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Short paper

Analyzing resuscitation conference content through the lens of the chain of survival

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Abstract

Background: Resuscitation science today often focuses on advanced topics such as extracorporeal cardiopulmonary resuscitation or targeted temperature management. However, the specific topics presented at resuscitation conferences have not been thoroughly analyzed. We thus analyzed resuscitation conferences abstracts using a chain of survival framework.

Methods: Two major resuscitation conferences (Resuscitation in Greece and Resuscitation Science Symposium in the USA) took place in the fall of 2024. We categorized all abstracts using chain of survival framework, analyzing authors' countries by geography and income. Additionally, artificial intelligence, deep learning, and machine learning approaches for data analysis were examined.

Results: "Recognition and prevention" was the top category at both conferences, comprising 37% of topics at Resuscitation 2024 and 32% at Resuscitation Science Symposium 2024. "Early Call for Help", "High-quality Cardiopulmonary Resuscitation", and "Recovery and rehabilitation" were underrepresented, with each <8%. At Resuscitation Science Symposium 2024, "Post-cardiac arrest care" (31%) and "Early defibrillation and advanced life support" (26%) were emphasized, compared to 21% each at Resuscitation 2024 for both chains. Resuscitation 2024 featured participants from 51 countries while Resuscitation Science Symposium 2024 included participants from 19 countries, predominantly high-income ones. At Resuscitation 2024, 54 abstracts, and at Resuscitation Science Symposium 2024, 47 abstracts used machine learning, each with one employing artificial intelligence. None used deep learning.

Conclusions: Conference abstracts aligned mainly with the early links of chain of survival and employing machine learning as a data analysis tool. Expanding participation from low-income countries could enhance inclusivity and contribute valuable perspectives to resuscitation science.

Keywords: Resuscitation science, Resuscitation conferences, Abstracts, Chain of survival, Inclusivity, Artificial intelligence, Machine learning, Deep learning

Introduction

A recent review has highlighted trending topics in resuscitation science over the decades, including extracorporeal cardiopulmonary resuscitation (CPR) or targeted temperature management.[1] Although analyzing resuscitation conference content is not new,[2–12] there has been limited examination of the specific topics presented. The National Institutes of Health (NIH) project grants significantly more funding to post cardiac arrest care than to other links in chain of survival.[13] This disparity is notable, considering the greater impact calling emergency medical services, bystander CPR, and early defibrillation have on survival outcomes.[13]

Building on that, we analyzed the content presented at two major resuscitation conferences in 2024 and categorized findings using a chain of survival.

Methods

In October and November 2024, two major conferences in resuscitation science took place. *Resuscitation 2024* (October 31 to November 2, Athens, Greece) by the European Resuscitation Council (ERC) and the *Resuscitation Science Symposium (ReSS) 2024* (November 16–17, Chicago, Illinois, USA) by the American Heart Association (AHA). Resuscitation 2024 listed 11 abstract categories

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on its conference webpage for researchers submitting abstracts, while ReSS 2024 featured 25 categories (Supplementary Appendix 1). Presented abstracts from both conferences were downloaded from the journals Circulation and Resuscitation using licensed version of web scraping software (WebHarvy, SysNucleus, India).[12,14] Two investigators (NF, ŠM) independently screened the titles and abstracts using Microsoft Excel 365 (Microsoft Corporation, USA). Due to the volume of abstracts, disagreements were resolved through three online meetings. Additionally, two investigators (RG, SS) provided input via email to clarify the inclusion criteria.

Included out-of-hospital cardiac arrest (OHCA) abstracts were categorized according to chain of survival with six links[15]: "Recognition and prevention", "Early call for help", "High-quality CPR", "Early defibrillation and advanced life support", "Post-cardiac arrest care", and "Recovery and rehabilitation".[15–17] Details for each link are in Supplementary Appendix 1. We excluded in-hospital cardiac arrest, pediatric and neonatal resuscitation, and topics not directly related to OHCA chain of survival, including reviews, cadaver and animal studies, protocols, first aid studies, education, medical conditions, and procedures. Traumatic cardiac arrest was included.

