American Red Cross

Focused Updates and Guidelines 2020

American Red Cross
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The American Red Cross Focused Updates and Guidelines 2020 is overseen by the American Red Cross Scientific Advisory Council and is part of the American Red Cross training services programs. The emergency care procedures outlined in these updates and guidelines reflect the standard of knowledge and accepted emergency practices in the United States at the time these updates and guidelines were published. It is the reader's responsibility to stay informed of changes in emergency care procedures.

Science and Technical Content

The scientific content and evidence within the American Red Cross Focused Updates and Guidelines 2020 is consistent with the most current science and treatment recommendations from:

- The International Liaison Committee on Resuscitation (ILCOR)

- The International Federation of Red Cross and Red Crescent Societies

- The Policy Statements, Evidence Reviews and Guidelines of:

  ◦ American Academy of Pediatrics (AAP)

  ◦ American College of Emergency Physicians (ACEP)

  ◦ American College of Obstetrics and Gynecology (ACOG)

  ◦ American College of Surgeons (ACS)

  ◦ Committee on Tactical Combat Casualty Care (CoTCCC)

  ◦ Obstetric Life Support™ (OBLS™)

  ◦ Society of Critical Care Medicine (SCCM) and the American College of Critical Care Medicine (ACCM)

  ◦ Surviving Sepsis Campaign (SSC)

Dedication

The American Red Cross Focused Updates and Guidelines 2020 are dedicated to the nurses, physicians, prehospital professionals, therapists, technicians, law enforcement, fire/rescue, advanced practice professionals, lifeguards, first responders, lay responders and all other professionals and individuals who are prepared and willing to take action when an emergency strikes or when a person is in need of care. These updates and guidelines are also dedicated to the employees and volunteers of the American Red Cross who contribute their time and talent to supporting and teaching lifesaving skills worldwide.

Acknowledgments

Many individuals shared in the development of the American Red Cross Focused Updates and Guidelines 2020 in various scientific, technical, editorial, creative and supportive ways. Their commitment to excellence made these updates and guidelines possible.

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The development of these updates and guidelines would not have been possible without the leadership, valuable insights and dedication of the subject matter experts, who generously shared their time to ensure the highest quality programs.

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American Red Cross Scientific Advisory Council

Since 1909, the American Red Cross has provided best-in-class resuscitation, first aid and safety education and certification, enabling students to obtain the competency required for effective recognition and care and leading to better outcomes for all those treated.

Behind every course stands a team of experts ensuring that what is taught is based on the latest clinical and educational science. This team, known as the American Red Cross Scientific Advisory Council, is a panel of 60+ nationally and internationally recognized experts from a variety of medical, nursing, EMS, scientific, educational and academic disciplines.

With members from a broad range of professional specialties, the Council has an important advantage: a broad, multidisciplinary expertise in evaluating existing and new assessment methodologies and technologies, therapies, and procedures, and the educational methods to teach them. Additionally, with on-the-ground experience, its members bring the know-how for real-world experience. The Council provides authoritative guidance on resuscitation, first aid, CPR, nursing, prehospital medicine, emergency and critical care, rescue practices, emergency preparedness, aquatics, disaster health and education.

We encourage you to visit our Scientific Advisory Resource Center at redcross.org/science.

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Table of Contents

American Red Cross
Training Services

About the Focused Updates and Guidelines 2020

This focused update summarizes results of the scientific evidence evaluations and guideline reviews overseen by the American Red Cross Scientific Advisory Council (ARCSAC) in 2019 and 2020 on topics related to Basic Life Support, Advanced Life Support, Pediatric Advanced Life Support, Neonatal Life Support, First Aid, Aquatics, Education, Disaster Health, and COVID-19. Evidence summaries are provided that include data, reviews and guidance from:

- The American Red Cross Scientific Advisory Council (ARCSAC)

- The International Liaison Committee on Resuscitation (ILCOR)

- The World Health Organization (WHO)

- The Society for Critical Care Medicine (SCCM)/American College of Critical Care Medicine

- The Surviving Sepsis Campaign (SSC)

- The American Academy of Pediatrics (AAP)

- The American College of Emergency Physicians (ACEP)

- Obstetric Life Support™ (OBLS™)

- The American College of Obstetrics and Gynecology (ACOG)

- The American College of Surgeons (ACS)

- The Stop the Bleed Campaign (STB)

- The Committee on Tactical Combat Casualty Care (Co-TCCC)

- Cardiac Arrest Registry to Enhance Survival (CARES)

Each chapter is organized by topic and contains the following recurring sections:

- **Red Cross Guidelines** presenting recommended actions for lay responders and healthcare professionals as appropriate

- **Evidence Summary** highlighting the more important science, when available, to support the guidelines

- **Insights and Implications** providing ARCSAC expert guidance and decisions, related observations, reviewer opinions or important gaps in knowledge or research

A timely and important section of the Focused Updates and Guidelines 2020 pertains to COVID-19 interim guidelines. These are intended to help lay responders and healthcare professionals provide the best care possible to persons with confirmed or suspected COVID-19, while minimizing the risk of transmission disease.

About the American Red Cross Scientific Advisory Council

The American Red Cross Scientific Advisory Council (ARCSAC) ensures the clinical and educational basis for Red Cross programs, products and guidance. The ARCSAC is a panel of 60+ nationally and internationally recognized experts in resuscitation, emergency medicine, critical care, trauma, nursing, first aid, education, special populations, prehospital medicine and systems, hospital-based medicine, quality and performance improvement, graduate and undergraduate medical education, continuing education, aquatics, and preparedness and disaster health. They review the available evidence to create scientific reviews, answers to questions, and position statements. Their guidance is incorporated into curricula for all Red Cross courses. The ARCSAC has been instrumental in providing scientific reviews used in formulating evidence-based guidelines for the Focused Updates and Guidelines 2020, and for providing expert opinion when evidence is lacking. The digital publication of the Focused Updates and Guidelines 2020 will allow incorporation of critical new evidence or guidelines as needed, including COVID-19, where the science is rapidly evolving.

CHAPTER **1**

First Aid

Glove Use for First Aid

An updated scientific review by ARCSAC in 2020 evaluated evidence to support a recommendation for glove use and type of glove when administering care that may lead to blood or body fluid exposure.[1]

Red Cross Guidelines

- Latex-free gloves should be used for first aid.

- Although they are latex-free, vinyl gloves should not be used for first aid.

- Nitrile gloves are recommended when handling blood or other potentially infectious body fluids.

- Gloves should be stored in their original packaging, away from direct heat or sunlight when possible, and should not be used beyond their expiration date or if visible signs of degradation (cracking or discoloration) are present.

Evidence Summary

The original review evaluated the advantages and disadvantages of latex (including low-protein latex), vinyl, and nitrile gloves for inclusion in a first aid kit.[1] Outcomes included incidence of sensitization and allergy, durability, barrier effectiveness, viral penetration, regulatory requirements and shelf life. No new studies were identified since the last update in 2016. Previous reviews have documented a significant prevalence of sensitivity and allergy to latex gloves, supporting a recommendation for latex-free gloves. Vinyl gloves have in the past been found to have relatively poor barrier effectiveness, as demonstrated in studies of viral leakage and water tightness,[2-4] with failure rates of 4% to 28% in water tightness tests. Gloves found to be watertight were subsequently tested for permeability to herpes simplex virus, with 10/1068 (0.95%) failing the permeability test.[2]

No new literature was identified to suggest a change in the recommendations for use of nitrile gloves for first aid.

Insights and Implications

Past concerns about durability and permeability of vinyl gloves to viruses are of particular importance during the COVID-19 pandemic.

Sudden Illness

Stroke: Recognition by Lay Responders

Stroke is a leading cause of disability and death. Clot-dissolving medications and interventional therapies have been found to be a highly effective treatment for stroke, reducing mortality and improving functional independence, but they must be administered in a hospital setting and within a time-sensitive window that begins Immediately after symptom onset and declines rapidly over the next several hours.[5,6] This gives urgency to the need for lay responders to quickly recognize stroke and call 9-1-1 or the designated emergency number.

Red Cross Guidelines

- Lay responders should use the signs of facial weakness, arm weakness or grip weakness on one side of the body, or speech disturbance to recognize the signs of a possible stroke and call 9-1-1 or the designated emergency number as quickly as possible if any one of these signs are present.

