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Commentary and concepts

Clinical staging of accidental hypothermia: The Revised Swiss System Recommendation of the International Commission for Mountain Emergency Medicine (ICAR MedCom)

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Abstract

Clinical staging of accidental hypothermia is used to guide out-of-hospital treatment and transport decisions. Most clinical systems utilize core temperature, by measurement or estimation, to stage hypothermia, despite the challenge of obtaining accurate field measurements. Recent studies have demonstrated that field estimation of core temperature is imprecise.

We propose a revision of the original Swiss Staging system. The revised system uses the risk of cardiac arrest, instead of core temperature, to determine the staging level. Our revised system simplifies assessment by using the level of responsiveness, based on the AVPU scale, and by removing shivering as a stage-defining sign.

Keywords: Core temperature, Emergency medicine, Cardiac arrest, Hypothermia, Out-of-hospital cardiac arrest, Emergency medical services

Introduction

Accidental hypothermia is defined as an involuntary drop of core temperature to <35 °C.[1] Hypothermia can occur almost anywhere in the world, including in tropical regions, and at any season. Accidental hypothermia is associated with a wide range of clinical presentations from minor manifestations, such as confusion, to critical conditions, such as cardiac arrest.[1–4] There are several clinical guidelines for the management of accidental hypothermia.[1,2,5] Classification of severity is based on measured core temperature.[5] Clinical signs and symptoms have been used to estimate core temperature when it

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cannot be measured. We describe limitations on the accuracy of this approach. Clinical practice in the staging of accidental hypothermia, both out-of-hospital and in-hospital, varies significantly worldwide. We propose a revised version of the widely used Swiss staging system that focuses on the likelihood of cardiac arrest rather than on core temperature. This system is designed for use in patients with primary accidental hypothermia in the absence of other factors affecting the level of consciousness. This should improve care by alerting medical personnel to the risk level at an early stage and by helping to make field decisions regarding treatment and disposition.

Need for staging of accidental hypothermia

Reliable staging is essential in the management of accidental hypothermia. Staging enables risk stratification to help guide treatment decisions. Resuscitation strategies depend on core temperature.[1,2,5] For example, the recommended number of defibrillations and whether vasopressors should be administered depend on whether core temperature is above or below 30 °C.[1,5] When core temperature is <28 °C, intermittent cardiopulmonary resuscitation (CPR) is a viable alternative if continuous CPR is not possible, as in technically challenging rescue situations.[5,6] Young, healthy patients with core temperatures <28 °C, elderly patients, and patients of any age with comorbidities who have core temperatures <30 °C, should be transferred to centres capable of extracorporeal cardiac life support (ECLS), as the risk of cardiac arrest is high.[3,5] Measurement of core temperature may also help to identify patients at high risk of cardiac arrest.[7] Core temperature should be used to estimate the likelihood of survival in hypothermic patients being rewarmed by ECLS.[8,9] On-site clinical staging of accidental hypothermia is necessary, because accurate measurement of core temperature is often impossible.

Staging to estimate core temperature

There are several staging systems for classifying the severity of accidental hypothermia. The most widely used systems are the Swiss system and the system published by the Wilderness Medical Society (WMS) (Table 1).[2,10] The Swiss system uses clinical signs to stage hypothermia when no core temperature is available.[10] The WMS system also uses clinical signs to estimate the degree of hypothermia when no core temperature is available.[2] Both systems correlate clinical stages with ranges of core temperatures.

Out-of-hospital temperature measurement

In the out-of-hospital and mountain rescue environments, core temperature measurement can inform transport and treatment decisions, although an accurate value can be difficult to obtain.[2,11] The most accurate method of measuring core temperature is an oesophageal probe.[2,5,11] Insertion of an oesophageal probe requires advanced training and is only used in patients who are intubated or in cardiac arrest. The tip of the probe is inserted into the lower third of the oesophagus.[1,2,5,11] Peripheral temperature measurements, including tympanic, oral, axillary, skin surface, bladder, and rectal temperatures, are not sufficiently accurate to guide clinical decisions.[5] Infrared tympanic thermometers are not reliable.[1,2,5] Epitympanic temperature measurement, with a thermistor, using a unit designed for field use, may be reliable for measuring core temperature.[1,2] However, the external auditory canal must be dry, insulated from the environment, and free of obstructions. Measurements may still be unreliable if conditions are wet or if there is haemodynamic instability or cardiac arrest.[1,2,5,11–13] There is a significant lack of availability of epitympanic thermometers specifically designed for field core temperature measurement.[2,14] Bladder and rectal temperatures lag behind oesophageal temperatures during rewarming and require exposure. Exposing a patient is not practicable in the field. Bladder and rectal temperatures should not be measured in the field.[11]

Clinical staging in the absence of core temperature measurement: the 'Swiss' system

Historical perspective

The Swiss staging system was first published in 2003, in a recommendation of the International Commission for Mountain

Table 1 – Summary of the two main clinical staging systems for accidental hypothermia: the original Swiss system[11] and the Wilderness Medical Society classification.[2] WMS - Wilderness Medical Society.

