

The Latest in Resuscitation Science Research: Highlights From the 2018 American Heart Association's Resuscitation Science Symposium

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This year's American Heart Association (AHA)'s Resuscitation Science Symposium (ReSS), held November 9 to 11, 2018, in Chicago, Illinois, brought together thought-provoking research from basic science to clinical trials and frontline work in the public health space. Across 16 sessions, >50 oral presentations were given on topics ranging from a first-person narrative from a patient's perspective of surviving cardiac arrest to the transcriptional profiling of the neuroprotective mechanisms of inhaled nitric oxide in pediatric arrest. A total of 275 posters and 27 oral presentations on 40 topics were presented.¹ Nine awards, including the inaugural winners of the Resuscitation Champion Award, were given.²

Awards

The Young Investigator Awards were presented to 10 investigators within the first 5 years of their appointments, honoring exemplary contributions to research in a broad range of topics (Table S1).

Lifetime Achievement Awards were presented to 2 clinician-researchers for their life-long work and contributions

to the field: Clifton W. Callaway, MD, PhD, of the University of Pittsburgh (Pittsburgh, PA) received the Lifetime Achievement Award in Cardiac Resuscitation, and Martin Schreiber, MD, of the Oregon Health and Science University (Portland, OR), received the Lifetime Achievement Award in Trauma Resuscitation Science.

Dr Callaway's research has centered on improving outcomes for brain injury following cardiac arrest by implementing a medically comprehensive and titrated approach to patients while mentoring multiple investigators in the resuscitation field.²

Dr Schreiber was distinguished for his roles both as a military officer and as a civilian physician and researcher. He served in 3 deployments in Iraq and Afghanistan and played a significant role in developing new resuscitation strategies including the use of recombinant factor VII, hypertonic saline, prothrombin complex concentrate, and stem cells.²

The inaugural Resuscitation Champion Award, designated for individuals who support the field via research and clinical improvements in government, industry, or public advocacy, was presented to Debra Egan, MPH, and George Sopko, MD, MPH, from the National Heart, Lung and Blood Institute.

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Accompanying Tables S1 through S3 are available at <https://www.ahajournals.org/doi/suppl/10.1161/JAHA.119.012256>

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The Ian G. Jacobs Award for International Group Collaboration to Advance Resuscitation Science was presented to the Core Outcome Set for Cardiac Arrest (COSCA),³ a partnership of patients, families, clinicians, researchers, and the International Liaison Committee on Resuscitation (ILCOR) that acknowledges the values and preferences of all stakeholders, particularly patients and their families.

This year's Best Oral Abstract awards were presented to Linn Andelius, Emmanuel O. Akintoye, Ernesto Lopez, and Takayuki Ogura. Andelius's study focused on the effect of smartphone applications on bystander defibrillation participation. Lopez's research evaluated antithrombin III's contribution to the protective and reparative effects of fresh frozen plasma following hemorrhagic shock. Akintoye's research highlighted the importance of modifiable social determinants such as insurance type and hospital percutaneous coronary intervention capability of health in patient outcomes as significant predictors of survival to hospital discharge after cardiopulmonary resuscitation (CPR) for in-hospital cardiac arrest (IHCA). Ogura studied the use of the prehospital traumatic bleeding severity score as a predictor of massive transfusion utilization (Table S2). Table S3 provides names, titles, and research fields of winning abstracts.

Women in Resuscitation Science Networking Meeting

This year's Women in Resuscitation Science focused on the gender pay gap and teaching salary negotiation for women in the workplace, sponsored by the American Association of University Women. During this workshop, participants learned the fundamentals of salary negotiation through facilitated discussion and role playing.

Japanese Circulation Society and AHA Session

ReSS continued the long tradition of a joint session between the Japanese Circulation Society and the AHA. Dr Yoshio Tahara of the National Cerebral and Cardiovascular Center Hospital (Osaka, Japan) illustrated how extracorporeal membrane oxygenation, coronary angiography, and temperature management have been aggressively implemented in Japan over the past decade. Dr Jon Rittenberger of the University of Pittsburgh (Pittsburgh, PA) shared data from the Pittsburgh Post-Cardiac Arrest Service demonstrating how the initial neurologic examination is used for prognostication and for determining the patients most likely to benefit from early coronary angiography and electroencephalography monitoring. Dr Eji Hirakawa of Nagasaki University (Nagasaki, Japan) demonstrated the difference between surface and brain

temperature in the postarrest patient and discussed optimal temperature management for this population.

Population Health Initiatives

Dispatch-Assisted CPR: From Saving Lives to Implementation

The plenary session, "Dispatch-Assisted CPR: From Saving Lives to Implementation," was a multiperspective panel that described the experience of an emergent cardiac arrest from the point of view of all stakeholders, including a survivor, a family member, good Samaritans/laypeople, a rehabilitation specialist, and a dispatcher. Each panelist described the same event from his or her unique perspective, painting a multifaceted picture of the faceless heroes on the other end of the phone who make the difference between life and death. The discussion emphasized the crucial parts played by all parties in successful outcomes for cardiac arrest.