- Lay responders who are trained and equipped to measure blood glucose may do so in individuals with suspected stroke and report those values to prehospital professionals. Blood glucose measurement should not delay the initial call to 9-1-1 or the designated emergency number.

Evidence Summary

A 2020 ILCOR systematic review[7] and consensus on science with treatment recommendations (CoSTR)[8] evaluated the use of rapid stroke scoring scales in adults with suspected acute stroke, compared with basic first aid assessment without the use of a stroke scale. Outcomes included time to treatment from symptom onset, recognition of stroke, and increased public/layperson recognition of stroke signs. All studies were observational with stroke scales applied by emergency medical services (EMS) personnel or nurses. Evidence was deemed of very low certainty.

Four stroke scales were evaluated for time to treatment, each by a single study. Decreased time to treatment was associated with use of the Kurashiki Prehospital Stroke Scale (KPSS),[9] the Ontario Prehospital Stroke Screening Tool (OPSST),[10] and the Face, Arm, Speech, Time, Emergency Response (FASTER) stroke scale.[11] An association was found between the use of both the Face, Arm, Speech, Time (FAST) scale and the Los Angeles Prehospital Stroke Scale (LAPSS) and an increased number of patients with confirmed stroke or TIA.[12,13] The use of FASTER was associated with a higher number of patients who received thrombolytic therapy.[11]

The accuracy of stroke recognition with the use of each scale was determined by a summary sensitivity, specificity and prevalence.[8] Because scales that include glucose measurement are capable of excluding hypoglycemia as a cause of stroke-like symptoms, subgroup analysis was performed based on the inclusion or exclusion of glucose measurement as a component of the stroke scale. For stroke scales without blood glucose measurement—FAST, Cincinnati Prehospital Stroke Scale (CPSS), the Prehospital Ambulance Stroke Test (PreHAST), and the Balance, Eyes, Face, Arms, and Speech Test (BEFAST)—the estimated summary sensitivity for stroke scales ranged between 0.80 to 1.00, while specificity ranged from 0.26 to 0.55. The estimated summary sensitivity of stroke scales including blood glucose measurement—LAPSS, OPSST, Recognition of Stroke in the Emergency Room (ROSIER), Melbourne Ambulance Stroke Scale (MASS), Medic Prehospital Assessment for Code Stroke (MedPACS)—ranged from 0.74 to 0.97, while specificity ranged from 0.18 to 0.86.[8]

One observational study of 72 adults[14] showed an association between the use of training in the recognition of stroke and improved identification of signs of stroke, from 76.4% (55/72) before training compared with 94.4% (68/72) immediately after training (RR, 1.25; 95% CI, 1.07–1.42). At 3 months after training, 96.9% of participants (63/65) were still able to identify signs of stroke (RR, 1.27; 95% CI, 1.11–1.45).

A strong recommendation is made by ILCOR that first aid providers use stroke assessment scales/tools for adults with suspected acute stroke (low-certainty evidence).[8]

A weak recommendation by ILCOR suggests the use of FAST, MASS, CPSS or LAPSS for stroke assessment (low-certainty evidence).[8]

The use of stroke assessment scales/tools that include blood glucose measurement, when available, such as MASS or LAPSS, are suggested by ILCOR in the first aid setting to increase specificity of stroke recognition (low-certainty evidence).[8]

A weak recommendation by ILCOR suggests the use of the FAST or CPSS assessment tools when blood glucose measurement is unavailable (low-certainty evidence).[8]

Insights and Implications

An ideal stroke assessment system for lay responders must have few steps and take minimal time to complete. It should be easily understood, learned, and remembered, and it should have high sensitivity for identifying stroke. A scale that includes one or more of the signs of facial weakness, arm weakness, reduced grip strength, or speech disturbance to assess for possible stroke is included in current first aid curriculum (FAST). The new addition of an option to determine blood glucose is felt to be a test that is commonly performed at home in elderly diabetics—a population at increased risk for stroke—but not a skill expected of lay responders.

Suspected Stroke: Supplementary Oxygen Use

Non-hemorrhagic strokes typically result in a zone of ischemic brain tissue. It has been theorized that the use of high-flow oxygen early in the course of a stroke may help to reduce this area of ischemia.

Red Cross Guidelines

- For individuals with suspected stroke, supplemental oxygen should not be routinely used.

Evidence Summary

An ILCOR systematic review and CoSTR evaluated the use of supplementary oxygen compared with no supplementary oxygen for suspected acute stroke.[8] A total of eight in-hospital randomized controlled trials (RCTs) and one retrospective observational prehospital study were identified for evaluating the use of supplementary oxygen for stroke. In general, low to very low-certainty evidence from these studies did not demonstrate a benefit from the use of supplementary oxygen (delivered at 2 LPM ranging to 45 LPM) for outcomes of survival at 3 months, 6 months, and a year,[14-15] for favorable neurological outcomes,[15-21] and for quality of life outcomes.[16,17]

A weak recommendation was made by ILCOR against the routine use of supplementary oxygen for adults with acute suspected stroke in the first aid setting (low to very low certainty of evidence).[8]

Insights and Implications

There is no clear benefit from the use of oxygen for suspected stroke. Oxygen should not be empirically used for suspected acute stroke but, if hypoxemia is determined to be present, titrating supplemental oxygen is acceptable. The focus for lay responders should be on rapid activation of EMS and the expeditious transfer of a person with suspected stroke to a hospital.

Nontraumatic Chest Pain in Adults: Timing of Aspirin

Aspirin is an easily available, over-the-counter medication that has become established as a treatment for acute myocardial infarction with demonstrated improved survival.[18-20]

Red Cross Guidelines

- While waiting for emergency services to arrive, lay responders should encourage alert adults experiencing nontraumatic chest pain to chew and swallow aspirin, unless that person has a known aspirin allergy or has been advised by a healthcare professional not to take aspirin.

Evidence Summary

An ILCOR systematic review[21] and CoSTR[8] evaluated evidence to support the use of aspirin in the first aid setting for individuals with nontraumatic chest pain. The previous 2015 ILCOR review recommended the use of aspirin in adults with chest pain of suspected myocardial origin.[20] Because lay responders may not recognize the signals associated with myocardial ischemia or infarction (MI), the 2020 review used a revised search strategy to include nontraumatic chest pain.

No studies were identified that specifically evaluated administration of aspirin by lay responders. Two observational studies with a total of 2,122 participants with an MI[22,23] reported an association between greater survival at 7 days and 30 days, without increased risk of complications, with use of "early" compared with "later" aspirin administration. Aspirin was considered early in the Freimark[22] study if given in the prehospital setting, while the study by Barbash[23] defined early as after symptom onset and prior to administration of thrombolytics. The study by Freimark also reported an association between increased survival at 1 year with early administration compared with later administration of aspirin.[22] The rate of major complications is unknown, although complications of minor bleeding have been previously noted in ISIS-2.[19]

A weak recommendation by ILCOR for adults with nontraumatic chest pain suggests the early administration of aspirin as a first aid intervention compared with late, in-hospital administration of aspirin (very low-certainty evidence).[8]

Insights and Implications

The evidence supporting these recommendations is of very low certainty, but recommendations were further supported by task force and writing group discussion of the potential lifesaving benefits versus potential harmful effects.[8] Despite the associated survival benefit from use of aspirin for acute myocardial infarction,[19,22] one study from Sweden reported that only 58% of patients with acute MI transported by EMS received aspirin[24]; a convenience survey of prehospital providers who transported patients with a chief complaint of chest pain reported that only 25% (13/52) of patients received aspirin, with the most common reason for not administering being the paramedic's belief that the chest pain was not of a cardiac nature.[25] The ILCOR review acknowledged that previous 2015 guideline recommendations restricting use of aspirin to adults with chest pain of suspected cardiac origin likely led to similar reluctance for the first aid use of aspirin in true cases of myocardial infarction

or ischemia.[8] For this reason, the population of the systematic review was expanded to include all nontraumatic chest pain, although no studies were identified for use of aspirin in undifferentiated chest pain. Finally, the potential adverse effects from a single dose of aspirin were felt to be of very low risk, as long as it is not administered in the presence of allergy or other known contraindication to aspirin.[26]

Anaphylaxis: Assisting with and Administering Epinephrine

An ARCSAC scientific review on the use of epinephrine auto-injectors (EAIs) for people with signs and symptoms of anaphylaxis was updated in 2020.[8]

Red Cross Guidelines

- The lay responder should be trained to assist with the administration of epinephrine by auto-injector for suspected anaphylaxis.

