

Accidental Environmental Hypothermia in a Nonagenarian Resulting in Cardiac Arrest

Jan Stingl¹, Francis X. Guyette², Tomáš Drábek³

¹ Faculty of Medicine, Masaryk University, Brno, Czech Republic;

² Department of Emergency Medicine, University of Pittsburgh School of Medicine, Pittsburgh, Pennsylvania, USA;

³ Department of Anesthesiology and Perioperative Medicine, University of Pittsburgh School of Medicine, Pittsburgh, Pennsylvania, USA

Received June 4, 2025; Accepted February 26, 2026.

Key words: Hypothermia – Cardiopulmonary resuscitation – Heart arrest – ECMO – Cardiac arrest – Nonagenarian – Elderly – Frailty

Abstract: Accidental hypothermia after environmental exposure and/or impaired thermoregulation resulting in significant decrease in body temperature and cardiac arrest (CA) is linked to 1,500 deaths annually in the United States. Hypothermic CA treatment has specific presentation and clinical features. With appropriate treatment, its survival can reach 27–70%, contrasting ~ 10% in medical CA. Majority of accidental hypothermic CA survivors recover with favourable neurologic outcome. An integrated, dedicated multi-disciplinary team-approach is essential to maximize the chances of survival. We report on a 91-year-old female who was found outside and unresponsive in freezing temperatures. During transport, she required bag-and-mask ventilation. An esophageal temperature recorded 24.5 °C. Shortly after rapid sequence intubation, she developed CA. She was successfully resuscitated with chest compressions, epinephrine, atropine, and two defibrillations. Due to persistent hypothermia and bradycardia, she was rewarmed using extracorporeal membrane oxygenation. Perioperative transesophageal echocardiography showed normal cardiac function. She was extubated the next day. She remained stable for the rest of her hospital stay without focal neurological deficits on serial examinations. However, her post-arrest stay was complicated by acute delirium, likely from underlying dementia, with a waxing and waning level of consciousness, confusion, agitation and hallucinations. She was discharged on post-operative day 5. Her long-term recovery was complicated by repeated aspiration pneumonias, and gradual decline of her mental status due to Alzheimer's dementia. She died approximately two years later at the age of 93. Thus, full neurologic recovery remains possible after CA induced by severe hypothermia from environmental exposure, despite extreme age and frailty.

Mailing Address: Prof. Tomáš Drábek, MD., PhD., FASA, Department of Anesthesiology and Perioperative Medicine, University of Pittsburgh School of Medicine, 200 Lothrop St., Pittsburgh, PA 15213, USA; Phone: +1 412 647 1687; Fax: +1 412 624 0943; e-mail: drabekt@anes.upmc.edu

<https://doi.org/10.14712/23362936.2026.6>

© 2026 The Authors. This is an open-access article distributed under the terms of the Creative Commons Attribution License (<https://creativecommons.org/licenses/by/4.0>).

Introduction

While the majority of out-of-hospital cardiac arrests (CA) are deemed to be of cardiac origin, other causes may play a role. Accidental hypothermia after environmental exposure and/or impaired thermoregulation resulting in significant decrease in body temperature and CA is linked to 1,500 deaths annually in the United States (Paal et al., 2022). Hypothermic CA has specific presentation and clinical features. Accordingly, its treatment should follow a protocol distinct from extracorporeal life support (ECLS) (Lott et al., 2021). With appropriate treatment, its survival can reach 27–70%, contrasting ~ 10% in medical CA from medical causes, as reported in major CA registries (Nishiyama et al., 2023). Of note, majority of accidental hypothermic CA survivors recover with a favourable neurologic outcome (Frei et al., 2019; Podsiadlo et al., 2021). Environmental exposure resulting in severe hypothermia in the prehospital setting, and the possibility of progression of hypothermia to CA must be promptly recognized and treated en route and throughout the continuum of care, to optimize the outcomes. An integrated, dedicated multi-disciplinary team-approach is essential to maximize the chances of survival with favourable outcome (Patterson et al., 2020).

