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| Question |
| **Should a duration of less than 20 minutes compared with a duration of at least 20 minutes be used for cooling of thermal burns with water?** |
| **Population:** | Adults and children with heat induced thermal burns |
| **Intervention:** | Active cooling using water as an immediate first aid intervention for 20 minutes or more duration |
| **Comparison:** | Active cooling using water as an immediate first aid intervention for any other duration. |
| **Main outcomes:** | Size of burn, Depth, Pain, Adverse effects (hypothermia), Wound healing, Complications (Need for skin grafting) |
| **Setting:** | First aid |
| **Perspective:** | First Aid provider |
| **Background:** | There is inconsistency in guidelines by international organizations for the duration of cooling of thermal burns. Too short a duration of cooling of a burn may lead to the need for skin grafting, prolonged medical/hospital care, or life-threatening injuries. Too long a duration of cooling of burns may lead to hypothermia or other adverse effects and complications. This review seeks to identify evidence to support recommendations for a duration of cooling of a burn with water for less than 20 minutes, or for 20 minutes or more. |
| **Conflict of interests:** | None declared |

# Assessment

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| ProblemIs the problem a priority? |
| Judgement | Research evidence | Additional considerations |
| ○ No○ Probably no○ Probably yes● Yes○ Varies○ Don't know | Burn injuries remain a global health problem. Fire-related thermal burns cause the deaths of 195,000 people every year {World Health Organization 2011}.Cooling of burns with water for pain relief has been used and shown to be beneficial for many decades {Raghupati 1968 68-72}. A randomized controlled trial of the use of water to cool burns has been shown to be just as effective in reducing skin temperature as manufactured products {Cho 2017 502}. Cooling with lukewarm water has also been shown as an appropriate first aid intervention to reduce burn depth in humans {Wright 2019 1472}.  |  |
| Desirable EffectsHow substantial are the desirable anticipated effects? |
| Judgement | Research evidence | Additional considerations |
| ○ Trivial○ Small● Moderate○ Large○ Varies○ Don't know | Since no RCTs were found, only observational cohort studies with outcomes assessed at one time were included, analysis has been done on a study population level. Summary of findingsSize as a percentage of Total Body Surface Area (TBSA) for the total population: No benefit was found for cooling for 20 minutes or more compared with cooling for less than 20 minutes (Std Mean difference in size of burn in % of TBSA 0.05; 95% CI, -0.15 – 0.04).A scatterplot for size and duration of cooling was completed, see below. Duration; 1=<5min, 2=5-10min, 3=10-20min, 4=20min or more. The figure indicates confounding by indication, i.e. larger burns have longer durations of cooling. This might be due to the effect of pain relief by cooling or the fear of a worse outcome in larger burns, although this is conjecture by the Task Force.For the critical outcome of any degree of a full thickness depth burn (yes/no), defined as deep dermal or full thickness burns, we identified very low certainty evidence (downgraded for risk of bias, inconsistency, indirectness and imprecision) from two observational studies enrolling a total of 3597 adults and children {Griffin 2020 75; Wood 2016 11}. Significant heterogeneity limited a meta-analysis, and the overall direction of effect could not be determined. Effect estimates were used to illustrate the effect range as the synthesis method. In a cohort study in children {Griffin 2020 75}, the result was in favour of cooling of a burn for less than 20 minutes compared with cooling for less than 20 minutes (RR 0.90; 95% CI 0.83-0.97). However, in the study on adults {Wood 2016 11}, the result was the opposite, i.e. in favour of cooling for 20 minutes or more over cooling for less than 20 minutes (RR 1.11, 95% CI 1.00-1.22).Days to re-epithelialization (wound healing): No benefit was found from cooling a burn for 20 minutes or more when compared with cooling for less than 20 minutes (Std Mean Difference the wound healed 0.01 days later; 95% CI, -0.08 – 0.11).Skin grafting: No benefit was found from cooling a burn for 20 minutes or more when compared with cooling for less than 20 minutes (RR 1.37; 95% CI, 0.61 – 3.08).For the important outcome of pain, a single study {Fein 2014 609} provided information from 24 children aged below five years old. Access to raw data revealed