ECMO in the Mountains

8 November 2023

ISMM
International Society
for Mountain Medicine

KAITIAKI ORA
TACTICAL MEDICINE NEW ZEALAND

New Zealand Society for
MOUNTAIN MEDICINE

Dr Malin Zachau, MBBS, DRCOG, DipIMC (retired)

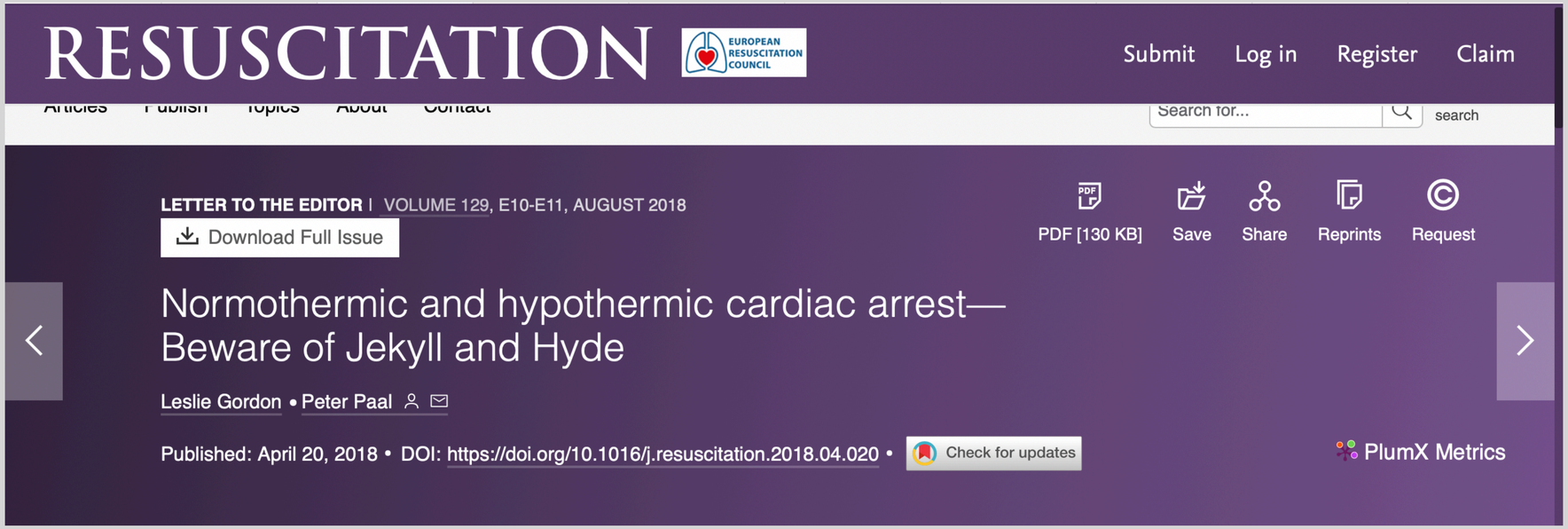
Original research | Open access | Published: 31 October 2023

Extracorporeal cardiopulmonary resuscitation for hypothermic refractory cardiac arrests in urban areas with temperate climates

Tal Soumagnac, Jean-Herlé Raphalen, Wulfran Bougouin, Damien Vimpere, Hatem Ammar, Samraa Yahiaoui, Christelle Dagron, Kim An, Akshay Mungur, Pierre Carli, Alice Hutin & Lionel Lamhaut

Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine **31**, Article number: 68 (2023)
| Cite this article

No statistically significant difference in survival rates between patients treated with *pre-hospital* ECPR compared with patients treated with *in-hospital* ECPR



HYPOTHERMIC CARDIAC ARREST

- Good prognosis for neurological intact survival
- Long duration of CPR, maybe hours
- Intermittent CPR can be OK
- Max 3 shocks <30*C
- No drugs <30*C

Hypothermic cardiac arrest

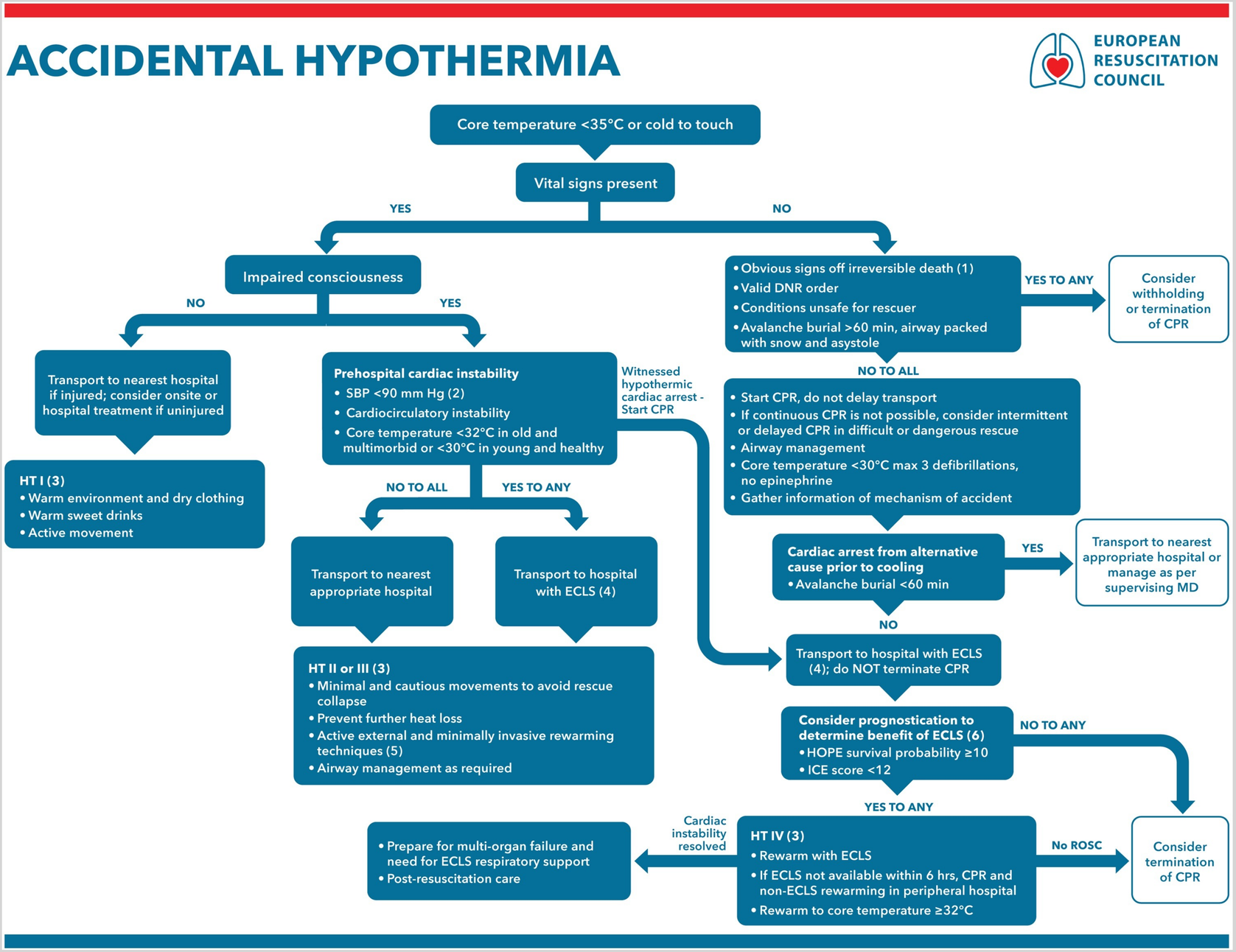
ECPR:

- ERC 2021 guidelines
- Selection criteria
- ECMO practical details
- Outcomes

New Zealand mountains:

- Avalanche vs terrestrial (AvaLife)
- Incidence
- Links in the chain of rescue
- Destination policy
- How you as ECMO practitioners can make a real difference

2021 ERC Guidelines



***Management in accidental hypothermia*.**

(1) Decapitation; truncal transection; whole body decomposed or whole body frozen solid (chest wall not compressible).

(2) SBP < 90 mmHg is a reasonable prehospital estimate of cardiocirculatory instability but for in-hospital decisions, the minimum sufficient circulation for a deeply hypothermic patient (e.g., <28 °C) has not been defined.

(3) Swiss staging of accidental hypothermia.

(4) Direct transport to an ECMO centre is recommended in an arrested hypothermic patient. In remote areas, transport decisions should balance the risk of increased transport time with the potential benefit of treatment in an ECLS centre (e.g. 6 h).

(5) Warm environment, chemical, electrical, or forced air heating packs or blankets, and warm IV fluids (38–42 °C). In case of cardiac instability refractory to medical management, consider rewarming with ECLS.

