|  |
| --- |
| Question |
| **Should pressure dressings/bandages/devices compared with direct manual pressure be used for adults and children with severe, life-threatening external bleeding?** |
| **Population:** | Adults and children with severe, life-threatening external bleeding |
| **Intervention:** | Direct pressure to the wound with a compression dressing, compression bandage, or compression device |
| **Comparison:** | Direct manual pressure (manual or pressure dressings) |
| **Main outcomes:** | Death owing to bleeding, cessation of bleeding (restoration of hemostasis), and time to hemostasis, death from any cause, decrease in bleeding, and adverse effects (e.g. wound infection, limb loss, re-bleeding, pain related to an intervention). Where possible, the EtD tables also include information regarding outcomes related to provider ability to use / ease of use / feasibility / satisfaction (for method of bleeding control) and predictors of use/response (for method of bleeding control). |
| **Setting:** | All studies performed in the out-of-hospital setting (direct evidence), as well as studies providing indirect evidence about the effects of interventions collected in combat (military) settings, simulations (i.e. human volunteers, human cadaver or other models excluding animal models), and studies performed in the hospital setting, that clinical content experts judged as performed in sufficiently similar conditions to still be informative.  |
| **Perspective:** | Of the first aid provider and/or patient |
| **Background:** | Traumatic injury is a leading cause of morbidity and mortality and a major cause of death from traumatic injury is uncontrolled bleeding. Tourniquets and hemostatic dressings have the potentially to prevent morbidity and mortality from traumatic bleeding. Therefore it is easy to see that first aid care is essential to help prevent injury related morbidity and mortality, as injured persons can exsanguinate from severe injuries in only a few minutes.Current first aid recommendations for an individual with severe, life-threatening external bleeding includes applying direct pressure as standard therapy. Tourniquets and hemostatic dressings have been found to control bleeding effectively, therefore may be considered for use when standard measures are unable to control hemorrhage or in the situation where a first aid provider is unable to use standard first aid practices (for tourniquets) or for body areas where a tourniquet cannot be applied or is unable to control bleeding (for hemostatic dressings). There is no or limited data supporting the use of pressure points, elevation, or localized cold therapy.  |
| **Conflict of interests:** | None identified |

# Assessment

|  |
| --- |
| ProblemIs the problem a priority? |
| Judgement | Research evidence | Additional considerations |
| ○ No○ Probably no○ Probably yes● Yes○ Varies○ Don't know | Traumatic injury is the leading cause of injury related morbidity and mortality throughout the world, resulting in millions of hospitalizations each year. The leading cause of preventable mortality in injured patients is uncontrolled hemorrhage (Jacobs 2014 67). Hemorrhage is cited as the primary cause of death in 35% of traumatic mortalities and often contributes to death ultimately attributed to other causes (Kauvar 2006 S3). In addition, trauma related deaths disproportionality affects those in low and middle income countries where well established pre-hospital trauma systems may not exist (World Health Organization 2018). | Pressure dressings/bandages have been used in the past to attempt to obtain initial hemostasis and/or to maintain hemostasis once initial control is achieved. However, there is very little data comparing the use of a pressure dressing/bandage/device with direct manual pressure alone. |
| Desirable EffectsHow substantial are the desirable anticipated effects? |
| Judgement | Research evidence | Additional considerations |
| ○ Trivial● Small○ Moderate○ Large○ Varies○ Don't know |