Saving Lives Through Public Health Initiatives

Dr Bernd Böttiger from Cologne, Germany, gave an inspiring talk on the "Kids Save Lives" campaign (<https://www.youtube.com/watch?v=0Yf4umHnD3c> "Kids Save Lives", n.d.).⁴ This movement is achieving remarkable penetration in Europe, and multiple counties have enacted mandatory CPR training in public schools. Germany alone has observed a doubling from $\approx 20\%$ to $\approx 40\%$ in rates of bystander CPR across the country. Dr Amy Stewart from Advocate Lutheran General Hospital (Park Ridge, IL) presented her work on "Stop the Bleed, Campaign for Public Trauma Response" (<https://www.bleedingcontrol.org>), an effort led by the American College of Surgeons Committee on Trauma, emphasizing the role that gun violence has played in public health, particularly trauma, in the United States. The Stop the Bleed campaign still uses the "ABCs" for resuscitation: *alert* (call 911), *find the source of bleeding*, and *compress*. Stop The Bleed aims to empower the general public by teaching and distributing basic techniques for bleeding control.

Dr Carolina Hansen from Copenhagen, Denmark, discussed the need to consider and pass legislation requiring CPR training in schools globally. She noted that the barriers to implementing CPR training in schools in Denmark and the United States are similar, particularly because of lack of knowledge and fear of teaching incorrect technique among the educators expected to teach students. She concluded by calling for better communication with and expectations of legislation for end users as a means to improve public awareness and training in CPR. Dr Mary Chang from the University of Texas Southwestern Medical Center (Dallas, TX) discussed the use of training kiosks in increasing bystander execution of CPR.

Resuscitation Health Services Research, Adult and Pediatric Epidemiology

Texas researchers presented data on sex differences in outcomes among those with out-of-hospital cardiac arrest, finding that women, although having higher rates of return of spontaneous circulation (ROSC), have lower survival when adjusting for confounders. The session concluded with a discussion about the cost-effectiveness of public access automated external defibrillators (AEDs). Researchers from Denmark investigated the return on investment of public AEDs. Their findings suggest that it costs about \$54 000 for public AEDs to provide 1 quality-adjusted life-year, which is well within World Health Organization and AHA high/intermediate values for interventions.

Dr Victoria L. Vetter from the Children's Hospital of Philadelphia discussed the impact of legislation in 38 states requiring CPR training as a graduation requirement. Although "CPR in Schools" is associated with a 17% to 25% increase in bystander CPR rates across all ages and in every state where it was enacted, significant disparities among gender and race still exist.

Dr Mathias J. Holmberg from Beth Israel Deaconess Medical Center (Boston, MA) presented a new analysis of "Get With The Guidelines—Resuscitation" to measure the incidence of IHCA in US hospitals. Compared with previous estimates, there are >310 000 IHCA victims in the United States annually, suggesting a large and growing burden of disease. Meanwhile, the number of pediatric IHCAs has decreased, estimated at ≈7100 annually, demonstrating that IHCA is often predictable and thus preventable.

Dr Lars W. Andersen from Aarhus University in Denmark and his team presented a cost-effectiveness analysis of public access defibrillation. He concluded that public access defibrillation costs \$54 000 for each quality-adjusted life-year saved. The cost of public access defibrillation per quality-adjusted life-year saved meets the generally accepted threshold of \$50 000 per quality-adjusted life-year for cost-effectiveness and is comparable to other generally accepted cardiovascular interventions considered efficacious.

Researchers from Michigan, now a statewide partner in CARES (Cardiac Arrest Registry to Enhance Survival), presented data on the estimated patient-standardized clinical outcomes for OHCA across emergency medical services (EMS) agencies in Michigan. Significant variability exists, with the highest performing EMS agencies achieving 40% ROSC and the lower performing agencies achieving 11% ROSC.

Improving CPR Education for Laypeople and Professionals

During the closing session of ReSS, several presentations discussed issues surrounding improving CPR education and

decreasing barriers to layperson response. In the United States, state legislation requiring CPR training in schools has resulted in more people trained and an increase in the number of patients discharged after cardiac arrest with favorable functional outcomes. Nevertheless, gender and racial gaps remain regarding lay rescuer response among those studied.

Closed caption television videos were reviewed to observe and describe what real-life cardiac arrest events look like in the out-of-hospital setting. For patients suffering cardiac arrest, there is often a prodrome of unsteady gait, agonal breathing, and abnormal posturing. For lay rescuers responding, responses range from shaking or shouting at the person, holding the head of the person, and attempting to stand them up or lift their legs. In an Arizona community, residents were engaged, trained, and asked to voluntarily take calls to allow researchers to study the response time of lay rescuers versus EMS providers for both chest compressions and AED delivery. In multiple simulated scenarios, lay rescuers demonstrated faster response times compared with EMS. In Australia, cardiac rehabilitation patients were targeted for increased CPR training efforts. Preliminary results suggest that CPR training can be implemented in cardiac rehabilitation programs but that time requirement to do so is still a barrier to implementation.

