

CRÈME DE LA CONFERENCE

The Latest in Resuscitation Research: Highlights From the 2024 American Heart Association's Resuscitation Science Symposium

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Dr Dianne Atkins (University of Iowa College of Medicine) was presented with the Lifetime Achievement Award in Cardiac Resuscitation Science. She played a critical role in the raised awareness of the prevalence of ventricular fibrillation cardiac arrest in children and the prioritization of early defibrillation in the pediatric cardiac arrest algorithm, which is now a standard of care. She called for continued research into the optimal design of pediatric automated external defibrillators for use by both health care providers and lay rescuers.

The Resuscitation Science Symposium Champion Award was presented to Richard Price, the president and founder of PulsePoint. PulsePoint is a 911-connected mobile application that alerts layperson volunteers of people with cardiac arrest in their vicinity requiring assistance to facilitate bystander cardiopulmonary resuscitation (CPR). Price's passion

and commitment to early bystander intervention have resulted in PulsePoint now being implemented in multiple cities across the United States. He stated how he aims to continue building upon the application's new automated external defibrillator registry to improve the rates of public access defibrillation.

The Kids Saves Lives campaign was awarded the Ian G. Jacobs Award for International Group Collaboration to Advance Resuscitation Science for its work on championing CPR education for schoolchildren around the world and advocating for legislation requiring CPR education in schools. Drs Bernd Böttiger and Federico Fiorenzo Semeraro accepted the award on behalf of the group, reflected on how far the initiative has come, and reaffirmed their ongoing resolve to improve survival rates from out-of-hospital cardiac arrest (OHCA) through robust CPR training for all schoolchildren.

Key Words: cardiac arrest ■ cardiopulmonary resuscitation ■ science communication ■ trauma

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All abstracts published in conjunction with the American Heart Association's Resuscitation Science Symposium 2024 can be found online here: https://www.ahajournals.org/toc/circ/150/Suppl_1.

This manuscript was sent to Sula Mazimba, MD, MPH, Associate Editor, for review by expert referees, editorial decision, and final disposition.

The American Heart Association Resuscitation Science Symposium was held in Chicago, Illinois, from November 15 to 17, 2024. This report summarizes the awards, scientific content, and special sessions presented during this academic meeting.

For Sources of Funding and Disclosures, see page 9.

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DICKINSON W. RICHARDS LECTURE/ MAX HARRY WEIL EARLY CAREER AWARD COMPETITION FOR RESUSCITATION SCIENCE

This session was moderated by Dr Jonathan Elmer (University of Pittsburgh) and Dr Lorrel Toft (University of Nevada Reno). Dr Robert W. Neumar (University of Michigan), delivered the Dickinson W. Richards Memorial Lecture, named in honor of Dr Richards, a 1956 Nobel laureate recognized for his pioneering work on cardiac catheterization. In his presentation titled “Post-Cardiac Arrest Syndrome: The Case for a Conceptual Reboot,” Dr Neumar reflected on the evolution of the post-cardiac arrest syndrome as a conceptual framework since its introduction in 2008.¹ He emphasized the challenges of translating preclinical data into tangible improvements in patient outcomes. He proposed adopting new strategies to target post-cardiac arrest brain injury mechanisms, including ischemic depolarization, reperfusion repolarization, dysregulation, and the processes of recovery and repair.² Additionally, he underscored the need for mechanistic-guided clinical trials and innovative trial designs to efficiently identify and evaluate treatments with meaningful therapeutic effects.

The Max Harry Weil Early Career Award Competition finalists Dr Pavitra Kotini-Shah (University of Illinois), Dr Ryan Coute (University of Alabama), and Dr Alex Presciutti (Massachusetts General Hospital) presented their research in front of an expert panel of senior scientists. Dr Kotini-Shah won the competition with her presentation titled “Sex Hormone Trajectories and Association to Outcomes after Out-of-Hospital Cardiac Arrest.” Her research revealed that lower levels of estrone are associated with improved survival outcomes following OHCA and that women tend to exhibit better neurological recovery than men, potentially due to sex-specific pathways that remain unexplored.³ Finalists Dr Ryan Coute (University of Alabama at Birmingham) and Alex Presciutti, PhD (Massachusetts General Hospital), showcased their work on the resuscitation science investigator pipeline⁴ and the psychosocial intervention needs of survivors of cardiac arrest and their caregivers, respectively.

