

Letter to the Editor

The Chainmail of Survival-A modern concept of an adaptive approach towards cardiopulmonary resuscitation

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# The Chainmail of Survival

## A modern concept of an adaptive approach towards cardiopulmonary resuscitation

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**Disclosures:** Sebastian Schnaubelt is International Liaison Committee on Resuscitation (ILCOR) Education, Implementation and Teams (EIT) Task Force member, European Resuscitation Council (ERC) Advanced Life Support Science and Education Committee member, and Young ERC Research representative. Robert Greif is ILCOR EIT Task Force Chair and ERC director of guidelines. Koen Monsieurs is Chair of the ERC.

*To the Editor*

The so-called “chain of survival” is a concept of successively linked steps deemed important in cardiopulmonary resuscitation (CPR) for out-of-hospital or in-hospital cardiac arrest (CA). It was first systematically addressed in an American Heart Association statement by Cummins and colleagues in 1991 (1), and dates back to similar concepts by Friedrich Wilhelm Ahnefeld (2) or the first steps of modern CPR by Peter Safar (3). Already back in the nineties, when studies reporting outcomes after bystander-witnessed CA could still fit into one table (1), it was stated that “more people can survive sudden cardiac arrest when a particular sequence of events occurs as rapidly as possible” (1) – a train of thought still applicable today: A sequence of “Early access”, “Early CPR”, “Early defibrillation”, and “Early advanced care” (1) are cornerstones of CPR in 2022 (4).

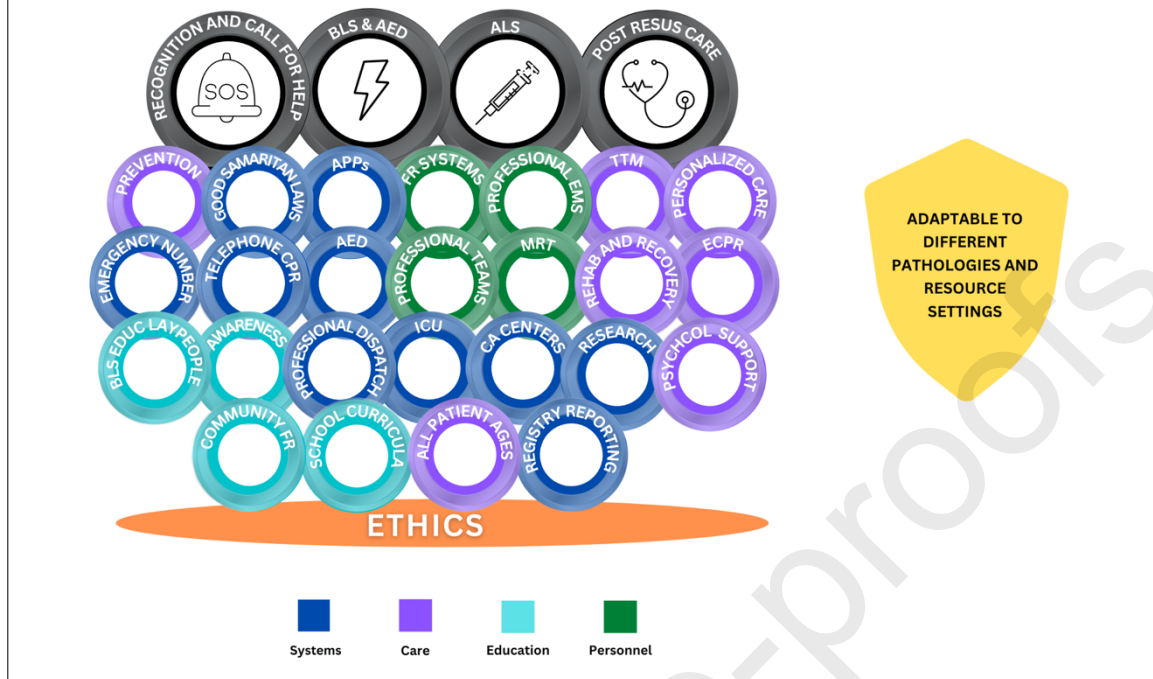
However, the chain of survival has since come a long way, being expanded and adapted, for instance towards drowning victims. (5) Technical developments provide new perspectives such as drones delivering defibrillators or extracorporeal life support (4). Such adaptations are necessary but could lead to a variety of different chains of survival; bent and cut, without an underlying system.