- Where state laws and regulations permit, lay responders should administer epinephrine by auto-injector using the person's own prescribed epinephrine for a suspected anaphylactic reaction.

- Lay responders who are trained should administer epinephrine auto-injector using undesignated stock epinephrine to individuals with suspected anaphylaxis if permissible by state legislation and regulation and compliant with organizational requirements.

- A second dose of epinephrine may be considered for continued signs or symptoms of anaphylaxis within 5 to 15 minutes after the first dose.

Evidence Summary

The ARCSAC review, first completed in 2006, included information about available EAIs in the United States, administration and dose information, controversies regarding recognition of anaphylaxis in the first aid setting, benefits of epinephrine for anaphylaxis, undesignated stock EAI legislation, and complications from use of EAIs and changes in administration.[1] The latest 2020 update adds five studies to the scientific foundation. Two studies compare different EAI devices.[27,28] An observational survey study of 22 adolescents with a history of anaphylaxis who were provided EAI training with a smartphone app examined the impact of this training on correct use of EAI and reported an association between smartphone app use and training effectiveness.[29] A second survey study evaluating recognition of anaphylaxis and EAI administration reported an association between supervised EAI administration and improved scores of anaphylaxis recognition.[30] One RCT with 113 participants compared successful administration, time to successful epinephrine injection, and failed steps between use of EAI and prefilled syringes at various steps.[31] More participants correctly gave epinephrine with prefilled syringes compared with the EAI across all four steps (14% versus 2.3%, p<0.001). Time to administration did not differ with technique.

Insights and Implications

No changes are made to the guidelines for EAI use in anaphylaxis. The available scientific evidence continues to support a position that early administration of epinephrine in an individual experiencing anaphylaxis plays a key role in reducing mortality. First aid education should continue to emphasize how to recognize the signs and symptoms of anaphylaxis, indications for EAI use, assisting in the administration of epinephrine auto-injectors and administration where allowed by state regulation and law.

Opioid-Associated Emergency: Recognition by Lay Responders

An ARCSAC Answer in 2020 evaluated if lay responders can recognize the signs and symptoms of opioid toxicity requiring naloxone administration.[1]

Red Cross Guidelines

- An overdose education program should educate lay responders to recognize signs of an opioid overdose, including diminished level of responsiveness/consciousness and abnormal breathing.

Evidence Summary

No studies were identified that directly evaluated the recognition of opioid overdose by lay responders. One study used pre- and post-training questions to evaluate the trainees' understanding of signs of opioid overdose, demonstrating that a brief training session could improve trainees' understanding of signs of opioid overdose.[32] In a second study, participants were given an educational session, including the recognition of opioid overdose and naloxone training, followed by a simulation scenario of opioid overdose.[33] The simulation manikin had the overdose symptoms of decreased responsiveness/consciousness and altered respirations. Participants were graded on the ability to recognize altered level of responsiveness/consciousness and abnormal breathing and to perform emergency actions following the recognition of opioid overdose. The study found that trained participants can recognize signs of an opioid overdose in a simulated environment.

Insights and Implications

The signs and symptoms of opioid overdose should be incorporated into course curriculum to guide lay responders regarding who should receive naloxone for opioid reversal.

Opioid-Associated Emergency: Naloxone Dosing Frequency

How frequently should naloxone be re-dosed, and is there is a benefit to repeat doses sooner than 4 minutes? This was evaluated by a Red Cross SAC Answer in 2020.[1]

Red Cross Guidelines

- Following an initial dose of naloxone, subsequent doses of either intramuscular (IM) or intranasal (IN) naloxone should be repeated every 2 to 3 minutes until desired response is achieved.

- Intranasal doses should be administered with a new nasal device with each repeated dose.

Evidence Summary

Lay responders trained in naloxone administration should give naloxone when a person is in respiratory or cardiac arrest from suspected opioid overdose by intravenous (IV), intranasal (IN) or intramuscular (IM) administration as soon as available and once chest compressions, ventilation, and defibrillation have been optimized. The current Red Cross recommendation is to repeat doses after 4 minutes. The U.S. Food and Drug Administration's approved product labeling for naloxone states that if the desired response is not obtained after the initial dose, subsequent doses of IN naloxone with a new nasal spray device should be administered every 2 to 3 minutes until emergency medical assistance arrives.

When naloxone is administered intravenously, the onset of action is apparent within 2 minutes.[34] Both IN and IM formulations have demonstrated median peak plasma exposure (Tmax) within 15 to 30 minutes after administration, with initial naloxone plasma concentrations detectable at 2.5 minutes following intranasal administration, which is consistent with rapid systemic absorption.[35-37] The exact timing of repeated naloxone administration with inadequate response after the initial dose has not been systematically studied. Available pharmacokinetic data in healthy volunteers showed that IN naloxone bioavailability is approximately 50% relative to IM administration; therefore, dosing of IN naloxone is recommended at 4 mg/dose in severe overdose situations.[42-45] A 2-mg IN dose of naloxone may not be sufficient to provide reversal of opioid overdose in patients exposed to high concentrations of opioids.[38] Since IN naloxone is available as a 2-mg and 4-mg formulation, healthcare professionals and trained lay responders using 2-mg formulations would likely see improved response from more frequent dosing and thus, faster and higher systemic concentrations.[37,39]

If the intended effect of naloxone is not seen after the first dose, repeat doses are indicated. Although there are concerns of over-antagonism with naloxone reversal, the consequences of inadequate dosing arguably caries a greater risk than the risk of undesirable withdrawal effects, especially with higher concentration opioid formulations.[40]

The FDA product labeling as well as prehospital emergency medical services guidelines recommend repeat dosing of naloxone in 2 to 3 minutes.[38,41]

Insights and Implications

It is important to recognize the need for repeated dosing and to stress this in educational programs.

Hypoglycemia: Glucose Administration Routes and Forms

A 2019 ILCOR systematic review[42] and CoSTR[8] focused on the routes of glucose administration, such as sublingual, buccal or swallowed, and forms of glucose (spray, gel, paste, chewed). An updated ARCSAC scientific review[1] incorporates evidence for dietary sources of sugar and includes recommendations for treatment if glucose tablets are not available.

Red Cross Guidelines

- A person with suspected hypoglycemia in the first aid setting who is awake and able to swallow should be encouraged to swallow glucose (e.g., tablets, liquid or gel).

- Emergency services should be activated if symptoms do not resolve within 10 minutes or if symptoms worsen.

- For children with suspected hypoglycemia who are awake but unwilling or unable to swallow glucose, applying a slurry of granulated sugar and water under the tongue may be considered.

- For an individual with suspected hypoglycemia who is not awake or not able to swallow, oral glucose should not be administered.

- For adults and children with suspected hypoglycemia who are awake and able to swallow, if glucose tablets are not available, the person should be encouraged to use a dietary form of sugar, such as sucrose or fructose-containing foods, in an amount equivalent to approximately 15 grams for children, 20 grams for adults. (See table: Dietary Sugars for Hypoglycemia.)

Dietary Sugars for Hypoglycemia

Type of Food or Fluid	Carbohydrates/Serving	Measure Representing 20g Carbohydrates	Clinical Relief Within 15 Minutes after Ingestion (%)*
Glucose tablets	4 g/tablet	5 tablets	194/223 (87%)
Glucose/oligosaccharide mint candies	2.8 g/mint	5 to 10 mints	44/48 (91.7%)
Sucrose candies	0.9 g/piece	20 to 25 pieces	150/177 (84.7%)
Jelly beans	1.1 g/jelly bean	15 to 20 jelly beans	33/45 (73.3%)
Orange juice (unsweetened, from concentrate)	1 g/10 ml	200 ml	35/50 (70%)
Fructose (fruit leather/dried fruit strips)	10 g/strip	2 strips	111/165 (67.3%)
Whole milk	21.75 g/ml	435 ml	Not reported

*From: Singletary EM, Zideman DA, De Buck EDJ, et al. Part 9: First aid: 2015 International Consensus on First Aid Science with Treatment Recommendations. *Circulation*. 2015;132(Suppl 1):s269–s311.