WOMEN IN RESUSCITATION NETWORKING EVENT

This event was led by Drs Pavitra Kotini-Shah (University of Illinois at Chicago) and Lorrel Toft (University of Nevada, Reno) and brought together >100 female resuscitation scientists and their male allies with the goal of creating a safe space to share and discuss the triumphs, challenges, and realities of being a woman in

the field of resuscitation science. Attendees had roundtable discussions and shared experiences around the following themes: “Hard Work Versus Hustle Culture,” the art of saying “no,” and advocacy and support for women in resuscitation science at the institutional level. The discussions highlighted the importance of work-life balance, self-care, and devaluing external validation. The event concluded with a reflection of the power of persistence, during which the moderators celebrated the growth and expansion of the Women in Resuscitation group since its inception 14 years ago.

SPECIAL SESSIONS

Targeted Temperature Management Academy Breakfast Session: Updates and Controversies in Postarrest Care

This preconference workshop, presented as a “learning studio” and independently sponsored and organized by the Targeted Temperature Management (TTM) Academy, provided an evidence-based overview of targeted temperature management and neuroprognostication for the adult post-cardiac arrest population. Dr Benjamin Abella (Mount Sinai Health System) presented the historical context of TTM and reviewed recent randomized controlled trial data. Dr Abella emphasized that current data do not eliminate the role of TTM and advocated for a tailored approach to treating severely injured patients rather than adopting a “1-size-fits-all” model of care. Dr Jonathan Elmer (University of Pittsburgh) discussed the limitations of current tools for neuroprognostication and highlighted the concern regarding early withdrawal of life-sustaining therapy. He outlined a 3-step practical approach to neuroprognostication designed to help clinicians navigate the process effectively.

Hot Topics in Critical Care Cardiology and Cardiac Arrest

This session was moderated by Drs Christopher Barnett (University of California San Francisco) and Andrea Elliott (University of Minnesota) and highlighted prominent topics in critical care cardiology. Dr Penelope Rampersad (New York University Langone Health) discussed the evolving role of multidisciplinary cardiogenic shock teams in prevention of in-hospital cardiac arrest (IHCA). She highlighted how these teams' early identification and intervention on cardiogenic shock have increased the use of advanced therapies including mechanical circulatory support, and improved survival and outcome metrics in patients with IHCA.

Dr Anezi Uzendu (University of Texas Southwestern) reviewed randomized trials that investigated the role of early coronary angiography and percutaneous

coronary intervention in OHCA care. He described how literature has consistently exhibited no benefit from emergent coronary angiography in the absence of ST-segment elevation in resuscitated patients after OHCA.^{5–10} He highlighted the need for better prediction models to identify patients with OHCA with culprit coronary lesions amenable to percutaneous coronary intervention.

Dr Demetris Yannopoulos (University of Minnesota) explained the state of the research on heart–lung interaction in venoarterial extracorporeal membrane oxygenation and extracorporeal cardiopulmonary resuscitation (ECPR). He outlined current dogmas and theoretical data on left ventricular hemodynamics and unloading during venoarterial extracorporeal membrane oxygenation. He analyzed pressure–volume loop data and invasive studies performed during venoarterial extracorporeal membrane oxygenation in humans and animal models of left ventricular failure^{11,12} and found that ejection fraction may increase with this intervention and left ventricular unloading is often achieved assuming aortic valve opening despite conflicting theoretical data.

Dr Sean Van Diepen (University of Alberta) provided an evidence-based framework for postarrest intensive care unit (ICU) care for patients with OHCA based on review of the latest randomized controlled trial literature. He reviewed the 2024 joint Canadian Cardiology Societies' guidelines for postarrest care in OHCA¹³ and discussed evidence on TTM^{14–19}; hemodynamic, oxygenation, and ventilation targets^{20,21}; prevention of ventilator-associated pneumonia²²; and thresholds for seizure treatment in patients who are comatose.²³

Interactive Late-Breaking Resuscitation Science Session

This was a podcast-style session moderated by Drs Ashish Panchal (The Ohio State University) and Michael Kurz (University of Chicago). Dr David Gagnon (Maine Medical Center) shared results from the PROTECT (Ceftriaxone to Prevent Pneumonia and Inflammation After Cardiac Arrest) trial.²⁴ This pilot randomized controlled trial targeted early-onset pneumonia after cardiac arrest by prophylactically administering ceftriaxone versus a matching placebo. Although the trial was stopped early, the intervention reduced early-onset pneumonia in survivors of OHCA treated with targeted temperature management.

