. *Note: Neither of these are currently being used as part of our current guideline*

3. Ultrasound

- a. Ultrasound-based Doppler (including LDI) can assist field triage when angiography or nuclear imaging is unavailable.

4. Angiography (DSA and MRA)

- a. Digital Subtraction Angiography (DSA) evaluates microvascular integrity; guides catheter-directed thrombolysis to restore perfusion in severe cases.
 - i. *Note: This is not part of our current guideline*
- b. Fluorescent microangiography is a modality with evidence to suggest its utility in evaluating frostbite. Lacey et al in 2019 demonstrated a strong positive correlation between microangiography studies and amputation level. The major advantage of microangiography is that it can be performed at bedside, minimizing imaging and thus time to treatment
 - i. **Although a great option and resource – it is not currently available at our institution and is therefore not part of our current guideline.**
- c. Contrast-enhanced MRA can reveal vascular compromise in limbs, aiding in early interventional decision-making.
 - i. *Note: This is not part of our current guideline*

5. Nuclear Medicine: Bone Scintigraphy & SPECT/CT

- a. **Three-phase 99mTc-MDP bone scans** assess early perfusion and tissue viability, typically performed 2–7 days post-injury.
 - i. Recommend that all patient's with concerns for 3rd/4th degree frostbite undergo a triple-phase bone scan (TPBS) 24 hours following administration of tPA and if was not a candidate for tPA within 24-48 hours following admission.
 - ii. Repeat TPBS should be ordered 72 hours following the initial study to assess for tissue viability and possible need for surgical intervention including grafting and amputation
 - iii. Patients with concerns for the need for amputation should have a consult placed with the local prosthetist (Hangar)
- b. **Multiphase scans with SPECT/CT** precisely localize vascular deficits and significantly aid prognostication and surgical planning, often earlier than clinical signs appear.
 - ii. SPECT/CT can be ordered at the same timing as above instead of a TPBS – however if used in place of a TPBS should be ordered as the initial and follow up for better comparison.

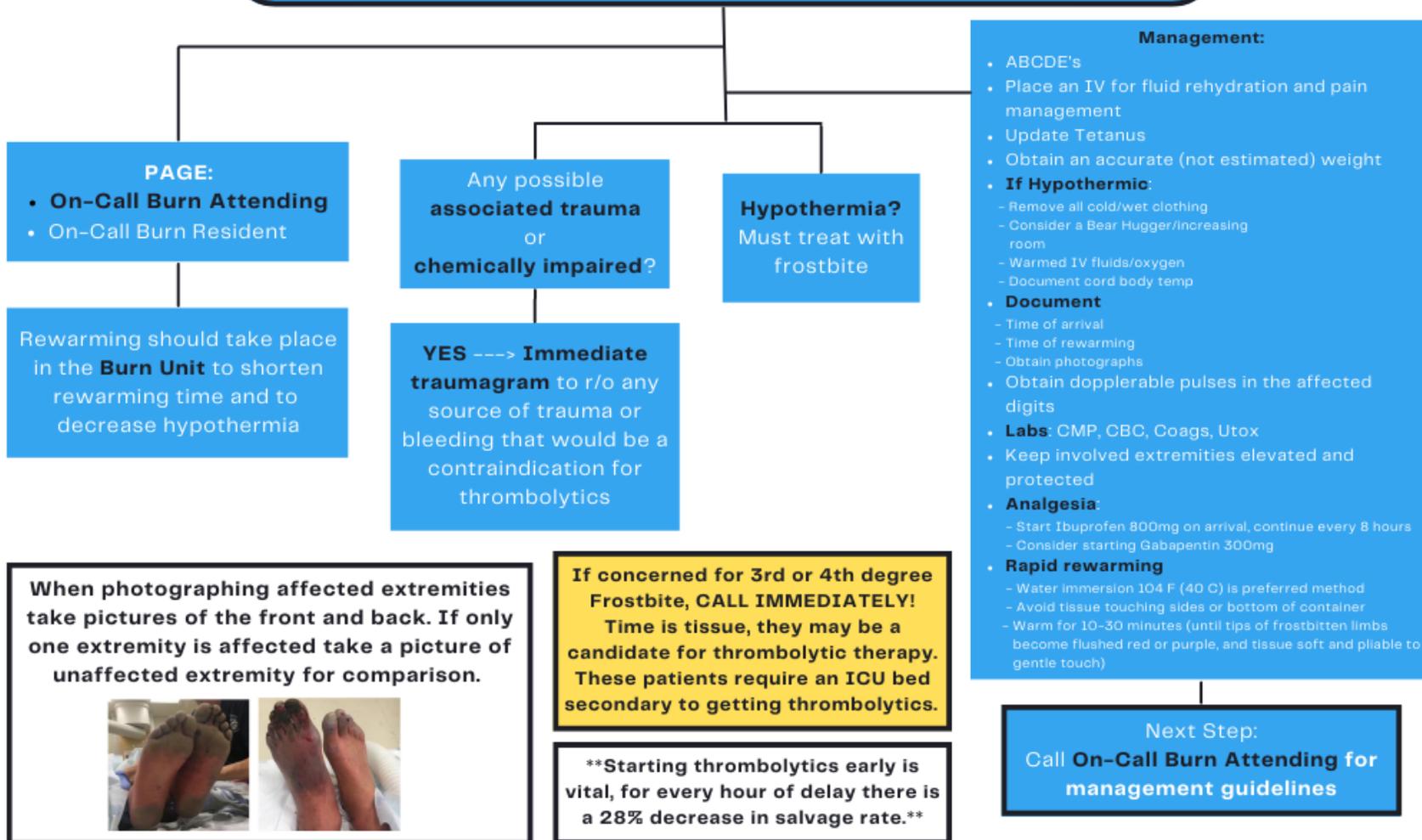
Quick Reference for *Approximate* Expected Dose Based on Weight

