Snake Bite First Aid: 
Interest of Experimental Studies

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Disclaimers

• Disclaimers
  – Nothing to declare

• Apologies
  – For those investigators whose work is not covered
Objectives

• Describe how venoms are disseminated after a poisonous snakebite on an extremity
• List the proposed first aid measures for delaying dissemination of venoms
• Evaluate the scientific studies that support or refute methods of snake bite first aid
• List and critique the authoritative recommendations for field treatment of poisonous snakebites
venom dissemination: poisonous snakebite on an extremity

• Subcutaneous envenomation
  – Lymphatic flow into vascular system

• Muscle envenomation
  – Lymphatic flow into vascular system

• Vascular envenomation
  – Direct inoculation of vascular system
  – Rapid onset of systemic illness
Mechanisms of lymph flow

• One way lymphatic endothelial valves (absorption into lymph vessels)
• Contractile fibers in lymph endothelial cells
• Propulsion of lymph by external compression from skeletal muscle
• Intrinsic pump: smooth muscle contractions in the larger lymphatic vessel walls (major mechanism at rest).
Venom transported to central circulation by lymphatic system

Controlled study in Rabbit
Tiger Snake Venom, 5 mg in 0.1 mL of saline
Extremity injection
With or without ligation of lymphatic channels in groin.
End point was death from respiratory paralysis.
Survival times ~10 minutes versus survival to one hour
Proposed first aid measures for delaying dissemination of venoms

• Suction to remove venom
  – Sawyer extractor & related devices/techniques

• Electric shock

• Retard lymphatic flow
  – Pressure-immobilization bandage
  – Compression pad/ring
  – Lymphatic Flow Inhibitor
    • (GTNO) glyceryl trinitrate ointment
Sawyer Extractor Pump Kit
$17.00
Item # 407144
This item may be available in your local REI store.
find in store
Free U.S. standard shipping through April 15.
No minimum purchase!
Free shipping with REI Store Pickup.
Venom Extraction Unit for treatment of or snakes bites. K205-034

If applied in the first three minutes, a Venom Extractor can remove a portion of the venom. Wipe the bite site with alcohol wipes to prevent the infection and apply the alcohol relief wipes. Instruction how to use on the back of the package.

If in doubts as to degree of injury, call physician

List Price: $15.99

Sale Price: $12.99
Extractor Pump Kit For Removal of Poisons from snake bites, bee and wasp stings, mosquito bites & more SKU: B4L

The Extractor Vacuum Pump was designed specifically to provide the most powerful suction available for the safe extraction of venoms and poisons. Because the Extractor's Double Chamber Pump action is so powerful you will not need to use the dangerous scalpel blades or knives associated with less effective bite kits. Because it's a Pump and not a Syringe, it's easy to use with one hand. Just select which of the four plastic cups best covers the bitten area, attach it to the pump, then a simple push of the plunger with your thumb and the Extractor Pump will quickly and effectively remove venoms and poisons from below your skin. By simply cleaning the cups after each use you may safely reuse the pump over and over again.

List Price: $38.99
Sale Price for 2: $32.00
CONCLUSION:
Sawyer Extractor pump removed bloody fluid from our simulated snakebite wounds but virtually no mock venom removed. Suction is unlikely to be an effective treatment for reducing the total body venom burden after a venomous snakebite.

Alberts MB, Shalit M, LoGalbo F.
Electric Shock: Ineffective and Dangerous

Inhibition of Lymphatic Flow
Human Foot to groin lymphatic transit time

- simulated snakebite
  - 50 μl of sterile radiolabeled colloid injected subcutaneously in the dorsum of the foot
- human volunteers
  - six male, nine female; age 20–65 years
- 13 min (range 4 to 81 minutes)
Commonwealth Serum Laboratories Method
ace wrap and splint

Pneumatic splint

Monash Method
Firm Pad and broad bandage
Methods

• Subjects: 12 healthy subjects 18 to 28 years
• Venom surrogate: radioiodinated insulin
Monash Method
Figure 2. The rate of appearance of radioactivity in the blood after subcutaneous injection of $^{14}C$-insulin. Subject (A) was untreated; subjects (B), (C), and (D) received first aid treatment for the durations shown by the arrows. Each subject was injected at time zero. (Note logarithmic scale on the time axis.)
Pressure immobilization Bandages

- Anesthetized pigs
- Distal forelimb
- 10 mg Eastern Coral snake (*Microcrus fulvius*) venom
- End-point: survival to 8 hours, respiratory failure

Pressure-Immobilization Bandages in a Porcine Model Of Eastern Coral Snake (*Micrurus fulvius*) Envenomation

![Graph showing the respiratory rate over time in minutes. The graph compares baseline values with those in the control and treatment (Tx) groups.](image)
Pressure-Immobilization Bandages in a Porcine Model Of Eastern Coral Snake (*Micrurus fulvius*) Envenomation

% survival to 8 hours

<table>
<thead>
<tr>
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<th>Untreated</th>
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<td>Pressure-Immobilization Bandages</td>
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% survival to 8 hours
Lymphatic blockage for venoms with local necrosis & systemic toxicity

• Sequester venom in extremity

• Expectation
  – Delay systemic toxicity
  – Increase local toxicity
First aid for Russell’s viper bites

Local compression immobilisation first aid:

