**Clinical question.**

In victims of a venomous snakebite (P) does pressure immobilization (I) of an extremity, when compared to no therapy (C), improve outcome (O)?

**Is this question addressing an intervention/therapy, prognosis or diagnosis?** Intervention/therapy

**State if this is a proposed new topic or revision of existing worksheet.** Revision

**Conflict of interest specific to this question**

Do any of the authors listed above have conflict of interest disclosures relevant to this worksheet? No

**Search strategy (including electronic databases searched).**

PubMed

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("snakes"[MeSH Terms] OR "snakes"[All Fields] OR "snake"[All Fields]) AND ("immobilisation"[All Fields] OR "immobilization"[MeSH Terms] OR "immobilization"[All Fields]) AND English[lang] - 87

("snakes"[MeSH Terms] OR "snakes"[All Fields] OR "snake"[All Fields]) AND ("first aid"[MeSH Terms] OR ("first"[All Fields] AND "aid"[All Fields]) OR "first aid"[All Fields]) AND (("2000/01/01"[PDAT] : "2008/10/10"[PDAT]) AND English[lang]) - 51
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AHA EndNote Master library

Cochrane database for systematic reviews and Central Register of Controlled Trials

Hand searches of journals, review articles, and books

**State inclusion and exclusion criteria**

Only articles in the peer reviewed literature were included

No abstracts

Studies that do not specifically answer the question

**Number of articles/sources meeting criteria for further review:**

11
## Summary of evidence

### Evidence Supporting Clinical Question

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### Outcomes – Please define outcomes for this question, place them after letters below and use letters to identify studies which evaluate this outcome

A = Survival  
B = Intracompartmental Pressure  
C = Swelling  
D = Slowing Venom/Tracer Spread  
E = Other  

*Italics = Animal studies*
Evidence Neutral to Clinical question

| Good | | | | | Sutherland (1981) – C |
|------|------|--------|--------|------------------|
| Fair | | | Pe (2000) – C |
| Poor | | | | |
| 1 | 2 | 3 | 4 | 5 |

Level of evidence

Outcomes – Please define outcomes for this question, place them after letters below and use letters to identify studies which evaluate this outcome
A = Survival  C = Swelling  E = Other
B = Intracompartmental Pressure  D = Slowing Venom/Tracer Spread  Italics = Animal studies

Evidence Opposing Clinical Question

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A = Survival  C = Swelling  E = Other
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**REVIEWER’S FINAL COMMENTS AND ASSESSMENT OF BENEFIT / RISK:** (please include implementation considerations including at a minimum training, environment and availability):

The preponderance of evidence is supportive for use PI following snake envenomation. The landmark article is by Sutherland (Sutherland 1979, LOE 5) in a study in monkeys showing that application of a bandage at ~55 mm Hg and simultaneous immobilization with a splint is both efficacious and safe in retarding venom uptake into the systemic circulation and thus improving outcome until definitive in-hospital treatment can be received. Additional studies in humans (i.e. Howarth 1994, LOE 2) and animals (i.e. German 2005, LOE 5) have further demonstrated that lymphatic flow and “mock venom” uptake can be significantly or nearly completely reduced by proper application of both pressure and immobilization, with use of one or the other alone being insufficient. No adverse effects were seen within certain prescribed pressure ranges (>40 mm Hg and <70 mm Hg for upper limbs, >55 and < 70 mm Hg in lower limbs), which was translated into a useful and practical field estimation by a comfortably tight bandage under which a finger could be passed.

Previous concerns were raised that not all snake bites may benefit from pressure immobilization, and venom that produces more local tissue effects than systemic effects may in theory be worsened by “trapping” the venom in one place. This remains controversial. The recent work (Bush 2004, LOE 5) in a North American species demonstrated its effectiveness on survival in non-neurotoxic snakes.

The primary problem, based on two studies, pertains to first aid provider retention of ability to perform proper PI application (Norris 2005, LOE 5; Simpson 2008, LOE 5).

**Acknowledgements:**

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**Citation List**


Summary: This prospective, controlled cohort study of 12 humans were subjected to radioactive “mock venom” injections and three first aid treatments evaluated. Three subjects received either “CSL” pressure bandages, an air splint, or Monash method (firm pad and bandage), and three additional controls had no first aid measure. The authors conclude that the Monash method prevented uptake but the other two methods were ineffective. In a commentary that follows, authors Duncan, Tibbals, and Sutherland note that the Monash method is in effect a type of pressure immobilization technique, and had significantly higher pressure (120 mm Hg compared to 55 mm Hg) than the other two methods studied. At that level it was compared to an arterial tourniquet, which may have prevented uptake but they cautioned should not be adopted as a first aid measure until safety could be determined. Positive/Neutral (supports pressure immobilization in general but technique is in question). LOE 2 - D; Fair


