



Accidental hypothermia- An update

Peter Paal MD PD MBA EDAIC EDIC
Department of Anaesthesiology and Intensive Care Medicine
Hospitallers Brothers Hospital, Salzburg, Austria



Speakers honoraria
Dräger, Gebropharma, Teleflex, Teva, and Zoll

REVIEW

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Accidental hypothermia—an update

The content of this review is endorsed by the
International Commission for Mountain Emergency
Medicine (ICAR MEDCOM)

Peter Paal^{1,2,3*} , Les Gordon^{4,5}, Giacomo Strapazzon^{3,6}, Monika Brodmann Maeder^{3,6,7}, Gabriel Putzer¹,
Beat Walpoth⁸, Michael Wanscher⁹, Doug Brown^{3,10}, Michael Holzer¹¹, Gregor Broessner¹² and Hermann Brugger^{1,6}



Content

Pathophysiology

Therapy

Outlook

Table 1 Staging of accidental hypothermia [73]

Stage	Clinical findings	Core temperature (°C) (if available)
Hypothermia I (mild)	Conscious, shivering ^a	35–32 °C
Hypothermia II (moderate)	Impaired consciousness ^a ; may or may not be shivering	<32–28 °C
Hypothermia III (severe)	Unconscious ^a ; vital signs present	<28 °C
Hypothermia IV (severe)	Apparent death; Vital signs absent	Variable ^b

^aShivering and consciousness may be impaired by comorbid illness (i.e. trauma, CNS pathology, toxic ingestion, etc.) or drugs (i.e. sedatives, muscle relaxants, narcotics etc.) independent of core temperature
The lowest temperature from which successful resuscitation and rewarming has been achieved is currently 13.7 °C [11] for accidental hypothermia and 9 °C for induced hypothermia [12]. This does not preclude resuscitation attempts at even lower temperatures if clinical judgment suggests the possibility of successful resuscitation

^bThe risk of cardiac arrest increases below 32 °C, but as it is unlikely to be due solely to hypothermia until the temperature is <28 °C, alternative causes should be considered. Some patients still have vital signs <24 °C and the lowest reported temperature of a patient with vital signs is 17 °C [232, 233]

Paal P, et al. Scand J Trauma Resusc Emerg Med 2016, 24:111

Diminished O₂ metabolism

O₂-consumption 7%↓ /1°C↓

Lexow K. Arctic Med Res 1991;50 Suppl 6:112-4.

Soar J, Paal P et al. Resuscitation 2010;81:1400-33.