that the majority of children received analgesia; 10 out of 17 (59%) children with a duration of cooling of a burn for less than 20 minutes received paracetamol (7), morphine (4), or both (1) compared with 4 out of 7 (57%) children with a duration of cooling for 20 minutes or more, who received paracetamol/ibuprofen (3) and morphine (1).A sensitivity analysis was conducted and failed to demonstrate any difference for:1. Cooling for less than 10 minutes compared to 20 minutes or more2. Cooling for less than 10 minutes compared to 10 minutes or more3. Two studies {Harish 2019 433; Harish 2019 1743} included a group described as receiving “inadequate first aid" without providing a definition. However, patients who did not receive first aid were excluded. These studies were not included in the main analysis. However, we performed a sensitivity analysis including these studies and the results for all outcomes remain unchanged.*See Appendix 1 -Table 1 for characteristics of studies**See Appendix 2 – Less than 20 minutes versus 20 minutes or more**See Appendix 3 – Less than 10 minutes versus 10 minutes or more**See Appendix 4 – Less than 10 minutes versus 20 minutes or more* | The depth of a burn together with its size are closely related to the main costs for burn injuries {Eser 2016 1411}. Therefore, any first aid intervention reducing the depth and/or size of a burn may be seen to be cost effective, especially if it reduces complications {Fadeyibi 2015 1322} and hospital length of stay {Riedlinger 2016 462}.The temperature of the water and the cooling technique used (running water or immersion in water) was recorded as in three studies {Fein 2014 609; Griffin 2020 75; Wood 2016 11} as ‘cool running water’ and in one study as ‘cold water’ {Cuttle 2009 1028}.  An experimental human study {Wright 2019 1472} used water at a temperature of 16°C. A RCT used the coolest possible tap water, (24 °C to 27 °C) {Cho 2017 502}.The duration of cooling remains controversial and there is a lack of consistency between first aid guidance provided by healthcare organisations.In the UK at least 10 minutes of cooling with water is recommended. The World Health Organisation recommends at least 20 minutes, with evidence from animal studies supporting a duration of 20 minutes as optimal.Several cohort studies, assessing real life practice, show that the majority of people cool burns for a much shorter period than 20minutes {Seow 2016 905; Fiandeiro 2015 457; Scheven 2012 1224} which is probably due to poor education methodology and/or lack of compliance {Cox 2015 1435}.Skin grafting is prioritized to areas of function. In general, a burn that does not heal in 2 weeks should be grafted due to high risk of scarring. All studies were completed in burn centres and the majority of burns included were of a small size. This might indicate that these small burns were severe or in a location of the body that required hospital care. It is the Task Force’s clinical experience that small burns might not present at a health care facility or be admitted to a burn centre.  |
| Undesirable EffectsHow substantial are the undesirable anticipated effects? |
| Judgement | Research evidence | Additional considerations |
| ○ Large● Moderate○ Small○ Trivial○ Varies○ Don't know | One study {Fein 2014 609} included data on hypothermia. Out of 117 patients, 24 had a reported duration of cooling with water. Among the 117 patients five were classified as hypothermic (36-37 degrees Celsius) or were cold with shivering. All five patients were aged below four years old and had a duration of cooling less than 15 minutes. Four out of 5 were cooled in a shower, i.e., cooling of the whole body and not restricted to the burn area. | Too short a duration of cooling may not provide the anticipated effect while prolonged cooling may cause hypothermia, especially in children. |
| 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 | Certainty was downgraded due to risk of bias (see figures below) and indirectness since the evidence is from studies that indirectly compare the interventions of interest in the population of interest, and only report some of the outcome(s) critical for decision-making. The main reason for downgrading is lack of certainty about how well reported the duration of cooling corresponds to actual performed cooling duration. All cooling durations were self-reported, and all outcomes were assessed after the intervention at one time-point.*See appendix 5 for bias assessment.* |  |
| 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 evidence found. | Patient centred outcomes might be * pain
* the need for surgery/interventions