| **Certainty assessment** | **№ of patients** | **Effect** | **Certainty** | **Importance** |
| --- | --- | --- | --- | --- |
| **№ of studies** | **Study design** | **Risk of bias** | **Inconsistency** | **Indirectness** | **Imprecision** | **Other considerations** | **pressure dressings/bandages/devices** | **direct manual pressure** | **Relative(95% CI)** | **Absolute(95% CI)** |
| Mortality due to bleeding - not reported |
| -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | -  | CRITICAL  |
| Cessation of bleeding - Civilian (follow up: 15 to 50 minutes) |
| 1 | observational studies  | serious a | not serious  | not serious  | serious b | none  | In one series of cases with wounds from penetrating trauma in the pre-hospital civilian setting, 54/62 (87.1%) achieved bleeding cessation with the ELAD pressure dressing. (Naimer 2006 644) | ⨁◯◯◯VERY LOW  | CRITICAL  |
| Cessation of bleeding - In-hospital (follow up: range <10 to 90 minutes) |
| 1 | randomised trials  | not serious  | not serious  | very serious c | serious d | none  | One RCT in the hospital setting with 400 patients undergoing endovascular procedure showed that 73% of patients in the pneumatic compression device group achieved hemostasis, while 99% of patients in the clamp compression and manual compression groups achieved hemostasis (overall p<0.0001). (Lehman 1999 1118) | ⨁◯◯◯VERY LOW  | CRITICAL  |
| Cessation of bleeding - In-hospital |
| 1 | observational studies  | serious f | not serious  | serious g | serious d | none  | One cohort study with 64 patients with arterio-venous fistula puncture for hemodialysis showed that bleeding cessation was achieved in 47% and 44% with manual compression in the first and third week of the block study design, while 82% had bleeding cessation with the IRIS bandage in the second week of the study (p<0.05 compared to the first and third week). (Boulanger 2014 102) | ⨁◯◯◯VERY LOW  | CRITICAL  |
| Time to hemostasis - In-hospital |
| 3 | randomised trials  | not serious  | not serious  | very serious c | serious d | none  | Three RCTs with a total of 918 patients undergoing endovascular procedures. In one study (Lehmann 1999 1118), the mean time to hemostasis with the use of a pneumatic device was 15.6± 4.81 minutes compared with a mean time of 14.5 ± 4.5 minutes with the use of a clamp and 13.9 ± 3.5 minutes in the manual compression group (overall p=0.006). In another study (Walker 2001 366) the mean time to hemostasis in the Femostop device group was 35.2 ± 12.3 minutes compared with the manual compression time of 12.9 ± 12.4 minutes (p<0.001). In the third study, mean time to hemostasis by device was as follows: Femostop 40.2 ± 23.2, C-clamp 32.6 ± 9.8 and manual 27.5 ± 6.3 minutes. Time to hemostasis was found to be significantly different among the compression methods (p<0.0001).(Chlan 2005 391)  | ⨁◯◯◯VERY LOW  | CRITICAL  |
| Time to hemostasis - In-hospital |
| 2 | observational studies i | serious a | not serious  | serious j | serious k | none  | Two cohort studies with a total of 3,587 patients undergoing endovascular procedures. The first study (Sulzbach-Hoke 2010 E1) with 332 patients showed that the use of a C-clamp had a higher median compression time to achieve hemostasis than the use of direct manual compression (median [min-max]:, 35 min [10-110] vs 20 min [10-45]; p<0.001). The second study (Semler 1985 234) with 2,250 patients showed that the use of a mechanical clamp had a time to hemostasis of 19.9 minutes compared with 33.5 minutes for the use of direct manual pressure.  | ⨁◯◯◯VERY LOW  | CRITICAL  |
|  |
| Decrease in bleeding - Civilian (follow up: 15 to 50 minutes; assessed with: Cessation or decrease in bleeding) |
| 1 | observational studies  | serious a | not serious  | serious m | serious b | none  | In one series of cases with wounds from penetrating trauma in the pre-hospital civilian setting, 7/62 (11.3%) achieved a decrease in bleeding with the ELAD pressure dressing. (Naimer 2006 644) | ⨁◯◯◯VERY LOW  | IMPORTANT  |

 | While there is little available literature in the first aid population, it is unlikely that most pressure dressings/bandages/devices available to first aid providers (either commercial or improvised) would achieve the same pressures to that of direct manual pressure.  |
| Undesirable EffectsHow substantial are the undesirable anticipated effects? |
| Judgement | Research evidence | Additional considerations |
| ○ Large○ Moderate● Small○ Trivial○ Varies○ Don't know |