Dr Sonali Munot (The University of Sydney) reported on FirstCPR: A Pragmatic Cluster Randomized Controlled Trial Evaluating the Effect of Delivering Basic Life Support Education and Training to Community Organizations,²⁵ a trial that aimed to understand if basic life support education delivered in the context

of a community organization increased bystanders' training and willingness to do CPR. The researchers faced a large number of barriers engaging with many community organizations, but those who did engage saw improvements in the training and willingness to do CPR.

Dr Markus Skrifvars (University of Helsinki) gave the final presentation on long-term functional outcomes and quality of life after the TTH48 trial.¹⁷ For this study, survivors of OHCA were contacted 5 to 8 years after the original trial and evaluated for quality of life and functional outcome scores via telephone interviews. The research team also measured factors like anxiety and depression, posttraumatic stress disorder, fatigue, and cognitive decline using self- and relative questionnaires. They found that the vast majority of survivors had favorable outcomes, but self-reported sleep and fatigue problems and relative-reported cognitive decline were more prevalent.

Long-Term Survivorship and Outcomes

This session was moderated by Dr Katie Dainty (University of Toronto) and Dr Sachin Agarwal (Columbia University, New York). Dr Conrad Bjorshal (Stavanger University Hospital) presented his team's First Aider Follow-up Program, which acknowledges the emotional and psychological toll of performing CPR and aims to provide support to first-aiders who respond to resuscitation. His research highlighted that the structured follow-up programs in fostered resilience improved retention of lifesaving skills and enhanced preparedness for future emergencies.

Dr Alex Presciutti (Massachusetts General Hospital) presented his team's work, which explored the psychological interplay between survivors and their primary caregivers and emphasized the need for interventions that address shared stress and coping mechanisms. He demonstrated how dyadic approaches, such as joint counseling and structured support programs, can strengthen emotional resilience and improve long-term well-being for both survivors and caregivers.

Dr Vicky Joshi (Glasgow Caledonian University) provided a global perspective on research examining cognitive recovery trajectories, noting the significant variability in outcomes. She highlighted key factors influencing cognitive decline, including hypoxic brain injury and preexisting health conditions, and stressed the importance of early screening and tailored rehabilitation strategies. She reinforced the necessity of long-term follow-up and multidisciplinary care to help survivors navigate cognitive challenges and maintain their quality of life.

Dr Cecelia Ratay (University of Pittsburgh) explored strategies for integrating survivors into follow-up

clinical care and research initiatives aimed at improving long-term recovery. She emphasized the ethical importance of survivor engagement in research and described studies focused on reduced fear of recurrence, enhanced rehabilitation, and evaluation of the impact of postdischarge clinics on survivorship. She underscored that beyond survival, achievement of a meaningful quality of life should be the ultimate goal.

Best of the Best Oral Abstracts

This session was moderated by Dr Clifton Callaway (University of Pittsburgh) and Dr Rudolph Koster (University of Amsterdam). Dr Evan O'Keefe (Saint Luke's Mid America Heart Institute) discussed his team's work, which evaluated the time to bystander CPR beyond which bystander CPR is no longer associated with survival to hospital discharge. He reported that the odds of survival to hospital discharge were greatest when bystander CPR was started in the first minute when compared with no bystander CPR and that there was an inverse relationship between time to CPR and survival outcomes. He noted that after 10 minutes, there was no longer a survival benefit to bystander CPR compared with no CPR.

Carolina Tennyson, DNP (Duke Heart Center) described a before and after survey of paramedics who tested her team's novel educational tool designed to prepare interprofessional resuscitation teams to provide patient- and family-centered care during cardiac arrest. The tool used a framework called ABCD (Awareness, Be Present, Connect, and Debrief), and of the paramedics who responded, most felt more confident in communicating with families around resuscitations after receiving training with the educational tool.