rather than the size and depth of the burn. |
| Balance of effectsDoes the balance between desirable and undesirable effects favour the intervention or the comparison? |
| Judgement | Research evidence | Additional considerations |
| ○ Favours the comparison○ Probably favours the comparison● Does not favour either the intervention or the comparison○ Probably favours the intervention○ Favours the intervention○ Varies○ Don't know | No difference in the size, depth, wound healing or the need for skin grafting was found with any particular duration of cooling a burn. All cases with hypothermia (n=5) in the included studies were in children below 5 years old with burns of TBSA <5% who were cooled for a duration of less than 15minutes. | Several studies, including the ones in our review, show that compliance with current recommendations for burn cooling is poor. In the included studies 22% of participants were cooled for less than 10 minutes and 40% for less than 20 minutes; all studies were performed in Australia/New Zealand where guidelines recommend cooling for at least 20 minutes at the time when the studies were performed. Compliance with guidelines for durations was poor. |
| 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 evidence. | Cooling with running water might be cheap and available in most settings. Savings relate to a lack of need to go health care facilities which might be expensive in many countries.We acknowledge that clean running water might not always be available in developing countries. There is a cost savings considering that cooling with water could eliminate the expense of buying ‘cooling gels’, or stocking with cooling devices in first aid kits. |
| 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 evidence. |  |
| Cost effectivenessDoes the cost-effectiveness of the intervention favour the intervention or the comparison? |
| Judgement | Research evidence | Additional considerations |
| ○ Favours the comparison○ Probably favours the comparison○  Does not favour either the intervention or the comparison○ Probably favours the intervention○ Favours the intervention○ Varies●No included studies | No evidence. | FA cooling of burns with water could reduce the eventual cost of tertiary care in a burn centre |
| 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 evidence. | The implementation of effective burn prevention programs and improved treatment has resulted in a significant fall in thermal burn numbers in high-income countries.Today about 90–95% of burn injuries occur in low- and middle-income countries. Burns mostly affect the lowest socioeconomic classes and contribute to an important source of paediatric injury {WHO 2011; Wesson 2013 1477; Mitchell 2020 34}. Therefore, this first aid intervention might be very effective in relation to health equity. |
| AcceptabilityIs the intervention acceptable to key stakeholders? |
| Judgement | Research evidence | Additional considerations |
| ○ No○ Probably no○ Probably yes● Yes○ Varies○ Don't know | No evidence. | It would appear that most people cool burns for a shorter duration than the recommended time. We also have seen a pattern that may indicate confounding by indication, i.e. in larger burns the acceptability and compliance to cooling for a longer duration might be higher. We speculate that this might be due to possible pain relief during cooling and/or a fear of a worse outcome.Since we are only assessing duration of cooling, most casualties who could cool a burn for 10 minutes could probably have cooled their burn for 20 minutes and vice versa.Those with burns would likely find the intervention and the comparison acceptable the decrease in pain could potentially reduce the need for advanced medical care. |
| FeasibilityIs the intervention feasible to implement? |
| Judgement | Research evidence | Additional consideratsions |
| ○ No○ Probably no○ Probably yes● Yes○ Varies○ Don't know | No evidence. | First aid guidelines exist globally but compliance varies, especially for the smaller size of burns.In order to increase potential compliance a major educational programme, with associated costs, is required.  |

# Summary of judgements

|  | **Judgement** |
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| **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

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| 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 |
| ○  | ○  | ●  | ○  | ○  |

# Conclusions

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| Recommendation |
| We recommend the immediate active cooling of thermal burns using running water as a first aid intervention for adults and children (strong recommendation, very low certainty evidence).Because no difference in outcomes could be demonstrated with the different cooling durations studied, a specific duration of cooling cannot be recommended.Young children with thermal burns that are being actively cooled with running water should be monitored for signs and/or symptoms of excessive body cooling (Good Practice Statement).