| **Certainty assessment** | **№ of patients** | **Effect** | **Certainty** | **Importance** |
| --- | --- | --- | --- | --- |
| **№ of studies** | **Study design** | **Risk of bias** | **Inconsistency** | **Indirectness** | **Imprecision** | **Other considerations** | **pressure dressings/bandages/devices** | **direct manual pressure** | **Relative(95% CI)** | **Absolute(95% CI)** |
| Rebleeding - In-hospital |
| 1 | randomised trials  | not serious  | not serious  | very serious c | serious d | none  | One RCT comparing hemostasis techniques after endovascular procedures showed a rebleeding incidence rate of 16/102 (15.7%) with a pneumatic compression device, 5/143 (3.5%) with a compression clamp, and 4/152 (2.6%) with manual compression (overall p<0.0001). (Lehman 1999 1118) | ⨁◯◯◯VERY LOW  | IMPORTANT  |
| Rebleeding - In-hospital |
| 3 | observational studies  | serious a | not serious  | serious g,j | serious b | none  | Three observational studies with a total of 924 patients with either an arterio-venous fistula puncture for hemodialysis or undergoing endovascular procedures. The first study including 64 patients with arterio-venous fistula puncture for hemodialysis showed no benefit in rebleeding rates between the IRIS bandage and manual compression.(Boulanger 2014 102) One cohort study reported bleeding after hemostasis with a wristband device compared compared with manual compression and compressive dressing (0/112 [0%] vs 8/419 [1.9%]; p=0.21). (Neto 2015 271) A second cohort study reported the rate of bleeding complication with C-clamp (3/223 [1.3%]) and manual compression (2/105 [1.9%]).(Sulzbach-Hoke 2010 E1)  | ⨁◯◯◯VERY LOW  | IMPORTANT  |
| Complications/Adverse events - Civilian (follow up: range 15 to 50 minutes) |
| 1 | observational studies  | serious a | not serious  | serious a | serious q | none  | One series of cases with wounds from penetrating trauma showed that 4/62 (6.5%) had distal oedema in dressed areas. Naimer 2006 644) | ⨁◯◯◯VERY LOW  | IMPORTANT  |
| Complications/Adverse events - In-hospital |
| 3 | randomised trials  | not serious  | not serious  | very serious c | serious d | none  | Among three RCTs with a total of 918 patients undergoing endovascular procedure, one study showed a higher a higher rate of complications in the pressure device/bandages group compared to the manual pressure group. Walker 2001 366 reported 18.1% (21/116) vs. 9.0% (13/143) (RR=1.99, 95% CI: 1.04-3.80; p=0.04). Lehmann 1999 1118 reported a comparable rate for pneumatic compression (25%), clamp compression (30%), and manual compression (26%). The third study showed a lower rate in the pressure device group (94/207 [45.4%] vs. 56/99 [56.6%]) (RR=0.80, 95% CI: 0.64-1.01; p=0.06).(Chlan 2005 391) | ⨁◯◯◯VERY LOW  | IMPORTANT  |
| Complications/Adverse events - In-hospital (follow up: range 15 to 50 minutes) |
| 3 | observational studies t | serious u | not serious  | very serious c | serious d | none  | Three observational studies with a total of 3,794 patients with either an arterio-venous fistula puncture for hemodialysis or undergoing endovascular procedures. One cohort study in patients undergoing endovascular procedures showed a lower rate of complications in the mechanical clamp group compared to the manual pressure group (2% vs 6%; p<0.001).(Semler 1985 234) A second cohort study in patients undergoing percutaneous coronary intervention showed a comparable rate of complications with C-clamp compared with manual compression (40/223 [17.9%] vs 19/105 [18.1%]). The third study reported no complications using the IRIS bandage or manual compression in patients with AV fistula.(Boulanger 2014 102) | ⨁◯◯◯VERY LOW  | IMPORTANT  |

