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Correspondence

Cardiac arrest and medical technological innovations in the next decade: How about artificial intelligence-assisted tailored cardiopulmonary resuscitation?

To the Editor,

We have read with great interest the recent article from Semeraro et al.[1] on the next medical technological innovations and their impact on management of cardiac arrest. The authors have provided a forward-thinking analysis on how technological advancements are poised to transform the resuscitation field, rightly identifying the potential for artificial intelligence (AI) to restructure every aspect of the chain of survival. Thus, authors have envisioned the future implementation of sensors and wearable devices capable to continuously monitor the patient status, promptly individuate a cardiac arrest and activate the emergency system, together with robots that quickly initiate CPR and deliver defibrillation, and AI-staffed brain interfaces to optimize post-resuscitation care and prognostication.

We would like to consider another important technological development that deserves to be mentioned in the above vision of the next future, namely the "AI-assisted tailored CPR", i.e. CPR maneuvers guided by physiological feedbacks (e.g. aortic pressure, capnogram, ECG waveform analyses, brain or tissue oximetry and/or microcirculation and ultrasound) whose information is integrated through AI-based decision algorithms.[2] While current CPR guidelines recommend a one-size-fits-all protocols, future CPR will approach patients with tailored interventions, treatments, and drug dosing toward individual patient's medical history and physiology thank to innovative devices featuring AI, as described by Semeraro et al.[1] However, although the concept and first preclinical studies on tailored CPR have been conceived more than 10 years ago, this approach is still far away from its wide clinical implementation, being only small pilot feasibility studies available till now.[3–5]

Indeed, replicating Semeraro's approach using ChatGPT-4 and Gemini Advanced with the Gartner Hype Cycle (GHC) for AI 2023 as reference, tailored CPR is still considered at its early-stage research. On the Gartner Hype Cycle, given the nascent state of integrating AI with personalized CPR interventions, this technology is likely in the Innovation Trigger phase, moving towards the Peak of Inflated Expectations. The interest is growing, and early research is promising, but practical, regulatory, and technical challenges need to be addressed before it can move through the subsequent phases (Table 1).

While the potential is significant, the journey of AI-assisted tailored CPR through the Gartner Hype Cycle is still long, prior to achieve widespread clinical adoption and deliver on its promises to unequivocally revolutionize CPR and improve cardiac arrest outcome significantly. A decade has passed since this technology was framed and additional ten years are needed, based on current chatbots and virtual assistants, leading to an overall 20-year development period. Unfortunately, like the AI-assisted tailored CPR technology, we believe that a similarly long timeline of approximately two decades is necessary to achieve all the new advances described by Semeraro et al.[1] Nevertheless, we would also like to be confident that ChatGPT4 and Gemini Advanced predictions are correct so that the visionary dream depicted by Semeraro likely become reality by 2034.[1]

Disclosure

GR is ERC Director Congresses. Authors utilized ChatGPT-4 to create the content of Table 1. Subsequently, authors reviewed and edited the content as necessary, assuming full responsability for the publication's accuracy.

CRediT authorship contribution statement

Alberto Cucino: Data curation, Formal analysis, Methodology, Writing – original draft. **Francesco Palmisano:** Data curation, Formal analysis, Software. **Giuseppe Stirparo:** Conceptualization, Methodology, Supervision, Writing – review & editing. **Giulia Merigo:** Formal analysis, Investigation, Writing – original draft.

Table 1 – Predictive implementation timeline for AI-assisted tailored CPR.

Time	Phase	Interventions
Now	Innovation Trigger	Emergence of technology from research labs and pilot programs. Key developments: • AI algorithms that can analyze real-time patient data such as ECG, oxygen saturation, and other vital signs during cardiac arrest • Machine learning models trained on large datasets of past CPR events to predict the most effective intervention strategies for different scenarios • Neural networks to improve the accuracy of predictions and recommendations for CPR techniquesEarly prototypes of AI-assisted CPR devices or software, capable of providing real-time feedback to emergency responders Proof-of-concept studies demonstrating the potential of AI to improve the effectiveness of CPR by providing personalized recommendations
1–2 years	Peak of Inflated Expectations	Media hype and coverage of successful pilot projects, leading to high public and professional expectations Early adoption from some hospitals and emergency services on a trial basis Success stories: • Clinical trials report positive outcomes, with AI-assisted CPR showing improved survival rates compared to traditional methods • Case studies highlight significant improvements in patient outcomes due to tailored interventionsInvestor interest surges in venture capital investment in startups and companies developing AI-based medical technologies for CPR
2–4 years	Trough of Disillusionment	Implementation challenges: • Integration issues with existing medical devices and protocols • Regulatory hurdles in obtaining regulatory approvals from bodies like the FDA or EMA • Security and data privacy concernsMixed results from some trials and implementations, leading to skepticism and disappointment Provider shakeout from AI-driven CPR due to commercial viability issues
4–6 years	Slope of Enlightenment	Improved technologies: • Refined AI models with Improved accuracy and reliability based on feedback from initial implementations • Second-generation products with more advanced and user-friendly AI-assisted CPR devices and softwareWider understanding: • Clinical guidelines and best practices development for using AI in CPR • Educational programs for emergency responders on how to effectively use AI-driven CPR toolsSuccessful pilots demonstrating the benefits of tailored CPR interventions Evolving standards begin to evolve to accommodate and incorporate AI-based CPR techniques
6–10 years	Plateau of Productivity	Mainstream adoption: • Widespread use (AI-driven tailored CPR interventions become standard practice) in hospitals, ambulances, and other emergency medical settings • Proven effectiveness of improved patient outcomes, leading to broader acceptance and useRegulatory acceptance with clear guidelines and approved AI-assisted CPR devices for widespread use Economic viability leading to broad adoption by healthcare providers Integration with other technologies: • IoT Integration (Internet of Things) for real-time data collection and analysis • Telemedicine to guide remote CPR interventionsContinuous improvement and updates to AI algorithms and models to further enhance CPR effectiveness

Detailed Analysis of Tailored Cardiopulmonary Resuscitation Interventions on the Gartner Hype Cycle from ChatGPT-4

Giuseppe Ristagno: Conceptualization, Methodology, Supervision, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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