Last, researchers from the University of Pennsylvania (Philadelphia, PA) presented data on the implications of legislative efforts for CPR education. This presentation utilized national telephone survey data on CPR education to compare states with mandates for implementation of CPR training in school education to those without. The findings suggest that in states with current mandates, the younger population (aged 18–24 years) is significantly more likely to be trained. Table 1 provides a summary of oral presentations on population health initiatives.

Clinical Research

Managing the Airway During Resuscitation

Four major study results evaluating different airway management strategies during resuscitation were presented. Dr Henry Wang of the University of Alabama (Birmingham, AL) presented, "EMS Approaches to Airway in the US: Pragmatic Airway Resuscitation (PART) Trial,"⁵ a pragmatic trial of supraglottic (laryngeal) airway versus endotracheal tube placement in the prehospital setting conducted within the network of the Resuscitation Outcomes Consortium (ROC) in North America. Patients were randomized in clusters with a crossover design, and the primary outcome was survival at 72 hours. Results demonstrated a significant benefit for patients managed with a laryngeal tube across the primary and 3 secondary outcome measures (ROSC, hospital discharge, and favorable functional outcome).

Table 1. Summary of Oral Presentations on Population Health Initiatives

Lecture	Presenter	Country
Saving Lives Through Public Health Initiatives		
Kids Save Lives: CPR Training in Europe	Bernd Böttiger	Germany
Stop the Bleed Campaign for Public Trauma Response	Amy Stewart	USA
CPR Training Kiosks in The Public Setting	Mary Chang	USA
CPR in Schools: Denmark Experience	Carolina Hansen	Denmark
Improving CPR Education for Laypeople and Professionals		
Implications of Legislative Efforts on Layperson CPR Education	Audrey L. Blewer	USA
A Database of Sudden Cardiac Arrest Videos Describes Victim Pre and Post Arrest Appearance and Bystander Response	Matthew John Douma	Ireland
A Neighborhood Local Volunteer Response Network Improves Response Time for Cardiac Arrest	Karl B. Kern	USA
Increasing the Uptake of Cardiopulmonary Resuscitation Training Within Australian Cardiac Rehabilitation Programs	Susie Cartledge	Australia
“Cold” Debriefing After Pediatric In-Hospital Cardiac Arrests	Heather Wolfe	USA
Resuscitation health Services Research, Adult and Pediatric Epidemiology		
When Laws Save Lives: Impact of Legislation Requiring Cardiopulmonary Resuscitation Education in High Schools on Survival After Sudden Cardiac Arrest	Victoria L. Vetter	USA
Incidence of Adult In-Hospital Cardiac Arrest in the United States	Mathias J. Holmberg	USA
Sex Differences in Outcomes After Out-of-Hospital Cardiac Arrest Patients: Insights from the Resuscitation Outcomes Consortium Continuous Chest Compression Trial	Purav Mody	USA
Cost-Effectiveness of Public Access Defibrillation	Lars W. Andersen	Denmark
Evaluating Variation in Return of Spontaneous Circulation Rates Across EMS Agencies in Michigan	Mahshid Abir	USA

CPR indicates cardiopulmonary resuscitation; EMS, emergency medical services.

Dr Pierre Carli, from the Necker-Enfants Malades Hospital (Paris, France) presented, “EMS Approaches to Airway in the Cardiac Arrest Airway Management (CAAM) Trial.” CAAM is a prehospital noninferiority trial of bag-mask ventilation versus endotracheal tube (control group) conducted in Europe, where the standard practice involves airway management performed by physicians. Patients were randomized on scene, and the primary outcome was survival with good functional outcome (cerebral performance category 1–2 at 28 days). Results from the intention-to-treat analysis showed no significant difference in outcome between groups.

Dr. Jerry Nolan from the Royal United Hospital in Bath UK, presented results from the study: Effect of a Strategy of a Supraglottic Airway Device vs Tracheal Intubation During Out-of-Hospital Cardiac Arrest on Function Outcome, The AIRWAYS-2 Randomized Clinical Trial. Clustering occurred at the EMS level, and the primary outcome was good functional outcome at 30 days or hospital discharge, whichever occurred first. Results demonstrated a significant benefit for patients managed with a supraglottic airway regarding initial airway success but also the loss of an established initial airway. In sensitivity analysis, patients with good functional

recovery were significantly more likely to have had the supraglottic airway first (odds ratio: 2.06; 95% CI, 1.51–2.81), compared with the tracheal intubation group.