We report on a case of a frail, elderly female, who experienced accidental environmental exposure eventually progressing to hypothermic CA in an urban setting. A written Health Insurance Portability and Accountability Act authorization has been obtained from the patient's family for the publication of this case report.

Case report

An unresponsive 91-year-old female was discovered lying on a sidewalk without any clothing in freezing temperatures. She exhibited agonal breathing at the scene. Physical examination revealed contusions and abrasions on her forearms and knees, consistent with crawling with mottled skin. Emergency Medical Service crew noted significant hypothermia and bradycardia, and initiated bag-valve-mask ventilation before transporting her to the emergency department (ED). On arrival to the ED, the patient remained unresponsive and hypothermic, with heart rate in the 30–40 beats/min range, systolic blood pressure ~ 60 mm Hg, Glasgow Coma Scale score of 3 and minimal spontaneous respiration. Unfortunately, no other history regarding her premorbid status was obtainable at the time of presentation.

In the ED, appropriate vascular access was established, and airway was secured using rapid-sequence intubation facilitated by etomidate and vecuronium. An esophageal temperature probe was placed, revealing a temperature of 24.5 °C. Rewarming was initiated with infusion of warm normal saline, and surface warming using warming blankets.

Shortly after, the patient developed ventricular fibrillation CA. Resuscitation efforts using Advanced Cardiac Life Support (ACLS) protocol were initiated. We administered chest compressions, epinephrine and atropine. Return of spontaneous circulation was achieved after two defibrillation attempts, although significant hypothermia and bradycardia remained.

At this point in time, given her level of hypothermia and cardiovascular instability, cardiothoracic surgery service was consulted for emergent ECLS management of active rewarming, according to our pre-established protocol. Upon acceptance, she was transported into the operating room. She was sedated and mechanically ventilated with ongoing neuromuscular blockade. Initial venous blood gas revealed mixed metabolic and respiratory acidosis with pH 7.24, $p\text{vCO}_2$ 54 mm Hg, $p\text{vO}_2$ 29 mm Hg, HCO_3 22 mmol/l and base deficit –5 mmol/l. Lactate was 3.1 mmol/l. Electrolytes showed modest derangements that were subsequently corrected. Complete blood count showed anemia with hematocrit of 30, and markedly decreased platelet count of 68×10^9 /l, with functional collagen agonist platelet count of 16×10^9 /l. She was cannulated for extracorporeal membrane oxygenation (ECMO) via peripheral access using femoral artery and vein. Perioperative transesophageal echocardiography revealed small-size left ventricle with normal function, normal right ventricle size and function, trace mitral and tricuspid regurgitation, and borderline pulmonary hypertension. Transesophageal echocardiography confirmed favourable position of the venous ECMO venous cannula. After 86 minutes of ECMO-assisted rewarming, temperature of 37 °C was achieved, and she was successfully weaned from ECMO and decannulated in the operating room.

Considering her high risk of re-arrest, the patient was transferred to the intensive care unit (ICU) where she remained monitored for the next two days. Subsequent evaluation after weaning from sedations and reversing neuromuscular blockade revealed a stable and awake patient with intact reflexes. She exhibited purposeful movements, although it was unclear if she was able to follow commands consistently. Thus, we continued target temperature management (TTM) for fever suppression. She met extubation criteria the day after her CA, and she was discharged from the ICU the next day. She remained stable for the rest of her hospital stay without any

focal neurological deficits on serial examinations. However, her post-arrest stay was complicated by acute delirium, likely from underlying dementia, with a waxing and waning level of consciousness, confusion, agitation and hallucinations.

The patient was discharged to a dedicated nursing facility after a 5-day hospital stay. Per her family members at the time of discharge, she recovered fully to her previous mental and physical status without any new neurological deficits. She was seen two months post discharge for evaluation of a suspected hernia, which turned out to be a seroma after her ECMO cannulation. This was treated conservatively and resolved on its own.