Swiss system[11]			WMS[2]		
Category	Clinical findings	Estimated core temperature (°C)	Category	Clinical findings	Estimated core temperature (°C)
Stage 1	Clear consciousness with shivering	35–32	**Mild**	Normal mental status, shivering, but not functioning normally and unable to care for self	35–32
Stage 2	Impaired consciousness without shivering	<32–28	**Moderate**	Abnormal mental status with shivering, or abnormal mental status without shivering, but conscious	32–28
Stage 3	Unconsciousness	<28–24	**Severe/profound**	Unconscious	<28
Stage 4	Apparent death	24–13.7			
Stage 5	Death due to irreversible hypothermia	<13.7? (<9?)			

Emergency Medicine (ICAR MedCom) for medical on-site decision making in patients with accidental hypothermia.[10] It was developed for mountain rescue practitioners in the European Alps, but has since been disseminated more widely. The original Swiss system divided patients into five categories, or stages, according to clinical presentation, based on level of consciousness, presence or absence of shivering, and apparent death. Each stage defined an estimated core temperature range according to clinical findings.[10] In subsequently published revisions, stage 5, death due to irreversible hypothermia, was removed. The cut-off temperature for this stage is uncertain and based on historical survival records.[3,5]

The Swiss system is a useful tool when a reliable core temperature measurement is not available.[10] It can be used by basic and advanced medical providers.[10,11] The Swiss system has been incorporated into several guidelines for the management of accidental hypothermia.[1–3,5,15] Because the staging criteria were developed based on observed clinical findings in unpublished cases, the level of evidence should be considered to be low.

Limitations and reliability of the Swiss system

A significant limitation of the Swiss system is that physiological responses to hypothermia and clinical signs vary substantially amongst individuals.[2] The reliability of the temperature ranges proposed by the Swiss system was called into question following the publication of a case series of patients presenting with vital signs and measured core temperatures <24 °C.[16] According to the Swiss system, these patients should have been classified as Hyporhermia stage 3 based on the presence of vital signs, although their core temperatures corresponded to Hypothermia stage 4 (apparent death). Whilst the Swiss system is still a useful tool for the out-of-hospital classification of accidental hypothermia, the correlation between clinical stage and core temperature should be better defined.

The accuracy of the Swiss system was recently evaluated in two studies.[17,18] The first was a retrospective chart review of 183 published cases of accidental hypothermia from a variety of causes.[17] These 183 cases were combined in a second study with 122 additional cases of accidental hypothermia, retrospectively collected in two hospitals in Switzerland, for a total of 305 patients.[18] Only 185/305 (61%) of the patients were correctly classified by the Swiss system. These data demonstrated a significant discrepancy between clinical stages and measured core temperatures.[17,18] Core temperatures were overestimated using clinical staging in 55/305 cases (18%) and underestimated in 65/305 cases (21%).[18]

In both of these studies, the level of consciousness was evaluated using the Glasgow Coma Scale (GCS) and the AVPU scale (Alert, Voice, Pain, Unresponsive). Clear consciousness was defined as a GCS score of 15 or an AVPU rating of 'A.' Impaired consciousness was defined as a GCS score of 9–14 or an AVPU rating of 'V.' Unconsciousness was defined as a GCS score <9 or an AVPU rating of 'P' or 'U.'[17] The median GCS of the cases identified in the literature (183) was 3 (IQR 3–6); 81% of the patients were classified as having Hypothermia stage 3 or 4. The median GCS of the hospital cases was 15 (IQR 12–15); 83% of the patients were classified as stage 1 or 2.[17,18] These two studies highlight the potential consequences of incorrect staging. Staging a patient as being colder than the actual core temperature could lead to overtreatment, with increased use of resources, including unnecessary monitoring.[18] On the other hand, staging a patient as being warmer than the actual core temperature could lead to underestimating the risk of cardiac arrest and failure to transport a patient to an ECLS facility.

