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## Techniques and Procedures

### REMOVAL OF THE PREHOSPITAL TOURNIQUET IN THE EMERGENCY DEPARTMENT

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**Abstract—Background:** Life-threatening hemorrhage from extremity injuries can be effectively controlled in the prehospital environment through direct pressure, wound packing, and the use of tourniquets. Early tourniquet application has been prioritized for rapid control of severe extremity hemorrhage and is a cornerstone of prehospital trauma resuscitation guidelines. Emergency physicians must be knowledgeable regarding the initial assessment and appropriate management of patients who present with a prehospital tourniquet in place. **Discussion:** An interdisciplinary group of experts including emergency physicians, trauma surgeons, and tactical and Emergency Medical Services physicians collaborated to develop a stepwise approach to the assessment and removal (discontinuation) of an extremity tourniquet in the emergency department after being placed in the prehospital setting. We have developed a best-practices guideline to serve as a resource to aid the emergency physician in how to safely remove a tourniquet. The guideline contains five steps that include: 1) Determine how long the tourniquet has been in place; 2) Evaluate for contraindications to tourniquet removal; 3) Prepare for

tourniquet removal; 4) Release the tourniquet; and 5) Monitor and reassess the patient. **Conclusion:** These steps outlined will help emergency medicine clinicians appropriately evaluate and manage patients presenting with tourniquets in place. Tourniquet removal should be performed in a systematic manner with plans in place to immediately address complications. © 2020 Elsevier Inc. All rights reserved.

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### INTRODUCTION

Hemorrhage accounts for 35% of prehospital trauma deaths and nearly 40% of deaths within the first 24 h of injury (1). Life-threatening bleeding from extremity injuries can be effectively controlled in the prehospital environment through direct pressure, wound packing, and the use of tourniquets. Tourniquet application has been shown to be safe, particularly if the tourniquet can be removed within 2 h of application (2–4). Placement of prehospital tourniquets in the civilian population has also been associated with a sixfold survival benefit (5). Early tourniquet application has been prioritized for rapid control of life-threatening extremity hemorrhage and is a cornerstone of prehospital trauma resuscitation

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guidelines (6–9). Tourniquets are increasingly being carried by law enforcement officers, first responders, and Emergency Medical Services (EMS) units (10,11). Studies have shown that laypersons can properly apply tourniquets with minimal training (12,13). Programs, including Stop the Bleed, empower laypeople with knowledge and skills, including tourniquets, to stop life-threatening bleeding (14–17). Tourniquets may be applied by members of the general public, first responders, and EMS clinicians to patients suffering from life-threatening extremity hemorrhage.