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| Justification |
| This topic was prioritized by the FA Task Force due to ongoing debate about the optimal duration of cooling of thermal burns. In 2015 the International Liaison Committee on Resuscitation (ILCOR) published a consensus on science and treatment recommendation (CoSTR) {Singletary 2015 S269; Zideman 2015 e225} with a strong recommendation for the active cooling of thermal burns by first aid providers. It was noted in the Task Force insights of this CoSTR that studies included used different methods of cooling (water, gel pads) with varying temperatures, and the literature suggested that active cooling should take place as soon as possible for a minimum of 10 minutes. This led to criticism of the 10-minute minimum for cooling suggested in the studies and a proposed 20-minutes minimum duration of cooling {Goodwin 2016 1148; Walsh 2016 99}. The 20-minute duration of cooling was based on expert opinion and evidence from animal studies {Bartlett 2008 828; Cuttle 2008 626; Cuttle 2010 673}. Recent national guidelines struggle with similar challenges exemplified by the UK National Institute for Health and Care Excellence (NICE) statement in their first aid guidelines (National Institute for Health 2020 webpage) with advice is based mainly on expert opinions versus scientific evidence. The Task Force sought to conduct a rigorous systematic review using studies with higher certainty evidence, utilizing expert systematic reviewers and internationally recognised burns experts. In making these recommendations, the FA Task Force considered the following:• Although several large human studies were identified, the evidence was found to be inconclusive to either support or to refute the use of one duration of cooling with water compared with another. Therefore, from an evidence-based perspective, the optimal duration for cooling of thermal burns with water as a first aid intervention, and the optimal technique (running water versus immersion) remains unknown. • Very low certainty evidence failed to show a benefit in selected outcomes for a burn cooling duration of less than 20 minutes compared with cooling for 20 minutes or more. Likewise, we found no difference in outcome between cooling burns for less than 10 minutes compared to either 10 minutes or more or 20 minutes or more. • This treatment recommendation is minimally changed from 2015. In making a strong recommendation for immediate cooling of burns with water despite very low certainty evidence, the Task Force acknowledge that cooling with running water has previously been proved beneficial when compared with not cooling or compared with other methods of cooling in several different study designs; an animal study {Cuttle 2010 673}, an experimental study {Wright 2019 1472}, observational human studies {Cuttle 2009 1028; Tung 2005 12} and in one randomized human study {Cho 2017 502}. Guidelines might need to state a reasonable minimum cooling time suitable for the environment and epidemiology of burns in that specific geographic area. • In Task Force discussions, there was the consensus opinion that the optimal duration of cooling may not be a rigid time but rather influenced by the burn location, the size and depth of the burn as well as the temperature of the water used for cooling. For example, more severe / extensive / painful burns might require longer durations of cooling to observe a beneficial effect. • The Task Force discussed the effect of cooling on pain in superficial and partial thickness burns. Since cooling is thought to relieve pain it is possible that first aid providers may cool a burn until the pain has been relieved rather than for a specific duration of time. We did not have enough data to support this theory or a recommendation to cool a burn until there is relief of pain. • In burn research, the size of the burn is an essential outcome. The inclusion of the outcome of burn size was, a priori, deemed to be problematic in the ILCOR First Aid Task Force discussions. In first aid settings it is unreasonable to assume that either the surface area or the depth of a burn could or should be assessed before starting of cooling. It is plausible that a first aid provider may consider cooling a larger burn for a longer duration of time. A scatterplot comparing burn TBSA and duration of cooling suggests that larger burns induce longer cooling durations. • A concern was raised that cooling of burns in young children might result in hypothermia. This complication was identified in children under 4 years of age, particularly following use of full body showering for cooling. Evidence of this complication supports the Good Practice Statement. Even a short cooling duration, especially if full-body cooling is used may result in hypothermia. This highlights the need for instructions on cooling techniques to minimize the risk of hypothermia. • The review further stresses the poor compliance to the recommended duration of cooling of burns as directed in current guidelines. In total, out of 5978 included causalities with a reported duration of cooling, 2893 (47%) reported a cooling duration in line with current local guidelines (20 minutes or more) {HealthDirect 2020 webpage} and 3600 (60%) reported a cooling duration of 10 minutes or more. The Task Force discussed how the compliance to guidelines might be affected by recommending a shorter or longer duration of cooling. It is possible that recommending a shorter duration may increase compliance but conversely it could shorten the cooling duration further. |

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| Subgroup considerations |
| None, but sensitivity analysis on different duration as well as with and without the two studies having inadequate first aid as a control group. |
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| Implementation considerations |

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| Monitoring and evaluation |
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| Research priorities |
| * RCTs are needed comparing different durations of cooling using running water versus immersion water with similar temperatures.
* Future studies should focus on information on who performed the cooling, such as self-aid or bystander (very early), emergency medical service providers (early), an emergency department/burn centre (late) in order to better assess the clinical effectiveness of cooling strategies. Further, what is the optimal duration of cooling for burns that do not need assessment in burn centres or by advanced care providers?
* All included studies were from one geographical region, Australia, and all were completed in burn centres. Studies evaluating the duration of cooling with running water as a first aid intervention are needed from other continents and geographical regions.
* Additional research is needed to help identify alternative optimal cooling techniques when water is not available.
* Could pain relief with cooling of burns be a marker for appropriate duration of cooling of superficial burns?
* Do circumstances such as environment, type and location of burn change the time needed to cool a thermal burn?
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