(6) If the decision is made to stop at an intermediate hospital to measure serum potassium, a hospital en route to an ECLS centre should be chosen. HOPE and ICE scores should not be used in children, instead consider expert consultation.

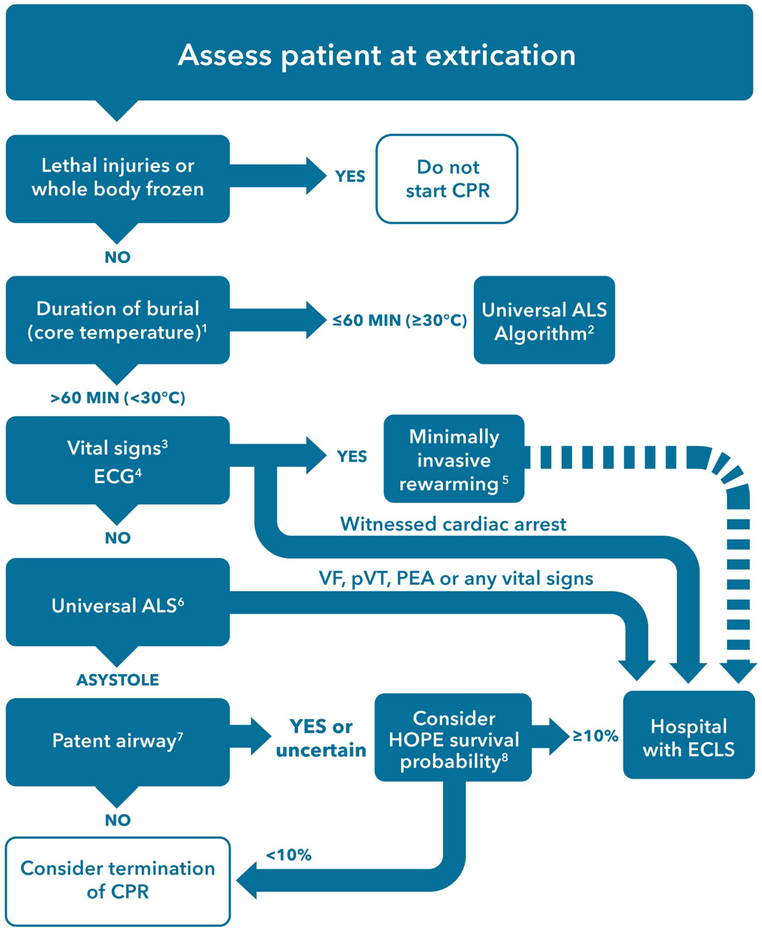
https://doi.org/10.1016/j.resuscitation.2021.02.011

2021 ERC Guidelines

St John CPG do not advocate for any resuscitation if airway obstructed (irrespective of burial duration)

AVALANCHE RESCUE

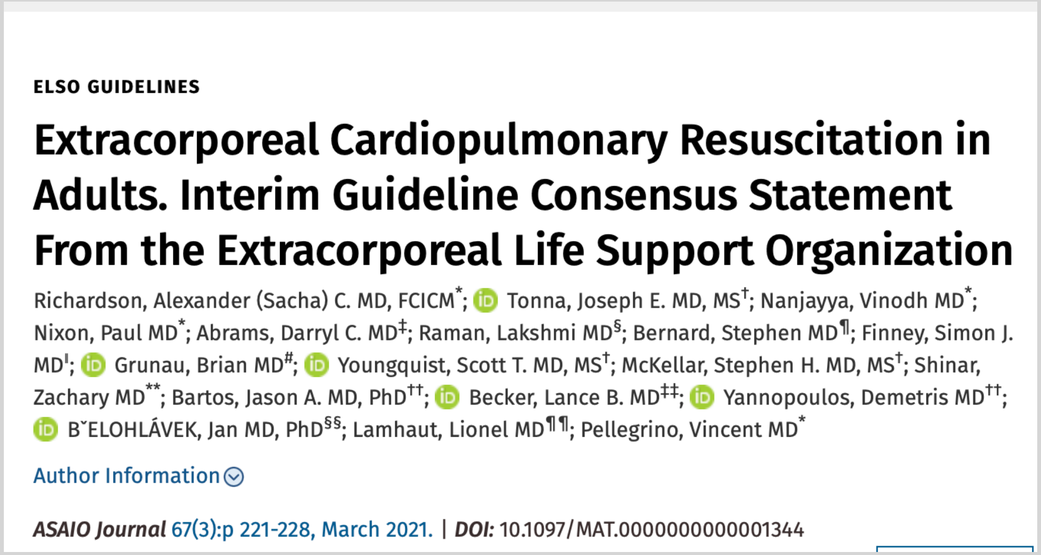
EUROPEAN RESUSCITATION COUNCIL



1. Core temperature may substitute if duration of burial is unknown.
2. Transport patient with injuries or potential complications (e.g. pulmonary oedema) to the most appropriate hospital.
3. Check for spontaneous breathing, pulse and any other movements for up to 60 seconds.
4. Use additional tools for detection of vital signs (end-tidal CO_2, arterial oxygen saturation (SaO_2), ultrasound) if available.
5. Transport patients with core temperature <30°C, systolic blood pressure <90mmHg or any other cardiocirculatory instability to a hospital with ECLS.
6. With deeply hypothermic patient (<28°C) consider delayed CPR if rescue is too dangerous and intermittent CPR with difficult transport.
7. If airway is patent, the additional presence of an air pocket is a strong predictor for survival.
8. If HOPE is not possible, serum potassium and core temperature (cut-offs 7 mmol/L and 30°C) can be used but may be less reliable

Abbreviations: ALS Advanced life support, CPR cardiopulmonary resuscitation, ECLS extracorporeal life support, PEA pulseless electrical activity, pVT pulseless ventricular tachycardia, SaO_2 arterial oxygen saturation, VF ventricular fibrillation

In AvaLife this depends on resources available, CPR limited to 6 minutes in some cases



ELSO GUIDELINES

Extracorporeal Cardiopulmonary Resuscitation in Adults. Interim Guideline Consensus Statement From the Extracorporeal Life Support Organization

Richardson, Alexander (Sacha) C. MD, FCICM[*]; Tonna, Joseph E. MD, MS[†]; Nanjayya, Vinodh MD[*]; Nixon, Paul MD[*]; Abrams, Darryl C. MD[‡]; Raman, Lakshmi MD[§]; Bernard, Stephen MD[¶]; Finney, Simon J. MD[‖]; Grunau, Brian MD[#]; Youngquist, Scott T. MD, MS[†]; McKellar, Stephen H. MD, MS[†]; Shinar, Zachary MD[**]; Bartos, Jason A. MD, PhD[††]; Becker, Lance B. MD[‡‡]; Yannopoulos, Demetris MD[††]; B˘ELOHLÁVEK, Jan MD, PhD[§§]; Lamhaut, Lionel MD[¶¶]; Pellegrino, Vincent MD[*]