Evidence Summary

The ILCOR review identified two randomized crossover studies comparing buccal glucose with oral glucose[43,44]; the first study[43] used glucose spray doses compared with a glucose tablet chewed and swallowed in healthy adult volunteers, while the second study[44] compared buccal application of instant glucose with swallowed instant glucose.[8] A lower plasma glucose concentration at 20 minutes was found, compared to the chewed tablet group, while buccal application of instant glucose resulted in fewer participants with an increased blood glucose at 20 minutes. Thus, both studies supported use of oral, swallowed glucose compared with buccal application. One RCT with 18 adults with insulin-dependent diabetes and hypoglycemia compared glucose gel to the oral/buccal mucosa with oral swallowed glucose tablets, or swallowed glucose solution.[45] A difference in resolution of symptoms or plasma glucose concentration was not found with the oral/buccal route compared with the oral route, although it was noted that some of the gel remained adherent to the mucosa and was thus partially swallowed.

Finally, one RCT compared equivalent amounts of sublingual administration of a wet paste of table sugar with oral administration (sugar on the tongue) in 42 children with acute malaria, or respiratory tract infections, and mild to moderate hypoglycemia (blood glucose between 50 to 80 mg/dl).[46] A significant increase in blood glucose concentrations at 20 minutes, decrease in time to resolution of hypoglycemia, and a higher likelihood of resolution of hypoglycemia (blood glucose 90 mg/dl or more) at 80 minutes were found in the sublingual group compared with the oral sugar group.[8]

A strong recommendation is made by ILCOR to use oral/swallowed glucose for adults and children with suspected hypoglycemia who are responsive/conscious and able to swallow (very low-certainty evidence).[8]

A weak recommendation by ILCOR suggests against buccal glucose administration compared with oral/swallowed glucose administration for adults and children with suspected hypoglycemia who are responsive/conscious and able to swallow (very low-certainty evidence).[8]

A weak recommendation by ILCOR suggests that if oral glucose (e.g., tablet) is not immediately available, a combined oral and buccal glucose (e.g., glucose gel) administration for adults and children with suspected hypoglycemia who are responsive/conscious and able to swallow (very low-certainty evidence).[8]

A weak recommendation ILCOR suggests the use of sublingual glucose administration for suspected hypoglycemia for children who may be uncooperative with the oral (swallowed) glucose administration route (very low-certainty evidence).[8]

Insights and Implications

Mild hypoglycemia occurs commonly in diabetics and is usually manifested with typical early signs and symptoms and preserved ability to swallow and follow commands. Early treatment can prevent progression to severe hypoglycemia, including confusion, seizures or coma. While it is tempting to allow a diabetic with mild hypoglycemia to use candies or soft drinks for symptoms of mild hypoglycemia, diabetes experts caution that this can lead to over-treatment with hyperglycemia and wide swings in blood glucose levels that may be harmful in the long run. Thus, the use of glucose tablets is preferred when available. Tablets are typically available over the counter in 4-gram size, and the recommended adult dose is 20 grams (5 tablets).

More severe hypoglycemia is accompanied by confusion with inability to follow commands and should not be treated with glucose by mouth, but should trigger immediate activation of EMS.

The recommendation for the option of sublingual sugar for children who are responsive/conscious but unwilling to swallow is based on a single study in a unique population of children with moderate hypoglycemia and malaria. The applicability of this route in the United States is uncertain.

Presyncope: First Aid

Presyncope, or near syncope, is the prodrome of syncope and is characterized by light-headedness, diaphoresis, nausea and a feeling of impending loss of responsiveness/consciousness. When it progresses to syncope, there is loss of responsiveness/consciousness associated with loss of postural tone and collapse. Physical injuries are frequent complications of syncope occurring in approximately 30% of patients seen in emergency departments.[47] Vasovagal and orthostatic hypotension are common causes of syncope. Efforts to prevent syncope have targeted these etiologies and include hydration and use of physical counterpressure maneuvers (PCMs). An ARCSAC scientific review in 2017[1] and a systematic review by ILCOR in 2019[48] and CoSTR[49] sought to evaluate first aid interventions for individuals with presyncope.

Red Cross Guidelines

- A person with signs or symptoms of presyncope should be assisted to a supine position.

- Once the person is in a safe position, physical counterpressure maneuvers may be considered to stop symptoms of presyncope.

- If there are no extenuating circumstances, lower body physical counterpressure maneuvers should be used over upper body and abdominal physical counterpressure maneuvers.

- Physical counterpressure maneuvers should not be used when symptoms of a heart attack or stroke accompany presyncope.

- If no improvement occurs within 1 to 2 minutes, or if symptoms worsen or reoccur, lay responders should call 9-1-1, or the designated emergency number and prehospital professionals should transport the person to the hospital.

Evidence Summary

No studies were identified in either review for interventions performed once symptoms of presyncope develop, other than the use of PCMs. Studies that included interventions such as hydration prior to an event that might trigger an episode of vasovagal syncope (i.e., blood donation, vaccination) were excluded.

All included studies evaluated the use of PCMs for presyncope in 17- to 75-year-olds. PCMs included contraction of the large muscles of the legs, arms or abdomen. These involved leg or arm tensing, crossing and squeezing, squatting, firm handgrip and abdominal tensing. One RCT with 19 participants with vasovagal syncope and a positive tilt-table test found the use of handgrip PCMs increased the likelihood of terminating syncope (RR, 1.80; 95% CI, 1.16–2.79; p=0.01).[50] This association was not found in four observational studies[51-54]; however, two observational follow-up studies[50,55] with 37 participants with recurrent vasovagal syncope in settings of daily life showed the use of handgrip and arm tensing was associated with termination of presyncope in 99% of episodes (349/351, RR not estimable). No injuries or adverse events related to the use of PCMs were reported in two observational studies (37 adults).[50,55]

Two observational studies enrolling 39 adults with vasovagal etiology presyncope reported increased systolic blood pressure with use of PCMs compared with the control (MD, 21 mmHg higher, 95% CI, 18.25–23.41 mmHg higher, p<0.0001), and one RCT[50] with very low-certainty evidence found higher systolic blood pressure in 19 adults with vasovagal etiology presyncope with the use of PCM compared with the control (MD, 32 mmHg higher, 95% CI, 12.48–51.52 higher, p=0.001).[48] Subgroup analyses of observational studies comparing upper body PCM with no PCM, and lower body PCM compared with no PCM suggested that the use of lower body PCMs may have an advantage over upper body PCMs for preventing progression of presyncope to syncope.[48]

Although no studies evaluated the use of hydration while presyncope symptoms were present, one RCT[56] found no difference in the rate of syncope and presyncope in adolescent blood donors following preloading with 500 mL of water, compared with no preloading.

A strong recommendation is made by ILCOR for the use of any type of PCM by individuals with acute symptoms of presyncope from vasovagal or orthostatic causes in the first aid setting (low and very low certainty of evidence). It is suggested that lower body PCMs such as leg crossing and tensing or squatting are preferable to upper body nd abdominal PCMs (very low certainty of evidence).[49]

Insights and Implications

The use of PCMs is easy and has the potential to greatly reduce the incidence of syncope and associated falls for individuals with vasovagal or orthostatic syncope. The use of PCMs will require training and coaching. While reviewers expressed concern about the potential for inappropriate use of PCMs, it was noted that study participant age extended to 75 years, and that no adverse effects or complications were reported. The recommendation to avoid use of PCMs in the presence of symptoms of a heart attack or stroke reflects this concern. The application of PCM will perhaps be most useful for self-first aid, or in situations where syncope is commonly encountered, such as following the sight of blood, emotional trauma, vaccinations or blood donations.

Seizures: Recovery Position

Should an actively seizing person be placed in a recovery position? A review by ARCSAC in 2018 addressed this question.[1]

Red Cross Guidelines

- An actively seizing adult, child or infant with loss of responsiveness/consciousness should be protected from injury without restraining their movements, and, if safe to do so, carefully turned on their side (a lateral side-lying recovery position) to help maintain an open airway.

- In situations where there is risk of injury to the lay responder or healthcare professional or the actively seizing adult, child or infant, turning the individual into the lateral side-lying recovery position should be delayed until the postictal period (when convulsions or muscle contractions cease).

Evidence Summary

Seizures are a common indicator of serious injury or illness and may not always be controlled by medications. The general first aid principles of managing an actively seizing individual is to prevent injury, protect the person's airway, and make sure the airway is open after the seizure has ended. Current Red Cross first aid educational materials advise: Give care to a person who has had a seizure the same way you would for an unresponsive/ unconscious person. When the seizure is over, make sure that the person's airway is open. Usually, the person will begin to breathe normally. If there is fluid in the person's mouth, such as saliva, blood or vomit, roll the person onto their side so that the fluid drains from the mouth. These first aid interventions are aimed at preventing the most common complications of seizures: (1) inadvertent injury, (2) aspiration, and (3) respiratory suppression.