Her long-term recovery was complicated by repeated aspiration pneumonias eventually necessitating placement of a PEG tube, atrial fibrillation, and gradual decline of her mental status due to Alzheimer's dementia. She died approximately two years after the accidental hypothermic CA at the age of 93.

Discussion

Accidental hypothermia is defined as an involuntary decrease of core body temperature below 35 °C (Lott et al., 2021) and can be further subdivided into mild (32–35 °C), moderate (28–32 °C), and severe (under 28 °C). Cardiac arrhythmia is uncommon above 32 °C, and most are seen below 30 °C. Patients > 65 years of age are at higher risk of arrhythmia between 30–32 °C (Lott et al., 2021). While severe hypothermia is often accompanied by bradycardia, hypotension, coagulopathy, and an increased risk of CA, it also offers unique protective benefits. A 1 °C decrease in core temperature reduces oxygen consumption by approximately 6%, meaning that at 30 °C, oxygen demand is decreased by about 50% (Mallet, 2002). This reduced metabolic rate protects the heart and the brain, and although the likelihood of CA is high, the odds of survival are greater than in normothermic patients (Paal et al., 2022). Similarly, accidental hypothermia has been shown to increase the odds of survival with a good neurological outcome five-fold compared to CA from cardiac causes (OR [odds ratio] 5.12, 95% CI [confidence interval] 2.98–8.80) (Takiguchi et al., 2024). However, these protective effects are only present if severe hypothermia develops before asphyxia or CA.

The gold standard for managing patients with severe hypothermia or hypothermic CA, as was the case in our patient, is rewarming with ECLS using cardiopulmonary bypass (CPB) or ECMO (Dow et al., 2019; Lott et al., 2021). ECMO is generally the

preferred method due to its availability, reduced heparinization requirements, and the ability to provide extended support after reaching normothermia (Paal et al., 2022). Studies have also reported better outcomes with ECMO in hypothermic CA patients (Paal et al., 2022). Importantly, most ECLS protocols will restrict its use for situations when CA is witnessed, have immediate bystander cardiopulmonary resuscitation (CPR) and typically have an age restriction of < 65 to < 75 years of age (Richardson et al., 2021; Olson et al., 2022). These indications are based primarily on ECMO use in patients for heart failure and may be excessively restrictive in other CA scenarios which would still yield favourable outcome. The geospatial eligibility of CA patients for ECLS-capable and ECLS-ready programs also remain a limiting factor (Gottula et al., 2022, 2025).

In cases when ECLS capabilities are not readily available immediately after the CA event (especially in prehospital settings), continuous CPR is essential and should be initiated without delay. Mechanical CPR is generally preferred because it requires fewer people and facilitates other procedures. However, there are no data suggesting that mechanical CPR is associated with better outcomes (El-Menyar et al., 2024). One of the plausible explanations is that mechanical devices tend to become misplaced (e.g. over the left ventricular outflow tract) in a large proportion of cases (Teran et al., 2019).

Only when continuous CPR is not feasible should delayed or intermittent CPR be performed, with delays or interruptions of no more than 5 minutes without CPR (if the core temperature is between 20–28 °C or unknown) and no more than 10 minutes without CPR (if the core temperature is below 20 °C) in between at least 5 minutes of compressions (Gordon et al., 2015). Administration of resuscitative medications is generally not recommended in ACLS protocols, as their effect and metabolism is decreased, which might lead to possible overdose once rewarmed (Gordon et al., 2015). However, individual international guidelines differ on this controversial topic. For example, the American Heart Association guidelines state that it may be reasonable to consider administration of epinephrine along with rewarming during hypothermic CA (Panchal et al., 2020) albeit in prolonged interval of 6–10 min at temperatures > 30 °C (Lott et al., 2021). Atropine has been shown hemodynamically ineffective in hypothermic patients (Wüst et al., 1976) and not associated with improved outcomes in other CA populations (Greif et al., 2024).