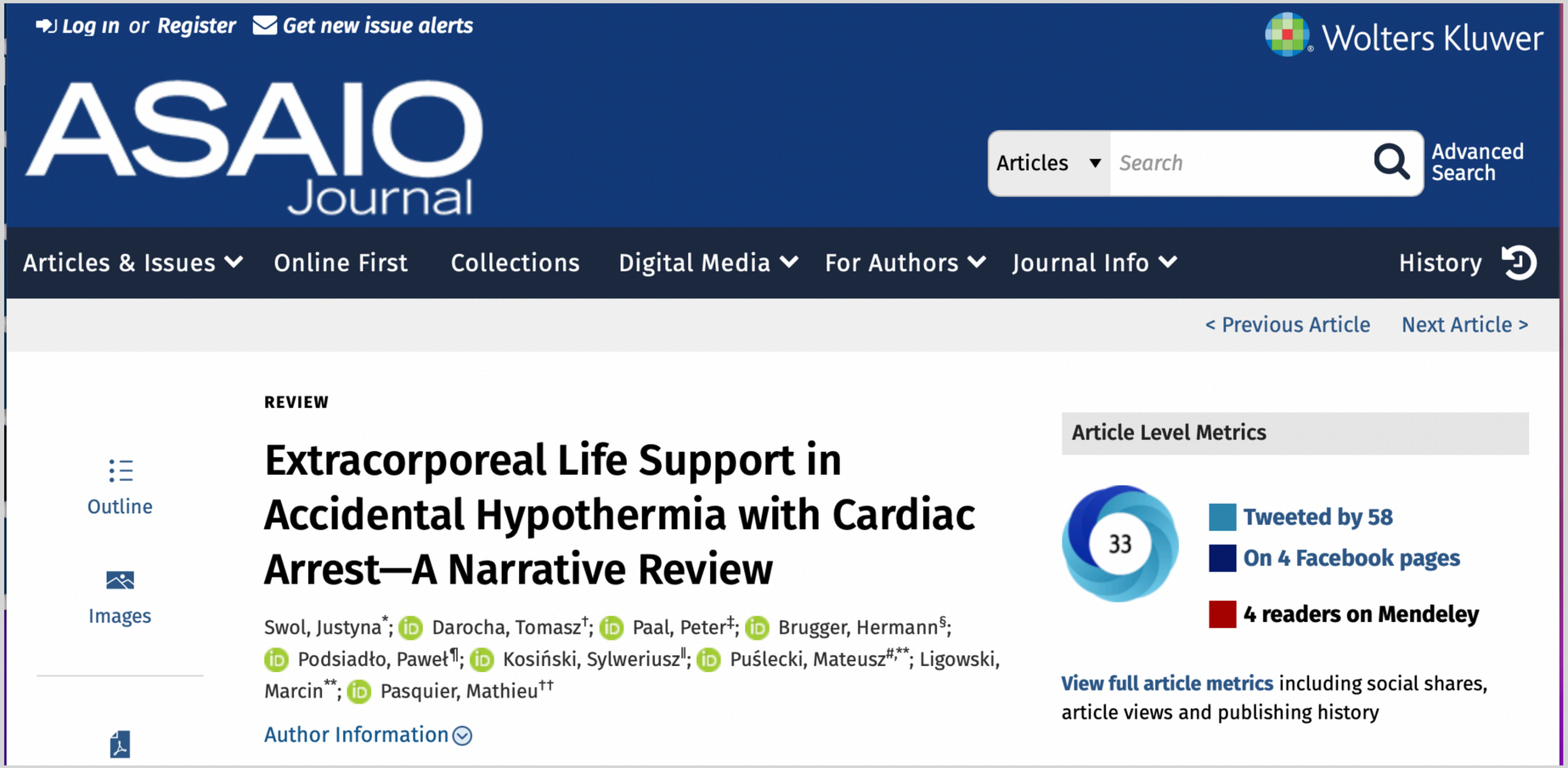
Author Information

ASAIO Journal 67(3):p 221-228, March 2021. | *DOI:* 10.1097/MAT.0000000000001344

Arrest to ECMO flow < 60 minutes of “low flow interval” *

***Unless other favourable prognostic features are present eg periods of intermittent ROSC/ hypothermia pre- arrest / young age/signs of life during CPR**

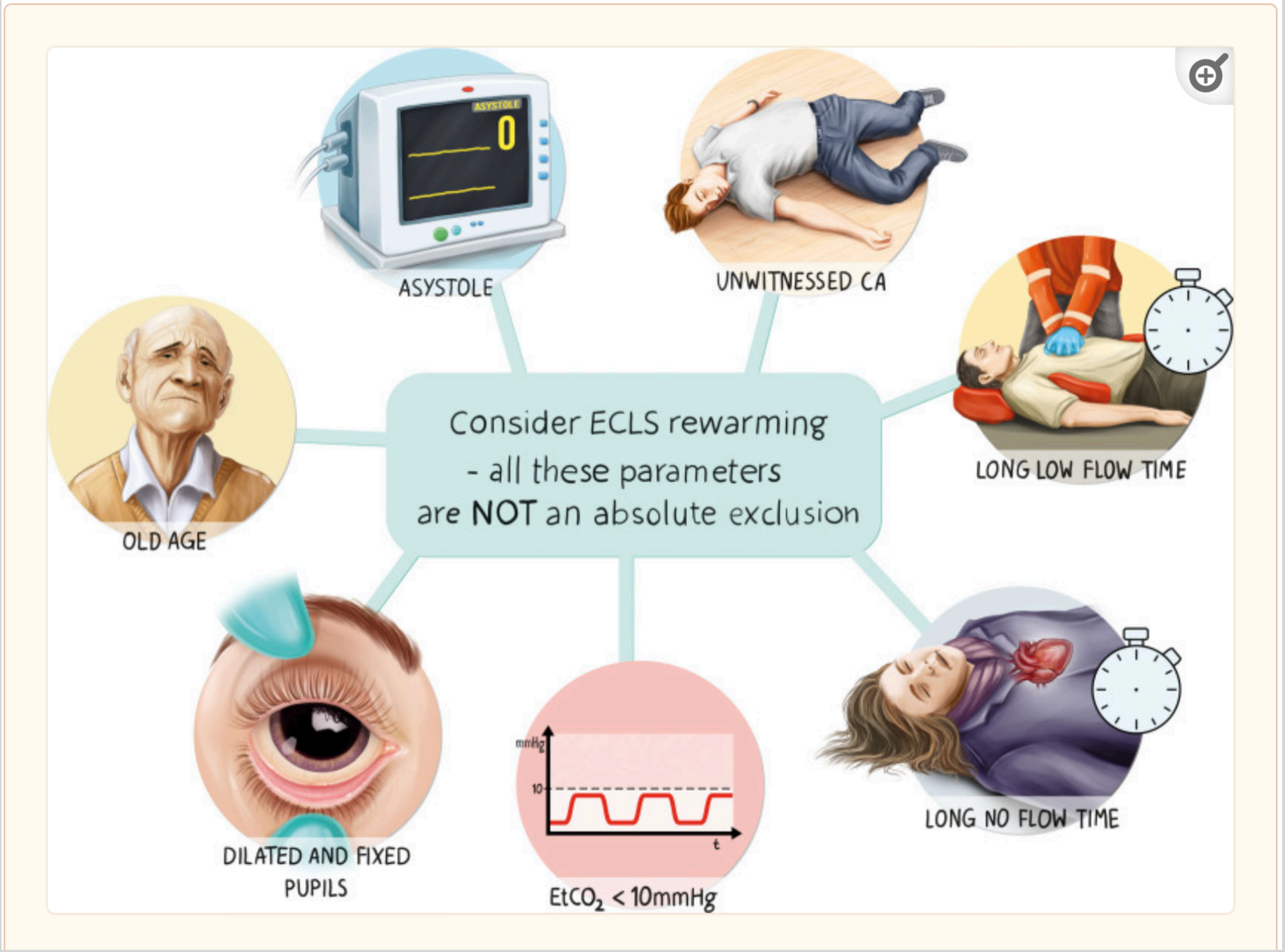
Inclusion :
ECPR can be initiated within 60 minutes of the arrest, though a longer interval may be considered circumstantially (e.g. hypothermic arrest)



https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8797003/

The following parameters considered as exclusion criteria for ECPR in normothermic patients

DO NOT contraindicate ECLS rewarming



Open Access Review

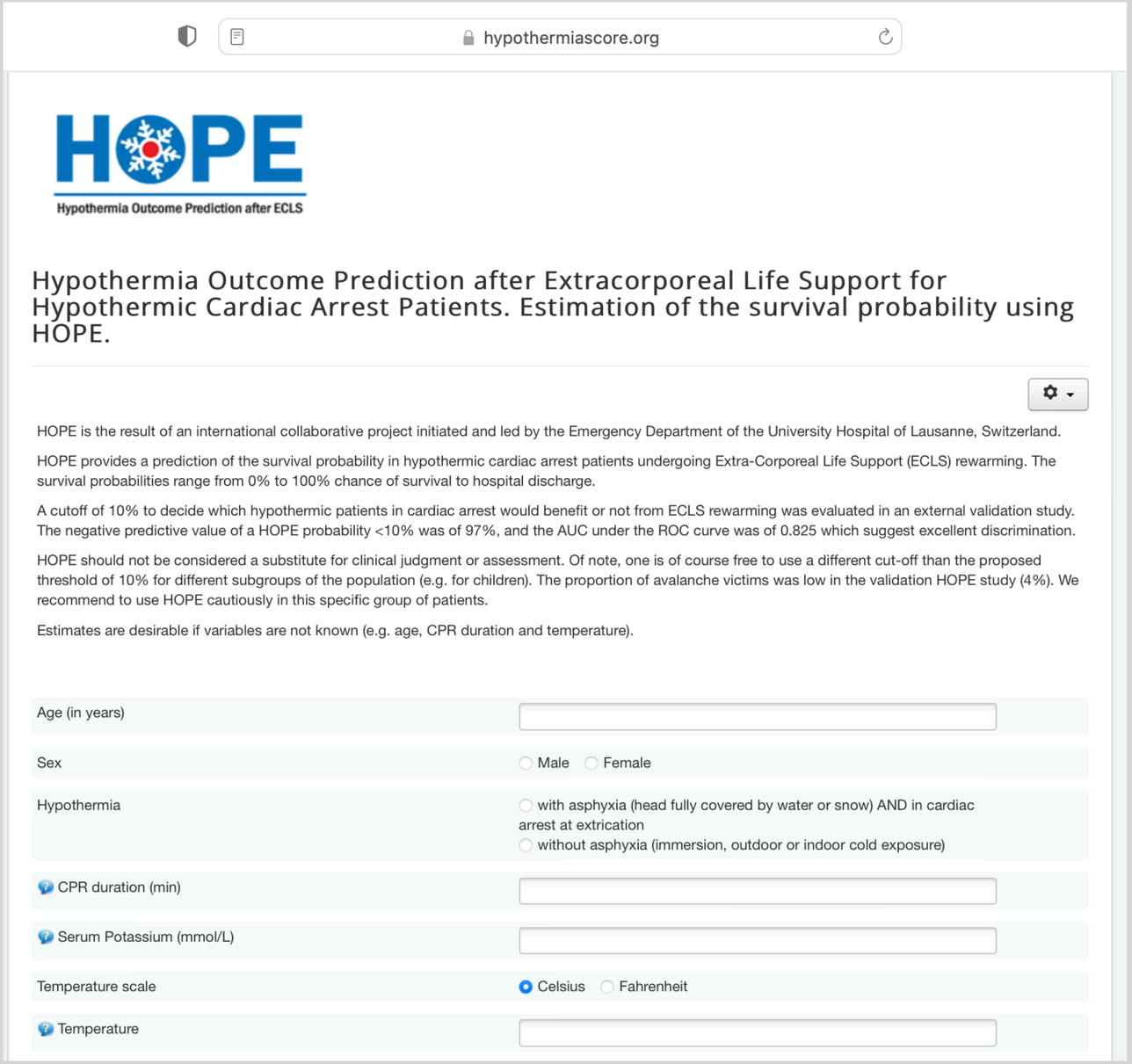
The Role of Extracorporeal Membrane Oxygenation ECMO in Accidental Hypothermia and Rewarming in Out-of-Hospital Cardiac Arrest Patients—A Literature Review