 Two cohort studies with a total of 3,587 patients undergoing endovascular procedures. The first study (Sulzbach-Hoke 2010) with 332 patients showed that the use of a C-clamp had a higher median compression time to achieve hemostasis than the use of direct manual compression (median [min-max]:, 35 min [10-110] vs 20 min [10-45]; p<0.001). The second study (Semler 1985) with 2,250 patients showed that the use of a mechanical clamp had a time to hemostasis of 19.9 minutes compared with 33.5 minutes for the use of direct manual pressure. l | Studies showed mixed results in the rate of complications or adverse events due to pressure dressings/bandages/devices. The application of a compression dressing, bandage or device will take longer to accomplish than applying manual pressure to a wound. This is an undesirable delay with severe, life-threatening bleeding when time is of essence to control bleeding. |
| Certainty of evidenceWhat is the overall certainty of the evidence of effects? |
| Judgement | Research evidence | Additional considerations |
| ● Very low○ Low○ Moderate○ High○ No included studies | The certainty of the evidence across all outcomes was determined to be very low. Certainty downgrades were due to risk of bias, indirectness and imprecision.  | There is a mix of low and very low certainty evidence. A number of critical outcomes and those with related RCTs had low certainty evidence. Most of the data is indirect, many studies looking at arterial access from endovascular procedures, which also decreases the certainty of the evidence.  |
| ValuesIs there important uncertainty about or variability in how much people value the main outcomes? |
| Judgement | Research evidence | Additional considerations |
| ○ Important uncertainty or variability○ Possibly important uncertainty or variability● Probably no important uncertainty or variability○ No important uncertainty or variability | No research evidence | Like other forms of hemostasis for control of severe, life-threatening bleeding, the outcomes of reduced mortality and control of bleeding are valued. The main goal is to have rapid, effective bleeding cessation. There is no specific research evidence regarding the value of pressure dressings/bandages/devices or direct manual pressure specifically.  |
| Balance of effectsDoes the balance between desirable and undesirable effects favor the intervention or the comparison? |
| Judgement | Research evidence | Additional considerations |
| ○ Favors the comparison● Probably favors the comparison○ Does not favor either the intervention or the comparison○ Probably favors the intervention○ Favors the intervention○ Varies○ Don't know | Several of the studies demonstrated no difference between manual pressure and pressure bandages/devices or higher benefit with manual compression. One RCT in the hospital setting with 400 patients undergoing endovascular procedure showed that 73% of patients in the pneumatic compression device group achieved hemostasis, while 99% of patients in the clamp compression and manual compression groups achieved hemostasis (overall p<0.0001) (Lehmann 1999 1118). One cohort study with 64 patients with arterio-venous fistula puncture for hemodialysis showed that bleeding cessation was achieved in 47% and 44% with manual compression in the first and third week of the block study design, while 82% had bleeding cessation with the IRIS bandage in the second week of the study (p<0.05 compared to the first and third week) (Boulanger 2014 102). Three RCTs (Lehmann 1999 1118, Walker 2001 366, Chlan 2005 391) with a total of 918 patients undergoing endovascular procedures. In one study (Lehmann 1999 1118), the mean time to hemostasis with the use of a pneumatic device was 15.6± 4.81 minutes compared with a mean time of 14.5 ± 4.5 minutes with the use of a clamp and 13.9 ± 3.5 minutes in the manual compression group (overall p=0.006). In another study (Walker 2001 366) the mean time to hemostasis in the Femostop device group was 35.2 ± 12.3 minutes compared with the manual compression time of 12.9 ± 12.4 minutes (p<0.001). In the third study (Chlan 2005 391), mean time to hemostasis by device was as follows: Femostop 40.2 ± 23.2, C-clamp 32.6 ± 9.8 and manual 27.5 ± 6.3 minutes. Time to hemostasis was found to be significantly different among the compression methods (p<0.0001).Two cohort studies (Sulzbach-Hoke 2010 E1, Semler 1985 234) with a total of 3,587 patients undergoing endovascular procedures. The first study (Sulzbach-Hoke 2010 E1 ) with 332 patients showed that the use of a C-clamp had a higher median compression time to achieve hemostasis than the use of direct manual compression (median [min-max]:, 35 min [10-110] vs 20 min [10-45]; p<0.001). The second study (Semler 1985 234) with 2,250 patients showed that the use of a mechanical clamp had a time to hemostasis of 19.9 minutes compared with 33.5 minutes for the use of direct manual pressure. One RCT comparing hemostasis techniques after endovascular procedures showed a rebleeding incidence rate of 16/102 (15.7%) with a pneumatic compression device, 5/143 (3.5%) with a compression clamp, and 4/152 (2.6%) with manual compression (overall p<0.0001) (Lehmann 1999 1118). Among three RCTs (Walker 2001 366, Lehmann 1999 1118, Chlan 2005 391) with a total of 918 patients undergoing endovascular procedure, one study (Walker 2001 366) reported a higher a higher rate of complications in the pressure device/bandages group compared to the manual pressure group ((18.1% (21/116) compared with 9.0% (13/143) (RR=1.99, 95% CI: 1.04-3.80; p=0.04)). Lehman et al (Lehmann 1999 1118) reported a comparable rate of complications with use of pneumatic compression (25%), clamp