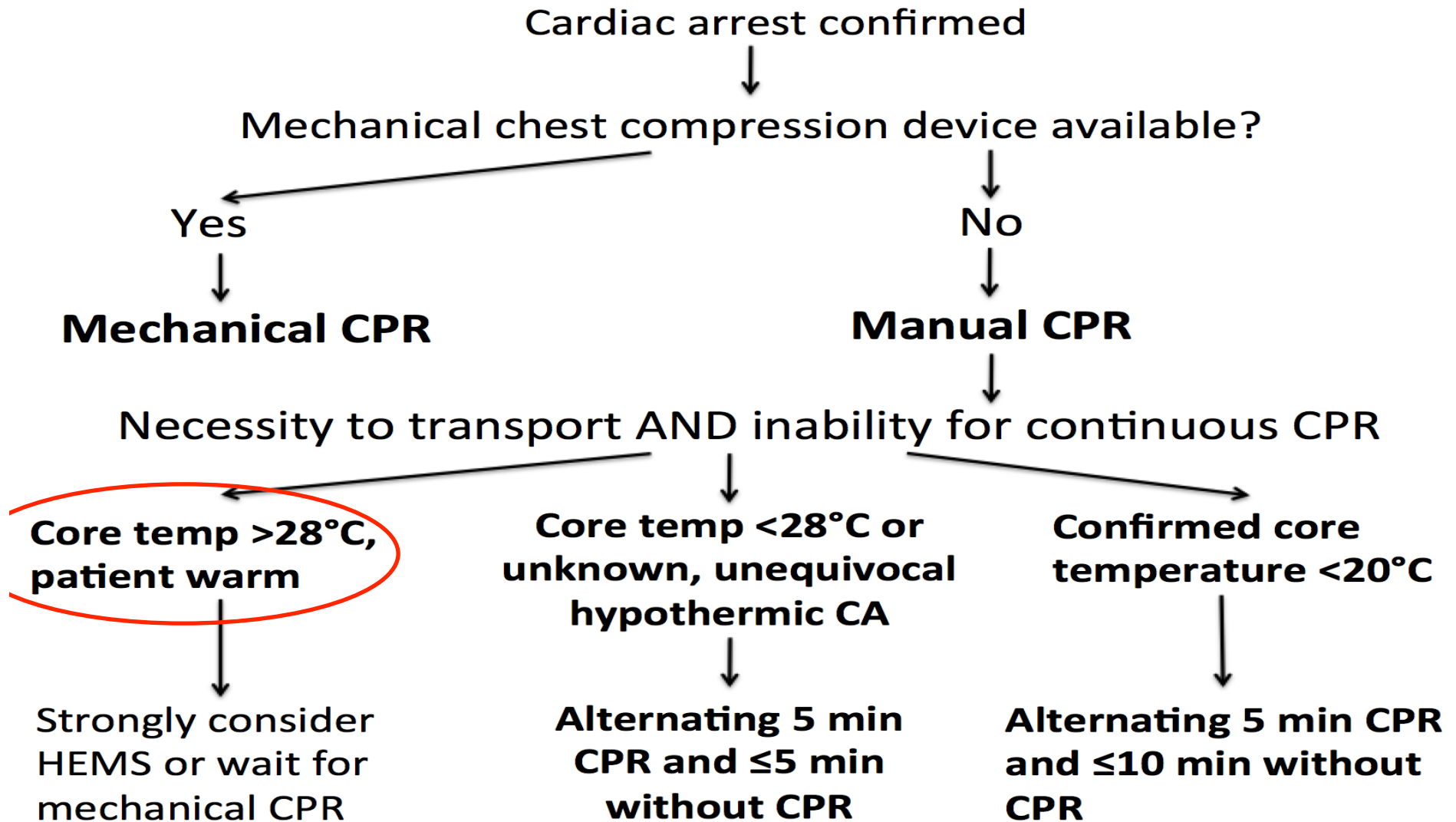
CPR

57-yr old woman, 16.9°C,
HR 6min-1. Rescue collapse.