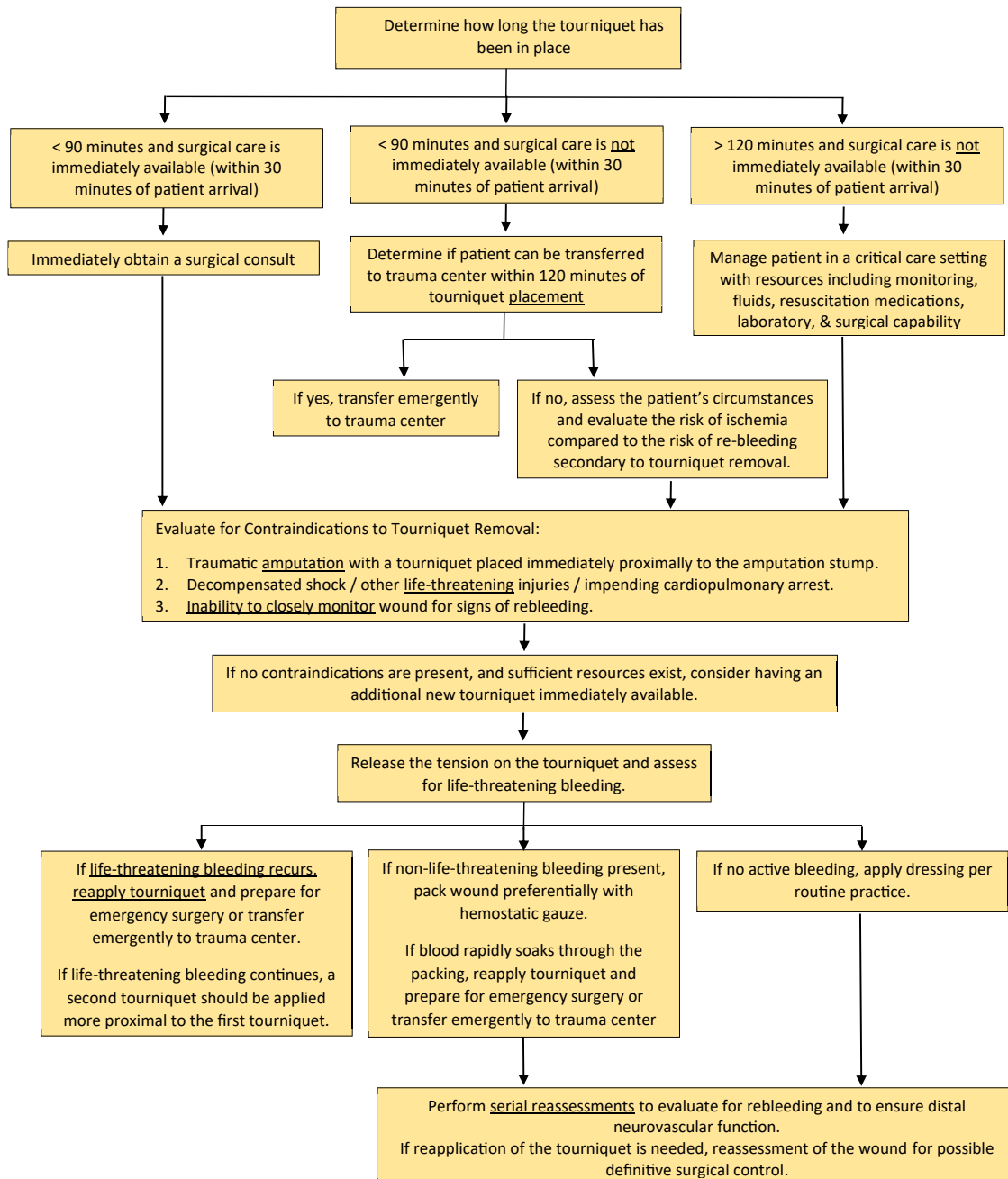
Emergency physicians must be knowledgeable regarding the initial assessment and appropriate management of patients who present with a tourniquet in place. This includes the indications, contraindications, proper methods, and potential pitfalls for tourniquet removal or conversion to another bleeding control maneuver or intervention. All efforts should be made to convert tourniquets to another type of bleeding control mechanism as soon as it can be done safely, and within 2 h when at all possible (7,8,18–20). Tourniquets in place for more than 2 h, especially those in place 6 h or longer, should be removed in a critical care setting, with the capability to address the local and systemic reperfusion effects associated with prolonged ischemia, as well as treat rhabdomyolysis, compartment syndrome, and other possible complications (21,22).

## DISCUSSION

An interdisciplinary group of experts including emergency physicians, trauma surgeons, and tactical and EMS physicians collaborated to develop a stepwise approach to the assessment and removal of a limb tourniquet in the emergency department (ED) after being placed in the prehospital setting. All members of this group were established subject matter experts and have credibility in multiple disciplines directly related to management of life-threatening hemorrhage including: emergency medicine (MJL, AMM, NT, CAG), trauma surgery (JP, KR, ALE), military medicine (JP, KR, CAG), and emergency medical services medicine (MJL, AMM, ALE, NT). In addition, multiple authors maintain national leadership roles within the Stop the Bleed community in the United States (MJL, ALM, CAG). The goal of this group was to share a best-practices approach to serve as a simple, yet comprehensive, resource for emergency physicians and resuscitation team members. A search of the existing literature was conducted and served as the base for the formation of the technique presented. This technique assumes familiarity with evaluation of the injured patient using standard best practices for initial trauma and critical care resuscitation.