by Hubert Hymczak [1,2], Aleksandra Gołąb [3,4,*], Sylweriusz Kosiński [5], Paweł Podsiadło [6], Dorota Sobczyk [7,8], Rafał Drwiła [1], Bogusław Kapelak [8], Tomasz Darocha [9] and Dariusz Plicner [8,10]

PRACTICAL DETAILS FOR ECPR REWARMING IN HYPOTHERMIC CARDIAC ARREST

- Be sure to use more than one site for venipuncture and more than one potassium value.
- Take care to avoid heamolysis since that will give artifactual high potassium value
- Since pre hospital thermometry unreliable, great care with history (ie no trauma, no asphyxia and cold before CA)
- Cannulation might be difficult due to bleeding due to coagulopahty.
- Anticoagulation is not needed.
- The ideal rate of rewarming of hypothermic ECLS patients remains unknown, but slower seems to have better neurological outcomes.
- Target should be less than 5 *C per hour increase, probably 4-5*C per hour until heart rhythm back to normal and then 1-2 *C per hour until normothermia.
- The gradient between inflow and outflow must be less that 10*C.

https://www.hypothermiascore.org



Coldest
Poland 2014

Eur J Cardiothorac Surg. 2020 Nov; 58(5): 1091–1092.
Published online 2020 Jun 26. doi: 10.1093/ejcts/ezaa159
PMCID: PMC7886275
PMID: 33084865

Successful resuscitation from accidental hypothermia of 11.8°C: where is the lower bound for human beings?

Tomasz Mroczek, Marcin Gladki, and Janusz Skalski

Core temp: 11.8 *C
Duration of CPR / mCPR: 2 hrs 7 minutes
Duration of ECMO: 23 hours
Time to discharge home: 64 days
Functional status: Normal at 5 year follow up

Longest cardiac arrest
Italy 2018

EMERGENCY MEDICAL SERVICES/CASE REPORT

Hypothermic Cardiac Arrest With Full Neurologic Recovery After Approximately Nine Hours of Cardiopulmonary Resuscitation: Management and Possible Complications

Alessandro Forti, MD; Pamela Brugnaro, MD; Simon Rauch, MD; Manuela Crucitti, MD; Hermann Brugger, MD; Giovanni Cipollotti, MD; Giacomo Strapazzon, MD, PhD*

*Corresponding Author. E-mail: giacomo.strapazzon@eurac.edu.

Alessandro Forti

Cardiac-Anaesthesist, Intensive Care Medicine Specialist, Aerospace Medicine, Helicopter Emergency Services Specialist

We describe here a case of full neurologic recovery from accidental hypothermia with cardiac arrest, which **involved the longest reported duration of mechanical cardiopulmonary resuscitation (CPR) and extracorporeal life support (8 hours, 42 minutes)**. A 31-year-old man experienced a witnessed hypothermic cardiac arrest with a core temperature of 26C° (78.8F) during a summer thunderstorm on the vertical wall of the Marmolada mountain in the Dolomites, Italy (Figure 1), in the late afternoon on a summer day (day 0).

Core temp: 26*C
Duration of CPR/ mCPR: 3 hrs 42 minutes
Duration of eCPR ECMO: 5 hours
Time to discharge home: Extubated on day 21
Functional status: CP1- back to climbing

Oldest
Norway 2014

Carlsen *et al. BMC Geriatrics* (2017) 17:249
DOI 10.1186/s12877-017-0646-6

BMC Geriatrics

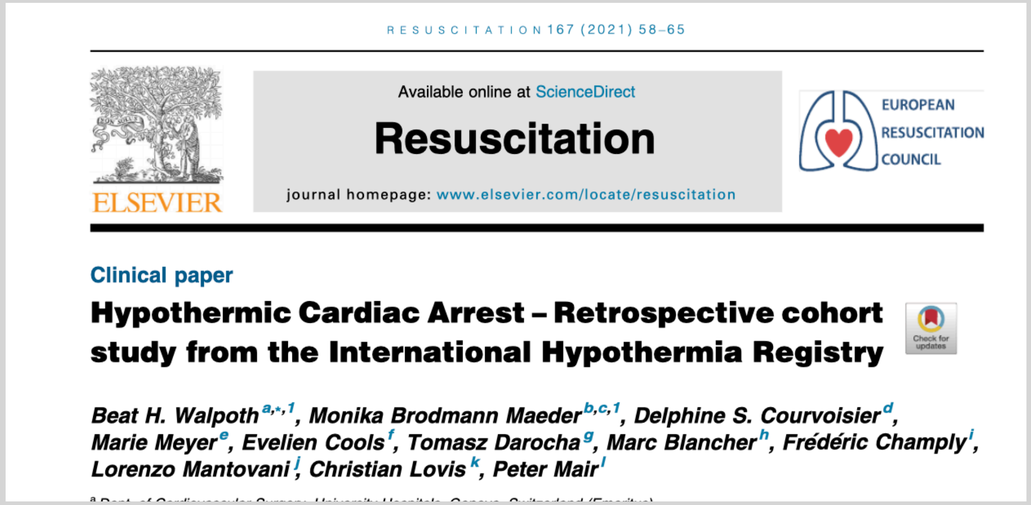
CASE REPORT Open Access

A 95 year-old suffering circulatory arrest after accidental hypothermia: a case report

Anders Wetting Carlsen[1], Anders M. Winnerkvist[2] and Guri Greiff[1,3*]

Core temp: 22.9*C
Duration of CPR/ mCPR: 41 minutes
Duration of eCPR CPB: 5 hours (?)
Time to discharge home: Extubated on day 1
Functional status: CP1- died 3 years later age 98

Up to 100% neurological intact survival in single centre studies



RESUSCITATION 167 (2021) 58–65

Available online at ScienceDirect

Resuscitation

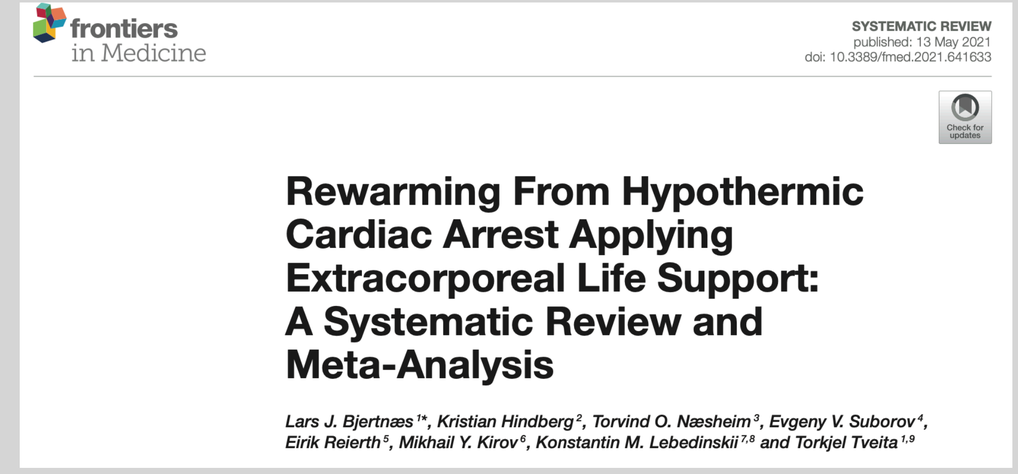
journal homepage: www.elsevier.com/locate/resuscitation