Extrication from 2000m

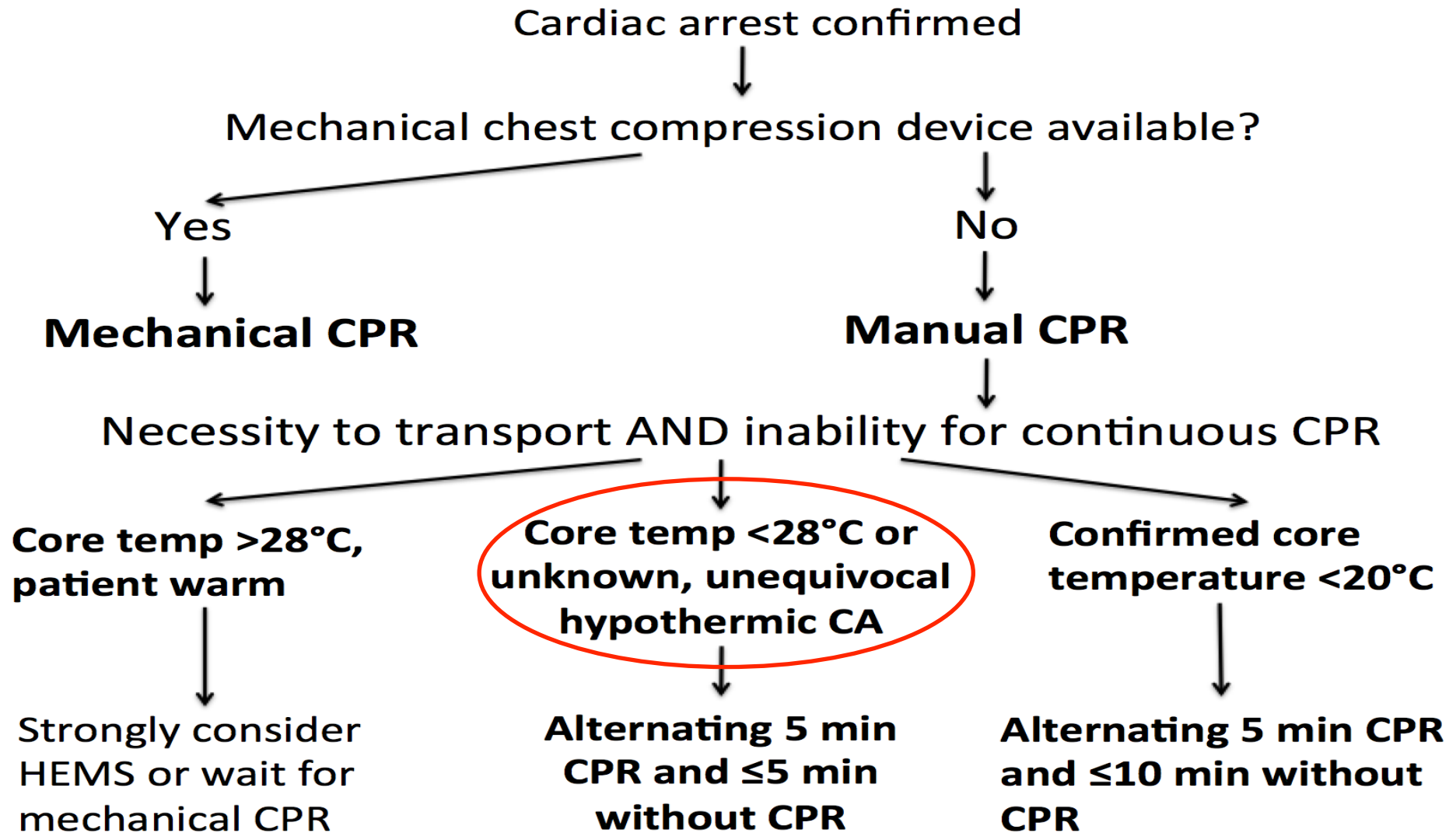


Boue Y, et al. Crit Care Med 2014 Feb;42(2):e167-70.

