American Red Cross
Scientific Advisory Council

American Red Cross Scientific Advisory Council
Scientific Review
Cardiac Arrest Secondary to Hyperthermia

Questions to be addressed:

For people in cardiac arrest due to hyperthermia, does any specific intervention, compared to other interventions, change outcomes?

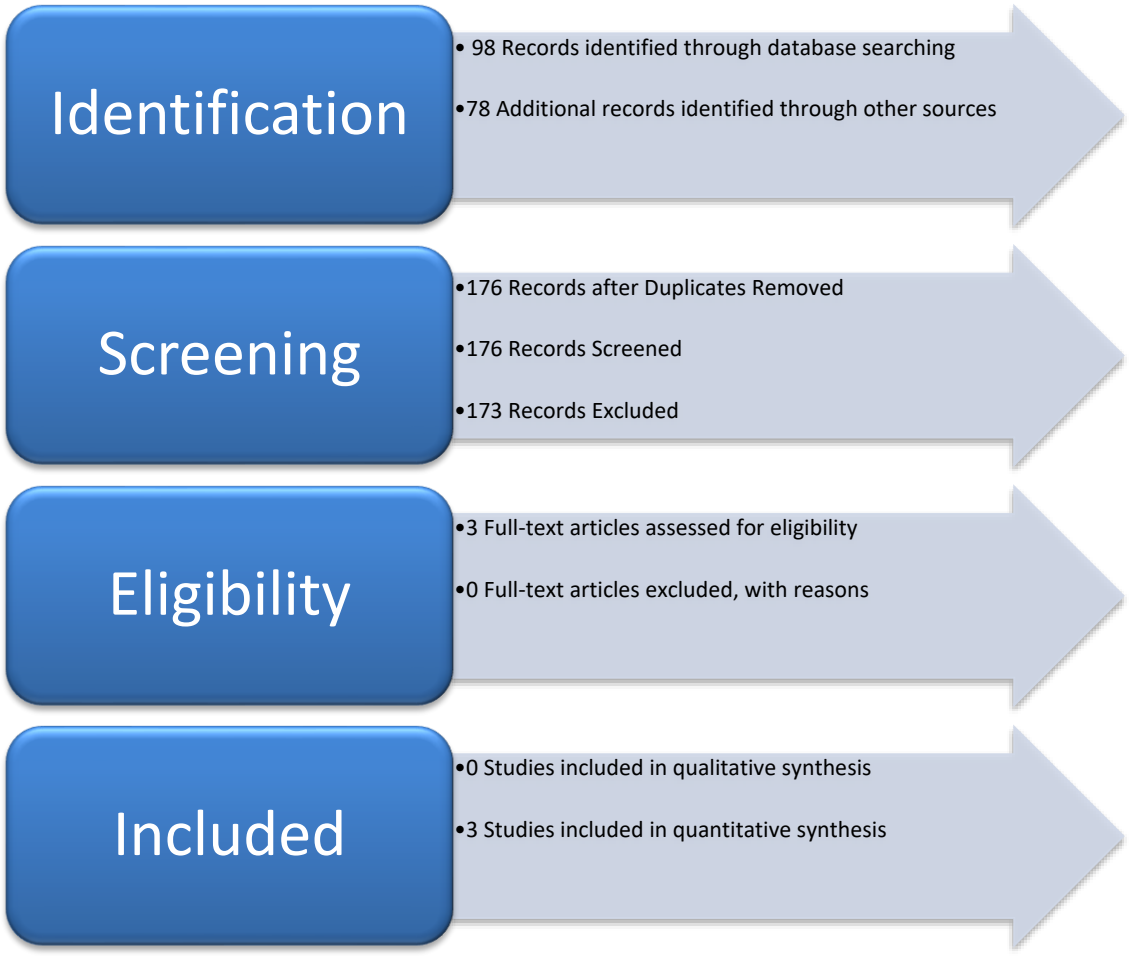
Introduction/Overview:

Specific interventions during cardiac arrest caused by conditions apart from primarily cardiac should be focused on ameliorating the cause of the cardiac arrest. The literature is reviewed to search for any interventions that are proven to be beneficial in cardiac arrest caused primarily by hyperthermia.

Search Strategy and Literature Search Performed

We excluded:
Hyperthermia post cardiac arrest
Drug and Anesthesia-associated hyperthermia
Heat effects in specific populations eg. Multiple Sclerosis, pregnancy
Review Articles, although we looked for relevant references in citations
Hyperthermia associated with EXERCISE as cause of cardiac arrest

Both authors reviewed inclusion/exclusion decisions independently and agreed to papers to be included.