Clinical paper

Hypothermic Cardiac Arrest – Retrospective cohort study from the International Hypothermia Registry

Beat H. Walpoth[a,,1], Monika Brodmann Maeder[b,c,1], Delphine S. Courvoisier[d], Marie Meyer[e], Evelien Cools[f], Tomasz Darocha[g], Marc Blancher[h], Frédéric Champly[i], Lorenzo Mantovani[j], Christian Lovis[k], Peter Mair[l]*

2010-2020 HCA:
36% survival (neurological intact)



frontiers in Medicine

SYSTEMATIC REVIEW
published: 13 May 2021
doi: 10.3389/fmed.2021.641633

Rewarming From Hypothermic Cardiac Arrest Applying Extracorporeal Life Support: A Systematic Review and Meta-Analysis

Lars J. Bjertnæs[1], Kristian Hindberg[2], Torvind O. Næsheim[3], Evgeny V. Suborov[4], Eirik Reierth[5], Mikhail Y. Kirov[6], Konstantin M. Lebedinskii[7,8] and Torkjel Tveita[1,9]*

31% survival after CPB

44% survival after ECMO(neurologically intact)

Inclusion criteria for IHR:

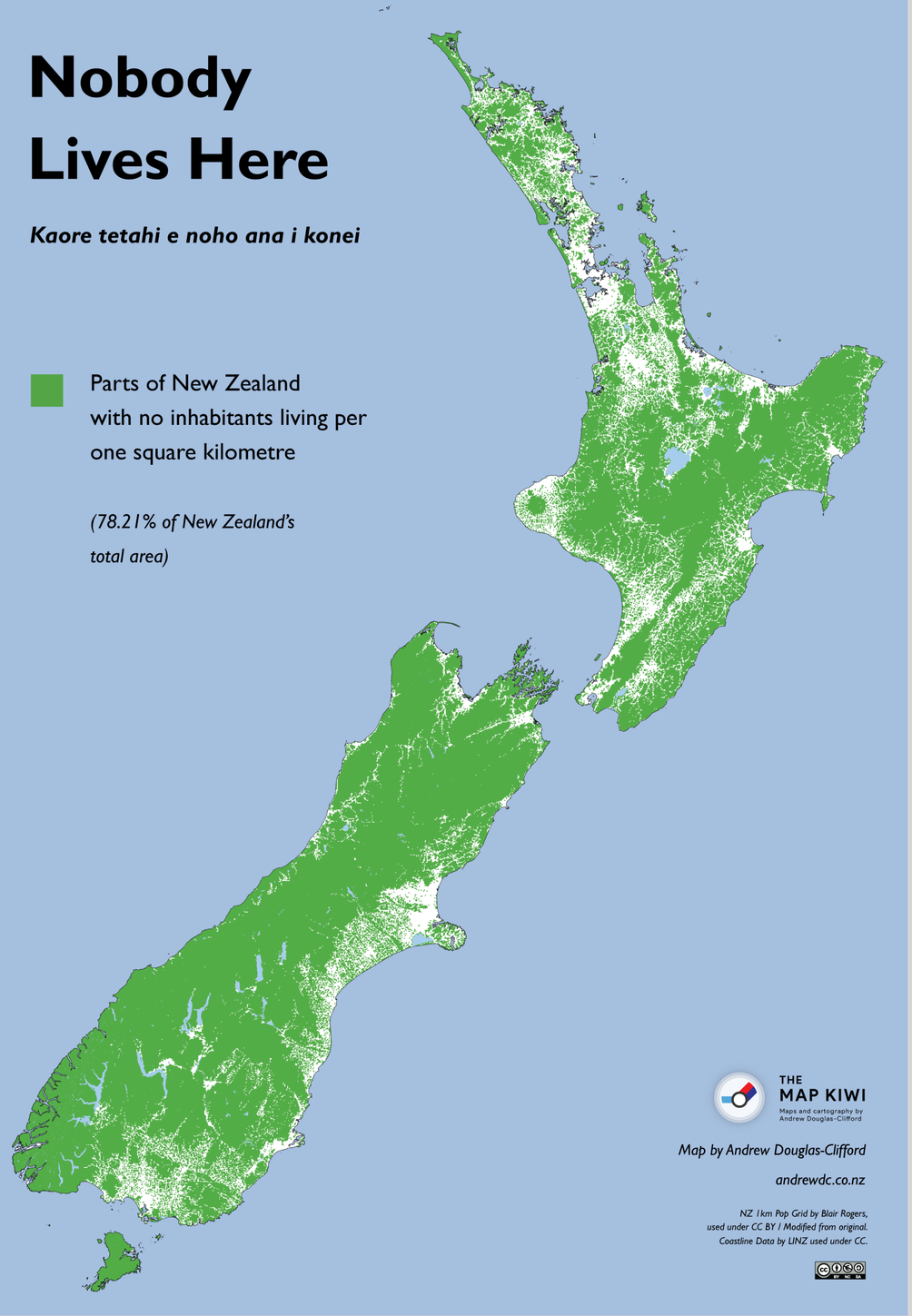
- Accidental hypothermia with body core temperature equal to or less than 32*C
- Any age, gender or co-morbidities
- Independent of hypothermia aetiology or patient outcome
- The registry is mainly prospective but retrospective entries are welcome

Nobody Lives Here

Kaore tetahi e noho ana i konei

Parts of New Zealand with no inhabitants living per one square kilometre

(78.21% of New Zealand's total area)

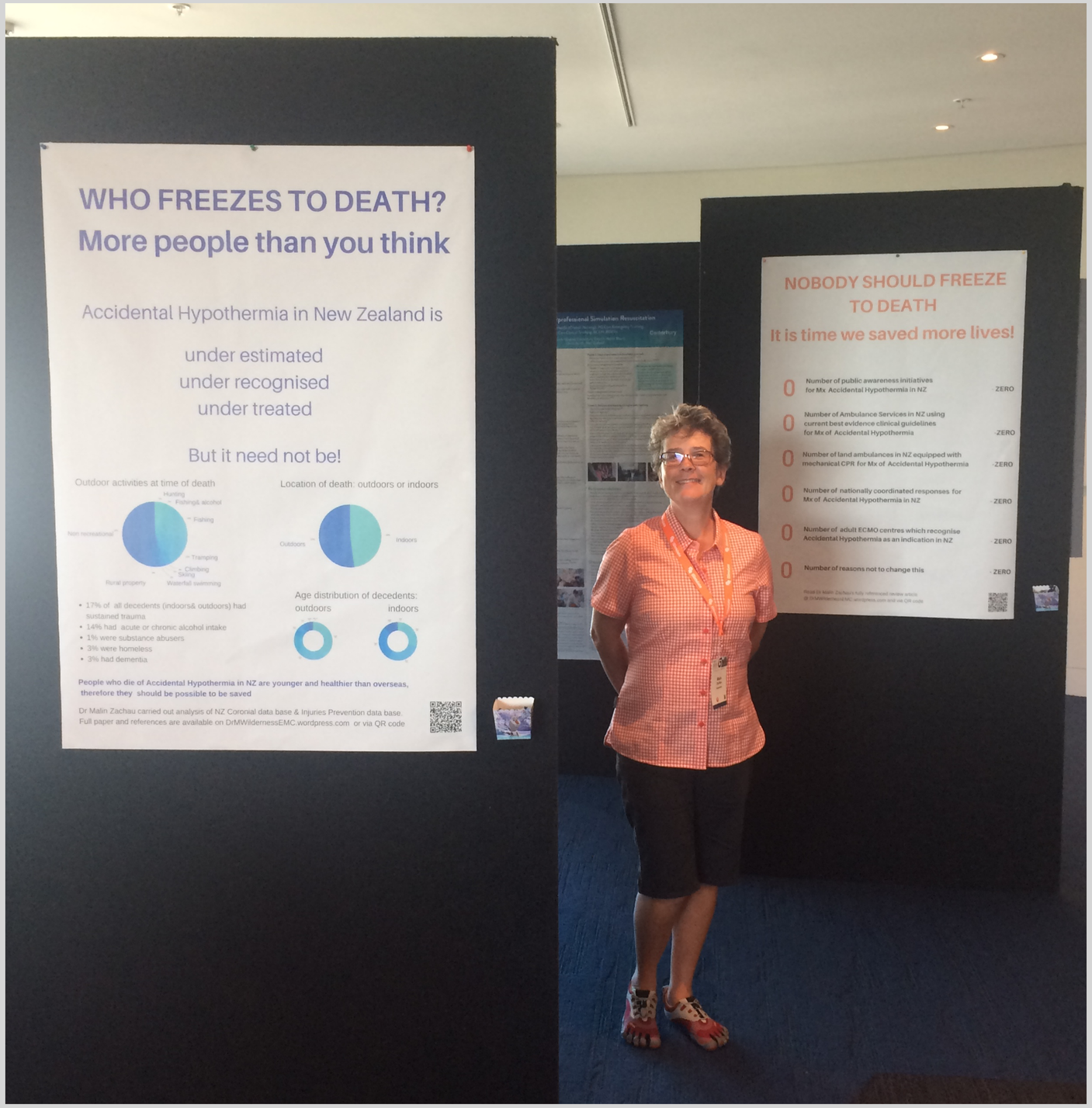


THE MAP KIWI
Maps and cartography by Andrew Douglas-Clifford

Map by Andrew Douglas-Clifford

andrewdc.co.nz

NZ Resuscitation Council conference 2018 poster exhibition



NZ accidental hypothermia statistics (nonavalanche ie non asphyxial)