PhD candidate Roos Edgar (Radboud University Medical Center) presented a validation study of the circulatory arrest detection algorithm developed for wristband-derived photoplethysmography.²⁶ Among the study population, the sensitivity to detect sudden cardiac arrest was 93% with no false-positive alarms in patients with true sudden cardiac arrest. He stated that the next steps include validating this study in a larger study population.

Dr Tomoyoshi Tamura (Keio University School of Medicine) reported a study on the relevance of diverse natural killer T cells after OHCA. The study showed that percentage of lymphocytes <12 hours after OHCA was independently associated with good neurological outcomes, that diverse natural killer T cells decreased inflammatory axes in multiple cell types after cardiac arrest, and that diverse natural killer T cell-deficient subjects had higher rates of neuronal injury and death. His team concluded that diverse natural killer T cells may be neuroprotective after cardiac arrest by suppressing inflammatory axes in the brain.²⁷

Behind the Science With the Chairs: 2024 American Heart Association/American Academy of Pediatrics Drowning Focused Update and 2024 American Heart Association/American Red Cross First Aid Guidelines

This was a "learning studio" independently sponsored and organized by the American Heart Association (AHA), the American Academy of Pediatrics and the American Red Cross. Dr Matthew Douma (University of Alberta) and Dr Eric Lavonas (University of Colorado) presented key updates from the First Aid Guidelines published in *Circulation*.²⁸ They discussed the new recommendation to train first responders in the administration of naloxone and the new stroke recognition guidelines, which were updated to include the use of the Features From Accelerated Segment Test algorithm for adults and includes a list of signs and symptoms of stroke in pediatric patients. They also reported on updated bleeding control recommendations and new guidelines created for first responders to assist patients in using their own medications.

Dr Cameron Dezfulian presented highlights from the 2024 guidelines for resuscitation following drowning.²⁹ He noted that the guidelines now frame cardiac arrest from drowning as a special circumstance wherein both circulation and oxygenation/ventilation are equally prioritized during basic life support, as hypoxia is the most common reason for arrest in this patient population. He discussed how providing rescue breaths, with and without equipment, as well as administering oxygen are the focus of resuscitation after drowning, and that availability and use of public-access defibrillators in aquatic environments are recommended.

Cardiac Arrest Due to Drugs of Abuse

This session was moderated by Dr Eric Lavonas (University of Colorado) and Dr Ameera Haamid (University of Chicago). Dr Ralph Wang (University of California San Francisco) reflected on how opioid-associated OHCA (OA-OHCA) has increased over the past decade and now is a common cause of OHCA that is underrecognized. He discussed recent observational data suggesting that naloxone is variably used in OA-OHCA by emergency medical services (EMS) although it may be beneficial in management but that there is no sufficient supporting data to recommend the use of additional opioid-specific therapy in the management of OA-OHCA.^{30,31}

Dr Jeanmarie Perrone (University of Pennsylvania) presented on the role of different drugs of abuse in OHCA. She noted that cocaine and methamphetamine contribute to cardiovascular death, but opioids, particularly fentanyl, drive lethality. She emphasized that

naloxone is a highly effective opioid-reversing agent that should be made widely available, and that the role of other emerging drugs, such as xylazine, benzodiazepines, and medetomidine in OHCA is not yet well understood.

Dr Gerard Carroll (Cooper University Healthcare) discussed his team's work on the management of opioid use disorder in the prehospital setting, stating that they are studying an EMS training program that encourages EMS to distribute Narcan kits before an overdose and initiate buprenorphine after an overdose. His team has delivered hundreds of field distributions, and a quarter of these individuals receive follow-up services. He emphasized the importance of such initiatives, as a third of patients who experience fatal overdose interact with EMS in the year before their overdose.

Dr Brian Grunau (University of British Columbia) reported on the association between bystander CPR strategy and neurological outcomes in OA-OHCA versus undifferentiated OHCA. He discussed his study based on British Columbia OHCA registry data, which concluded that chest compressions with ventilation was associated with a more favorable neurological recovery in OA-OHCA but not in undifferentiated OHCA. Furthermore, he mentioned that no CPR was associated with lower odds of favorable neurological recovery in undifferentiated OHCA but not in OA-OHCA.