Administration of Activase (Alteplase) when thrombolytic therapy (t-PA) is initiated at the Burn Center				
Weight (kg)	Bolus dose (mg) (over 2 min)	Infusion Dose (mg) (over 6 hours)	Rate (mL/hr)	Total Dose (mg)
40	6	36	6	42
42	6.3	37.8	6.3	44.1
44	6.6	39.6	6.6	46.2
46	6.9	41.4	6.9	48.3
48	7.2	43.2	7.2	50.4
50	7.5	45	7.5	52.5
52	7.8	46.8	7.8	54.6
54	8.1	48.6	8.1	56.7
56	8.4	50.4	8.4	58.8
58	8.7	52.2	8.7	60.9
60	9	54	9	63
62	9.3	55.8	9.3	65.1
64	9.6	57.6	9.6	67.2
66	9.9	59.4	9.9	69.3
68	10.2	61.2	10.2	71.4
70	10.5	63	10.5	73.5
72	10.8	64.8	10.8	75.6
74	11.1	66.6	11.1	77.7
76	11.4	68.4	11.4	79.8
78	11.7	70.2	11.7	81.9
80	12	72	12	84
82	12.3	73.8	12.3	86.1
84	12.6	75.6	12.6	88.2
86	12.9	77.4	12.9	90.3
88	13.2	79.2	13.2	92.4
90	13.5	81	13.5	94.5
92	13.8	82.8	13.8	96.6
94	14.1	84.6	14.1	98.7
95	14.25	85.5	14.25	99.75

IX. Frostbite Injury Practice Management Pathway

Vanderbilt Regional Burn Center

Frostbite Injury Practice Management Pathway



When photographing affected extremities take pictures of the front and back. If only one extremity is affected take a picture of unaffected extremity for comparison.



If concerned for 3rd or 4th degree Frostbite, CALL IMMEDIATELY! Time is tissue, they may be a candidate for thrombolytic therapy. These patients require an ICU bed secondary to getting thrombolytics.

Starting thrombolytics early is vital, for every hour of delay there is a 28% decrease in salvage rate.

Next Step:
Call On-Call Burn Attending for management guidelines