To determine the distribution of countries represented at both conferences we used data from affiliations of the first authors. The respective income classifications were sourced according to the uniform World Bank classification.[18]

We also explored how many abstracts presented artificial intelligence (AI) technologies for data analysis, such as narrow AI (e.g., generative AI chatbots), general AI (e.g., humanoid robots with human-like AI voice), and super AI (e.g., software-based AI systems exhibiting intelligence beyond human capabilities).[19,20] Additionally, the use of deep learning (DL), including artificial neural networks with multiple layers (commonly applied in pattern recognition), predictive modelling, image analysis, speech recognition, as well as machine learning (ML) algorithms, including linear and logistic regression models (widely used as standard statistical methods), for data analysis.[21–23]

To present the results in the "chain of survival" style, we used area-proportional circles including corresponding percentage. We chose an arbitrary base area of 1000 square units to represent 100% as the basis to calculate each circle's size. We assigned the colour blue for Resuscitation 2024, and red for ReSS 2024, which resulted in a proportional "chain of survival" illustrating the number of abstracts presented for each link.[13,24] Visualization of the figures were made in Powerpoint Microsoft 365 Apps for enterprise (Microsoft Corporation, USA) and Map Chart.[25,26]

Results

We analysed a total of 668 abstracts (491 abstracts from Resuscitation 2024; 177 from ReSS 2024). After applying the exclusion criteria, 259 abstracts from Resuscitation 2024 and 91 abstracts from Ress 2024 entered the analysis (Fig. 1).

At Resuscitation 2024, participants from 51 countries presented abstracts (top 3: 51 abstracts from Greece, 46 UK, 41 Tunisia). Thirty-four countries were classified as high-income, eight upper middle-income, seven lower middle-income, and two low-income countries (Fig. 2A). At ReSS 2024, participants from 19 countries gave presentation (top 3: 118 abstracts from the USA, 16 from Japan, six from China). Seventeen countries were rated as high-income countries and two as upper middle-income (Fig. 2B).

"Recognition and prevention" dominated as the leading category at both conferences, accounting for 37% of topics at Resuscitation 2024 and 32% at ReSS 2024. In contrast, "Early Call for Help", "High-quality CPR", and "Recovery and rehabilitation" were less prominent, each representing less than 8%. At ReSS 2024, "Post-cardiac arrest care" (31%) and "Early defibrillation and advanced life support" (26%) received significant attention, while at Resuscitation 2024, these categories each comprised 21% (Fig. 3).

ML for data analysis was reported in 54 abstracts at Resuscitation 2024 (multivariable logistic regression: $n = 42$; linear regression: $n = 4$; others used once: multiple regression, Markov model, bilayered neural network). Four abstracts mentioned ML without specifying the algorithms, and one employed narrow AI (ChatGPT-4o). None incorporated general AI, super AI, or DL. Similarly, at ReSS 2024, 47 abstracts used ML (41 used one method, 6 combined two; most used multivariable logistic regression: $n = 39$; others included univariate logistic: $n = 5$, Cox: $n = 3$, linear and Poisson: $n = 2$ each; single-use methods: SVMs, boosted trees, decision trees, CatBoost, cubic spline, MediaPipe). One abstract also employed narrow AI (ChatGPT-4). None incorporated general AI, super AI, or DL.

Discussion

The 'Recognition and Prevention' link of chain of survival framework was the most prominent topic at both 2024 resuscitation conferences. ML was frequently used for data analysis. Resuscitation 2024 featured more abstracts and broader global participation.

Resuscitation 2024 accepted nearly 500 abstracts, compared to under 200 at ReSS 2024. While a larger number fosters topic diversity, it may reduce depth and engagement. Fewer abstracts at ReSS 2024 may allow for deeper discussion but limit topic diversity. Resuscitation 2024 had its highest abstract count in a decade.[12] ReSS highlight reports lacked abstract data,[5–11] making comparisons difficult, though abstracts are valuable for tracking early-stage research.[27,28]

Most presenters were from host countries, but Resuscitation 2024 showed greater international and low-income country representation. In contrast, at ReSS 2024, predominantly researchers from high- and upper-middle-income countries presented their work. To be inclusive, future conferences could offer researchers from low-income countries more opportunities to participate,[29] contributing valuable insights from diverse settings and research conditions.