Another critical limitation of the Swiss system is the possible inconsistency of the two variables, level of consciousness and presence or absence of shivering. A patient can be staged in one group based on level of consciousness and in a different group based on the presence or absence of shivering. Shivering as a response to hypothermia is highly variable amongst individuals,[2] Shivering can occur at a core temperature <32 °C.[2] The presence of shivering could be falsely reassuring to rescuers.

Calculated optimal temperature thresholds for the various stages, based on the two retrospective studies, were very close to the original thresholds of the Swiss system: 32.1 °C (original threshold 32 °C), 27.5 °C (original threshold 28 °C), and 24.1 °C (original threshold 24 °C).[18]

Because there is significant overlap of core temperatures between adjacent groups, it was proposed that the use of overlapping intervals could decrease the rate of over-and underestimation.[18] For example, a 90% prediction interval would predict Hypothermia stage 1 at an actual core temperature ≥30 °C, stage 2 at 25–34 °C, stage 3 at 21–32 °C and stage 4 at <30 °C.[18] The mean core temperature is 33 ± 2 °C for stage 1, 29 ± 3 °C for stage 2, 26 ± 3 °C for stage 3 and 23 ± 4 °C for stage 4. The use of overlapping ranges is more suited to research use than to field use. The mean core temperature for stage 4 (23 ± 4 °C) is close to the mean core temperature in a study of 206 patients with witnessed hypothermic cardiac arrest (24 ± 3 °C).[7] It is also similar to the median core temperature of 106 survivors of hypothermic cardiac arrest rewarmed with ECLS (23 °C; IQR 21–25).[8] However, the comparisons are limited, because the studies included some patients with potential contributing factors to cardiac arrest other than hypothermia.[7,8]

The Revised Swiss System

Some of the limitations of the Swiss system can be overcome by using a revised system, including three major modifications. Firstly, the revised system uses level of consciousness as the primary element for staging, especially in patients with vital signs. Clinical observations, supported by a retrospective peer-reviewed analysis of patients with accidental hypothermia, have demonstrated a linear relationship between core temperature and decreased level of consciousness using the GCS scale,[19] providing evidence that the level of consciousness can indirectly estimate the risk of cardiac arrest in primary isolated hypothermia. Since one of the objectives of the Revised Swiss System is to simplify field staging, it uses the AVPU scale to assess the level of consciousness. The AVPU scale is simple and correlates with the GCS.[18]

Secondly, since shivering has high variability amongst individuals, it is not used as a stage-defining sign, although it can provide important information regarding the status of thermogenesis. Thirdly, instead of a core temperature range, the revised system estimates the level of risk of cardiac arrest due to hypothermia.

These modifications are intended to simplify use in the field. Because risk of cardiac arrest is not solely dependent on core temperature and is variable among individuals and their comorbidities, risk categories should be considered as overlapping instead of fixed stages. The Revised Swiss System uses level of consciousness, based on the AVPU scale, and presence or absence of vital signs to determine the stage of hypothermia and the risk of hypothermic

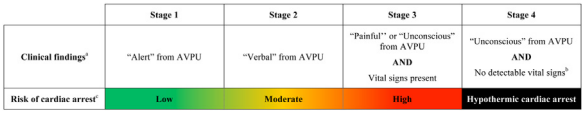

Fig. 1 – Revised Swiss System for staging of accidental hypothermia.

[a] In the Revised Swiss System, "Alert" corresponds to a GCS score of 15; "Verbal" corresponds to a GCS score of 9 –14, including confused patients; "Painful" and "Unconscious" correspond to a GCS score <9. While shivering is not used as a stage-defining sign in the Revised Swiss System, its presence usually means that the temperature is >30 °C, a temperature at which hypothermic CA is unlikely to occur.[8]

[b] No respiration, no palpable carotid or femoral pulse, no measurable blood pressure. Check for signs of life (pulse and, especially, respiration) for up to 1 min.[1]

[c] The transition of colours between stages represents the overlap of patients within groups. The estimated risk of cardiac arrest is based on accidental hypothermia being the only cause of the clinical findings. If other conditions impair consciousness, such as asphyxia, intoxication, high altitude cerebral oedema or trauma, the revised Swiss System may falsely predict a higher risk of cardiac arrest due to hypothermia. Caution should be taken if a patient remains "alert" or "verbal" showing signs of haemodynamic or respiratory instability such as bradycardia, bradypnoea, or hypotension because this may suggest transition to a stage with higher risk of cardiac arrest.

cardiac arrest (Fig. 1). Table 2 compares the differences between the original Swiss system and the Revised Swiss System (Table 2).