Dr Daniel W. Spaite from the University of Arizona (Tucson, AZ) presented, “Airway Management and Ventilation During Traumatic Injury.” Dr Spaite highlighted that trials on airway management are likely confounded by differences in ventilation practices, unintentionally because ventilation is not standardized or measured consistently. More attention to ventilation technique is needed for clinical practice, and future airway trials must consider how to control for ventilation variation and impact.

Circulatory Support for Cardiac and Trauma Emergencies

The plenary session, “Circulatory Support for Cardiac and Trauma Emergencies,” featured a panel of international experts discussing strategies to treat cardiovascular and traumatic shock. Dr Theresa M. Olasveengen from Oslo, Norway, showed preclinical data demonstrating how these models have been used to determine the optimal timing for

delivery of therapies and serve to evaluate novel therapies that may save lives in the future. Dr Paula Ferrada from Virginia Commonwealth University (Richmond, VA) reviewed indications for both tourniquets and resuscitative endovascular balloon occlusion of the aorta as temporalizing methods to control exsanguinating traumatic shock. Dr Jason Bartos from the University of Minnesota (Minneapolis, MN) shared compelling data demonstrating that 100% of his OHCA patients treated with extracorporeal life support experience multiple organ failure, and 84% have coronary artery disease. Dr Babar Basir from Detroit, Michigan, showed how a shock “system of care” successfully implemented in Detroit integrated EMS, emergency department, and in-hospital care.

New Insights Into Postarrest Assessment and Care

The session “New Insights Into Post-Arrest Assessment and Care” was presented on an array of long-term effects of cardiac arrest. Dr Sachin Agarwal of Columbia University (New York, NY) reported on a study of 114 cardiac arrest survivors over 12 months. He noted that survivors have a 36% screened positive rate for posttraumatic stress disorder at hospital discharge and 28% at 1 year after cardiac arrest. These participants tended to be younger and female and to have preexisting psychiatric diagnoses. Participants with posttraumatic stress disorder had consistently higher risk of 12-month risk of major adverse cardiac events and all-cause mortality.⁷

Dr Matthias Kohlhauer of Maisons-Alfort, France, presented data from a rabbit model of cardiac arrest instrumented to capture temperature, cerebral blood flow, cerebral vascular resistance, and arterial/venous differences in cerebral glucose, oxygen, and metabolic substrates. He found that ultra-rapid induction of hypothermia with total liquid ventilation reduced cerebral consumption of oxygen and glucose and reversed the lactate/pyruvate ratio compared with control animals.⁸

Dr Marco Hefti of the University of Iowa in Iowa City described a piglet model of pediatric cardiac arrest in which animals were randomized to inhaled nitric oxide or control after ROSC. Transcriptional profiling of cerebral tissue revealed differential gene expression related to synaptic transmission.

Dr Min Yang of Anhui Medical University (Hefei, China) noted the prevalence of postmyocardial dysfunction in the post-cardiac arrest syndrome and that exposure to epinephrine during resuscitation seems to exacerbate it. She tested ivabradine, a pharmacologic agent that reduces heart rate by inhibiting specific portions of the intrinsic pacemaker current, as a protective agent in a porcine model of cardiac arrest. Animals receiving ivabradine had lower heart rates, less echocardiographic evidence of myocardial dysfunction, and less histologic evidence of myocardial injury compared with controls.

Dr Ramani Balu of the University of Pennsylvania (Philadelphia, PA) presented human data on dynamic cerebrovascular autoregulation from a single-center cohort of human participants with diffuse hypoxic brain injury. Cerebrovascular pressure reactivity manifested in different phenotypes in participants who regained consciousness or remained in a vegetative state. Furthermore, cerebrovascular pressure reactivity had better discrimination of participants with and without eventual return of consciousness than intracranial pressure or brain tissue oxygenation.

Exploring Devices and Algorithms

A session exploring the use of devices and algorithms in resuscitation drew considerable attention as presenters shared data on the use of extracorporeal membrane oxygenation in patients with prolonged resuscitation, examined the associated outcomes of intravenous versus intraosseous access in OHCA, and introduced a novel AED algorithm that allows for continuous chest compressions while the device measures a rhythm, reducing resuscitation interruptions markedly. Dr Felipe Teran from the University of Pennsylvania (Philadelphia, PA) gave a visually captivating presentation on the use of transesophageal echocardiography intra-arrest in OHCA patients with preliminary data demonstrating safety, feasibility, and clinical impact. A key finding of this preliminary work is that in 41% of cardiac arrest cases, the area of maximal compression was found in the left ventricle; in the other 53%, it was in the aortic root or left ventricular outflow tract.⁹

Dr Corina De Graff from Academisch Medisch Centrum Amsterdam presented on her team’s work on prospectively evaluating a new algorithm (cprINSIGHT) which can analyze the ECG while rescuers continue CPR. The results show that this novel algorithm could analyze the ECG without the need for a pause in chest compressions 65% to 74% of the time and had 90% to 100% sensitivity and 100% specificity when it made a *shock* or a *no shock* decision.