Summary: In this study, the PI technique assessed use of the device in the Crotalus atrox. A porcine model was used, and the main outcomes were survival, extent of swelling, and intracompartmental pressure. Pigs who received PI survived longer than those that did not and had less swelling. However, intracompartmental pressure was higher in the PI group (though rare to have venom injected directly into compartment as was done in this study. LOE 5 – A,B,C; Fair

Summary: This randomized, controlled study used a porcine model for the first-ever assessment of PI in a North American coral snake (M. fulvius) envenomation. Following SQ injection of venom, animals received either PI (placed using aluminum and foam splints, used in a manner closely approximating actual clinical conditions) or no intervention. The primary endpoint was survival to 8 hours, and groups were also compared as to time to onset of systemic toxicity. Though 4 of 5 animals in the PI group survived, none in the control group lived. Signs of respiratory compromise were seen in only 2 PI animals (at 310 and 460 minutes post-envenomation); control animals manifested respiratory compromise in an average of 170 minutes post-envenomation. As assessed histologically, there were no local complications to PI use. LOE 5 – A,E ; Good


Summary: This study of 24 humans employed intradermal (9 subjects) and subcutaneous (15 subjects) injections of radiolabelled colloid to assess upper and lower extremity lymphatic transit times. Using the technique of immediate post-injection PI application in an upper and a lower extremity, the investigators used the non-PI extremities to serve as controls. Using a large field-of-view gamma camera, investigators demonstrated that immediate application of PI (40-70 mmHg) was an effective means of restricting peripheral-to-central lymphatic flow. It was also noted that strict immobilization was a requirement for lymphatic flow restriction (PI failed to restrict central lymphatic flow if subjects were allowed to walk for 10 minutes). Interestingly, if the PI bandage was applied too tightly (>70 mmHg) lymph flow actually increased; this was thought to possibly be due to discomfort-mediated muscle activity. LOE 2 - D; Good


Summary: Volunteers in a simulated snakebite scenario have difficulty applying PI correctly as defined in the literature. LOE 5 – E, Good


Summary: This study describes field trial of PI as a first-aid intervention in 42 Russell’s viper cases (19 of which involved actual envenomation). The trial was characterized by limited control analysis, in patients in whom PI was not executed. Though PI in a manner adherent to the protocol was carried out in a minority of cases (3/13 in whom PI was used), the authors were able to demonstrate efficacy of the PI technique in the following manner: During the first phase of hospitalization venom levels did not rise, but after PI was discontinued there was an associated rise in venom levels. Despite a wide range of PI times (30 minutes to 9 hours) there was minimal incidence of local necrosis and the incidence of local effects was no greater for PI cases than for cases (with proven systemic toxicity) in which PI was not applied. LOE 4 - D; Fair

Simpson ID, Tanwar PD, Andrade C (2008). The Ebbinghaus retention curve: training does not increase the ability to apply pressure immobilization in simulated snake bite–implications for

Summary: Neither written instructions nor intense training with feedback adequately prepares individuals to apply PIM with correct pressures under the wrap. LOE 5 – E; Good

Sutherland SK, Coulter AR, et. al. (1981). A study of the major snake venoms in the monkey – the movement of injected venom, methods that retard movement, and the response to antivenoms.

Summary: Confusing study with multiple venoms and procedures being performed and not clearly defined. It is difficult to discern scientific method and applicability. LOE 5 – A,D; Poor


Summary: In this study, the developer of the PI technique assessed use of the device in the crotalid Eastern diamondback. A monkey model was used, and the main outcome was radioimmunoassay for venom levels in plasma and urine. The study demonstrated very effective prevention of central movement of venom when PI was used, as compared to controls where there was no PI. Monkeys who received PI survived 24 hours and those that did not died. There was no change in extent of local changes between the two groups. The best results were obtained when antivenom was given before PI was removed. LOE 5 – A,C,D; Good


Summary: This study used a monkey model (with tiger snake envenomation) to provide one of the first demonstrations of the PI technique. A crude venom and a neurotoxin were injected into one of the lower limbs of the research animals, and PI was rapidly (within 60- 90 seconds) executed. An inflation pressure of 55 mmHg was used. Control animals were used, but full reporting on those animals was not part of this paper. In at least one animal, the injected monkey served as its own control due to faulty application of PI which was recognized and remedied. Overall, there was sufficient information in the results to make compelling case that PI, applied quickly and effectively with strict attention to both pressure and immobilization, significantly slowed central movement of both venom and neurotoxin. LOE 5 – D; Fair


Summary: This study of 15 cases of Russell’s viper envenomation (in Myanmar) seems to have involved some of the same cases as in Pe 2000. The authors employed RIA assays to check venom levels in the initial period of PI presence (in the hospital) and in the interval after PI removal. Venom levels remained low while PI was in place, but upon PI discontinuation venom levels increased significantly. LOE 4 – D,E; Fair