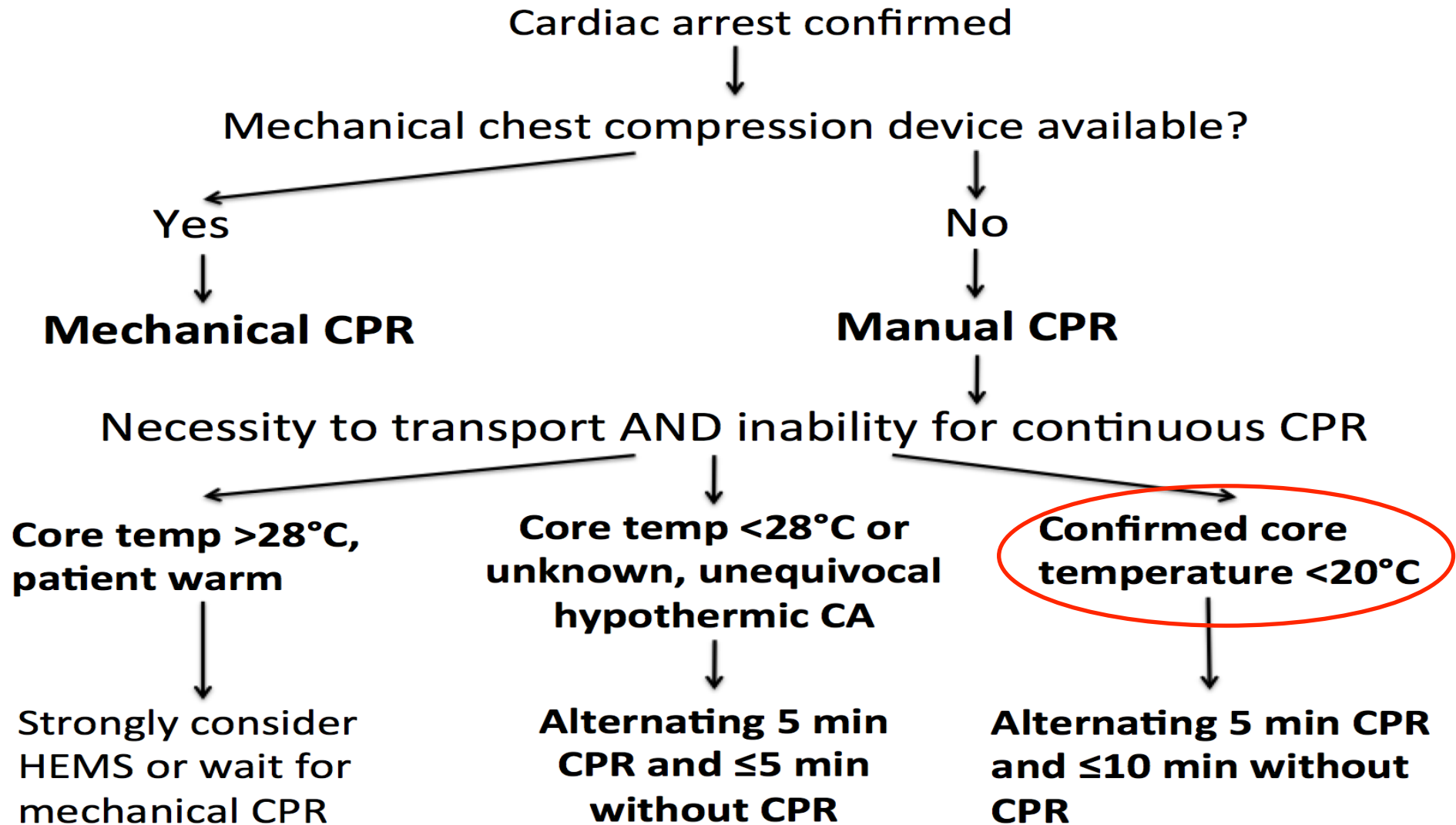
iCPR



iCPR



iCPR



Rewarming

Table 3. Effectiveness of Rewarming Techniques.

Technique	Rewarming Rate °C/hr	Indication
<u>Without cardiac support</u>		
Warm environment and clothing, warm sweet drinks, and active movement ⁹	2 (dependent on metabolic rate)*	HT I
Active external and minimally invasive rewarming (warm environment; chemical, electrical, or forced-air heating packs or blankets; and warm parenteral fluids) ^{3,15-18}	0.1–3.4	HT II or HT III with cardiac stability
Peritoneal dialysis ¹⁹	1–3	Uncertain
Hemodialysis ²⁰	2–4*	Uncertain
Thoracic lavage ^{21,22}	3*	HT IV when ECMO or CPB not available
Venovenous ECMO ²³	4*	Uncertain
<u>With cardiac support</u>		
Venoarterial ECMO ²⁴	6*	HT III with cardiac instability or HT IV
CPB ²	9*	HT III with cardiac instability or HT IV when ECMO not available

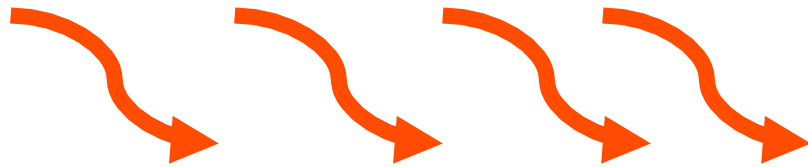
* Value is approximate.