- on average one a month
- half indoors, half outdoors
- biggest comorbidity is trauma (17%)
- alcohol and substance misuse very low

Hypothermia and Verification of Death Comparison

Hypothermia symptoms

- Cold induced stiffness

- Breathing can be very slow
- Pulse might not be manually palpated
- Heart sounds may not be audible
- Fixed and dilated pupils
- Asystole

NZ Guidelines

- rigor mortis
- visible injuries incompatible with life, or
- signs of decomposition

OR

- No signs of breathing (for one minute)
- No palpable central pulse (for 5–10 seconds)
- No audible heart sounds
- Pupils dilated and un-reactive
- Asystole (where a cardiac monitor or defibrillator is available)

Requirement for any specific body temperature to be reached prior to being verified dead?

No

Guidelines emphasise extreme caution in telling vita minima vs death in hypothermic patients

> 35°C

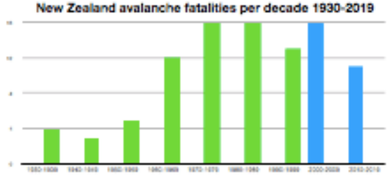
> 33°C

No, but mentioned in national guidelines on hypothermia

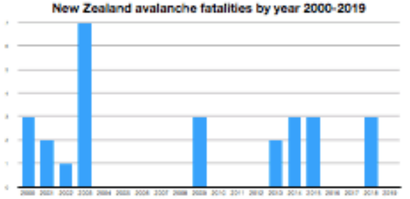
New Zealand avalanche patient resuscitation: Doomed to fail or room for improvement?

An analysis of coronial data of New Zealand avalanche fatalities 2000-2019

New Zealand avalanche fatalities per decade 1930-2019

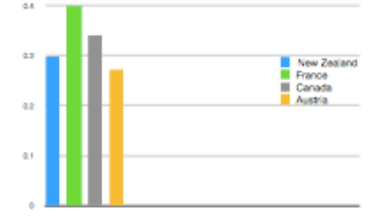


New Zealand avalanche fatalities by year 2000-2019



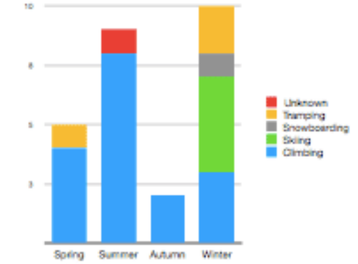
- In the years 2000-2019 the average annual death rate caused by avalanche in New Zealand is 1.3 / year
- 17 incidents; 1 with 4 deaths, 1 with 3 deaths, 4 with 2 deaths and 11 with 1 death

Annual avalanche deaths per million residents for various countries



- In New Zealand, data on participation numbers does not exist

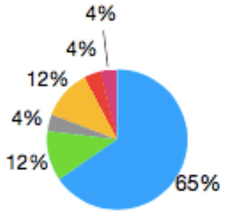
Avalanche fatalities in New Zealand 2000-2019 by season and activity



- All the decedents were male.

65% of avalanche fatalities are climbers

Activity at time of fatal avalanche in New Zealand 2000-2019



Total deaths: 26

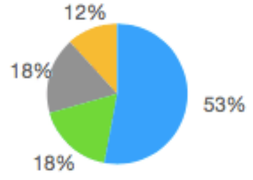
- Climbing 17
- Heli-skiing 3
- Skiing 1
- Tramping 3
- Snowboarding 1
- Unknown activity 1

Comparison of climber avalanche decedents in five countries as percentage of total avalanche fatalities

Country	USA	Canada	France	Norway	New Zealand
Years	2009-2019	2010- 2020	2010- 2019	2014- 2020	2000-2019
Climbing	9%	3%	8%	0%	65%
Reference source	CAIC	Avalanche Canada	ANENA	Varsom Snøskred	NZ MSC & coroner

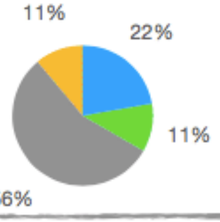
71% of the climbers who die in NZ avalanches die from trauma

Cause of death of New Zealand avalanche decedents 2000-2019



Climber deaths: 17

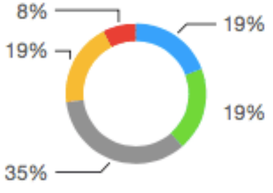
- Trauma 9
- Never found, presumed trauma 3
- Asphyxia 3
- Yet to have PM findings released 2



Non-Climber deaths: 9

- Trauma 2
- Hypothermia 1
- Asphyxia 5
- PM not done 1

The opportunity for companion rescue is limited by several factors



- Rescued by companion 5
- Solo (no companion) 5
- Entire Party died 9
- Companions too Injured to help 5
- No Equipment / Training 2

Time to rescue by companions

<30 min	Immediately by companion	6 minutes by companion	6 minutes by companion	About 20 minutes by companions	28 minutes by companions
Depth of burial	On surface	1.4metre	Visual clue	No data	Visual clue
Activity	Climbing	Climbing	Heli-skiing	Heli-skiing	Heli-skiing
Cause of death	Trauma	Presumed asphyxia	Asphyxia & heart failure	Asphyxia	Asphyxia

- In 1 case ICAR guidelines for resuscitation were not followed.

Time taken for organised rescue is affected by low population, few resources, & the tyranny of distance

All avalanche fatalities have occurred in South Island, within red box. Most of the climbing avalanche fatalities have occurred within Aoraki Mt Cook National Park.

South Island has just over 1 million inhabitants.

- 6 helicopter bases
- 9 helicopters
- 4 bases have paramedics
- 0 bases have doctors
- 1 professional SAR helicopter

Although we tend to think of New Zealand as a small set of Islands in the South Pacific, we are in fact quite big, and when compared to other countries, quite empty.

Virtual Snow Science Workshop 2020 Poster Presentation

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Context

- Data for survivors of avalanche incidents is not currently reliably collected by District Health Boards or any other agency.
- The analysis of fatal avalanche incidents, including cause of death, has not previously been carried out in NZ, despite it being commonly done and publicly available in other countries, eg Norway.
- No single body takes responsibility for the rescue, retrieval, and medical management of avalanche patients in NZ.
- Specific Avalanche First Aid training for recreationalists, professional snow industry and volunteer rescuers is not currently available in New Zealand.

Time to rescue/ body recovery (organised rescue)

1 - 12 hours	2 hours	2 hours	2 hours	2 hours	About 2 hours	About 2 hours	2.5 hrs	2.5 hrs
Depth of burial	On surface	On surface	On surface	On surface	Visual clue	No data	60 cm	3.5m
Activity	Climbing	Climbing	Climbing	Climbing	Climbing	Climbing	Skiing	Snow boarding
Cause of death	Trauma	Trauma	Trauma	Trauma	Awaiting PM result	Awaiting PM result	Hypo-thermia	Trauma

>12 hours	24 hours	24 hours	4 days	4 days	4 days	17 days	17days	Never	Never	Never
Depth of burial	1.5m	2m	Took an hour to shovel	No data	No data	Visual clue with some snow melt	Found close to companion			
Activity	Climbing	Climbing	Tramping	Climbing	Climbing	Tramping	Tramping	Climbing	Climbing	Climbing
Cause of death	Asphyxia	Asphyxia	Trauma	Trauma	Trauma	Asphyxia	Asphyxia	Presumed trauma	Presumed trauma	Presumed trauma

- There are another 3 cases where time to rescue or depth of burial data is not available.
- In 2 cases ICAR guidelines for resuscitation were not followed.