Critical Knowledge Gaps in Pediatric Cardiac Arrest

Dr Martha Kienzle (Children's Hospital of Philadelphia) discussed the physiologic premise of epinephrine during pediatric cardiac arrest, current practice, and future directions. She highlighted conflicting studies regarding the ideal epinephrine dosing frequency³²⁻³⁴ and discussed the physiologic premise by which epinephrine administered more frequently than guideline recommendations may benefit IHCA resuscitation.³⁵ She discussed the concept of epinephrine responsiveness^{36,37} and that there may be a time-dependent relationship between frequent epinephrine administration and return of spontaneous circulation (ROSC).^{34,38} Dr Kienzle identified knowledge gaps including optimal epinephrine dose, customization to physiology or phase of resuscitation, and considerations for patients on vasoactive infusions at the time of arrest.

Dr Alexis Topjian (Children's Hospital of Philadelphia) debated Dr Monica Kleinman (Boston Children's Hospital) on the topic of therapeutic hypothermia for children who are comatose after OHCA. Dr Topjian presented the "pro" for cooling and argued that although there is no universal benefit seen in studies to date,³⁹ given the modest risks and likely beneficial effects for some patients on neurological outcome, it is worth implementing. Dr Kleinman, presented the "con" for

therapeutic hypothermia, including the lack of blanket efficacy in pediatrics, and the fragility index of 1 of the HYPERION (Study of Sotatercept in Newly Diagnosed Intermediate- and High-Risk PAH Participants [MK-7962-005/A011-13]) trial.¹⁸ She argued that this is a resource-intensive therapy that can result in delays in neuroprognostication and thus should not be broadly applied.

Basic/Translational Oral Abstracts

This session was moderated by Dr Cindy Hsu (University of Michigan) and Dr Willard Sharp (University of Chicago). Dr Nicolas Segond (Université Grenoble Alpes) presented his work evaluating the impact of postarrest resuscitative endovascular balloon occlusion of the aorta on hemodynamics after ROSC in a pig model. His team found that among subjects who achieved ROSC after intra-arrest heads-up CPR and resuscitative endovascular balloon occlusion of the aorta inflation, those with half-deflated resuscitative endovascular balloon occlusions of the aorta after ROSC had improved mean arterial pressure, cerebral perfusion pressure, and coronary perfusion pressure compared with those with fully deflated resuscitative endovascular balloon occlusions of the aorta.

Dr Daiki Kaito (Keio University School of Medicine) presented his research, which aimed to evaluate the effect of nicotinamide mononucleotide administration on postarrest brain injury in a mouse model. Nicotinamide mononucleotide is a supplement that is a precursor to nicotinamide adenine dinucleotide, which has been shown to be protective against neuronal injury. His team found that subjects who received nicotinamide mononucleotide had increased nicotinamide adenine dinucleotide levels in the brain, improved 48-hour neurological function, less neuronal injury at 48 hours, and improved 7-day survival compared with subjects who receive placebo.

Dr Jacob Vine (Beth Israel Deaconess Medical Center) presented his work on how mitochondrial reserves affect response to thiamine in patients following cardiac arrest. His team found that patients following cardiac arrest with higher mitochondrial spare capacity and maximal respiration had decreased lactate at 24 hours compared with patients following cardiac arrest with low mitochondrial reserves, in which thiamine administration did not result in change in lactate at 24 hours. He argued that selective thiamine administration in patients following cardiac arrest with high mitochondrial spare capacity may improve outcomes in this cohort.⁴⁰

Dr Laura Faiver presented her work on the utility of jugular bulb venous oxygen saturation and postarrest electroencephalography in identifying patients following cardiac arrest who will have improved oxygen

extraction in response to hypertonic saline (HTS). Jugular bulb venous oxygen saturation after cardiac arrest may be elevated in the setting of diffusion-limited oxygen extraction secondary to perivascular edema, in which HTS may be beneficial. Her team found an independent association between HTS treatment and decreased jugular bulb venous oxygen saturation, suggesting that jugular bulb venous oxygen saturation can be used to identify patients with perivascular edema who may benefit from HTS; however, they found no interaction between qualitative electroencephalography, HTS, and change in jugular bulb venous oxygen saturation to suggest that electroencephalography can be used to identify patients who may benefit from HTS.⁴¹

Clinical Oral Abstracts

This session was moderated by Dr Jessica Fowler (Children's Hospital of Philadelphia) and Dr Carolina Maciel (University of Florida). Dr Lindsay Shepard (Children's Hospital of Pennsylvania) presented her work on intra-arrest tracheal intubation in pediatric IHCA. Her team used the AHA's Get With The Guidelines–Resuscitation database to perform an analysis of children aged <18 years with index IHCA without an invasive airway at time of CPR and found no association between intra-arrest intubation and survival between children who were intubated at a given minute during an ICHA versus children at risk of intubation in the same minute. She highlighted that when limiting the cohort to children >8 years, intra-arrest intubation was associated with increased survival.