Chain of survival links "Early Call for Help" and "High-Quality CPR" were less prominent, as both were underrepresented at both conferences, despite these chain of survival links significantly impacting OHCA survival.[24] A recent analysis of AHA adult BLS guidelines revealed a lack of high-quality evidence, with many recommendations based on lower-level data.[30] Conversely, ClinicalTrials.gov revealed more interventional studies than observational ones, along with a higher publication rate for these studies.[31] This highlights the urgent need for more robust research and consequently more funding. Resuscitation 2024 covered broad topics like education, epidemiology, and system-level care, while ReSS 2024 focused more on physiological details, post-arrest care, and emerging areas like health equity and AI. This reflects ReSS 2024′s specialized focus versus Resuscitation 2024′s broader approach. Future categories could highlight topics lacking high-quality evidence. Additionally, our study presented a difference between

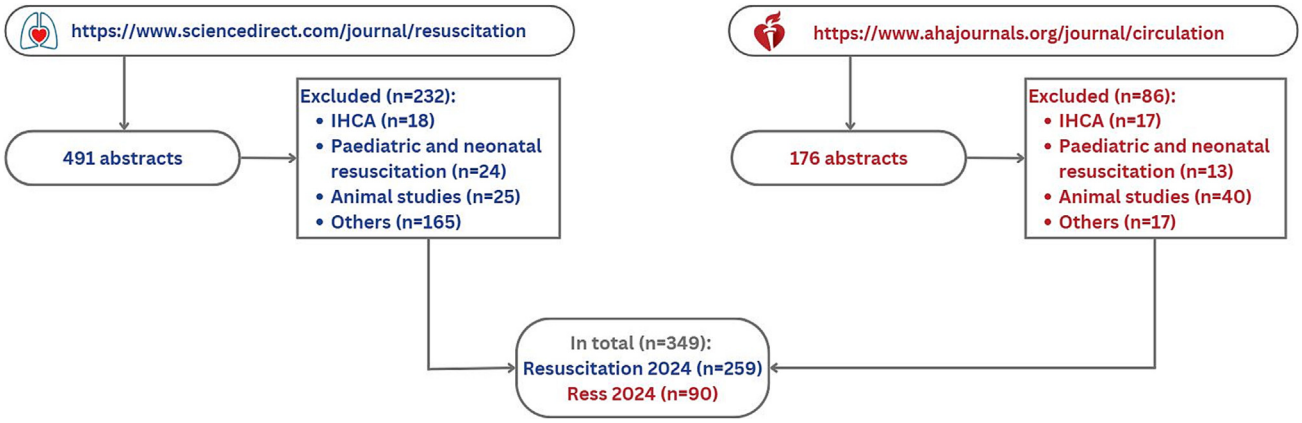

Fig. 1 – Resuscitation 2024 and ReSS 2024 abstracts included.

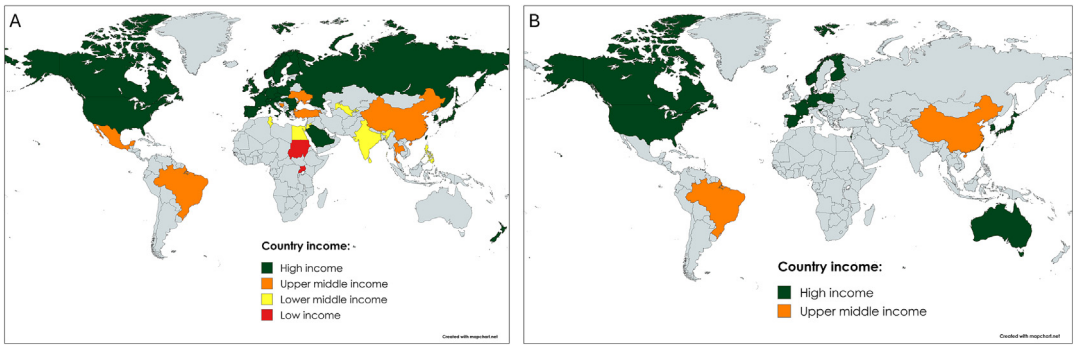

Fig. 2 – Countries where presenters came from at Resuscitation 2024 (A) and ReSS 2024 (B).