Elderly patients are more susceptible to hypothermia due to various factors, such as reduced subcutaneous fat, decreased body water and muscle mass, impaired

thermoregulation, and limited mobility, as well as reduced autonomic and behavioural thermoregulatory responses (Szekely and Garai, 2018). While these age-related changes contribute to increased heat loss and decreased heat production, comorbidities and underlying medical conditions are the most significant risk factors and are closely associated with higher mortality in hypothermic elderly patients (Ballester and Harchelroad, 1999; Ranhoff, 2002). Although advanced age in general is considered a poor prognostic factor in accidental hypothermia (Morita et al., 2018; Okada et al., 2019; Takauji et al., 2021), it is not a contraindication to ECLS in patients experiencing CA in this setting (Swol et al., 2022). That said, increased age has been shown to significantly shorten the toleration of hypothermic CA before permanent neurological injury occurs (Svensson et al., 1993; Kaneko et al., 2015), which further emphasizes the critical need for high-quality, continuous CPR, and early consideration of ECLS in this population. Given the absence of advance directives at the time of presentation, we provided a full scope of resuscitative efforts spanning from pre-hospital setting, ED, anesthesia and perioperative care to critical care in the ICU. Post-resuscitative TTM is essential. In our patient, we chose to continue TTM with fever prevention. If she was not purposeful, we would have maintained TTM at 36 °C. Per family wishes, ICU care was not limited. Long-term recovery was significant for further progression of pre-existing Alzheimer's disease, and aspiration pneumonia. Despite these setbacks, the patient survived for two more years with an acceptable quality of life.

To the best of our knowledge, this is only the second reported case of a successful resuscitation with ECMO of a hypothermic arrest in a nonagenarian patient. Our case highlights that full neurologic recovery remains possible after CA induced by severe hypothermia from environmental exposure, even at extremes of age. This underscores the powerful protective effects of pre-arrest hypothermia and suggests that resuscitation efforts should be considered in such scenarios, regardless of advanced age and pre-existing frailty. An integrated team approach with ECLS capacities is pivotal in facilitating care for these patients.