Brown D Brugger H, Boyd J, Paal P. N Engl J Med. 2012;367(20):1930-8.

Forced air warming blankets

Outside layer

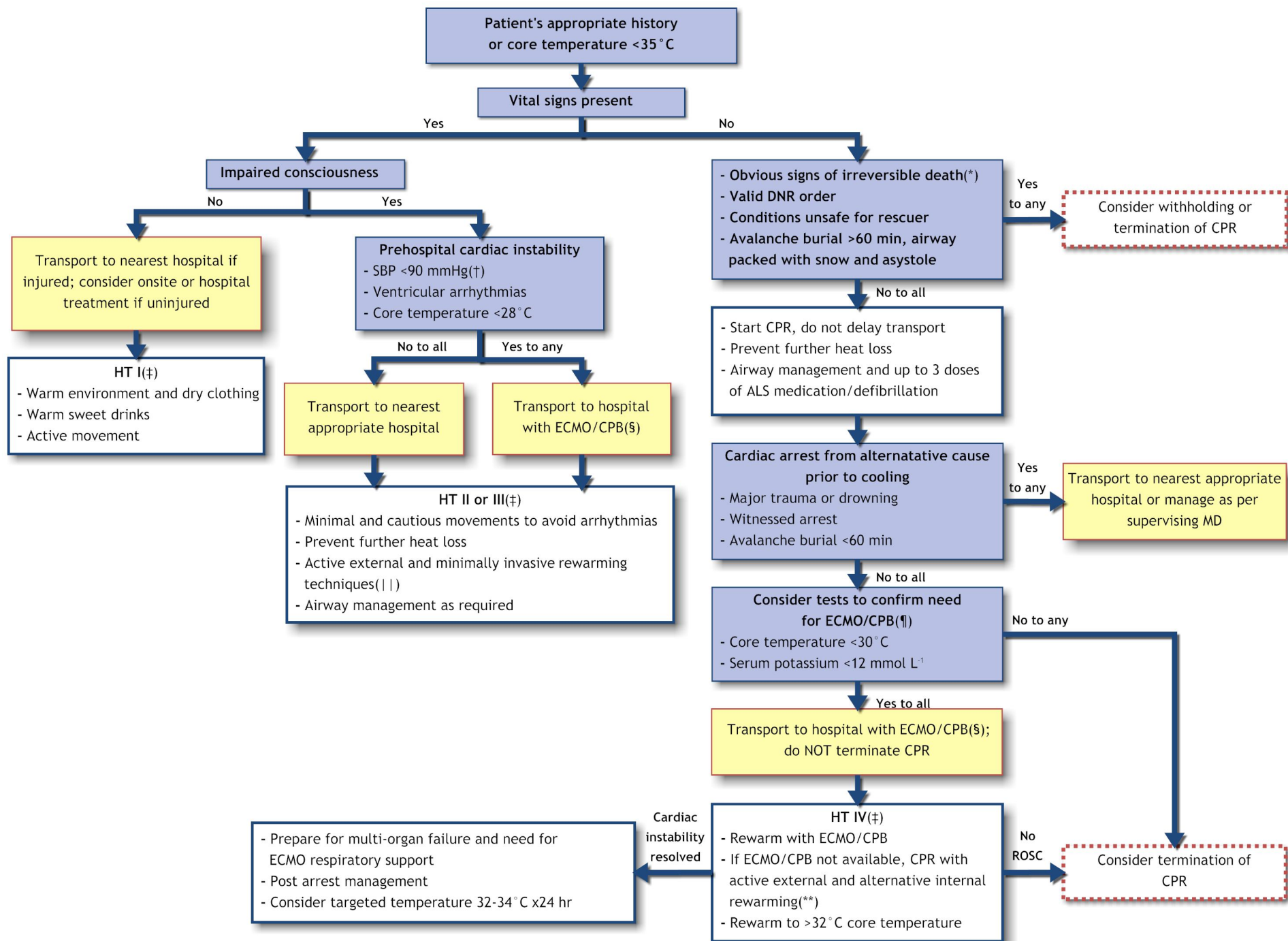