Dr Jason Bartos from the University of Minnesota presented a study examining the effects of resuscitation duration on neurologically intact survival in the Minnesota ROC extracorporeal cardiopulmonary resuscitation protocol. They found that 41% of patients receiving full resuscitative efforts were discharged neurologically intact; however, neurologically intact survival declined with increasing duration of CPR, with 100% survival in patients placed on extracorporeal life support within 30 minutes. Survival declined to 50% within 50 minutes and to 20% within 70 minutes, and the metabolic profile worsened during prolonged CPR.

A popular topic in this year’s agenda was the comparison of intraosseous versus intravenous access for the delivery of advanced life support drugs. Dr Purav Mody from the University

of Texas Southwestern (Dallas, TX) brought us further discussion of this topic with a presentation of data from the ROC Continuous Chest Compression Trial.¹⁰ Among 19 731 patients with available access information, intraosseous or intravenous access was attempted in 15.5% and 84.5% of patients, respectively, and was successful in 97% and 92% of these patients. Patients with attempted intraosseous access were actually very different: they were younger, were more likely female, received less bystander CPR, had lower proportions of shockable and witnessed arrests, had marginally faster times to access and to epinephrine administration, and less frequently received therapeutic hypothermia and coronary

angiography compared with patients with intravenous access. Table 2 provides a summary of oral presentations on clinical research.

Late-Breaking Abstracts in Resuscitation Science

Dr Gavin Perkins of the University of Warwick (Coventry, UK) shared the findings of the PARAMEDIC2 (Prehospital Assessment of the Role of Adrenaline: Measuring the Effectiveness of Drug Administration in Cardiac Arrest)¹¹ trial during the first late-breaking session. The trial demonstrated higher 30-day survival for the epinephrine group (3.2% epinephrine

Table 2. Summary of Oral Presentations on Clinical Research

Lecture	Presenter	Country
Circulatory Support for Cardiac and Trauma Emergencies		
Learning From Animal Models of Circulatory Shock	Theresa M. Olasveengen	Norway
REBOA for Trauma and Cardiovascular Emergencies	Paula Ferrada	USA
ECMO and Critical Care for Refractory VF	Jason Bartos	USA
Cardiogenic Shock: Science to Implementation	Mir Babar Basir	USA
New Insights into Postarrest Assessment and Care		
Ultra-Fast Hypothermia Inhibits Early Cerebral Consumption of Lactate After Experimental Cardiac Arrest in Rabbits: A Microdialysis Study	Matthias Kohlhauser	France
Transcriptional Profiling of the Neuroprotective Mechanisms of Inhaled Nitric Oxide in a Swine Model of Pediatric Cardiac Arrest	Marco Hefti	USA
Beneficial Effects of Hcn Inhibitor on Post-Resuscitation Myocardial Dysfunction in a Porcine Model of Cardiac Arrest	Min Yang	China
Cerebrovascular Pressure Reactivity Predicts Outcome in Diffuse Hypoxic-Ischemic Brain Injury	Ramani Balu	USA
Cardiac Arrest-Induced Posttraumatic Stress Increases 1-Year Risk of Major Adverse Cardiovascular Events and All-Cause Mortality	Sachin Agarwal	USA
Managing the Airway During Resuscitation		
EMS Approaches to Airway in the US: The PART Trial	Henry E. Wang	USA
EMS Approaches to Airway in Europe: The CAAM Trial	Pierre Carli	France
The Airways-2 Trial	Jerry Nolan	United Kingdom
Airway Management and Ventilation During Traumatic Injury	Daniel W. Spaite	USA
Exploring Devices and Algorithms		
Analyzing Heart Rhythm During Chest Compressions in Out-of-Hospital Cardiac Arrest Patients Using New Algorithm for Automated External Defibrillators	Corina de Graaf	Netherlands
Progressive Metabolic Derangement During Prolonged Resuscitation for Refractory VT/VF Cardiac Arrest and the Relationship to Neurologically Intact Survival with Extracorporeal Cardiopulmonary Resuscitation	Jason A. Bartos	USA
Intraosseous vs Intravenously Administered Advanced Life Support Drugs in Patients with Out-of-Hospital Cardiac Arrest: Insights from the Resuscitation Outcomes Consortium Continuous Chest Compression Trial	Purav Mody	USA
Resuscitative Transesophageal Echocardiography in the Emergency Department Evaluation of Out-of-Hospital Cardiac Arrest	Felipe Teran	USA

CAAM indicates cardiac arrest airway management; ECMO, extracorporeal membrane oxygenation; EMS, emergency medical services; PART, Pragmatic Airway Resuscitation Trial; REBOA, resuscitative endovascular balloon occlusion of the aorta; VF, ventricular fibrillation; VT, ventricular tachycardia.