Another system for the staging of hypothermia using level of consciousness

Independently, a Danish group has reported the successful implementation of a national simplified accidental hypothermia staging and treatment protocol. Accidental hypothermia is classified as mild in awake patients, moderate in unconscious patients, and severe in patients who appear lifeless. Core temperature and shivering are not considered in the primary assessment. This staging system is similar to the Revised Swiss System.[20]

Limitations

The Revised Swiss System should only be used when an accurate core temperature measurement is not available for patients with primary accidental hypothermia without accompanying trauma or other medical conditions that might affect the level of consciousness.[2] If conditions are present that may impair consciousness, such as asphyxia, intoxication, high altitude cerebral oedema or trauma, or if such a condition cannot be excluded, the Revised Swiss System may falsely predict a high risk of cardiac arrest, leading to overtreatment and overuse of resources, such as transfer to an ECLS facility.

Although it simplifies staging, the use of a single triage factor (level of consciousness) for staging is another potential limitation of the proposed system. The correlation of AVPU with GCS may not be completely consistent. Integration of other clinical information available in the field, such as vital sign changes, may help identify patients in transition to more severe stages with a higher risk of hypothermic cardiac arrest.

Patients can have different clinical presentations, including different levels of consciousness, at similar core temperatures. Risk categories for cardiac arrest overlap rather than being clearly defined. The Revised Swiss System provides guidance for the management of hypothermic patients, but is not a replacement for clinical judgment. Rescuers should use caution if a patient remains conscious, but shows signs of haemodynamic or respiratory instability, such as bradycardia, hypotension, or bradypnoea. These signs may suggest transition to a stage with higher risk of cardiac arrest.

The proposed revision of the Swiss staging system has not yet been validated. Prospective clinical validation of the Revised system would be difficult because severe primary hypothermia is rare.

Recommendations for the staging of accidental hypothermia

Suspected accidental hypothermia should be confirmed by an accurate measurement of core temperature, if possible. If core temperature cannot be measured, the Revised Swiss System should

Table 2 – Comparison between the original Swiss staging system for accidental hypothermia and the Revised Swiss System. AVPU – Alert, Verbal, Pain, Unresponsive.

	Original Swiss System [11] Clinical findings (estimated core temperature)	Revised Swiss System	Risk of hypothermic cardiac arrest
Stage 1	Clear consciousness with shivering (35–32 °C)	"Alert" from AVPU	Low
Stage 2	Impaired consciousness without shivering (32 –28 °C)	"Verbal" from AVPU	Moderate
Stage 3	Unconsciousness (28–24 °C)	"Painful" or "Unconscious" from AVPU **AND** Vital signs present	High
Stage 4	Apparent death (<24 °C)	"Unconscious"' from AVPU **AND** No detectable vital signs	Hypothermic cardiac arrest

be used to estimate the risk of hypothermic cardiac arrest in order to guide treatment, choice of destination hospital, and the need for ECLS rewarming.

Conclusions

Definitive diagnosis and staging of hypothermia require accurate core temperature measurement, which may be difficult to obtain in the field. The Revised Swiss System uses the AVPU scale and the presence or absence of vital signs to stage hypothermia. When a reliable core temperature measurement is not available, the Revised Swiss System should be used to estimate the risk of hypothermic cardiac arrest and guide treatment, choice of destination hospital and the need for ECLS rewarming. Users of the Revised Swiss System should be aware of the limitations of estimating the risk of cardiac arrest from accidental hypothermia in the presence of conditions that impair consciousness. Field studies should be performed to assess the application, outcomes, and benefits of the Revised Swiss System for guiding out-of-hospital care of patients with hypothermia.

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CRediT authorship contribution statement

Martin E. Musi: The conception and design of the study, Analysis and interpretation of data, Drafting the article or revising it critically for important intellectual content, Final approval of the version to be submitted. **Alison Sheets:** Analysis and interpretation of data, Drafting the article or revising it critically for important intellectual content, Final approval of the version to be submitted. **Ken Zafren:** Analysis and interpretation of data, Drafting the article or revising it critically for important intellectual content, Final approval of the version to be submitted. **Hermann Brugger:** Analysis and interpretation of data, Drafting the article or revising it critically for important intellectual content, Final approval of the version to be submitted. **Peter Paal:** Analysis and interpretation of data, Drafting the article or revising it critically for important intellectual content, Final approval of the version to be submitted. **Natalie Hölzl:** Analysis and interpretation of data, Drafting the article or revising it critically for important intellectual content, Final approval of the version to be submitted. **Mathieu Pasquier:** The conception and design of the study, Analysis and interpretation of data, Drafting the article or revising it critically for important intellectual content, Final approval of the version to be submitted.

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