Ms Louise de Claville H. Flarup (Region Hovedstaden, Denmark) presented her team's research on EMS response time and survival for patients with OHCA in public housing in Amsterdam, Copenhagen, and Vienna. Using data from the Amsterdam Resuscitation Studies and the Danish and Viennese Cardiac Arrest registries, they found that OHCA in public housing settings had longer EMS response times, fewer bystander interventions, and lower survival when compared with other residential areas.

Dr Rachel Beekman (Yale University) presented on the development of an innovative cardiac arrest recovery pilot program, which included frequent monitoring of inpatient recovery, prospective cognitive screenings, and care coordination by a multidisciplinary team to ensure optimal discharge planning. She described how the cardiac arrest recovery pilot program demonstrated that in-hospital cognitive screening was feasible and effective in identifying cognitive impairment at the time of discharge, while also successfully tracking patient recovery over time, anticipating needs upon discharge, and ensuring expedited outpatient neuropsychological follow-up.

Dr Sheng-En Chu (Far East Memorial Hospital, Taiwan) presented his randomized trial (EXEC-CPR

[Effect of Lower Versus Higher Oxygen Saturation Targets on Survival to Hospital Discharge Among Patients Resuscitated After Out-of-Hospital Cardiac Arrest]), which sought to assess whether or not transthoracic echocardiogram–guided chest compressions in patients with OHCA is associated with improved outcomes compared with conventional chest compressions. He reported that the team found no difference in sustained ROSC, survival to ICU admission, or discharge with favorable neurological outcomes between patients randomized to transesophageal echocardiogram (TEE)-guided chest compressions compared with those who receive conventional chest compressions.

Year in Review: Yesterday, Today, and Tomorrow! A Celebration of 100 Years of the AHA: Adults

Dr Thomas Rea (University of Washington) presented the Year-in-Review for Adults. He began by highlighting the potential larger impact of interventions delivered early in cardiac arrest care, as the physiologic window to affect change diminishes further from the initial event. He mentioned several key studies related to registries and measurement, including the new Utstein template, and a recent review article urging coordination among the multiple international cardiac arrest registries.^{42,43} He also noted the large number of publications this year focused on cardiac arrest disparities, including CPR in low-resource settings.^{44,45}

Dr Rea discussed studies focused on emerging technology aimed at facilitating early intervention in cardiac arrest, including smart watch detection of pulselessness, application-based crowdsourcing of the emergency response, telephone CPR instruction, and drone-delivered automated external defibrillators.^{46–49} He then highlighted the lack of sufficient data to conclude benefit of naloxone administration in cardiac arrest or support selection of specific vasopressor for postarrest shock.^{30,50,51} He also reviewed 3 major randomized trials showing no difference in outcomes with intravenous versus intraosseous medication administration,^{52,53} and briefly noted the neutral overall findings of a clinical trial that randomized patients with OHCA with ROSC and no ST-segment elevation to expedited transport to cardiac centers versus the closest hospital.⁵⁴

Regarding survivorship, Dr Rea highlighted a review of caregiver burden, a description of sleep disruption among survivors of cardiac arrest, and a study demonstrating that favorable neurological status at hospital discharge predicts long-term survival.^{55–57} He concluded by reviewing the International Liaison Committee on Resuscitation's Ten Steps Toward Improving In-Hospital Cardiac Arrest Quality of Care and Outcomes.⁵⁸