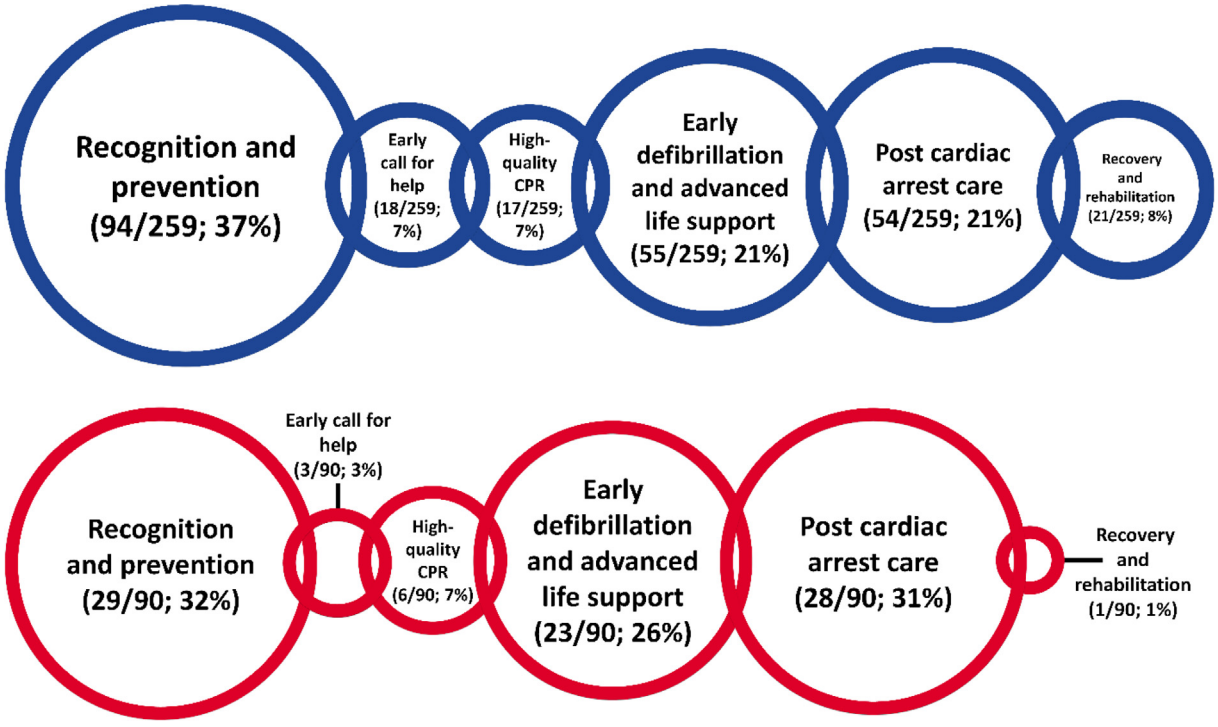

Fig. 3 – Numbers and percentage of abstracts across chain of survival presented at Resuscitation 2024 (blue) and ReSS 2024 (red). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

research NIH-funded research, which focused on "Post cardiac arrest care",[13] and the majority of conference abstracts which were categorized under chain of survival link "Recognition and Prevention". Notably, at ReSS 2024, "Post-cardiac arrest care" ranked second.

Currently, more ML is used for data analysis than AI. However, a recent review reports a growing body of literature about AI enhancing early OHCA care.[32] The rapid advancement of AI and DL technologies, such as text-to-video, may trigger future research and applications in resuscitation, particularly in education possibly creating teaching materials and provide feedback on performing CPR.[33]

Limitations

Our study has five limitations. First, we focused exclusively on abstracts available from two 2024 resuscitation conferences. Other conferences, like the Spark of Life conference in Australia were not included due to the unavailability of their abstracts. Second, for the country count at both congresses, we used the first authors' affiliation of published abstracts. However, incorporating data from co-authors might have altered these results. Third, we did not calculate Cohen's kappa for inter-rater agreement because disagreements were resolved through three additional online meetings, which were not recorded. Fourth, we excluded abstracts on in-hospital cardiac arrest, pediatric and neonatal resuscitation, animal studies, and topics not aligned with chain of survival, as they were outside the scope of our study. These topics could be explored in future research. Our fifth limitation is the lack of access to internal conference data, including attendance numbers, the ratio of submitted to accepted abstracts, and the criteria for abstract submission and acceptance.

Conclusion

Conference abstracts covered diverse topics, with most falling under chain of survival link "Recognition and Prevention" and ML was one of the commonly used data analysis approaches, though many abstracts relied on other methods as well. Increasing opportunities for participation from low-income countries while maintaining high standards of research would promote inclusivity and equity, as well as enhance diverse perspectives in advancing resuscitation science.