References

- Ballester, J. M., Harchelroad, F. P. (1999) Hypothermia: An easy-to-miss, dangerous disorder in winter weather. *Geriatrics* **54(2)**, 51–52, 55–57.
- Dow, J., Giesbrecht, G. G., Danzl, D. F., Brugger, H., Sagalyn, E. B., Walpoth, B., Auerbach, P. S., McIntosh, S. E., Nemethy, M., McDevitt, M., Schoene, R. B., Rodway, G. W., Hackett, P. H., Zafren, K., Bennett, B. L., Grissom, C. K. (2019) Wilderness Medical Society clinical practice guidelines for the out-of-hospital evaluation and treatment of accidental hypothermia: 2019 update. *Wilderness Environ. Med.* **30(4S)**, S47–S69.
- El-Menyar, A., Naduvilekandy, M., Rizoli, S., Di Somma, S., Cander, B., Galwankar, S., Lateef, F., Abdul Rahman, M. A., Nanayakkara, P., Al-Thani, H. (2024) Mechanical versus manual cardiopulmonary resuscitation (CPR): An umbrella review of contemporary systematic reviews and more. *Crit. Care* **28(1)**, 259.
- Frei, C., Darocha, T., Debaty, G., Dami, F., Blancher, M., Carron, P. N., Oddo, M., Pasquier, M. (2019) Clinical characteristics and outcomes of witnessed hypothermic cardiac arrest: A systematic review on rescue collapse. *Resuscitation* **137**, 41–48.
- Gordon, L., Paal, P., Ellerton, J. A., Brugger, H., Peek, G. J., Zafren, K. (2015) Delayed and intermittent CPR for severe accidental hypothermia. *Resuscitation* **90**, 46–49.
- Gottula, A. L., Shaw, C. R., Gorder, K. L., Lane, B. H., Latessa, J., Qi, M., Koshoffer, A., Al-Araji, R., Young, W., Bonomo, J., Langabeer, J. R., Yannopoulos, D., Henry, T. D., Hsu, C. H., Benoit, J. L. (2022) Eligibility of out-of-hospital cardiac arrest patients for extracorporeal cardiopulmonary resuscitation in the United States: A geographic information system model. *Resuscitation* **180**, 111–120.
- Gottula, A. L., Qi, M., Lane, B. H., Shaw, C. R., Gorder, K., Powell, E., Danielson, K., Ciullo, A., Johnson, N. J., Tonna, J. E., Hinckley, W. R., Koshoffer, A., Al-Araji, R., Bartos, J., Benoit, J., Hsu, C. H., Group, C. S. (2025) Prehospital ground and helicopter-based Extracorporeal Cardiopulmonary Resuscitation (ECPR) reduce barriers to ECPR: A GIS model. *Prehosp. Emerg. Care* **29(1)**, 53–61.
- Greif, R., Bray, J. E., Djarv, T., Drennan, I. R., Liley, H. G., Ng, K. C., Cheng, A., Douma, M. J., Scholefield, B. R., Smyth, M., Weiner, G., Abelairas-Gomez, C., Acworth, J., Anderson, N., Atkins, D. L., Berry, D. C., Bhanji, F., Bottiger, B. W., Bradley, R. N., Breckwoldt, J., Carlson, J. N., Cassan, P., Chang, W. T., Charlton, N. P., Phil Chung, S., Considine, J., Cortegiani, A., Costa-Nobre, D. T., Couper, K., Bittencourt Couto, T., Dainty, K. N., Dassanayake, V., Davis, P. G., Dawson, J. A., de Caen, A. R., Deakin, C. D., Debaty, G., Del Castillo, J., Dewan, M., Dicker, B., Djakow, J., Donoghue, A. J., Eastwood, K., El-Naggar, W., Escalante-Kanashiro, R., Fabres, J., Farquharson, B., Fawke, J., Fernanda de Almeida, M., Fernando, S. M., Finan, E., Finn, J., Flores, G. E., Foglia, E. E., Folke, F., Goolsby, C. A., Granfeldt, A., Guerguerian, A. M., Guinsburg, R., Malta Hansen, C., Hatanaka, T., Hirsch, K. G., Holmberg, M. J., Hooper, S., Hoover, A. V., Hsieh, M. J., Ikeyama, T., Isayama, T., Johnson, N. J., Josephsen, J., Katheria, A., Kawakami, M. D., Kleinman, M., Kloock, D., Ko, Y. C., Kudenchuk, P., Kule, A., Kurosawa, H., Laermans, J., Lagina, A., Lauridsen, K. G., Lavonas, E. J., Lee, H. C., Han Lim, S., Lin, Y., Lockey, A. S., Lopez-Herce, J., Lukas, G., Macneil, F., Maconochie, I. K., Madar, J., Martinez-Mejas, A., Masterson, S., Matsuyama, T., Mausling, R., McKinlay, C. J. D., Meyran, D., Montgomery, W., Morley, P. T., Morrison, L. J., Moskowitz, A. L., Myburgh, M., Nabecker, S., Nadkarni, V., Nakwa, F., Nation, K. J., Nehme, Z., Nicholson, T., Nikolaou, N., Nishiyama, C., Norii, T., Nuthall, G., Ohshimo, S., Olasveengen, T., Olaussen, A., Ong, G., Orkin, A., Parr, M. J., Perkins, G. D., Pocock, H., Rabi, Y., Raffay, V., Raitt, J., Raymond, T., Ristagno, G., Rodriguez-Nunez, A., Rossano, J., Rudiger, M., Sandroni, C., Sawyer, T. L., Schexnayder, S. M., Schmolzer, G., Schnaubelt, S., Lene Seidler, A., Semeraro, F., Singletary, E. M., Skrifvars, M. B., Smith, C. M., Soar, J., Lee Solevag, A., Soll, R., Stassen, W., Sugiura, T., Thilakasiri, K., Tijssen, J., Kumar Tiwari, L., Topjian, A.,