Year in Review: A Celebration of 100 Years of the AHA: Pediatrics

Dr Tia Raymond (Medical City Children's Hospital) presented the Year in Review for Pediatrics and focused on intra-arrest management, postarrest management, advanced therapies, and IHCA prevention and quality improvement. For intra-arrest management, she first discussed epinephrine administration. She reviewed 1 study showing sustained ROSC and shorter CPR duration among pediatric patients with IHCA receiving epinephrine at dosing intervals of <3 minutes,³⁴ another showing no association between early epinephrine administration and outcomes in pediatric CPR events from bradycardia and poor perfusion,⁵⁹ and a third noting higher rates of ROSC among infants undergoing delivery room resuscitation when given endotracheal epinephrine versus intravenous epinephrine, though all those who achieved ROSC also received intravenous epinephrine.⁶⁰ She then highlighted other studies that touched upon the associations of higher intra-arrest end-tidal CO₂ and cerebral regional oxygen saturations with better outcomes,^{61,62} the novel alternative of abdominal compression CPR for infants with recent cardiac surgery,⁶³ the association between prolonged chest compression pause and lower survival in pediatric IHCA,⁶⁴ and the association between fewer shocks before ROSC and higher likelihood of survival with favorable neurological outcomes among pediatric patients with IHCA with initial shockable rhythms.⁶⁵

For postarrest management, Dr Raymond discussed blood pressure and outcomes. She discussed 2 studies that identified the target mean arterial pressure, systolic blood pressure, and diastolic blood pressure threshold for the first 6 hours after arrest that are associated with favorable neurological outcomes.^{66,67} She also highlighted studies showing that duration and magnitude of hypotension as well as hypercapnia and hypoxia following pediatric resuscitation were associated with unfavorable neurological outcomes and lower survival to hospital discharge, respectively.^{68,69}

Dr Raymond then highlighted pediatric ECPR. She presented 1 study showing improved survival to discharge in pediatric cardiac arrest during cardiac surgery compared with conventional CPR, and another highlighting the benefit of ECPR in select pediatric cases of OHCA.^{70,71} She concluded with a brief review of the Pediatric Cardiac Critical Care Consortium's cardiac arrest prevention quality improvement project and the International Liaison Committee on Resuscitation's Ten Steps Toward Improving In-Hospital Cardiac Arrest Quality of Care and Outcomes.^{58,72}

AHA/Japanese Circulation Society Joint Session

This session, moderated by Dr Masashi Okubo (University of Pittsburgh) and Dr Naoki Nakayama

(Yokohama City University Medical Center), focused on TTM and ECPR. Dr Rachel Beekman (Yale University) reviewed current guidelines for TTM and highlighted the need for targeted trials with select populations as response to therapy likely depends on severity of injury. Dr Hiromichi Naito (Okayama University) presented his ongoing randomized control trial (R-CAST OHCA [Neurological Outcomes With Hypothermia Versus Normothermia in Patients With Moderate Initial Illness Severity Following Resuscitation From Out-of-Hospital Cardiac Arrest: Protocol for a Multicenter Randomized Controlled Trial]) evaluating neurological outcomes for hypothermia versus normothermia in patients with moderate postarrest illness severity, and Dr Akihiko Inoue (Hyogo Emergency Medical Center) introduced his upcoming randomized trial (SAVE-J NEUROTHERM [Hypothermia Versus Normothermia After Extracorporeal Cardiopulmonary Resuscitation for Out-of-Hospital Cardiac Arrest: A Cluster Randomized Trial]), which will examine survival for patients with OHCA receiving ECPR who are randomized to targeted hypothermia or targeted normothermia. Dr Jason Bartos (University of Minnesota) discussed the importance of ECPR center experience, patient selection, modifying arrest interventions, and postarrest care in developing a successful system of care for ECPR.

Mythbusting: Debates in Cardiac Arrest Clinical Care and Research

This session featured 2 exciting debates between experienced resuscitation scientists. In the first debate titled "Myth: Nobody Needs to Be Cooled Below 36", Dr Katherine Berg (Beth Israel Deaconess Medical Center) argued the "pro" position in favor of temperature control with targets <36 °C for some patients, while Dr Laurie Morrison (University of Toronto) argued the "con" position.

Dr Berg reviewed the current International Liaison Committee on Resuscitation, AHA, and European Resuscitation Council guidelines support cooling <36 °C and the systemic reviews supporting the guideline recommendations.^{73–76} Although the average treatment effect of cooling is neutral, she argued that it was shown to be beneficial in certain subgroups and should therefore be particularly used in patients who fit certain phenotypes.⁷⁷ Dr Morrison highlighted recent meta-analyses and the TTM2 trial, which found no benefit of temperature control to <36 °C.^{18,78,79} She emphasized that improvements in cardiac arrest outcomes come from better protocolized and evidence-based care—not just a specific target temperature.