The search for studies evaluating a recovery position for people who are actively seizing failed to identify any studies specifically addressing this topic in the out-of-hospital setting. However, indirect studies have recently evaluated the cause of a serious complication, sudden unexpected death in epilepsy (SUDEP).[57] Sudden unexpected death in epilepsy represents one of the most severe consequences of generalized tonic-clonic seizure (GTCS), occurring with an incidence of up to 9 per 1000 patient-years in patients with refractory epilepsy.[57] SUDEP is the leading cause of seizure-related mortality in patients with intractable epilepsy.[57]

Generalized tonic-clonic seizures are often associated with respiratory dysfunction. There is growing evidence that peri-ictal respiratory disturbances contribute to the pathophysiology of sudden unexpected death in epilepsy.[58] Following GTCS, patients have impaired arousal and may be motionless. Patients with SUDEP are usually prone. The postictal immobility and duration have been shown to be associated with respiratory dysfunction. Postictal immobility may thus contribute to SUDEP by not permitting repositioning of the head to allow unimpeded ventilation.

One indirect study examined the impact of peri-ictal nursing interventions on respiratory dysfunction (RD), the duration of postictal generalized EEG suppression (PGES), and duration of postictal immobility (PI) duration in patients with localization-related epilepsy and secondarily generalized convulsions.[57] Nursing interventions—including repositioning to a lateral recumbent position, oral suctioning, and oxygen administration—were found to reduce seizure duration, respiratory dysfunction, and EEG suppression in the epilepsy monitoring unit (EMU) but have not been studied in outpatients.

The Epilepsy Foundation[59] recommends that first aid for a person who is seizing and unresponsive/unconscious include:

- Stay with the person and start timing the seizure.

- Keep the person safe.

- Turn the person onto their side if they are not awake and aware.

- Do not put any objects in their mouth.

- Do not restrain the person.

- Stay with them until they are awake and alert after the seizure.

- Know when to call for emergency help.

Insights and Implications

Despite limited evidence, ARCSAC acknowledged the risks of aspiration with seizures and of SUDEP. Red Cross guidelines are based on a prior ILCOR and ARCSAC review for recovery position,[20] and recovery position following a seizure,[20] and guidance from the Epilepsy Foundation.

Life-Threatening Bleeding

The use of direct, manual pressure has for decades been considered the gold standard in Red Cross first aid for control of bleeding. Life-threatening bleeding, however, is not always controlled by manual pressure; just over a third of people with major traumas die from uncontrolled bleeding, often in minutes. ARCSAC has conducted multiple reviews about bleeding control techniques and devices that can be used. In addition, a comprehensive systematic review of techniques to control life-threatening bleeding was completed by ILCOR in 2020[60] with four distinct accompanying CoSTRs[8]. These are separated broadly into use of direct pressure, pressure dressings, and pressure points; use of tourniquets; use of hemostatic dressings; and use of hemostatic devices. While some studies included children, data was limited and subgroup analysis not performed. The ILCOR review noted that in the absence of evidence for the pediatric population, it is reasonable to apply recommendations for control of life-threatening bleeding to children.[8]

Direct Pressure, Pressure Dressings, Pressure Points

Direct pressure is commonly recommended for the initial control of bleeding. Is there evidence to support the use of direct pressure, pressure dressings, or pressure points for the control of life-threatening bleeding?

Red Cross Guidelines

- For individuals with life-threatening external bleeding, direct manual pressure must be applied to achieve initial bleeding cessation for wounds not amenable to a tourniquet, or when a tourniquet is not immediately available.

- When applying direct pressure, the dressing should be in direct contact with the bleeding source.

- When applying direct pressure, the dressing in contact with the bleeding source should not be removed.

- Only one dressing should be used to apply pressure. If the dressing becomes soaked, while not preferred, adding one more dressing may be considered. If that dressing becomes saturated, the additional dressing may be removed and replaced with a new dressing.

- Mechanical pressure, such as pressure bandages or devices, may be considered in situations when direct manual pressure is not feasible.

- Indirect manual pressure (e.g., pressure points) should not be used for the treatment of life-threatening external bleeding.

- If direct pressure is applied and the bleeding is controlled, applying a pressure dressing may be considered to maintain bleeding cessation. Since pressure dressings may deliver less pressure to a wound comparatively than direct pressure, wounds with pressure dressings in place should be monitored for bleeding through the dressing. If bleeding recurs through a pressure dressing, additional layers of gauze/compression wrap should not be applied. Instead, apply direct manual pressure to the wound/original dressing.

Evidence Summary

No human studies were identified in the ILCOR review for use of proximal pressure points, and no evidence was found for elevation of extremities or cryotherapy as means for controlling life-threatening bleeding.[8] Limited and primarily indirect evidence was identified regarding the use of direct pressure in the ILCOR systematic review[60] and accompanying CoSTR.[8] Very low-certainty evidence from three RCTs with a total of 918 in-hospital participants undergoing arterial endovascular procedures each reported a faster time to bleeding cessation with the use of direct manual pressure compared with the use of mechanical compression or clamping devices.[61-63]

For the use of pressure dressings, very low-certainty evidence from one case series of 62 individuals with penetrating traumatic wounds in the prehospital, civilian setting reported control of bleeding in 87% of individuals who had a commercial pressure dressing applied, and a reduction in bleeding in another 11%.[64] Additional very low-certainty evidence from one cohort study including 64 patients with arteriovenous fistula puncture for hemodialysis reported cessation of bleeding with the use of manual pressure in 45.5%, compared with 82% cessation of bleeding with the use of the elastic compression (IRIS) bandage ($p<0.05$).[65]

A strong recommendation is made by ILCOR that first aid providers use direct manual compression compared with the use of external compression devices or pressure dressings/bandages for severe life-threatening external bleeding (very low certainty of evidence).[8]

A strong recommendation is made by ILCOR against the use of pressure points compared with the use of direct pressure by first aid providers for severe, life-threatening external bleeding (very low certainty of evidence).[8]

An ARCSAC Answer updated in 2020 evaluated the evidence for use of additional layers of gauze dressings in the setting of refractory bleeding.[1] Limited evidence was identified evaluating pressure generated at the skin surface with direct manual pressure, pressure with a cloth bandage over a pad, an elastic bandage over a nonadherent pad, and the same setup with an addition of a wooden block under the elastic bandage.[64] Direct manual pressure was found to generate the most pressure. A three-phase randomized controlled crossover trial in 2019 evaluated differences in pressure generated when adding increasing layers of gauze and different techniques of force application.[66] Results reported that the greatest force was generated using a single stack of gauze placed over a wound with direct pressure applied using two stacked hands. Direct manual force was also noted to generate more pressure than compression with pressure dressings.[66]

A prior ARCSAC review addressed the issue of multiple layers of dressing.[1] While no study could be found that addressed the effect of addition of cloth or gauze dressing material on top of already soaked material, one study did compare the pressure generated at the skin surface with direct manual pressure, pressure via a cloth bandage over a non-adherent pad, an elastic bandage over a non-adherent pad, and the same set-up with addition of a wooden block under the elastic bandage.[67] This study, using a pressure sensor under each technique applied to normal skin, reported that direct manual pressure was found to generate the most pressure, well above systolic blood pressure, compared with the other dressings and pressure dressing.[67]

ARCSAC expert opinion consensus was to ensure that the initial dressing is in direct contact with bleeding sources and to not remove that layer.

Insights and Implications

Despite the sparse amount and low certainty of evidence evaluating the use of direct pressure for life-threatening bleeding, ARCSAC noted that direct manual pressure has been shown effective for less severe bleeding and is readily available. The lack of prehospital and pediatric studies is recognized as a research gap. For non-life-threatening bleeding, there is no evidence to support of the use of pressure dressings compared with direct manual pressure for the initial control of bleeding, and there is no evidence to support the practice of layering additional gauze dressings for ongoing bleeding through the initial dressing.

Tourniquets

ARCSAC reviews[1] and an ILCOR CoSTR[8] and systematic review[60] evaluated evidence for the use of tourniquets from the prehospital military setting and the prehospital civilian setting. Where evidence was not available from these settings, simulation studies were considered (manufactured compared with improvised tourniquets; windlass-style manufactured tourniquets compared with other manufactured tourniquet designs).