compression (30%), and manual compression (26%). The third RCT (Chlan 2005 391) showed a lower rate of complications in the pressure device group (94/207 [45.4%] compared with 56/99 [56.6%]) (RR=0.80, 95% CI: 0.64-1.01; p=0.06).Three observational studies (Semler 1985 234, Sulzbach-Hoke 2010, Boulanger 2014 102) with a total of 3,790 patients with either an arterio-venous fistula puncture for hemodialysis or undergoing endovascular procedures. One cohort study (Semler 1985 234) in patients undergoing endovascular procedures showed a lower rate of complications in the mechanical clamp group compared to the manual pressure group (2% vs 6%; p<0.001). A second cohort study in patients undergoing percutaneous coronary intervention showed a comparable rate of complications with C-clamp compared with manual compression (40/223 [17.9%] vs 19/105 [18.1%])(Sulzbach-Hoke 2010). The third study (Boulanger 2014 102) reported no complications using the IRIS bandage or manual compression in patients with AV fistula. | Several studies demonstrated no difference between manual pressure and pressure bandages/devices or higher benefit with manual compression.Most of the data is indirect, many studies looking at arterial access from endovascular procedures, however these do demonstrate benefit to manual compression.Time to hemostasis favors the comparison (direct manual pressure) for immediate control of life-threatening bleeding. |
| Resources requiredHow large are the resource requirements (costs)? |
| Judgement | Research evidence | Additional considerations |
| ○ Large costs○ Moderate costs○ Negligible costs and savings○ Moderate savings○ Large savings● Varies○ Don't know | No research evidence  | While there or no studies available, commercial pressure dressings/bandages/devices would be more expensive than providing direct manual pressure with gloves alone or gloves and a small bandage.There were several types used in the various studies (e.g. Femostop, IRIS, generic, etc.), all which cost a different amount. There is an element of human resource use included. Holding direct manual pressure takes away an individual from performing other interventions. This could be of detriment in an incident where there are multiple people injured or if a person has multiple life-threatening concerns (e.g. airway compromise and bleeding) |
| Certainty of evidence of required resourcesWhat is the certainty of the evidence of resource requirements (costs)? |
| Judgement | Research evidence | Additional considerations |
| ○ Very low○ Low○ Moderate○ High● No included studies | No research evidence  | There is some uncertainty as we know of no direct studies offering a comparison. However, search for commercial products that provide external compression reveals that they are of increased cost over standard dressings. |
| Cost effectivenessDoes the cost-effectiveness of the intervention favor the intervention or the comparison? |
| Judgement | Research evidence | Additional considerations |
| ○ Favors the comparison● Probably favors the comparison○ Does not favor either the intervention or the comparison○ Probably favors the intervention○ Favors the intervention○ Varies○ No included studies | No research evidence | When comparing pressure devices/bandages/dressings to direct pressure, there would be minimal or negligible cost for direct pressure. Aside from standard first aid training, additional resources would not be necessary. |
| EquityWhat would be the impact on health equity? |
| Judgement | Research evidence | Additional considerations |
| ○ Reduced● Probably reduced○ Probably no impact○ Probably increased○ Increased○ Varies○ Don't know | No research evidence  | With the potential increased cost of external compression dressings along with a lack of benefit over direct manual compression there is likely a reduction in equity for those that would not be able to afford commercial devices. |
| AcceptabilityIs the intervention acceptable to key stakeholders? |
| Judgement | Research evidence | Additional considerations |
| ○ No○ Probably no○ Probably yes○ Yes● Varies○ Don't know | Naimer SA, Tanami M, Malichi A, Moryosef D. Control of traumatic wound bleeding by compression with a compact elastic adhesive dressing. Mil Med. 2006 Jul;171(7):644-7.* 56 of 62 providers were "highly satisfied", 5/62 were "satisfied" and 1 was dissatisfied with compression dressing with ELAD (elastic adhesive dressing)
 | Due to the cost of devices (including training/implementation) as well as the limited data on effectiveness when compared to direct pressure may lead to a lower likelihood of acceptability. The intervention may be more acceptable to stakeholders with specific requirements (e.g., hospital) for hands-free control of bleeding or in situations where a first aid provider’s attention is required elsewhere.The acceptability likely depends on the stakeholder and region. |
| FeasibilityIs the intervention feasible to implement? |
| Judgement | Research evidence | Additional considerations |
| ○ No○ Probably no○ Probably yes○ Yes● Varies○ Don't know | Naimer SA, Tanami M, Malichi A, Moryosef D. Control of traumatic wound bleeding by compression with a compact elastic adhesive dressing. Mil Med. 2006 Jul;171(7):644-7.* Medical staff manipulating the EI.AD reported they were highly satisfied in 54 (90%), satisfied in 5 (8%), and dissatisfied in a single case (1%).
 | While we know of no studies regarding feasibility, they are likely feasible to implement as providers may already be aware of the use of a dressing. Increasing provider instruction in order to be able to apply more pressure with the dressing would be feasible.Feasibility would likely vary by region. |