CRediT authorship contribution statement

Nino Fijačko: Writing – review & editing, Writing – original draft, Visualization, Supervision, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Sebastian Schnaubelt:** Writing – review & editing, Visualization, Formal analysis, Conceptualization. **Vinay M Nadkarni:** Writing – review & editing, Visualization, Formal analysis, Conceptualization. **Špela Metličar:** Writing – review & editing, Supervision, Methodology, Formal analysis, Data curation. **Robert Greif:** Writing – review & editing, Supervision, Methodology, Formal analysis, Data curation.

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Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: 'NF is a member of the European Resuscitation Council (ERC) Basic Life Support BLS Science and Education Committee (SEC). VMN is the past-board chair of the International Liaison Committee on Resuscitation (ILCOR) and, an emeritus member of the ILCOR Pediatric Task Force. SS is member of the ILCOR Education, Implementation and Teams (EIT) Task Force EIT and ERC Advanced Life Support SEC ALS. RG is ERC Director of Guidelines and ILCOR, and ILCOR Task Force chair for Education Implementation and Team; and member of the editorial board of Resuscitation Plus.'

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Appendix A. Supplementary material

Supplementary material to this article can be found online at https://doi.org/10.1016/j.resplu.2025.100951.

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REFERENCES

1. Danış F, Kudu E. The evolution of cardiopulmonary resuscitation: global productivity and publication trends. Am J Emerg Med 2022;54:151–64. https://doi.org/10.1016/j.ajem.2022.01.071.