Review Process and Literature Search of Evidence Since Last Approval Performed

Updated June 2022

#1	Search ("Heart Arrest/etiology"[Mesh] OR "Heart Arrest/physiopathology"[Mesh] OR "Heart Arrest/therapy"[Mesh]) Filters: English Filter 2017-2022	9308
#2	Search ("Heat Stroke/etiology"[Mesh] OR "Heat Stroke/physiopathology"[Mesh] OR "Heat Stroke/therapy"[Mesh])	1087
#3	#1 AND #2	3
#4	Search "Heart Arrest/etiology"[Mesh] OR "Heart Arrest/physiopathology"[Mesh] OR "Heart Arrest/therapy"[Mesh] OR "Heart Arrest"[Mesh] OR "Cardiopulmonary Resuscitation"[Mesh]	6266

#5	Search ((("Heat Stroke/etiology"[Mesh] OR "Heat Stroke/physiopathology"[Mesh] OR "Heat Stroke/therapy"[Mesh]))) OR ((((("Hot Temperature"[Mesh]) OR "Heat Stress Disorders"[Mesh]) OR "Heat-Shock Response"[Mesh]) OR "Heat Stroke"[Mesh]) Filter English Filter 2017-2022	19916
#6	#4 AND #5	19

None of the 3 articles in #3 were relevant.

2020 ARC SAC First Aid publication "Exertional Hyperthermia and Heatstroke: Cooling Techniques" was reviewed.

Scientific Foundation:

We found many articles outlining that death increases with extreme in temperatures, especially elderly patients (i.e. there is an increase in death in the population when temperatures are at extreme hot or cold). We found no human randomized controlled studies looking at hyperthermia as a cause of cardiac arrest. There are multiple studies for targeted temperature management post cardiac arrest [avoid hyperthermia] which does not answer the question.
We looked at studies involving cardiac arrest related to hyperthermia with different treatment options. There were no human studies, and a few case reports which were reviewed but excluded as the number of human case reports [one adult and three pediatric] was too few to draw reliable conclusions from. Animal literature was reviewed.

In Japan this topic is especially relevant as culturally whole-body bathing in high temperatures is common. There is documentation of 14,000 cases of sudden cardiac death during bathing, and temperature effects are postulated to be involved. [Suzuki, M Acute Medicine & Surgery 2014; 1:101-104]. These are retrospective studies, and there are no studies of intervention.

We found limited evidence that prolonged heat exposure can lead to cardiovascular collapse, even after body temperature has returned to normal [Eshel Resuscitation 37 (1998) 189-195]. We found limited evidence that hyperthermia-induced cardiac arrest in primates is associated with hypoglycemia [Eshel G, Aviat Space Environ Med 1997: 68(5)415-20). We know that body core temperature can be lowered by evaporative loss [Callaway CW, Circulation 2015 132(Suppl 2):S465-S482] and immersive cooling [Giesbrecht Aviat space Environ Med 2007; 78(6): 561-7].

We reference the American Red Cross Hyperthermia Guideline [June 2016]. We recognize that there is no data indicating the management of hyperthermia supersedes initiation of cardiac resuscitations [chest compressions with or without ventilations, AED].

Cooling by immersion would significantly impede cardiac resuscitation. Cardiac resuscitation is of primary concern in arrest. Immersion is unlikely to be feasible in hyperthermic cardiac arrest,

chest compressions are note effective in water. Evaporative cooling and ice packs may be feasible.

Scientific Foundation Updated June 2022

Of the 19 studies in #6, none spoke to the question. For information/background there was an observational study from Israeli that indicated higher heat had higher mortality, but there were no intervention assessments (Kranc 2017, Yamakazi 2017). There are studies that indicate effectiveness of CPR in hot environments is diminished (Martin-Contey 2020, Barcala-Furelos, 2020).

Overview of Recommendation:

Specific Recommendations and Strength

Standards: For cardiac arrest initiated by hyperthermia, we recommend initiating cardiac resuscitation as per best practices [chest compressions with or without ventilations, AED].

Guidelines: Initiation of hyperthermic protocols including environmental manipulation and evaporative cooling per current ARC SAC guidelines if feasible during resuscitation. Immersion during CPR is not recommended.

Options: None

Knowledge Gaps and Future Research

There are no randomized control trials investigating the best management plan for hyperthermia-induced cardiac arrest. Human studies are not possible, so animal studies would be appropriate. What is the best method to cool during hyperthermia-induced cardiac arrest?

