



## **ARC SAC ADVISORY Pediatric Tourniquet Use**

### **Overall Recommendation:**

Data from epidemiologic studies and expert consensus specific that tourniquets should be used to treat life-threatening extremity hemorrhage in the pediatric population. This review demonstrates that a windlass tourniquet tested in two human studies (Combat Application Tourniquet Generation 7) can successfully occlude pulses down to a limb circumference of 13 cm in children as young as 2 years of age. For reference, this limb circumference is about the size of an average cucumber or a golf ball. As there is no evidence for either manufactured or improvised tourniquet use for children less than 2 years of age, it is the expert opinion of the First Aid Sub-Council that direct manual compression should be used to treat hemorrhage in children in this age group.

### **Recommendations and Strength (using table below):**

Standards:

- None

Guidelines:

- A manufactured windlass tourniquet should be used to treat life threatening extremity hemorrhage in children approximately 2-years-of-age and older. (LOE 3b)

Options:

- Direct pressure, with a hemostatic agent if available, should be used for children with life-threatening extremity bleeding when a windlass tourniquet is not available. (LOE 7)
- Direct pressure, with a hemostatic agent if available, should be used to treat life-threatening extremity bleeding in children less than 2-years-of-age. (LOE 7)

\* The only tourniquet that was tested in humans was the C-A-T<sup>®</sup> GEN7.

### **Questions to be addressed:**

In the pediatric population is one tourniquet type compared with another tourniquet type favored for lower limit of age, success rate, outcome, ease of use, or adverse effects?

### **Introduction/Overview:**

While tourniquets have become standard therapy for life threatening bleeding in adults, little data is available to guide the use of tourniquets in pediatric patients. Although the principles of bleeding control remain the same in both adult and pediatric patients, body size may limit the use of tourniquets in smaller limb circumferences. For instance, some tourniquets employ a rigid mechanical advantage system (e.g. windlass or ratchet) that precludes the ability to fit

circumferences that are smaller than that mechanism. As tourniquets rely on the ability to tighten enough to occlude distal blood flow, these circumference limitations may prevent successful use of certain tourniquets on the smaller limbs of pediatric patients. This question evaluates the pediatric trauma literature to determine if tourniquets can be successfully applied, and if there are lower age limits or tourniquet mechanisms recommended for pediatric casualties.

**Summary of Scientific Foundation:**

A literature search identified 7 studies for inclusion. One was an observational trial in volunteers age 6-16 years, one observational trial in pediatric patients age 2-7 years of age undergoing elective orthopedic surgery, two used models of pediatric limb circumferences, two were epidemiologic studies of tourniquet use in the pediatric population in conflict zones and one was a case report. One study on human volunteers demonstrated consistently successful application in both upper arms and upper legs of children  $\geq 6$  years of age (Harcke 2019). A second study demonstrated successful application in human participants 2-7 years of age with a minimal limb circumference of 13 cm (Kelly 2019). Studies in manikin and PVC models generally demonstrate that some windlass and ratcheting tourniquets have increased failure rates as model circumferences, with failure rates becoming increasingly higher in sizes that would model the upper extremities of children under 5 years of age (El-Sherif 2019, Vretis 2018). It is possible that the pliability of human tissue made the mechanism less of a factor than with the less pliable materials used in the two model studies. No study in this review specifically evaluated ease of use or lay provider use in the pediatric population. The First Aid Sub-council placed a high value on the human studies that suggest a windless type tourniquet (specifically C-A-T® GEN7) can abolish distal pulses in both the upper and lower extremities, if applied appropriately, to a child as young as 2 (in this case with a limb circumference of 13 cm). In using manikins and PVC pipe models the overall trend was that the smaller the circumference of the model, the less likely the tourniquet was to be successfully applied, however the overall results were inconsistent, and the Sub-council chose to significantly downgrade the certainty of these studies. In our review the Sub-council considered the position statements from both the Pediatric Trauma Society and the Committee for Tactical Emergency Casualty Care Pediatric Working Group, both of which advocate for the use of tourniquets for life-threatening extremity hemorrhage in the pediatric population (Cunningham 2018, Joint Trauma System 2019).