Red Cross Guidelines

- A manufactured tourniquet should be used as first-line therapy for life-threatening extremity bleeding and should be placed as soon as possible after the injury.

- If a manufactured tourniquet is not immediately available or if a properly applied manufactured tourniquet fails to stop bleeding, direct manual pressure with the use of a hemostatic dressing, if available, should be used to treat life-threatening extremity bleeding.

- If a manufactured tourniquet is not available and direct manual pressure with or without the use of a hemostatic dressing fails to stop life-threatening bleeding, lay responders and healthcare professionals trained in the use of an improvised tourniquet may consider using one.

Evidence Summary

Four cohort studies with 527 prehospital civilians were identified in the ILCOR review[60] but could not be combined for meta-analysis due to heterogeneity.[68-71] These studies suggested a reduction in mortality due to bleeding with the prehospital use of tourniquets (range, 0–4%) compared with the use of direct pressure alone (range, 0–14%). The largest of two prehospital military cohort studies with 70 participants reported a higher rate of bleeding cessation on arrival to the hospital with prehospital tourniquet placement (83.3%) compared with those without tourniquet (60.7%; p=0.033).[72]

Two simulation studies[73,74] with healthy volunteers reported a higher rate of ablation of distal pulse with use of manufactured tourniquets compared with improvised tourniquets. Simulation studies showed no clear benefit for any one tourniquet design (i.e., elastic stretch and wrap, ratcheting) compared with a manufactured windlass tourniquet.[60] A manikin study reported simulated bleeding cessation in 100% of manikins with use of a manufactured windlass tourniquet, in 40% with use of an improvised bandage tourniquet, and in 10% with use of an improvised bandana tourniquet.[75]

Guidelines from the Tactical Field Care Phase of Tactical Combat Casualty Care (TCCC)[76] for use of a tourniquet were reviewed and recommend application of a limb tourniquet to control life-threatening external hemorrhage that is anatomically amenable to tourniquet use or for any traumatic amputation by applying directly to the skin 2 to 3 inches above the bleeding site, and if bleeding is not controlled with the first tourniquet, to apply a second tourniquet side-by-side with the first.

A weak recommendation by ILCOR suggests that first aid providers use a tourniquet in comparison with direct manual pressure alone for severe, life-threatening external bleeding that is amenable to the application of a tourniquet (very low certainty of evidence).[8]

A weak recommendation by ILCOR suggests that first aid providers use a manufactured tourniquet rather than an improvised tourniquet for severe, life threatening external bleeding (very low certainty of evidence).[8]

No recommendation can be made in regard to any one particular design of tourniquet (i.e., windlass, ratcheting) compared with another.[8]

Insights and Implications

The systematic review by ILCOR of control of life-threatening bleeding did not attempt to evaluate the sequence of care for life-threatening bleeding, but rather, focused on individual modalities such as direct pressure, pressure dressings, and hemostatic dressings.[60] Red Cross recommendations attempt to add sequencing of care. ILCOR reviewers acknowledge that while there are few comparative studies of tourniquet use and direct pressure alone, evidence suggests that tourniquets, when applied appropriately, stop bleeding in the majority of cases.[8] Not every area of the body is amenable to the use of a tourniquet; some wounds may be located too proximal on a limb (adjacent to the axilla or groin) to permit proper application of a tourniquet.

Junctional tourniquets have been used in military settings for wounds in these locations, but data is lacking to recommend for civilian use. The Stop the Bleed national campaign and call to action encourages bystanders to become trained, equipped and empowered to help in a bleeding emergency before advanced care responders arrive.[77] Both Stop the Bleed and the American Red Cross recommend using a manufactured tourniquet as first-line therapy for life-threatening extremity bleeding but recognize that a tourniquet may not always be available. In this event, Red Cross recommends applying strong, steady direct manual pressure with a hemostatic dressing, if available. Guidelines from the Tactical Field Care Phase of Tactical Combat Casualty Care 2018[76] for use of a tourniquet recommend application of a limb tourniquet to control life-threatening external hemorrhage that is anatomically amenable to tourniquet use or for any traumatic amputation by applying directly to the skin 2 to 3 inches above the bleeding site, and if bleeding is not controlled with the first tourniquet, to apply a second tourniquet side-by-side with the first.

Pediatric Tourniquets

The use of tourniquets in treating life-threatening bleeding is central to management. As current tourniquets and data predominantly come from battlefield application, there are questions of their applicability and usage in children.

Red Cross Guidelines

- A manufactured windlass or ratcheting tourniquet should be used to treat life-threatening extremity hemorrhage in children approximately 2 years of age and older. Preference for smaller children should be to use a device specifically designed to allow use on children. In older and large children, non-pediatric-specific windlass and ratcheting tourniquets may be considered.

- The ability to snugly apply a tourniquet on a smaller child's extremity prior to engaging the windlass rod or ratcheting mechanism may be considered an indication that, once engaged, the tourniquet will be able to apply sufficient circumferential pressure to successfully occlude distal blood flow and to stop bleeding.

- An elastic tourniquet may be considered in the absence of a windlass rod or ratcheting tourniquet that can achieve tightening in a child.

- While the correct placement of a tourniquet is 2 to 3 inches above the wound, if such placement in a child does not allow sufficient tightening of the tourniquet, the tourniquet should be moved higher on the limb but not over a joint.

- Direct pressure with a hemostatic dressing, if available, should be used for children with life-threatening extremity bleeding when an applied tourniquet does not tighten around the child's extremity.

- Direct pressure with a hemostatic dressing, if available, should be used to treat life-threatening extremity bleeding in infants and children less than 2 years of age.

Evidence Summary

A 2019 ARCSAC review assessed use of tourniquets in the pediatric population.[1] The literature search identified seven studies for inclusion, including an observational trial in volunteers ages 6 to 16 years, one observational trial in pediatric patients 2 to 7 years of age undergoing elective orthopedic surgery, two models of pediatric limb circumferences, two epidemiologic studies of tourniquet use in children in conflict zones, and one case report.[1]

One study on human volunteers demonstrated consistently successful application in both upper arms and upper legs of children 6 years of age or older.[78] A second study demonstrated successful application in human participants 2 to 7 years of age with a minimal limb circumference of 13 cm.[79] Studies in manikin and PVC models generally demonstrate that some windlass and ratcheting tourniquets have increased failure rates as model circumferences, with failure rates becoming increasingly higher in sizes that would model the upper extremities of children under 5 years of age.[80] It is postulated that the pliability of human tissue made the mechanism less of a factor than with the less pliable materials used in the two model studies. No study in this review specifically evaluated ease of use or lay provider use in the pediatric population.

Insights and Implications

The only tourniquet that was tested in humans in the ARCSAC review was the C-A-T® GEN7. More human studies are needed to determine whether other tourniquet types are able to be used successfully in the pediatric population and the lower age limits to which these tourniquets can be successfully applied in both upper and lower extremities. While only one windlass tourniquet model was tested in humans, the data and ARCSAC expert opinion support the use of windlass design tourniquets. Also, while not tested in humans, the data and ARCSAC expert opinion also support the use of a ratcheting tourniquet on children.[1] Also, while there is no human data, non-human data and expert opinion support the use of an elastic trouniquet when others are not availble.

The First Aid Subcouncil placed a high value on the human studies that suggest a windless type tourniquet (specifically C-A-T® GEN7) can abolish distal pulses in both the upper and lower extremities, if applied appropriately, to a child as young as 2 years old (in this case with a limb circumference of 13 cm). In using manikins and PVC pipe models, the overall trend was that the smaller the circumference of the model, the less likely the tourniquet was to be successfully applied; however, the overall results were inconsistent, and the First Aid Subcouncil chose to significantly downgrade the certainty of these studies. In this review the ARCSAC First Aid Subcouncil also considered the position statement from the Pediatric Trauma Society and the Committee for Tactical Emergency Casualty Care Pediatric Working Group, both of which advocate for the use of tourniquets for life-threatening extremity hemorrhage in the pediatric population.[81,76]

ARCSAC acknowledged the variability in sizes of children and that devices not specifically designed for children may not provide sufficient tightening to achieve bleeding control on younger and smaller children or infants. ARCSAC also acknowledged that older and large children may be of sufficient size for tourniquets designed for adults to be effective. A good indication that a tourniquet will be able to successfully occlude distal blood flow and stop bleeding from a wound in a child is the ability to tighten a tourniquet on the extremity prior to twisting the windlass rod or using the ratcheting mechanism.