In the second debate, "Myth: RCTs Will Always Be Neutral in Cardiac Arrest," Dr Jonathan Elmer (University of Pittsburgh) argued the "pro" position while Dr Markus Skrifvars (University of Helsinki) argued the "con" position.

Dr Elmer began by sharing the large number of clinical trials in cardiac arrest that have been neutral, and noted 2 principal problems that can obscure the impact of the trial interventions: (1) that randomized controlled trials measure population-level effects and (2) postrandomization confounding, by which clinicians provide different care to patients with different treatment trajectories. He argued that these problems cannot be addressed by large sample size alone, and that efforts should instead focus on identifying appropriate patient populations in whom to study therapies. Dr Skrifvars argued that neutral trials provide important information including subgroup analyses, reanalyses, and Bayesian analyses as well as epidemiologic lessons around things like cost and efficiency. He contended that our trials are just severely underpowered and that we need larger, broader clinical trials, as phenotyping and individualized therapies limits generalizability.

Emerging Technologies in Cardiac Arrest Resuscitation

This session was moderated by Drs Johanna Moore (Hennepin County Medical Center) and Robert Sutton (Children's Hospital of Philadelphia). Dr Lance Becker (Northwell Health) discussed his team's work on the use of mitochondrial transplantation to mitigate ischemia-reperfusion injury and improve outcomes after cardiac arrest.⁸⁰ His team induced ventricular cardiac arrest in pig models, who afterwards received intra-arrest care according to advanced cardiovascular life support guidelines. Immediately after ROSC, subjects received either intravenous mitochondrial transplantation or respiration buffer and were hemodynamically monitored. Subjects receiving mitochondrial transplantation had improved mean arterial pressure and cardiac output, laying the groundwork for future research to advance mitochondrial transplantation as a novel therapeutic strategy in cardiac arrest.

Dr Jake Sunshine (University of Washington and Research Scientist at Google) described the development of an automated cardiac arrest detection algorithm implemented on Google's latest smartwatch. Upon confirming a loss of pulse with smartwatch sensors, the device triggers an audio alarm and contacts emergency services if there is no response or movement.⁴⁶ This technology has been validated in simulations and induced pulselessness, but its impact on OHCA outcomes remains uncertain.

Dr Tiffany Ko (Children's Hospital of Philadelphia) described a novel neurometabolic optical monitor, which uses advanced noninvasive frequency-domain diffuse optical spectroscopy to monitor brain oxygenation. In an animal model, her team showed the neurometabolic optical monitor to be an early predictor of ROSC,⁸¹ but that targeted interventions using the

neurometabolic optical monitor during CPR failed to achieve brain oxygenation targets.

Dr Felipe Teran (Weill Cornell Medicine, New York) presented the role of TEE during cardiopulmonary resuscitation. He discussed how intra-arrest TEE is a valuable tool for visualizing the heart during cardiac arrest and optimizing chest compression depth and compression point in real time, minimizing compression over the left ventricular outflow tract.⁸² The Resuscitative TEE Collaborative Registry, led by Dr Teran, is currently investigating the role of intra-arrest TEE.⁸³

CONCLUSIONS

The 2024 Resuscitation Science Symposium conference gathered researchers and clinicians from across the globe to exchange insights and explore innovative approaches in resuscitation science. Spanning topics from foundational laboratory studies to public health initiatives, debates in acute care, and groundbreaking clinical trials, this year's event fostered a spirit of collaboration and challenged attendees to view resuscitation through fresh and multidisciplinary lenses.

ARTICLE INFORMATION

Affiliations

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Disclosures

Dr Abella has received consulting and speaking honoraria from Becton Dickinson and Stryker Medical. Dr Johnson serves on the scientific advisory board for Opticyte, Inc. Dr Yang serves on the medical advisory board for Philips Healthcare. Dr Owyang serves as faculty for the Resuscitative TEE Workshop. Dr Jacob Vine was supported by a National Heart, Lung, and Blood Institute grant (T32HL155020). Dr. Teran is the owner of ResusMedX LLC and course director of The Resuscitative TEE Workshop. The remaining authors have no disclosures to report.

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