- Trevisanuto, D., Vaillancourt, C., Welsford, M., Wyckoff, M. H., Yang, C. W., Yeung, J., Zelop, C. M., Zideman, D. A., Nolan, J. P., Berg, K. M. (2024) 2024 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations: Summary from the basic life support; advanced life support; pediatric life support; neonatal life support; education, implementation, and teams; and first aid task forces. *Resuscitation* **205**, 110414.
- Kaneko, T., Neely, R. C., Shekar, P., Javed, Q., Asghar, A., McGurk, S., Gosev, I., Byrne, J. G., Cohn, L. H., Aranki, S. F. (2015) The safety of deep hypothermic circulatory arrest in aortic valve replacement with unclampable aorta in non-octogenarians. *Interact. Cardiovasc. Thorac. Surg.* **20(1)**, 79–84.
- Lott, C., Truhlar, 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.; ERC Special Circumstances Writing Group Collaborators (2021) European Resuscitation Council Guidelines 2021: Cardiac arrest in special circumstances. *Resuscitation* **161**, 152–219.
- Mallet, M. L. (2002) Pathophysiology of accidental hypothermia. *QJM* **95(12)**, 775–785.
- Morita, S., Matsuyama, T., Ehara, N., Miyamae, N., Okada, Y., Jo, T., Sumida, Y., Okada, N., Watanabe, M., Nozawa, M., Tsuruoka, A., Fujimoto, Y., Okumura, Y., Kitamura, T., Hayashi, Y. (2018) Prevalence and outcomes of accidental hypothermia among elderly patients in Japan: Data from the J-Point registry. *Geriatr. Gerontol. Int.* **18(10)**, 1427–1432.
- Nishiyama, C., Kiguchi, T., Okubo, M., Alihodzic, H., Al-Araji, R., Baldi, E., Beganton, F., Booth, S., Bray, J., Christensen, E., Cresta, R., Finn, J., Grasner, J. T., Jouven, X., Kern, K. B., Maconochie, I., Masterson, S., McNally, B., Nolan, J. P., Eng Hock Ong, M., Perkins, G. D., Ho Park, J., Ristau, P., Savastano, S., Shahidah, N., Do Shin, S., Soar, J., Tjelmeland, I., Quinn, M., Wnent, J., Wyckoff, M. H., Iwami, T. (2023) Three-year trends in out-of-hospital cardiac arrest across the world: Second report from the International Liaison Committee on Resuscitation (ILCOR). *Resuscitation* **186**, 109757.
- Okada, Y., Matsuyama, T., Morita, S., Ehara, N., Miyamae, N., Jo, T., Sumida, Y., Okada, N., Kitamura, T., Iiduka, R. (2019) Prognostic factors for patients with accidental hypothermia: A multi-institutional retrospective cohort study. *Am. J. Emerg. Med.* **37(4)**, 565–570.
- Olson, T., Anders, M., Burgman, C., Stephens, A., Bastero, P. (2022) Extracorporeal cardiopulmonary resuscitation in adults and children: A review of literature, published guidelines and pediatric single-center program building experience. *Front. Med. (Lausanne)* **9**, 935424.
- Paal, P., Pasquier, M., Darocha, T., Lechner, R., Kosinski, S., Wallner, B., Zafren, K., Brugger, H. (2022) Accidental hypothermia: 2021 update. *Int. J. Environ. Res. Public Health* **19(1)**, 501.
- Panchal, A. R., Bartos, J. A., Cabanas, J. G., Donnino, M. W., Drennan, I. R., Hirsch, K. G., Kudenchuk, P. J., Kurz, M. C., Lavonas, E. J., Morley, P. T., O'Neil, B. J., Peberdy, M. A., Rittenberger, J. C., Rodriguez, A. J., Sawyer, K. N., Berg, K. M.; Adult Basic and Advanced Life Support Writing Group (2020) Part 3: Adult basic and advanced life support: 2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation* **142(16_suppl_2)**, S366–S468.