Moreover, low- and middle-income countries and low-resource settings in general may require entirely different resource and priority allocations than high-resource environments. A chain of survival developed by people from high-income areas can thus have severe limitations in true global implementation: One can hardly expect clinicians fighting for clean drinking water to also think about drones or extracorporeal life support. The chain would therefore have to be tailored to achieve international recognition beyond the edge of the well-filled plate of some. Sub-versions would then emerge due to the heterogeneity of the bespoke setting, ranging from local to system-wide levels. Of note, ethical feasibility of resuscitative efforts must not be forgotten: Should ALS take place if there is no mechanical ventilator or ICU? What about starting BLS without the prospect of ALS?

The classic chain of survival suggests if one single link is broken, the whole chain does not function anymore. We therefore propose the term “chainmail of survival” as a modern concept for adaptations of CPR systems in a globalized but still heterogeneous world (*Figure 1*). Rather than one single chain, it depicts multiple joined links strengthening the whole mission of resuscitative endeavors, even when single links cannot function strong enough or are missing. “Hanging” from the original essential parts (*Figure 1*), it also serves as a mind map of resuscitation, an overview of desirable goals, and a common basis for adaptations (e.g., towards CA etiologies, resource settings, or peri-arrest pathologies). Moreover, the chainmail symbolizes “protection” from cardiac arrest. It can be extended on the grounds of new scientific discoveries, or – rarely – cut if parts become obsolete. Organisations such as the International Liaison Committee on Resuscitation (ILCOR) or regional councils could address it in their recommendations, providing a truly comprehensive tool for an adaptive and flexible approach towards the shared goal of improving CPR outcomes globally.

# THE CHAINMAIL OF SURVIVAL

AN ADAPTIVE APPROACH TOWARDS CARDIOPULMONARY RESUSCITATION



**Figure 1:** The chainmail of survival. BLS = basic life support; AED = automated external defibrillator; ALS = advanced life support; Resus = Resuscitation; Apps = Applications (e.g., on a mobile phone); FR = first responder; EMS = emergency medical service; TTM = targeted temperature management; CPR = cardiopulmonary resuscitation; MRT = medical response team; Rehab = rehabilitation; ECPR = extracorporeal cardiopulmonary resuscitation; Educ = education; ICU = intensive care unit; Psychol = psychological.

## References

1. Cummins RO, Ornato JP, Thies WH, Pepe PE. Improving survival from sudden cardiac arrest: the 'chain of survival' concept. A statement for health professionals from the Advanced Cardiac Life Support Subcommittee and the Emergency Cardiac Care Committee, American Heart Association. *Circulation*. 1991 May;83(5):1832–47.
2. Dick WF. Friedrich Wilhelm Ahnefeld. *Resuscitation*. 2002 Jun 1;53(3):247–9.
3. Safar P, Bircher N. History and phases and stages of cardiopulmonary cerebral resuscitation. In: *Cardiopulmonary Cerebral Resuscitation*. Philadelphia: WB Saunders Co; 1988.
4. Berg KM, Cheng A, Panchal AR, Topjian AA, Aziz K, Bhanji F, et al. Part 7: Systems of Care: 2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation*. 2020 Oct 20;142(16\_suppl\_2):S580–604.
5. Szpilman D, Webber J, Quan L, Bierens J, Morizot-Leite L, Langendorfer SJ, et al. Creating a drowning chain of survival. *Resuscitation*. 2014 Sep;85(9):1149–52.

## Conflict of Interest Statement

for

*The Chainmail of Survival - A modern concept of an adaptive approach towards cardiopulmonary resuscitation*

by Sebastian Schnaubelt, Robert Greif, and Koen Monsieurs

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- Sebastian Schnaubelt is International Liaison Committee on Resuscitation (ILCOR) Education, Implementation and Teams (EIT) Task Force member, European Resuscitation Council (ERC) Advanced Life Support Science and Education Committee member, and Young ERC Research representative.
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