# Summary of judgements

|  | **Judgement** |
| --- | --- |
| **Problem** | No | Probably no | Probably yes | **Yes** |  | Varies | Don't know |
| **Desirable Effects** | Trivial | **Small** | Moderate | Large |  | Varies | Don't know |
| **Undesirable Effects** | Large | Moderate | **Small** | Trivial |  | Varies | Don't know |
| **Certainty of evidence** | **Very low** | Low | Moderate | High |  |  | No included studies |
| **Values** | Important uncertainty or variability | Possibly important uncertainty or variability | **Probably no important uncertainty or variability** | No important uncertainty or variability |  |  |  |
| **Balance of effects** | Favors the comparison | **Probably favors the comparison** | Does not favor either the intervention or the comparison | Probably favors the intervention | Favors the intervention | Varies | Don't know |
| **Resources required** | Large costs | Moderate costs | Negligible costs and savings | Moderate savings | Large savings | **Varies** | Don't know |
| **Certainty of evidence of required resources** | Very low | Low | Moderate | High |  |  | **No included studies** |
| **Cost effectiveness** | Favors the comparison | Probably favors the comparison | Does not favor either the intervention or the comparison | Probably favors the intervention | Favors the intervention | **Varies** | No included studies |
| **Equity** | Reduced | **Probably reduced** | Probably no impact | Probably increased | Increased | Varies | Don't know |
| **Acceptability** | No | Probably no | Probably yes | Yes |  | **Varies** | Don't know |
| **Feasibility** | No | Probably no | Probably yes | Yes |  | **Varies** | Don't know |

# Type of recommendation

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Strong recommendation against the intervention | Conditional recommendation against the intervention | Conditional recommendation for either the intervention or the comparison | Conditional recommendation for the intervention | Strong recommendation for the intervention |
| X | ○  | ○  | ○  | ○  |