NZ avalanche statistics

- Avalanche deaths on average 1/ year, none since 2018
- 65% are climbers
- 71% of those die of trauma
- 1 confirmed hypothermic death the last 15 years
- Average helicopter response time 90 minutes

Chain of survival for Avalanche rescue:
Not all links are equal in hypothermic cardiac arrest

Companion rescue

Alpine rescue & Avalanche dogs

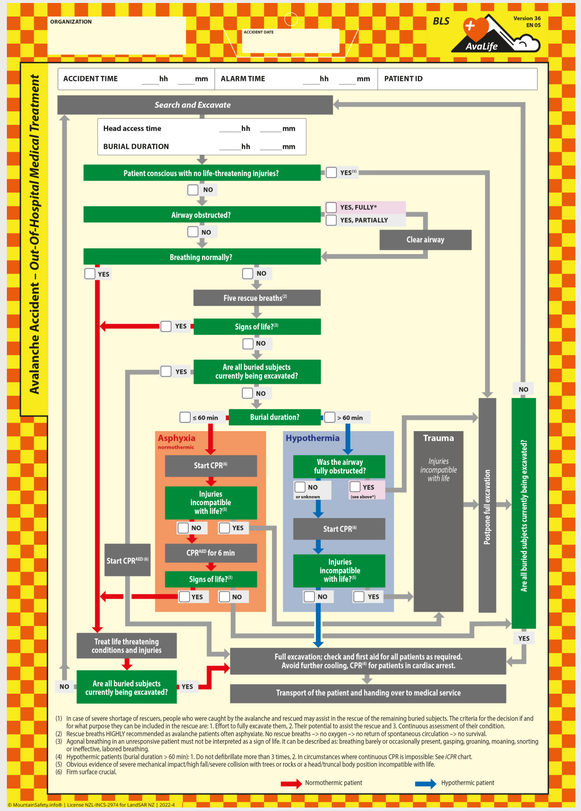
EMS/ HEMS

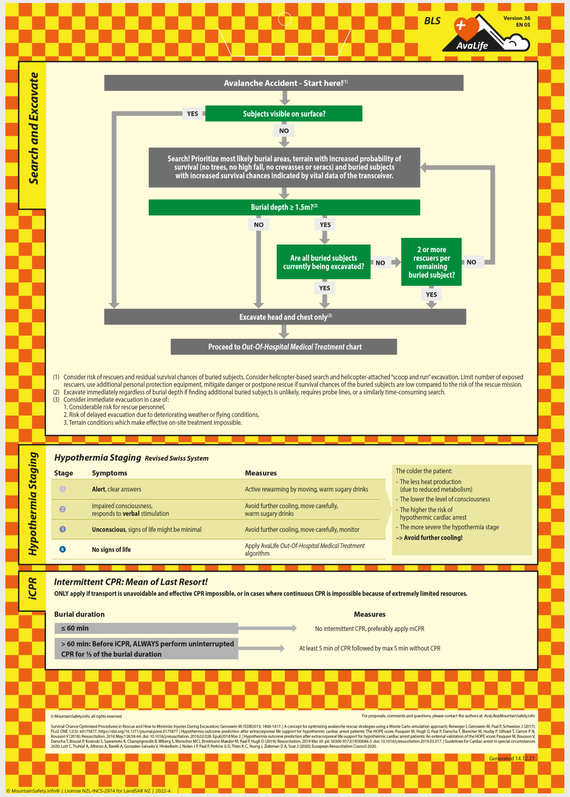
Hospital

DrM@WildernessEMC

6 February 2019 **(DRAFT)**
see website
drmwildernessemc.wordpress.com
for more details

The use of AvaLife algorithm mandated by NZSAR in 2022





ORGANIZATION

ACCIDENT DATE

ALS

Version 36
EN 04

AvaLife

Avalanche Accident – Out-Of-Hospital Medical Treatment

ACCIDENT TIME ____hh ____mm | ALARM TIME ____hh ____mm | PATIENT ID

Search and Excavate

Head access time ____hh ____mm

BURIAL DURATION ____hh ____mm

Patient conscious with no life-threatening injuries? YES[1] / NO

Airway obstructed? YES, FULLY* / YES, PARTIALLY / NO

Clear airway

Breathing normally? YES / NO

Five rescue breaths[2]

Signs of life? YES / NO

Core temperature? (Burial duration)
< 30° C (> 60 min)
≥ 30° C (≤ 60 min)

Postpone full excavation

Are all buried subjects currently being excavated? NO / YES

Asphyxia
normothermic

Start CPR[3]

Injuries incompatible with life?[3] YES / NO

VF / pVT / PEA

ECG?

Asystole

ECG unavailable

Are all buried subjects currently being excavated? YES / NO

Universal ALS algorithm

CPR[ALS] for 6 min

Signs of life? YES / NO

Hypothermia

ECG?[4]

Bradycardia

VF / pVT / PEA

Asystole

ECG unavailable

Was the airway fully obstructed? NO[5] or unknown / YES (see above*)

Monitor, move carefully, avoid further cooling

Start CPR[ALS]

Injuries incompatible with life?[3] NO / YES

Alert hospital with ECLS

Trauma

Injuries incompatible with life

Consider termination of CPR

Treat life threatening conditions and injuries

Are all buried subjects currently being excavated? NO / YES

Full excavation; check, monitor and treat all patients as required.
Avoid further cooling, CPR[7] or mechanical CPR (mCPR) for patients in cardiac arrest.

Transport in accordance with *Medical Transport Priority* chart

Transport to hospital with ECLS[8] in accordance with *Medical Transport Priority* chart

HOPE ?

Estimated survival probability

Scan the QR code or go to www.hypothermiascore.org
Hypothermia -(-) with asphyxia- MUST be selected for ALL buried subjects who were already in cardiac arrest at the time of excavation!
Only enter Hypothermia +(-) without asphyxia- for partially or non-buried subjects, and for cases of witnessed cardiac arrest.

HOPE ≥ 10% / HOPE < 10%

Rewarm patient with ECLS

In-Hospital Medical Treatment

(1) In case of severe shortage of rescuers, people who were caught by the avalanche and rescued may assist in the rescue of the remaining buried subjects.
The criteria for the decision if and for what purpose they can be included in the rescue are:
1. Effort to fully excavate them, 2. Their potential to assist the rescue and 3. Continuous assessment of their condition.
(2) Rescue breaths HIGHLY recommended as avalanche patients often asphyxiate. No rescue breaths –> no oxygen –> no return of spontaneous circulation –> no survival.
(3) Obvious evidence of severe mechanical impact/high fall/severe collision with trees or rocks or a head/truncal body position incompatible with life.
(4) Use additional tools for detection of vital signs (end-tidal $etCO_2$, arterial oxygen saturation (SaO_2), ultrasound) if available.
(5) If airway was patent, the additional presence of an air pocket is a strong ***out-of-hospital*** predictor for survival.
(6) Core temperature < 30° C: no epinephrine, do not defibrillate more than 3 times. Further defibrillation attempts, as well as use of epinephrine with intervals prolonged to 6 - 10 min, only when core temperature is ≥ 30° C.
(7) Core temperature < 28° C or burial duration > 60 min in circumstances where continuous CPR is impossible: See *iCPR* chart.
(8) Also transport patients with core temperature < 30° C AND life threatening hemodynamic instability to a hospital with ECLS.
(9) Firm surface crucial.

Normothermic patient / Hypothermic patient / Minimal chances of survival

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AvaLife

Hypothermia Staging

Hypothermia Staging *Core Temperature and Revised Swiss System*

Stage	Measured core temperature	Symptoms	Measures
1	35 - 32° C	**Alert**, clear answers[1]	Active rewarming by moving, warm sugary drinks
2	< 32 - 28° C	Impaired consciousness, responds to **verbal** stimulation[1]	Avoid further cooling, move carefully, warm sugary drinks
3	< 28° C	**Unconscious**, signs of life might be minimal[1]	Avoid further cooling, move carefully, monitor
4	Variable[2]	**No signs of life**	Apply AvaLife *Out-Of-Hospital Medical Treatment* algorithm

(1) Consciousness may be impaired by trauma or drugs.
(2) Hypothermic cardiac arrest in young, healthy persons occurs < 30° C, in older persons and persons with pre-existing diseases already < 32° C. Some persons still have vital signs < 24° C.

iCPR

Intermittent CPR: Mean of Last Resort!

ONLY apply if transport is unavoidable and effective CPR impossible, or in cases where continuous CPR is impossible because of extremely limited resources.