Updated Knowledge Gaps and Future Research June 2022

There are no targeted studies for management of hyperthermia-induced cardiac arrest, but there is ongoing research on management of severe heat stroke.
At present, working to obtain ROSC is key to survival, yet there are no studies on 'cool then do CPR' vs. ''Do CPR then cool' vs. 'Cool and do CPR at the same time'.
It is not feasible to immerse in water and perform CPR at the same time. There is no role for immersion with a mCPR device [Autopulse and Lucas both indicate 'do not submerge'].

Implications for American Red Cross Programs

Incorporate current cardiac arrest management with hyperthermia management, but do not impede cardiac arrest interventions.

REFERENCES

RESULTS FROM SEARCH:

Kranc H, Novack V, Shtein A, Sherman R, Novack L. **Extreme temperature and out-of-hospital-cardiac-arrest. Nationwide study in a hot climate country.** Environ Health. 2021 Apr 5;20(1):38. doi: 10.1186/s12940-021-00722-1. PMID: 33820550; PMCID: PMC8022396.

Yamazaki S, Michikawa T. **Association between high and low ambient temperature and out-of-hospital cardiac arrest with cardiac etiology in Japan: a case-crossover study.** Environ Health Prev Med. 2017 Jul 13;22(1):60. doi: 10.1186/s12199-017-0669-9. PMID: 29165155; PMCID: PMC5664445.

Martin-Conty JL, Polonio-López B, Maestre-Miquel C, Mohedano-Moriano A, Durantez-Fernández C, Mordillo-Mateos L, Jurado-Palomo J, Viñuela A, Bernal-Jiménez JJ, Martin-Rodríguez F. **Physiological Response of Quality Cardiopulmonary Resuscitation, Crossover Trial on Mannequin in Extreme Temperature Conditions.** Int J Environ Res Public Health. 2020 Aug 12;17(16):5835. doi: 10.3390/ijerph17165835. PMID: 32806606; PMCID: PMC7460077.

Barcala-Furelos R, Fernández-Méndez M, Cano-Noguera F, Otero-Agra M, Morán-Navarro R, Martínez-Isasi S. **Measuring the physiological impact of extreme heat on lifeguards during cardiopulmonary resuscitation. Randomized simulation study.** Am J Emerg Med. 2020 Oct;38(10):2019-2027. doi: 10.1016/j.ajem.2020.06.042. Epub 2020 Jun 26. PMID: 33142168.

HYPERTHERMIA FIRST AID ARTICLES:

Rublee, C, [et al]. **Evidence-Based Heatstroke Management in the Emergency Department.** 2021. PMID: 33856299 PMCID: PMC7972371 DOI: 10.5811/westjem.2020.11.49007

Douma, M J, [et al]. **First aid cooling techniques for heat stroke and exertional hyperthermia: A systematic review and meta-analysis.** 2020. PMID: 31981710 DOI: 10.1016/j.resuscitation.2020.01.007

Hirschhorn, R, [et al]. **Exertional Heat Stroke Knowledge and Management among Emergency Medical Service Providers.** 2021. PMID: 34068481 PMCID: PMC8126007 DOI: 10.3390/ijerph18095016

Ito, C, [et al]. **Safety and efficacy of cold-water immersion in the treatment of older patients with heat stroke: a case series.** 2021. PMID: 33659066 PMCID: PMC7893982 DOI: 10.1002/ams2.635

Szymanski, M, [et al]. **Emergency Medical Service Directors' Protocols for Exertional Heat Stroke.** 2020. PMID: 32987646 PMCID: PMC7598696 DOI: 10.3390/medicina56100494

Leyk, D, [et al]. **Health Risks and Interventions in Exertional Heat Stress.** 2019. PMID: 31554541 PMCID: PMC6783627 DOI: 10.3238/arztebl.2019.0537

Wasserman, D, [et al]. **EMS Methods To Cool A Patient In The Field**. 2022. StatPearls Publishing.

Parker, K, [et al]. **Do Alternative Cooling Methods Have Effective Cooling Rates for Hyperthermia Compared With Previously Established CWI Cooling Rates?** 2020. Journal of Sport Rehabilitation. DOI 10.1123/jsr.2019-0098

O'Connor, G, [et al]. **Exertional heat illness in adolescents and adults: Epidemiology, thermoregulation, risk factors, and diagnosis**. 2022. UptoDate.

Belval, L. [et al]. **Consensus Statement- Prehospital Care of Exertional Heat Stroke.** 2018. PMID: 29336710 DOI: 10.1080/10903127.2017.1392666

Monseau, A J, [et al]. **Status of US Emergency Medical Service Protocols Regarding Pre-Transfer Cooling for Exertional Heat Stroke**. 2021. 13(11): e19505. doi:10.7759/cureus.19505