## Technique: See Figure 1 (flow diagram)

1. *Determine how long the tourniquet has been in place and the availability of surgical resources.* If the exact duration cannot be determined, use time of EMS arrival to the scene.
  - a. If the tourniquet has been in place < 90 min, and surgical care is immediately available (within 30 min of patient arrival in the ED), immediately obtain a surgical consult. This is to help minimize the duration of tourniquet time to < 120 min and thus, help minimize ischemic tissue injury.
  - b. If the tourniquet has been in place < 90 min and surgical support is not immediately available, determine if the patient can be transferred to, and arrive at, a trauma center within < 120 min of tourniquet placement. If so, transfer to trauma center.
    - i. If the tourniquet is, or will be, in place > 120 min, consider consultation with the trauma surgeon at the trauma center, and assess the individual patient's circumstances (including presence of shock, other life-threatening emergencies, and the severity of the wound) and evaluate the risk of ischemia compared with the risk of re-bleeding secondary to tourniquet removal.
  - c. If a tourniquet has been in place > 120 min, assess for a contraindication to tourniquet removal.
    - i. If the treating physician determines that it is in the patient's best interests to remove a tourniquet that has been in place for  $\geq 2$  h, we highly encourage this be done in a critical care setting (ED/intensive care unit/operating room) that has resources including monitoring, fluids, resuscitation medications, laboratory, and surgical capability.
2. *Evaluate for Contraindications to Tourniquet Removal:* The following conditions are considered contraindications to tourniquet removal.
  - a. Traumatic amputation with a tourniquet placed immediately proximal to the amputation stump (within several inches).
  - b. Decompensated shock/other life-threatening injuries/impending cardiopulmonary arrest.
    - i. After the patient is stabilized, the tourniquet may be evaluated for removal as part of the secondary survey.
  - c. Inability to closely monitor wound for signs of rebleeding.
    - i. Once a tourniquet is removed, direct patient monitoring is required for a minimum of 1 h for signs of significant re-bleeding.



**Figure 1. Emergency department approach to the patient with a prehospital tourniquet.**

3. *Prepare for Tourniquet Removal:* If no contraindications to tourniquet removal are present, and sufficient resources exist, consider having an additional new tourniquet immediately available in the event that reapplication of the tourniquet becomes necessary and the initial tourniquet is damaged. Additional equipment, including hemostatic gauze, dressing materials, cardiac monitoring, and Advanced Cardiac Life Support medications should also be readily available.

- a. Clinicians should be aware that tourniquets are subject to significant wear and tear during application, therefore, having access to a new tourniquet, if at all possible, is advised (23–25).
- b. If the initial tourniquet was placed very high (proximally), a second tourniquet may be prepositioned in a location closer to the injury (within a few inches) but not directly over a joint.

4. Release the Tension on the Tourniquet:
  - a. If life-threatening bleeding is noted from the wound, re-tighten the tourniquet (or, if necessary, apply the second/backup tourniquet), noting the time of tourniquet reapplication. Prepare the patient for emergency surgery or transfer to a trauma center.
  - b. If no active bleeding, apply a dressing per routine practice.
    - i. Continue to monitor the wound for signs of recurrent bleeding.
  - c. If non-life-threatening bleeding is present:
    - i. A hemostatic agent-impregnated gauze (preferred, if available) should be packed into the wound.
      1. Manual pressure should be held for a minimum of 3–5 min.
      2. Firmly secure the gauze in place with a pressure dressing.
    - ii. If no hemostatic gauze is available, sterile gauze should be used to pack into the wound.
      1. Apply manual pressure followed by a firmly secured pressure dressing after bleeding has stopped.
    - iii. If blood rapidly soaks the recently placed packing, tourniquet removal (conversion) has failed.
      1. Tighten the tourniquet within a few inches of the wound, but not over a joint.
      2. If bleeding still persists, apply a second tourniquet proximal to the first tourniquet. Make arrangements for urgent surgical evaluation or transfer to a trauma center.
  - d. After successful conversion of the tourniquet to a pressure dressing, assess the extremity for the presence of distal pulses, and motor and sensory function.
    - i. If no further bleeding is noted, keep the tourniquet loose on the limb, in case needed for re-bleeding.
5. *Monitor & Reassess*: Once a patient with a tourniquet has been converted successfully to a conventional dressing, it is essential that the patient undergo serial reassessments for evidence of re-bleeding and to ensure the presence of distal neurovascular function.
  - a. Continue diagnostic evaluation and management, while carefully observing the patient for recurrence of bleeding for a minimum of 1 h.
  - b. As the patient's condition stabilizes and blood pressure increases, so do the chances for rebleeding.

- i. The previously placed tourniquet(s) should remain loose and proximal to the injury in case prompt reapplication is needed.
- c. If reapplication is needed, reassessment of the patient and their wound is indicated, and definitive surgical control may be needed.

## CONCLUSION

Life-threatening extremity bleeding may occur after instances of everyday traumatic injuries, as well as in mass casualty and high-threat situations. Patients will arrive at EDs via EMS and also via self-presentation, with tourniquets in place. These steps outlined will help emergency medicine clinicians initially caring for the traumatically injured patient to appropriately evaluate and manage patients presenting with tourniquets in place. Tourniquet removal (conversion) in the ED should be performed in a systematic manner, with plans in place to address complications.

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