versus 2.4% for placebo) but not in survival with favorable neurologic outcome on discharge (2.2% in the epinephrine group and 1.9% in the placebo group). Dr Peter J. Kudenchuk of the University of Washington (Seattle, WA) presented a secondary analysis from the ROC. Their goal was to determine whether intraosseous or intravenous administration of medication was associated with outcome. Although the intraosseous group received a higher percentage of CPR during their resuscitation, the survival benefit of administering amiodarone or lidocaine was not found in the intraosseous group. Administering amiodarone or lidocaine did improve survival in the intravenous group. Dr Jasmeet Soar, chair of the advanced life support subcommittee of Southmead Hospital (Bristol, UK), then revealed the new ILCOR recommendations on antiarrhythmic drug use during CPR and after ROSC.¹² Given the results of the above trial, either lidocaine or amiodarone can be used in ventricular fibrillation/ventricular tachycardia cardiac arrest. These 2 presentations illustrated how ILCOR rapidly incorporated new data into its guidelines.

Year In Review: Trauma and Cardiac Arrest

At the cardiac year in review, Dr Clifton Callaway highlighted 2018's major studies on epinephrine,^{11,13,14} airway management,^{5,6} and variation in outcome between regionalized EMS and cardiac arrest centers.¹⁵⁻¹⁷ Unique in the past year were studies on teamwork, resuscitation science education,¹⁸ and resuscitation training. Finally, the Core Outcome Set for Cardiac Arrest Clinical Trials (COSCA)³ collaboration defined a new benchmark for good clinical practice in cardiac arrest trials, recommending study outcomes to include measurement and reporting of survival (discharge or 30 days), functional outcome (discharge or 30 days), AND health-related quality of life at 90 days.

In his review of 2018's trauma research developments, Dr Samuel Tisherman of Baltimore, MD, highlighted the Stop the Bleed campaign and a study demonstrating that teaching laypeople to use tourniquets is feasible and optimal with an in-person course, compared with using flashcards, an audio

training kit, or no training at all. This session also highlighted studies in prehospital plasma, suggesting that it may be beneficial with long transports and blunt injury. Finally, researchers are revisiting hypothermia as a treatment for traumatic brain injury. The POLAR-RCT (Prophylactic Hypothermia Trial to Lessen Traumatic Brain Injury—Randomized Clinical Trial)¹⁹ tested early prophylactic hypothermia in patients with severe traumatic brain injury versus controlled normothermia. There was no significant difference in favorable functional outcome or independent living at 6 months after injury in the hypothermia group.

Dr Per Nordberg of the Karolinska Institute (Stockholm, Sweden) discussed the long-awaited PRINCESS (Prehospital Resuscitation Intra-Arrest Cooling Effectiveness Survival Study),²⁰ which used a transnasal cooling device to deliver targeted temperature management to 34°. Patients in the investigational arm arrived at target temperature significantly faster (time to target 101 versus 182 minutes) than controls. However, there was no significant difference in functional outcome at 90 days between groups.

Basic Science

Laboratory Studies of CPR and Postarrest Recovery

The session on CPR and postarrest recovery discussed a range of themes from brain function to the effect of elevation on cerebral perfusion pressure.

Dr Qinyue Guo of Virginia Commonwealth University (Richmond, VA) presented data on the effects of PEG-20k (polyethylene glycol 20k) administered on initiation of chest compressions in a randomized cardiac arrest model of Sprague-Dawley rats. Animals receiving PEG-20k had reduced cerebral edema, as measured by wet-to-dry ratio of the brain, and cerebral microcirculation, as measured by sidestream dark-field imaging.²¹

Dr Wolfgang Weihs of the Medical University of Vienna (Vienna, Austria) described an observation in his rat model of

Table 3. Summary of Oral Presentations on Basic Science: Laboratory Studies of CPR and Postarrest Recovery

Lecture	Presenter	Country
Polyethylene Glycol-20k Improves Post-Resuscitation Cerebral Microcirculation	Qinyue Guo	USA
Repopulation of CA1 Region in the Hippocampus Is Accompanied by Increased Diameter and Reduced Glial Scarring After Ventricular Fibrillation	Wolfgang Weihs	Austria
Spatiotemporally Controlled Ultrasound-Triggered Release of Nitric Oxide Using Nano Au-Polymersomes/ S-Nitrosoglutathione Mitigates Post-Resuscitation Cerebral Vasoconstriction and Neuronal Apoptosis via Reciprocating Akt-eNOS-NO Signaling	Wei-Tien Chang	Taiwan
Controlled Progressive Elevation Maximizes Cerebral Perfusion Pressure During Head-Up CPR in a Swine Model of Cardiac Arrest	Johanna C. Moore	USA

Akt indicates protein kinase B; CPR, cardiopulmonary resuscitation; eNOS, endothelial nitric oxide synthase; NO, nitric oxide.

cardiac arrest that hippocampal cells were initially lost in the early post-cardiac arrest phase but that a sizable number of animals had evidence of repopulation over the course of the next 20 weeks. This finding has implications for the long-term recovery of neurologic function in human postcardiac arrest patients.