Burial duration	Measures	Measured core temperature
≤ 60 min	No intermittent CPR, preferably apply mCPR	≥ 28° C
> 60 min: Before iCPR, ALWAYS perform uninterrupted CPR for ⅓ of the burial duration	At least 5 min of CPR followed by max 5 min without CPR	< 28° C
	At least 5min of CPR followed by max 10min without CPR	< 20° C

Avalanche Accident – Medical Transport Priority

Priority (1)

Out-Of-Hospital Medical Treatment (Multiple patients)

Breathing AND life-threatening injuries? YES → 1 / NO

Burial duration > 60 min AND patent airway AND CPR AND life-threatening injuries? YES → 2 / NO

Breathing AND unconscious OR impaired consciousness? YES → 3 / NO

Burial duration ≤ 60 min AND CPR? YES → If multiple patients need to be transported, transport to closest medical facility capable of measuring serum potassium to determine HOPE. Reassess based on HOPE → 4 / NO

Burial duration > 60 min AND patent airway AND CPR? Transport to hospital with ECLS YES → ECG asystole or unavailable? NO → If ECLS not available within 6 hrs, consider CPR and non-ECLS rewarming in peripheral hospital. → 5

ECG asystole or unavailable? YES → If multiple patients need to be transported, transport to closest medical facility capable of measuring serum potassium to determine HOPE. Reassess based on HOPE

NO

Other patients in CPR? YES → 6 / NO

Conscious, injured patients? YES → 7 / NO

All remaining patients → 8

(1) Transport priority is based on probability of survival and the urgency of treatment to preserve the chances of survival.
Priorities may change based on means of transport and their availability, transport times to appropriate medical facilities, weather conditions and out-of-hospital treatment options.

Search and Excavate

Avalanche Accident - Start here![1]

Subjects visible on surface? YES / NO

Search! Prioritize most likely burial areas, terrain with increased probability of survival (no trees, no high fall, no crevasses or seracs) and buried subjects with increased survival chances indicated by vital data of the transceiver.

Burial depth ≥ 1.5m?[2] NO / YES

Are all buried subjects currently being excavated? NO / YES

2 or more rescuers per remaining buried subject? NO / YES

Excavate head and chest only[3]

Proceed to *Out-Of-Hospital Medical Treatment* chart

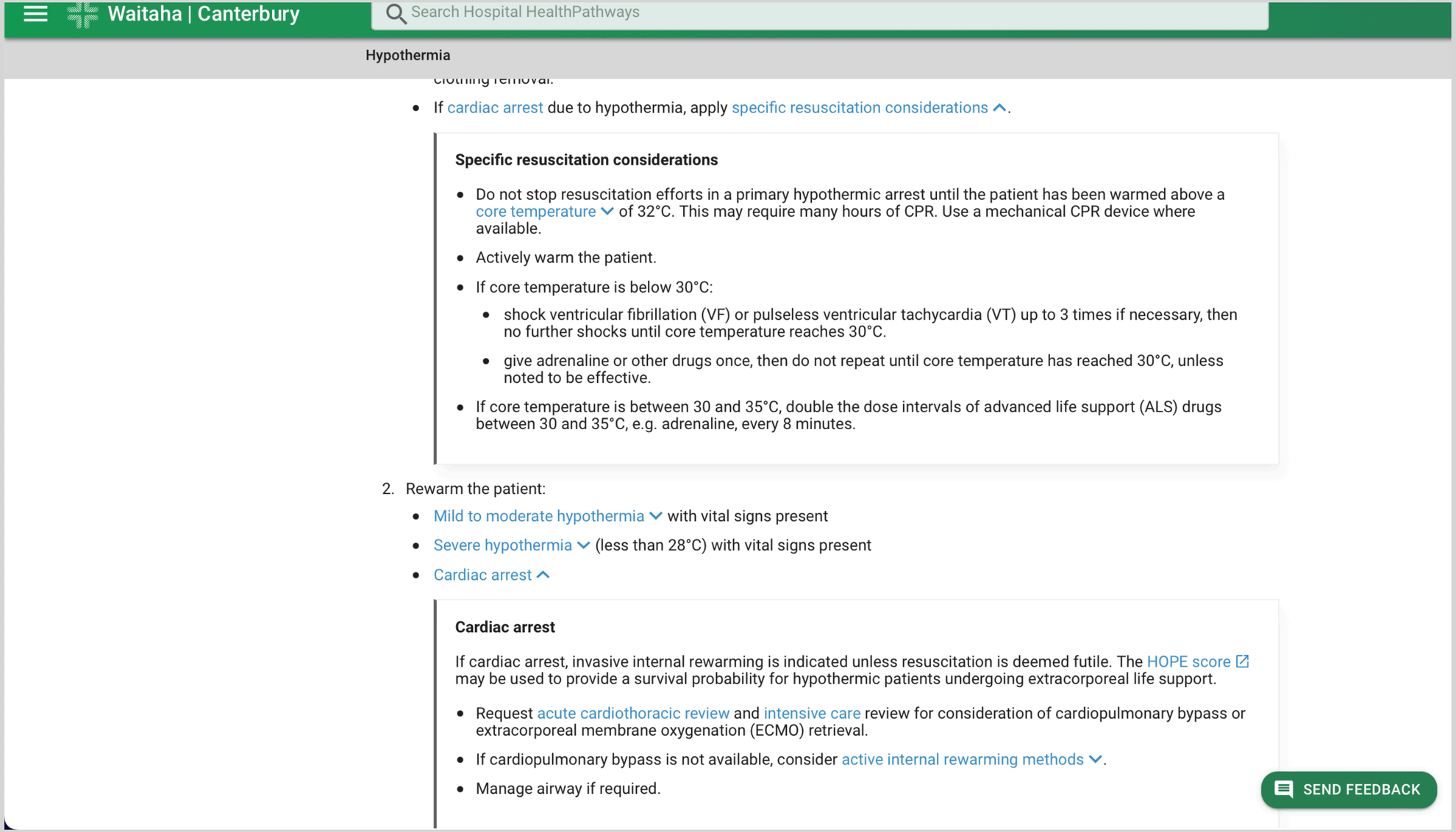
(1) Consider risk of rescuers and residual survival chances of buried subjects. Consider helicopter-based search and helicopter-attached "scoop and run" excavation. Limit number of exposed rescuers, use additional personal protection equipment, mitigate danger or postpone rescue if survival chances of the buried subjects are low compared to the risk of the rescue mission.
(2) Excavate immediately regardless of burial depth if finding additional buried subjects is unlikely, requires probe lines, or a similarly time-consuming search.
(3) Consider immediate evacuation in case of:
1. Considerable risk for rescue personnel,
2. Risk of delayed evacuation due to deteriorating weather or flying conditions,
3. Terrain conditions which make effective on-site treatment impossible.

For proposals, comments and questions, please contact the authors at: Aval.Rx@MountainSafety.info

Survival Chance Optimized Procedures in Rescue and How to Minimize Injuries During Excavation; Genswein M; ISSW2013; 1408-1417. | A concept for optimizing avalanche rescue strategies using a Monte Carlo simulation approach; Reiweger I, Genswein M, Pual B, Schweizer J (2017); PLoS ONE 12(5): e0175877. https://doi.org/10.1371/journal.pone.0175877 | Hypothermia outcome prediction after extracorporeal life support for hypothermic cardiac arrest patients; The HOPE score; Pasquier M, Hugli O, Paal P, Darocha T, Blancher M, Husby P, Silfvast T, Carron P-N, Rousson V (2018); Resuscitation. 2018 May;126:58-64.doi: 10.1016/j.resuscitation.2018.02.026. Epub2018 Mar 2.| Hypothermia outcome prediction after extracorporeal life support for hypothermic cardiac arrest patients: An external validation of the HOPE score; Pasquier M, Rousson V, Darocha T, Bouzat P, Kosinski S, Sawaniewicz K, Chamigniewski B, Wiberg S, Wanscher MCJ, Brodmann Maeder M, Paal P, Hugli O (2019); Resuscitation. 2019 Mar 30. pii: S0300-9572(19)30066-3. doi: 10.1016/j.resuscitation.2019.03.017. | Guidelines for Cardiac arrest in special circumstances 2020 Lott C, Truhlář A, Alfonzo A, Barelli A, Gonzalez-Salvado V, Hinkelbein J, Nolan J P, Paal P, Perkins G D, Thies K-C, Yeung J, Zideman D A, Soar J (2020). European Resuscitation Council 2020.

CPG’s
Equipment

Waitaha / Canterbury Hospital Health Pathways



What can you as ECMO practitioners do to make a real difference?

- ECMO rewarming capability: H-CA only or unstable hypothermia too?
- Destination policy
- Referral criteria
- Education of pre-hospital responders

My website with all the references

“One can hardly expect clinicians fighting for clean drinking water to also think about drones or extracorporeal life support.”
Sebastian Schnaubelt, January 2023, Resuscitation

“Be mindful of potential paternalistic views from high-resource systems when offering support and follow an anti-colonial social theory”
CPR in low-resource settings, Sept 2023, Lancet