Forced Air 42°C



Inside layer







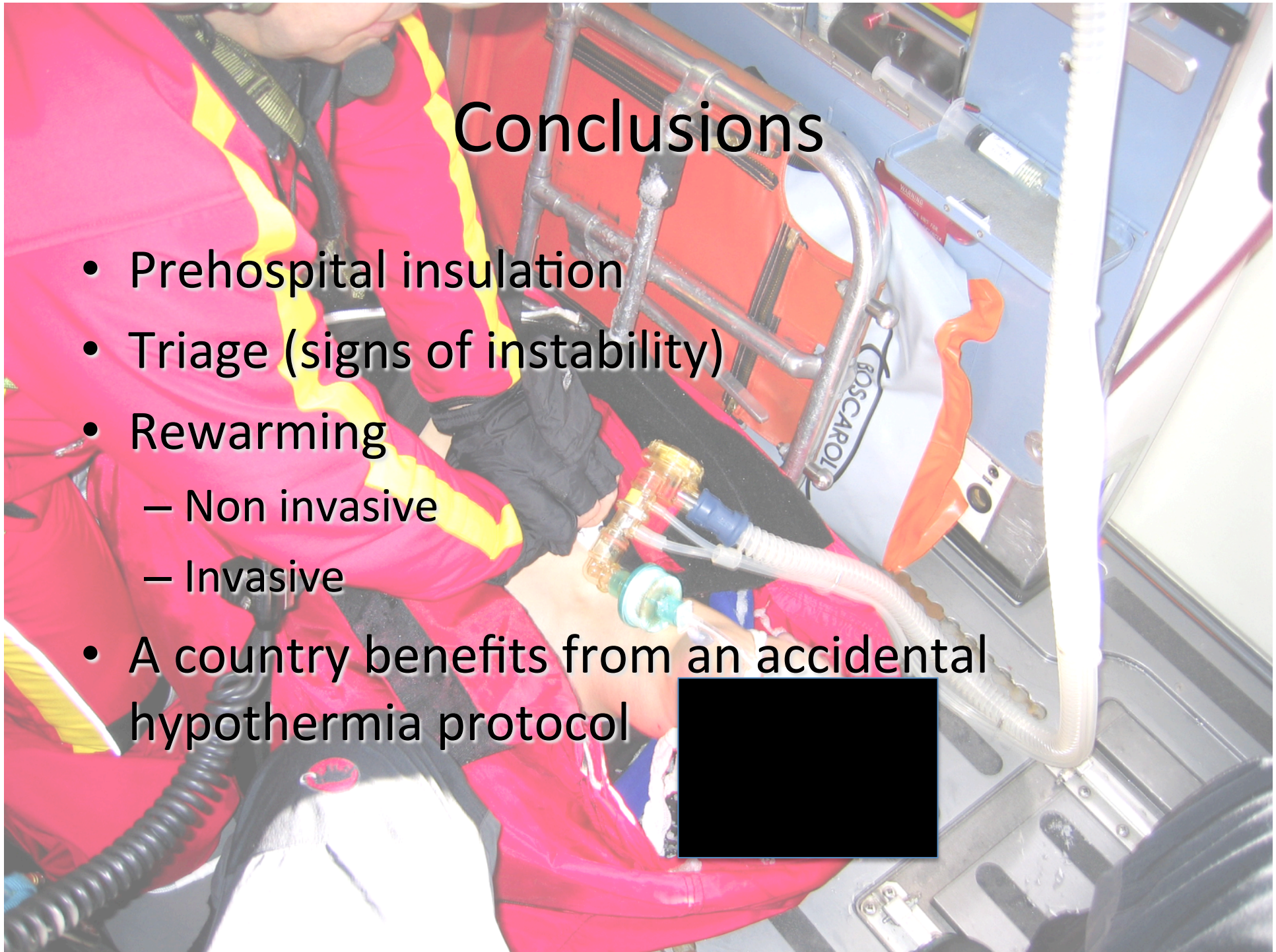
The most extreme reported accidental hypothermia cases