Hemostatic Dressings

An ARCSAC scientific review on hemostatic agents was updated in 2019[1] and an ILCOR CoSTR on the use of hemostatic dressings for life-threatening bleeding was completed in 2019.[8]

Red Cross Guidelines

- If a hemostatic dressing is available, it may be considered as adjunctive therapy to direct manual pressure and/or wound packing for the treatment of life-threatening external bleeding.

Evidence Summary

The ILCOR review[8,60] identified low-certainty evidence from one RCT including 160 emergency department patients with extremity stab wounds showing a greater proportion of patients had cessation of bleeding in under 5 minutes with use of a chitosan-coated hemostatic dressing plus direct pressure (51.2%) compared with patients who received pressure dressings (32.5%; RR, 1.58; 95% CI, 1.08–2.31).[82] This same study found a decrease in bleeding (as measured by the mean number of blood-soaked gauzes) with the use of chitosan-coated hemostatic dressings compared with use of direct pressure alone (mean difference (MD), 0.43 fewer gauze sponges; 95% CI, 0.85–0.01 fewer).[8] There was insufficient evidence to recommend one type of hemostatic dressing compared with another.

The ARCSAC scientific review[1] identified one other RCT[83] demonstrating the ability of lay responders to successfully apply hemostatic gauze for control of bleeding, as well as multiple retrospective studies reporting effecting bleeding control with hemostatic gauze, particularly to the scalp and face. The lay responder study demonstrated that lay responders can effectively apply hemostatic gauze and were most successful with use of an injectable mini sponge delivery system.[83]

A weak recommendation by ILCOR suggests that first aid providers use a hemostatic dressing with direct pressure as opposed to direct pressure alone for severe, life-threatening external bleeding (very low certainty of evidence).[8]

For the treatment of severe, life-threatening external bleeding by first aid providers, due to very limited data and very low confidence in effect estimates, ILCOR is unable to recommend the use of any one specific type of hemostatic dressing compared with another.[8]

Insights and Implications

The ILCOR review[8,60] acknowledged the influence of one RCT[82] from the civilian setting in which a larger percentage of participants (51.2%) achieved cessation of bleeding within 5 minutes when a hemostatic dressing was used with direct pressure compared with direct pressure alone (32.5%). With the exception of injectable hemostatic mini sponges, hemostatic dressings require the application of firm direct pressure. Thus, although there will be training needs and increased costs associated with hemostatic dressings, they can be a useful adjunctive therapy to direct pressure for controlling life-threatening bleeding.

Guidelines from the Tactical Field Care Phase of Tactical Combat Casualty Care[76] for use of hemostatic dressings were reviewed and note that hemostatic dressings should be applied with at least 3 minutes of direct pressure, and because each dressing works differently, if one fails to control bleeding, consider removing that dressing and applying a new dressing of the same type or a different type.

Bleeding Control Kits

What are the recommended minimum contents for a Red Cross Stop the Bleed kit for personal lay responder use, family use, or multi-casualty use? A 2020 ARCSAC Answer[1] reviewed the contents of various military first aid kits, as well as the contents of bleeding control kits.

Red Cross Guidelines

- The minimum contents for a personal bleeding kit should include an effective tourniquet, compressive 6-inch dressing, S-rolled gauze, trauma shears, large nitrile gloves, and a bag or container to hold the equipment.

- A family kit should include a tourniquet that could be used on a child.

- The number of bleeding control kits for a public access kit will vary depending on the size of the venue but supplies for 20 to 50 people at a location at once may be considered. A hemostatic dressing should be included in public kits.

Evidence Summary

A specific tourniquet type or design was not recommended, due to lack of evidence. A 2019 review of limb tourniquets that rated tourniquets for arterial occlusion, speed, simplicity, optimal occlusion pressure, specifications, known complications and usage determined the C•A•T® GEN6, C•A•T® GEN7, SOF® Tactical Tourniquet-Wide, Tactical Mechanical Tourniquet (TMT™) and Tactical Ratcheting Medical Tourniquet® (RMT) had adequate scores.[84] Evidence for determining the number of personal bleeding kits in a public access kit is sparse. One study suggests that supplies for 20 bleeding adults and children should be available in any location servicing more than 50 people at once.[85] Including a hemostatic dressing in personal or multiuse kits is potentially beneficial since they have been shown to be more effective at stopping bleeding than direct pressure alone (with or without gauze), and it has been shown that laypersons are able to use them.[83]

Insights and Implications

The revised recommendation aligns with other recognized national recommendations. The addition of a hemostatic dressing will likely add to the cost of a kit, but it is anticipated that their benefit will justify their cost.

Injuries

Acute Closed Extremity Joint Injuries: Compression Wrapping

Elastic wraps are commonly available for use on soft tissue or joint injuries. An ILCOR systematic review[86] and CoSTR[8] evaluated the use of a compression or elastic wrap plus standard first aid, compared with standard first aid without a wrap for adults with a closed extremity joint injury in the prehospital setting. Evidence came from in-hospital or clinic settings and was deemed of low or very low certainty.

Red Cross Guidelines

- Lay responders may consider applying a compression wrap during the recovery of an ankle sprain or strain to promote comfort, if trained in their use.

Evidence Summary

The ILCOR review[86] identified two RCTs[87,88] and one non-RCT[89] with 122 adults with ankle sprains. No reduction of pain was found from use of a compression bandage compared with no compression bandage, a splint or an air splint (standardized mean difference (SMD), 0.34; 95% CI, -1.0–0.79, p=0.12).[86] A similar lack of benefit was found for the outcomes of pain at rest and pain with walking after 6 to 9 days in one RCT,[90] while three RCTs[87,90,91] and one non-RCT[89] showed no reduction of swelling/edema with use of a compression bandage compared with no compression bandage, or with a noncompressive stocking, a splint or an air splint. One RCT[90] with 117 adults with ankle sprains showed fewer days before return to sports with use of a compression bandage compared with use of a noncompressive stocking (median number of days reported, 95% CI not calculable).[86]

A weak recommendation is made by ILCOR to apply a compression bandage, or for no application of a compression bandage for adults with an acute closed ankle joint injury (very low-certainty evidence). No recommendation could be made for or against a compression bandage for closed joint injuries besides the ankle.[8]

Insights and Implications

The reviewers noted that standard first aid could include elevation of the extremity and the use of cold packs, splints, noncompressive stockings, or braces, thus introducing potential confounders and heterogeneity. One outcome not considered was stakeholder satisfaction. It was acknowledged that proper application of a compression wrap requires training, and that an improper, too-tight application may worsen outcomes by exacerbating pain or swelling from a tourniquet effect. The clinical equipoise and lack of harm associated with use of a compression bandage or wrap in this review supported a recommendation for either application, or

no application of a compression bandage, and for Red Cross, with the caveat to only apply a wrap if the lay responder is trained in the application technique. Should a compression wrap be applied and pain increases, the wrap should be promptly removed.

Mild Traumatic Brain Injury (Concussion): First Aid

The recognition and management of concussion is an important first aid topic.

Red Cross Guidelines

- A possible concussion (mild traumatic brain injury) should be considered in any person with witnessed trauma (forceful bump, blow, or jolt) to the head, or jolt to the body that results in rapid movement of the head.

- Any person having sustained a mild traumatic brain injury or concussion must be removed from activity (i.e., sport or other recreational activities) and must be referred to a healthcare professional experienced in evaluating and managing concussion.

- Any person who a lay responder believes has received trauma (forceful bump, blow, or jolt) to the head or body that results in rapid movement of the head and brain and has signs or symptoms listed in the table below must be presumed to have a mild traumatic brain injury or concussion. (See table: Signs and Symptoms of Mild Traumatic Brain Injury or Concussion.)

Signs and Symptoms of Mild Traumatic Brain Injury or Concussion

Physical	Cognitive	Affective	Sleep
Headache	Difficulty thinking	Irritability	Drowsiness
Nausea/vomiting	Foggy	Sadness	Sleeping more/less
Balance	Difficulty concentrating	Anxiety	Difficulty sleeping
Dizzines	Decreased processing	Heightened emotions	
Double/blurry vision	Difficulty remembering	Nervousness	
Sensitive to light/noise	Difficulty recalling events		
Tinnitus	Feeling sluggish		
Fatigue			
Not feeling right			
Loss of consciousness			

Evidence Summary

The management of concussion was last fully reviewed by ARCSAC in 2018.[1] There has been no new evidence that would alter the Red Cross guidelines since that review. A scoping review by ILCOR in 2020[8] searched for literature describing the use of a simple, single-stage scoring tool for use in the first aid setting and failed to identify any such tool. Concussion scoring tools are available for athletic trainers and providers in sports settings that require a baseline score prior to injury, but these two-stage scoring systems are not applicable to the acute first aid setting.