Dr Johanna C. Moore of the Hennepin County Medical Center (Minneapolis, MN) presented a serendipitous observation from her laboratory studying a porcine model of “heads-up CPR” in cardiac arrest. While testing different degrees of head angle (20°, 30°, and 40°) during CPR, they noticed that animals with a progressive increase in head elevation (ie, moving from 20° to 40°) displayed higher cerebral and coronary perfusion pressures compared with animals with progressive decrease in head elevation (ie, moving from 40° to 20°). The improved hemodynamics were

largely driven by an increase in mean aortic pressure and a decrease in intracranial pressure.²² Table 3 provides a summary of oral presentations on basic science.

Social Media Impact of ReSS 2018

During ReSS 2018 the conference hashtag #ReSS18 was used to disseminate and amplify, in real time via Twitter, the science presented during the conference. Analysis of social media activity including the hashtag #ReSS18 using Symplur healthcare social medial analytics (Symplur), shows that there were >2000 tweets throughout the 3-day conference, engaging 454 users worldwide who generated 7.7 million impressions and shared 68 articles and >1800 visuals. Figure depicts a chart with the 50 most frequently used terms using the hashtag #ResSS18.

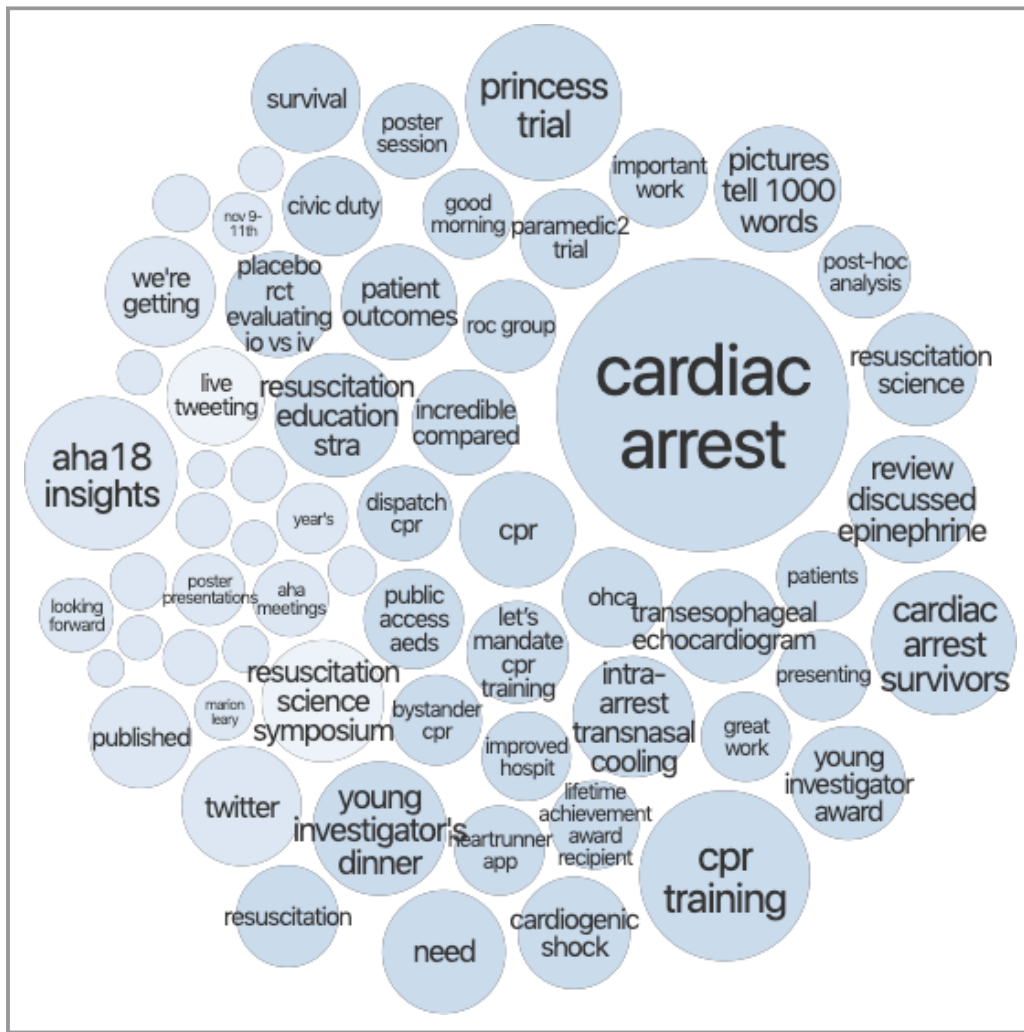


Figure. Social medial trending terms #ReSS18. Bubble chart visualizing the 50 most frequently used words in tweets using the hashtag #ResSS18 throughout the conference. Period: Sunday, November 4, 2018, 12:00 AM, through Saturday, November 17, 2018, 12:00 AM. Source: Symplur, healthcare analytics. AHA indicates American Heart Association; CPR, cardiopulmonary resuscitation; ReSS, Resuscitation Science Symposium.