- Patterson, P. D., Hupfeld, T. C., Forbes, N., Blickley, Z. J., Collins, J. A., Pegram, A. M., Guyette, F. X. (2020) Accidental hypothermic cardiac arrest and extracorporeal membrane oxygenation: A case report. *J. Am. Coll. Emerg. Physicians Open* **1(3)**, 158–162.
- Podsiadlo, P., Darocha, T., Svendsen, O. S., Kosinski, S., Silfvast, T., Blancher, M., Sawamoto, K., Pasquier, M. (2021) Outcomes of patients suffering unwitnessed hypothermic cardiac arrest rewarmed with extracorporeal life support: A systematic review. *Artif. Organs* **45(3)**, 222–229.
- Ranhoff, A. H. (2002) Accidental hypothermia in the elderly. *Tidsskr. Nor. Laegeforen.* **122(7)**, 715–717. (in Norwegian)
- Richardson, A. S. C., Tonna, J. E., Nanjaya, V., Nixon, P., Abrams, D. C., Raman, L., Bernard, S., Finney, S. J., Grunau, B., Youngquist, S. T., McKellar, S. H., Shinar, Z., Bartos, J. A., Becker, L. B., Yannopoulos, D., Bělohávek, J., Lamhaut, L., Pellegrino, V. (2021) Extracorporeal cardiopulmonary resuscitation in adults. Interim Guideline Consensus Statement from the Extracorporeal Life Support Organization. *ASAIO J.* **67(3)**, 221–228.
- Svensson, L. G., Crawford, E. S., Hess, K. R., Coselli, J. S., Raskin, S., Shenaq, S. A., Safi, H. J. (1993) Deep hypothermia with circulatory arrest. Determinants of stroke and early mortality in 656 patients. *J. Thorac. Cardiovasc. Surg.* **106(1)**, 19–28; discussion 28–31.
- Swol, J., Darocha, T., Paal, P., Brugger, H., Podsiadlo, P., Kosinski, S., Puslecki, M., Ligowski, M., Pasquier, M. (2022) Extracorporeal life support in accidental hypothermia with cardiac arrest – A narrative review. *ASAIO J.* **68(2)**, 153–162.
- Szekely, M., Garai, J. (2018) Thermoregulation and age. *Handb. Clin. Neurol.* **156**, 377–395.
- Takauji, S., Hifumi, T., Saijo, Y., Yokobori, S., Kanda, J., Kondo, Y., Hayashida, K., Shimazaki, J., Moriya, T., Yagi, M., Yamaguchi, J., Okada, Y., Okano, Y., Kaneko, H., Kobayashi, T., Fujita, M., Shimizu, K., Yokota, H. (2021) Accidental hypothermia: Characteristics, outcomes, and prognostic factors – A nationwide observational study in Japan (hypothermia study 2018 and 2019). *Acute Med. Surg.* **8(1)**, e694.
- Takiguchi, T., Tominaga, N., Hamaguchi, T., Seki, T., Nakata, J., Yamamoto, T., Tagami, T., Inoue, A., Hifumi, T., Sakamoto, T., Kuroda, Y., Yokobori, S.; SAVE-J II Study Group (2024) Etiology-based prognosis of extracorporeal CPR recipients after out-of-hospital cardiac arrest: A retrospective multicenter cohort study. *Chest* **165(4)**, 858–869.
- Teran, F., Dean, A. J., Centeno, C., Panebianco, N. L., Zeidan, A. J., Chan, W., Abella, B. S. (2019) Evaluation of out-of-hospital cardiac arrest using transesophageal echocardiography in the emergency department. *Resuscitation* **137**, 140–147.
- Wüst, H. J., Huse, K., Lennartz, H. (1976) Cardiovascular changes caused by atropine in normo- and hypothermic methoxyflurane anaesthesia (author's transl.). *Anaesthetist* **25(9)**, 418–424. (in German)