2. Lulic I, Lukic A, Lukic IK, et al. Twitter verse of resuscitation 2015 – the guidelines congress. Resuscitation 2016;106:e15–6. https://doi.org/10.1016/j.resuscitation.2016.07.035.
3. Lukic A, Lulic I, Lukic IK. Education first: content analysis of #erc15prague tweets. Resuscitation 2016;106:e21–2. https://doi.org/10.1016/j.resuscitation.2016.06.035.
4. Leary M, McGovern S, Dainty KN, et al. Examining the use of a social media campaign to increase engagement for the American Heart Association 2017 resuscitation science symposium. J Am Heart Assoc 2018;7:e008710. https://doi.org/10.1161/JAHA.118.008710.
5. Leary M, McGovern S, Dainty KN, et al. The latest in resuscitation science research. J Am Heart Assoc 2018;7:e008589. https://doi.org/10.1161/JAHA.118.008589.
6. Teran F, McGovern SK, Dainty KN, et al. The latest in resuscitation science research: highlights from the 2018 American Heart Association's resuscitation science symposium. J Am Heart Assoc 2019;8:e012256. https://doi.org/10.1161/JAHA.119.012256.
7. Teran F, Perman SM, Mitchell OJL, et al. Highlights from the American Heart Association's 2019 resuscitation science symposium. J Am Heart Assoc 2020;9:e016153. https://doi.org/10.1161/JAHA.120.016153.
8. Horowitz JM, Owyang C, Perman SM, et al. The latest in resuscitation research: highlights from the 2020 American Heart Association's resuscitation science symposium. J Am Heart Assoc 2021;10:e021575. https://doi.org/10.1161/JAHA.121.021575.
9. Owyang CG, Abualsaud R, Agarwal S, et al. Latest in resuscitation research: highlights from the 2021 American Heart Association's resuscitation science symposium. J Am Heart Assoc 2022;11:e026191. https://doi.org/10.1161/JAHA.122.026191.
10. Stancati JA, Owyang CG, Araos JD, et al. The latest in resuscitation research: highlights from the 2022 American Heart Association's resuscitation science symposium. J Am Heart Assoc 2023;12:e031530. https://doi.org/10.1161/JAHA.123.031530.
11. Kaviyarasu A, Perman S, Balakrishnan R, et al. The latest in resuscitation research: highlights from the 2023 American Heart Association's resuscitation science symposium. J Am Heart Assoc 2025e037295. https://doi.org/10.1161/JAHA.124.037295.
12. Fijačko N, Creber RM, Abella BS, et al. Using generative artificial intelligence in bibliometric analysis: 10 years of research trends from the European resuscitation congresses. Resusc Plus 2024;18:100584. https://doi.org/10.1016/j.resplu.2024.100584.
13. Coute RA, Mader TJ, Kurz MC. Evaluation of National Institutes of Health cardiac arrest research based on "chain of survival" links. Acad Emerg Med 2022;29:1381–2. https://doi.org/10.1111/acem.14569.
14. WebHarvy web scraping software | no-code web scraper. WebHarvy; n.d. https://www.webharvy.com/ (accessed January 2, 2025).
15. Schnaubelt S, Monsieurs KG, Fijacko N, et al. International facets of the 'chain of survival' for out-of-hospital and in-hospital cardiac arrest – a scoping review. Resusc Plus 2024;19:100689. https://doi.org/10.1016/j.resplu.2024.100689.
16. Greif R, Bray JE, Djärv T, et al. 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. Circulation 2024CIR.0000000000001288. https://doi.org/10.1161/CIR.0000000000001288.
17. Greif R, Bray JE, Djärv T, et al. 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 2024;2024:110414. https://doi.org/10.1016/j.resuscitation.2024.110414.
18. WDI – the world by income and region; n.d. https://datatopics.worldbank.org/world-development-indicators/the-world-by-income-and-region.html (accessed December 22, 2024).
19. Kaplan A, Haenlein M. Siri, Siri, in my hand: who's the fairest in the land? On the interpretations, illustrations, and implications of artificial intelligence. Bus Horiz 2019;62:15–25. https://doi.org/10.1016/j.bushor.2018.08.004.
20. Damar M, Özen A, Çakmak ÜE, Özoğuz E, Erenay FS. Super AI, generative AI, narrow AI and chatbots: an assessment of artificial intelligence technologies for the public sector and public administration. J AI 2024;8:83–106. https://doi.org/10.61969/jai.1512906.
21. Pichler M, Hartig F. Machine learning and deep learning—a review for ecologists. Methods Ecol Evol 2023;14:994–1016. https://doi.org/10.1111/2041-210X.14061.
22. Stiglic G, Kocbek P, Fijacko N, Zitnik M, Verbert K, Cilar L. Interpretability of machine learning-based prediction models in healthcare. WIREs Data Min Knowl Discovery 2020;10:e1379.
23. Sufriyana H, Husnayain A, Chen Y-L, et al. Comparison of multivariable logistic regression and other machine learning algorithms for prognostic prediction studies in pregnancy care: systematic review and meta-analysis. JMIR Med Inform 2020;8:e16503. https://doi.org/10.2196/16503.
24. Deakin CD. The chain of survival: Not all links are equal. Resuscitation 2018;126:80–2. https://doi.org/10.1016/j.resuscitation.2018.02.012.
25. Voorrips RE. MapChart: software for the graphical presentation of linkage maps and QTLs. J Hered 2002;93:77–8. https://doi.org/10.1093/jhered/93.1.77.
26. Create your own custom map. MapChart; n.d. https://mapchart.net/index.html (accessed December 29, 2024).
27. Scherer RW, Ugarte-Gil C, Schmucker C, Meerpohl JJ. Authors report lack of time as main reason for unpublished research presented at biomedical conferences: a systematic review. J Clin Epidemiol 2015;68:803–10. https://doi.org/10.1016/j.jclinepi.2015.01.027.
28. von Elm E, Costanza MC, Walder B, Tramèr MR. More insight into the fate of biomedical meeting abstracts: a systematic review. BMC Med Res Methodol 2003;3:12. https://doi.org/10.1186/1471-2288-3-12.
29. Schnaubelt S, Garg R, Atiq H, et al. Cardiopulmonary resuscitation in low-resource settings: a statement by the International Liaison Committee on Resuscitation, supported by the AFEM, EUSEM, IFEM, and IFRC. Lancet Glob Health 2023;11:e1444–53. https://doi.org/10.1016/S2214-109X(23)00302-9.
30. Junedahl E, Lundgren P, Andersson E, et al. The evidence supporting AHA guidelines on adult cardiopulmonary resuscitation (CPR). PLoS One 2024;19:e0309241. https://doi.org/10.1371/journal.pone.0309241.
31. D'Andria Ursoleo J, Bugo S, Losiggio R, Bottussi A, Agosta VT, Monaco F. Characteristics of out-of-hospital cardiac arrest trials registered in ClinicalTrials.gov. J Clin Med 2024;13:5421. https://doi.org/10.3390/jcm13185421.
32. Viderman D, Abdildin YG, Batkuldinova K, Badenes R, Bilotta F. Artificial intelligence in resuscitation: a scoping review. J Clin Med 2023;12:2254. https://doi.org/10.3390/jcm12062254.
33. Ko S, Lee Y, Choi M, Choi D, Lee CA, Hou J-U. Harnessing optical flow in deep learning framework for cardiopulmonary resuscitation training. Expert Syst Appl 2024;238:121775. https://doi.org/10.1016/j.eswa.2023.121775.