Conclusion

ReSS 2018 was, once again, an outstanding opportunity for resuscitation science researchers to meet and present the latest in cardiac arrest research, from basic science to clinical trials and public health interventions.

Disclosures

Ms. Leary has received research support from the Zoll Foundation, Medtronic Foundation, Laerdal Foundation, the American Heart Association, and the Astrazeneca Foundation. Leary has received in-kind support from Laerdal Medical. Leary is licensing IP related to virtual reality. Dr Blewer has a research grant from the American Heart Association. Dr Teran has received research support from the Zoll Foundation. Dr Rittenberger has research funding from Mallinkrodt LLC and BrainCools LLC. Dr Kurz receives research funding from the Society of Critical Care Medicine, Emergency Medicine Foundation, Zoll Medical Corporation, and the Zoll Foundation. In addition, Dr Kurz has received honoraria for speaking on behalf of Zoll Medical Corp and is a member of the Board of Directors of Rapid Oxygen Corporation.

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Key Words: blogging • cardiac arrest • resuscitation • resuscitation science symposium • science communication • social media

SUPPLEMENTAL MATERIAL

Table S1. ReSS 2018 Awards.

Name	Award Name
Clifton W. Callaway, MD, PhD.	Lifetime Achievement in Cardiac Resuscitation Science
Martin Schreiber, MD.	Lifetime Achievement in Trauma Resuscitation Science
The Core Outcome Set for Cardiac Arrest (COSCA)	Ian G. Jacobs Award for Group Collaboration
Debra Egan, MPH	Resuscitation Champion Award
George Sopko MD, MPH	Resuscitation Champion Award

Table S2. 2018 Young Investigator Award Winners.

Name	Abstract Title
Sachin Agarwal	Cardiac Arrest-induced Posttraumatic Stress Increases 1-year Risk of Major Adverse Cardiovascular Events and All-cause Mortality Cost-Effectiveness of Public Automated External Defibrillators
Lars Anderson	Cost-Effectiveness of Public Automated External Defibrillators
Jason Bartos	Progressive Metabolic Derangement During Prolonged Resuscitation for Refractory VT/VF Cardiac Arrest and the Relationship to Neurologically Intact Survival with Extracorporeal Cardiopulmonary Resuscitation
Audrey Blewer	Variation In Both Layperson Cardiopulmonary Resuscitation Delivery And Subsequent Survival From Sudden Cardiac Arrest Based On Neighborhood-level Ethnic Characteristics
Jose Juarez	Cardiopulmonary Resuscitation Process Measures Associated with Return of Spontaneous Circulation in Non-Shockable Out-of-Hospital Cardiac Arrest
Rohan Khera	Pulselessness Despite Cardiopulmonary Resuscitation for Bradycardia in Hospitalized Children: Prevalence, Predictors of Survival, and Implications for Hospital Profiling
Matthias Kohlhauer	Ultra-fast Hypothermia Inhibit Early Cerebral Consumption Of Lactate

	After Experimental Cardiac Arrest In Rabbits: A Microdialysis Study.
Christina Miyake	A Population Based Study in a Large Ethnically Diverse Metropolitan City Reveals Racial and Ethnic Disparities in Pediatric Cardiac Arrest
Purav Mody	Sex Differences in Outcomes after Out-of-Hospital Cardiac Arrest Patients: Insights from the Resuscitation Outcomes Consortium Continuous Chest Compression Trial
Adrian Ripeckyj	Unselective Pulmonary Vasodilation Is An Important Factor In Sodium Nitroprusside Enhanced Cardiopulmonary Resuscitation Improved Blood Flow

Table S3. 2018 Best Abstract Award Winners.

Name	Abstract Title	Category
Linn Andelius	Dispatching Lay Rescuers Through a Smartphone Application is Associated With Increased Bystander Defibrillation in Out-of-Hospital Cardiac Arrest	Cardiac Resuscitation Science
Emmanuel O. Akintoye	Association Between Hospital Volume of Cardiopulmonary Resuscitation for In-Hospital Cardiac Arrest and Survival to Hospital Discharge	Cardiac Resuscitation Science
Ernesto Lopez	Antithrombin III Contributes to the Vascular Protective and Reparative Effects of Fresh Frozen Plasma Following Hemorrhagic Shock	Trauma Resuscitation Science
Takayuki Ogura	The Most Accurate Massive Transfusion Prediction Score at the Scene of Injury: The Pre-Hospital Traumatic Bleeding Severity Score	Trauma Resuscitation Science