- Rubber pad with strip of bandage (left)
- Cotton pad (right)
- Cotton strip for bandaging the cotton pad (top)
First aid for Russell’s viper bites

• Prospective study
• Humans bitten by Russell’s viper.
• Serum venom levels measured by ELIZA assay
Variable time from bite to application of pad

Fig 2 - Venom levels of cases with the pad in place, before and after release of the pad.
First aid for Russell’s viper bites

Local compression immobilization first aid trial

Side effects: - similar to controls

Local swelling, pain and tenderness
local necrosis (8% vs 10%)
-Blackening 10%

Had applied as long as 2hrs in one without ill effects

PIB for Rattlesnake Envenomation

- Randomized controlled study
- Porcine model
- 250 mg Western Diamondback Rattlesnake venom (limitation)
- Antivenom administered after 24 hours
- Two groups
  - PIB applied
  - Control

analgesia

• Fentanyl patch applied at the beginning of the procedure
• General anesthesia for 5 hours
• Pain management by veterinarian staff
• Morphine and NSAID given PRN
• Surviving animals were walking, eating, drinking, appeared in no great distress
One pig in the treatment group died precipitously when the bandage was removed.

Two pigs in the treatment group survived for 28 days with use of the limb.
Is long term survival possible with chronic lymphatic blockage?

- Smyrnioudis et al., SAEM, May, 2012
- 10 pigs
- Randomized control trial
  - (Ace wrap + cast) versus no intervention
  - Pressure not monitored
- Relevance to bites without antivenin
- 10 mg Eastern Coral Snake Venom
  - Antivenin no longer available in USA
- Endpoint: survival to 21 days
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<tr>
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<td>2</td>
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<tr>
<td>3</td>
<td>Ace + Cast</td>
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<td>4</td>
<td>Control</td>
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Conclusions

• Long term survival is possible with PIBs in the absence of antivenin therapy for Eastern Coral Snake envenomations (and perhaps for other elapids)
• Large variability in survival
• Necrosis occurred in surviving animals
• Future studies must monitor pressures
Torso envenomations

- Jason Hack MD
- Circumferential compression device
- Porcine Studies in Eastern Coral Snake and Eastern diamondback
Fig. 2  a Vital signs. Pulse rate during experiment until just prior to cardiovascular collapse. b Mean arterial pressures during experiment until just prior to cardiovascular collapse.
A pharmacological approach to first aid treatment for snakebite

Megan E Saul1, Paul A Thomas2, Peter J Dosen3, Geoffrey K Isbister4,5, Margaret A O’Leary5, Ian M Whyte4,5, Sally A McFadden6 & Dirk F van Helden3

Snake venom toxins first transit the lymphatic system before entering the bloodstream. Ointment containing a nitric oxide donor, which impedes the intrinsic lymphatic pump, prolonged lymph transit time in rats and humans and also increased rat survival time after injection of venom. This pharmacological approach should give snakebite victims more time to obtain medical care and antivenom treatment.

caused marked slowing in foot-to-groin lymph transit time in each subject from 13 min (range 4–81 min) without GTNO to 54 min (range 6.5–162 min) with GTNO, a 344 ± 52% increase (mean ± s.e.m.; n = 15; P < 0.0001; Fig. 1).

We also undertook lymphatic transit measurements in rats anesthe-
tized with urethane (~1.5 g per kg body weight intraperitoneally) and maintained at 37 °C. Groin lymphatic vessels were surgically exposed (Supplementary Fig. 1). We measured foot-to-groin lymph transit times visually through a microscope in the presence of GTNO or a base ointment, with ointment applied over the entire leg within 20 s after hind foot injection of marker dye (India ink13). Transit time with GTNO treatment was threefold greater compared to control treatment (9.4 ± 0.8 min, n = 13 with GTNO versus 3.2 ± 0.2 min, n = 16 without GTNO; P < 0.0001). This outcome was similar to that observed in humans (Fig. 1). There was no significant difference (P = 0.12)
Lymphatic Flow Inhibitor

- nitric oxide (NO) impedes the intrinsic pump
- Saul et al.
  - Topical NO-releasing agents
  - Delay lymphatic transit time
  - delay onset of systemic toxicity.
Lymphatic Flow Inhibitor

• (GTNO) glyceryl trinitrate ointment (0.2% wt/wt)
  – Rectogesic, Care Pharmaceuticals; commercially available
  – 15 gm, circle, proximal to injection, 5 cm diameter
• simulated snakebite
  – 50 μl of sterile radiolabeled colloid injected subcutaneously in the dorsum of the foot
• human volunteers
  – six male, nine female; age 20–65 years
Foot to groin lymphatic transit time increased from 13 min (range 4 to 81 minutes) to 54 min (range 6.5 to 162 minutes) 344+52% increase, p < 0.0001
Anesthetized rats, eastern brown snake venom (*Pseudonaja textilits*)

Conclusions

• Blocking lymph flow with Pressure Pad, pressure immobilization bandages, circumferential device, & nitric oxide inhibitor delay systemic toxicity & may even limit local toxicity.

• Lymphatic flow blockage may have a role in the absence of definitive antivenin therapy.

• Pressure monitoring is essential in future studies.
Recommendations (North America)

American Heart Association recommends PIB for NA envenomations

AACT & ACMT no role in NA envenomations