# Conclusions

|  |
| --- |
| Recommendation |
| We recommend that first aid providers use direct manual compression in comparison with external compression devises or pressure dressings/bandages to obtain initial hemostasis for people with severe life-threatening external bleeding (strong recommendation, based on very low certainty of evidence). |
|  |

|  |
| --- |
| Justification |
| * In making a strong recommendation, we considered direct manual pressure as the fundamental first step in the initial management of life-threatening bleeding
* The Task Force was strongly influenced by 3 RCT’s (Chlan 2005 391, Lehmann 1999 1118, Walker 2001 366) in which the use of manual compression achieved a shorter average time to hemostasis than the use pressure dressings/bandages/devices in patients undergoing endovascular procedures.
* We considered that direct manual pressure is available to all first aid providers, has no cost and can be provided equitably in all jurisdictions. Whereas the use of pressure dressings or devices may increase the cost, health care disparity and may need specialized training in order to use.
* The Task Force acknowledges that improved education is likely to be needed to enhance the quality of direct manual pressure for the cessation of life-threatening bleeding. It is felt that this training should be incorporated into all standard first aid training and would not take additional resources to do so. The Task Force acknowledges that the study results are mixed and indirect and that when applied appropriately, external compression devices/bandages may be equally efficacious.
 |

|  |
| --- |
| Subgroup considerations |
| N/A |

|  |
| --- |
| Implementation considerations |
| N/A |

|  |
| --- |
| Monitoring and evaluation |
| N/A |

|  |
| --- |
| Research priorities |
| Research is still required on the optimal method of providing direct pressure and how to teach this. There is a lack of studies comparing direct manual pressure to pressure devices/bandages in the presence of severe, life-threatening hemorrhage in the first aid setting.  |

**References**

Boulanger H, Ahriz-Saksi S, Flamant M, Vigeral P. Evaluation of post-puncture bleeding time of arteriovenous fistulas with IRIS® bandage. J Vasc Access. 2014 Mar-Apr;15(2):102-7. doi: 10.5301/jva.5000176. Epub 2013 Oct 31.

Chlan LL, Sabo J, Savik K. Effects of three groin compression methods on patient discomfort, distress, and vascular complications following a percutaneous coronary intervention procedure. Nurs Res. 2005 Nov-Dec;54(6):391-8.

Lehmann KG, Heath-Lange SJ, Ferris ST. Randomized comparison of hemostasis techniques after invasive cardiovascular procedures. Am Heart J. 1999 Dec;138(6 Pt 1):1118-25.

Naimer SA, Tanami M, Malichi A, Moryosef D. Control of traumatic wound bleeding by compression with a compact elastic adhesive dressing. Mil Med. 2006 Jul;171(7):644-7.

Neto SA, de Freitas JO Jr,Berti SL, et al. Comparison of conventional compressive dressings vs. wristband devices after catheterization by radial approach. Revista Brasileira de Cardiologia Invasiva (English Edition). 2015;23(4):271-275.

Semler HJ. Transfemoral catheterization: mechanical versus manual control of bleeding. Radiology. 1985 Jan;154(1):234-5.

Sulzbach-Hoke LM, Ratcliffe SJ, Kimmel SE, Kolansky DM, Polomano R. Predictors of complications following sheath removal with percutaneous coronary intervention. J Cardiovasc Nurs. 2010 May-Jun;25(3):E1-8. doi: 10.1097/JCN.0b013e3181c83f4b.

Walker SB, Cleary S, Higgins M. Comparison of the FemoStop device and manual pressure in reducing groin puncture site complications following coronary angioplasty and coronary stent placement. Int J Nurs Pract. 2001 Dec;7(6):366-75.

**Other References (not listed in above table)**

Jacobs L and Burns KJ. *The Hartford Consensus to improve survivability in mass casualty events: Process to policy.* Am J Disaster Med. 2014;**9**(1):67-71.

Kauvar DS, Lefering R, and Wade CE. *Impact of hemorrhage on trauma outcome: an overview of epidemiology, clinical presentations, and therapeutic considerations.* J Trauma. 2006;**60**(6 Suppl):S3-11.

World Health Organization. *Injuries*. [cited 2018 21-JUN-2018]; Available from: <http://www.who.int/topics/injuries/en/>.