Longest no flow time	42 year old male, found in crevasse, 7 metres under snow, <u>no vital signs. CPR started only after 70 minutes in hospital when patient was asystolic.</u> 19°C core temperature. ECLS rewarming. Full recovery ⁴¹
Longest CPR time	42 year old male, found outdoors, asystolic. CPR started. 23.2°C, <u>6,5 hours CPR and non-ECLS rewarming until ROSC.</u> Full recovery ⁵⁴
Lowest survived body core temperature	29 year old female, fell into water fall gully, flooded by icy water but able to breathe. Lifeless for approx. 45 minutes. CPR started after rescue. At hospital admission 13.7°C and K ⁺ of 8.2 mmol L ⁻¹ . ECLS rewarming., Full recovery ⁷²
Longest persisting VF	42 year old male, found outdoors, CPR started. Repeated shocks, hospital transfer. 22°C. ECLS rewarming started at 130 minutes. CPR and after 38 shocks, successful shock at 30°C, full recovery ⁸⁹
Longest intermittent CPR	57 year old female, witnessed cardiac arrest in French Alps at 2000 m altitude in a snowstorm; transport distance to EMS vehicle of 1.1 km, 122 metres difference in height; 1 minute CPR alternating with 1 minute walking for 25 minutes, 5 hours CPR, ECLS rewarming, full recovery ⁶³

Longest submersion	<p>2.5 year old, submersion in cold water for at <u>least 66 min.</u> 19°C, ECLS rewarming. Full recovery⁹⁰</p> <p>7 year old child, submersion in icy water for <u>at least 83 minutes.</u> CPR for 64 minutes. 13.8°C, K+ 11.3 mmol L⁻¹. ECLS rewarming. Full recovery⁷³</p>
Longest survival in an avalanche	<p>Female, core temperature <32°C, when found somnolent, disorientated. 1st- 2nd degree frost bite on hand and feet. No injuries. 43 hours and 45 minutes⁹¹</p>
Longest time in an avalanche indoor	<p>Seven days trapped in a house which in part collapsed after being hit by an avalanche. Heiligenblut, Austria (personal communication)</p>
Highest survived potassium in an avalanche victim	<p>Avalanche victim. K 6.4 mmol L⁻¹, survived; core temperature and neurological outcome are not reported⁹²</p> <p>On page 16, it says that the potassium was 6.7 but that is incorrect.</p>
Highest survived potassium in an adult	<p>34 year old female, 20°C. Cold environment exposure. Asystole, K 7.9 mmol L⁻¹. ECLS rewarming. Survived, neurologic outcome not reported⁹³</p>
Highest potassium in an accidentally hypothermic patient	<p>7 year old and, cold water submersion, K 11.3 mmol L⁻¹.⁷³</p> <p>And 31 month old child, cold water submersion, K 11.7 mmol L⁻¹ ⁷¹</p>
Longest time in a crevasse	<p>27 year old male, 8 days, good outcome, no temperature or other specific details reported.⁹⁴ 70 year male, moderate fractures of skull, vertebral column, pelvis, and femur. 6 days, 33.5°C, cold injuries to toes. Otherwise good outcome⁹⁵</p>

Conclusions

- Prehospital insulation
- Triage (signs of instability)
- Rewarming
 - Non invasive
 - Invasive
- A country benefits from an accidental hypothermia protocol




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Thank you

peter.paal@bbsalz.at