Insights and Implications

A simple, single stage scoring system to help lay responders recognize a concussion remains a research gap. This emphasizes the need for first aid course curriculums to include descriptions of signals of concussion.

Avulsed Permanent Tooth: Temporary Storage

A systematic review[92] by ILCOR and CoSTR[8] updated a 2015 review[20] evaluating storage solutions appropriate for temporary storage of an avulsed permanent tooth. These reviews are consistent with ARCSAC reviews on this topic.[1]

Red Cross Guidelines

- An avulsed permanent tooth should be immediately replanted if possible.

- If an avulsed permanent tooth cannot be immediately replanted, the tooth should be stored in Hank's Balanced Salt Solution or in oral rehydration salt solution, or wrapped in cling film to improve the likelihood of successful replantation.

- If an avulsed permanent tooth cannot be immediately replanted and Hank's Balanced Salt Solution, oral rehydration salt solutions, or cling film are not available, storage of the tooth in cow's milk or saliva may be considered.

- An avulsed permanent tooth should not be stored in tap water.

Evidence Summary

The updated review[92] expanded the interventions to include storage media, containers or technique, and compared this with storage in whole milk or the patient's saliva. Multiple comparisons were made, including Hank's Balanced Salt Solution (HBSS), propolis, oral rehydration salts, Ricetral, coconut water, egg white, rice water, cling film plastic wrap, tap water, buttermilk, castor oil, turmeric extract, neem extract, 0.9% saline solution, probiotic media, aloe very gel, saliva, Eagle's medium, Dentosafe® box, and storage in a different person's mouth. The viability of periodontal ligament (PDL) cells was used as a measure of tooth viability in 23 included studies and expressed as the number or percent of viable PDL cells.[92]

Twelve RCTs and one observational study compared the use of Hank's Balanced Salt Solution (HBSS) with cow's milk, with meta-analysis showing that cell viability rates for teeth stored in HBSS for 5 minutes up to 24 hours were significantly higher than for teeth stored in milk (SMD, 2.47; 95% CI, 1.59–3.34).[92] Two RCTs[93,94] showed increased viability with immersion in oral rehydration salt solution for 45 to 90 minutes compared with milk (SMD, 4.16; 95% CI, 2.10–6.23). One RCT[95] found a higher rate of cell growth after 7 and 14 days following 120 minutes of storage in cling film when compared with immersion in milk (MD, 0.45 and 0.41; 95% CI, not calculable, p=0.033). Three RCTs[96-98] showed no difference in success of replantation (as measured by PDL cell healing) following immersion in saliva compared with milk (RR, 0.96; 95% CI, 0.65–1.43). One RCT[99] with very low-certainty evidence showed harm from immersion in tap water compared with skim milk at 60 minutes, 180 minutes, 6 hours, and 24 hours, with a lower percentage of viable PDL cells. One observational study[100] reported harm associated with 45-minutes immersion in tap water compared with milk, with a lower percentage of viable PDL cells. Evidence favored cow's milk to saline, buttermilk, castor oil, and turmeric extract in preserving cell viability.[92]

A weak recommendation by ILCOR suggests use of Hank's Balanced Salt solution (HBSS), propolis (from 0.04 mg to 2.5 mg per ml 0.4% ethanol), oral rehydration salt (ORS) solutions including Ricetral, ORS solutions containing sodium chloride, glucose, potassium chloride, citrate (or extruded rice), or cling film compared with any form of cow's milk for temporary storage of an avulsed tooth that cannot be immediately replanted (very low-certainty evidence).[8]

If none of the above choices are available, ILCOR suggests the use of cow's milk, any percent fat or form, was suggested, compared with tap water, buttermilk, castor oil, turmeric extract or saline (sodium chloride) for temporary storage of an avulsed tooth (very low-certainty evidence).[8]

There was insufficient evidence for ILCOR to recommend for or against temporary storage of an avulsed tooth in saliva compared with alternative solutions, and insufficient evidence to recommend for or against temporary storage of an avulsed tooth in probiotic media, epigallocatechin-3-Gallate, Dentosafe® box, or egg white compared with cow's milk.[8]

Insights and Implications

Avulsion of a permanent tooth is best treated by immediate replantation, when possible. This is not typically considered a first aid skill. Thus, the goal is to help the person with an avulsed tooth to receive care by a dentist or healthcare professional trained in replantation of the tooth. Storage of a tooth in a suitable media can prolong the viability of attached periodontal ligament cells, helping to improve the chances of successful replantation.

The 2020 ILCOR review[8] concluded that although milk was shown to extend the PDL cell viability before replantation compared with saline or tap water, efficacy at preserving cell viability was demonstrated with use of HBSS, propolis, oral rehydration salt solution, rice water and cling film. This review differs from the 2015 review[20] in that coconut water is no longer recommended as a storage solution since recent studies provide conflicting evidence. Egg white is no longer recommended since a beneficial effect was not confirmed by new studies. Oral rehydration salt solution and cling film were added as recommended solutions or techniques for temporary storage. ILCOR now also recommends storage in milk before tap water, buttermilk, castor oil and turmeric extract.[8]

The new recommendation for use of cling film, while based on a single very low-certainty study, is viewed as particularly useful for first aid and in the austere environment where liquid storage solutions may not be available, but additional studies are needed to confirm this benefit. The recommendation for HBSS is supported by the greatest number of RCTs; this solution is found in over-the-counter dental storage kits sold in most pharmacies and can be added to first aid supplies for sporting events where dental avulsion is a risk.

The Red Cross recommendations have taken into account the lack of availability in the United States of many of the solutions evaluated in the ILCOR review. Finally, it should be noted that the studies included were experimental and well-designed prospective studies are needed to determine whether the findings translate to the clinical setting.

Caustic Attacks: First Aid

Caustic attacks are also known as "acid attacks" and are a form of violent assault in which acid or another corrosive (caustic) substance is thrown on a person with the intent to disfigure, maim, torture or kill. A 2020 ARCSAC Answer was completed for the question, what is the appropriate first aid for a person following an acid attack?[1]

Red Cross Guidelines

- Following a caustic exposure, contaminated clothing should be removed as soon as possible and continuous irrigation of the exposed area should be started immediately

Evidence Summary

A review of this topic identified gray literature that estimates an incidence of 1,500 caustic attacks per year throughout the world. Attacks do not typically kill the victim but are perpetrated with the intent to permanently scar and disfigure, and are accompanied by significant psychological and socioeconomic morbidity.[101-103] Caustics used in the developing world include nitric and sulfuric acids along with sodium hydroxide; hydrofluoric acid is also readily available from cleaning supplies.[104-106] There are few studies related to intentional caustic attacks, and most evidence for first aid is derived from treatment of industrial accidents. A small study demonstrated that patients who receive immediate (within 10 minutes) large volume water irrigation for at least 15 minutes had smaller areas of full-thickness burn and shorter length of stay.[107] Another study suggests that water irrigation should continue until a neutral pH is reached.[102] Burns with hydrofluoric acid cause deeper damage through liquefactive necrosis.[104] Sodium hydroxide is a readily available alkali commonly used in chemical assaults that penetrates deeply and continues to cause damage long after the initial exposure. Corneal damage with perforation and scarring can result.[106,108] Continuous irrigation is recommended for these exposures for up to 2 hours.[109]

The literature suggests that following a caustic exposure, early removal of contaminated clothing and immediate continuous irrigation will decrease the time that skin and eyes are exposed to chemicals and will decrease burn severity.

Insights and Implications

Red Cross first aid curriculum includes care for caustic exposures. Intentional acid attacks or caustic attacks should be included in the potential sources of exposure.

Burn Care and Cooling

The management of burns has been a point of discussion in first aid for years. While cooling has been a hallmark of care, the specific duration and temperature has been debated.

Red Cross Guidelines

- Adults and children who sustain thermal burns should have overlying clothing and jewelry removed.

- Thermal burns should be immediately cooled, preferably with cool running water applied to the burn for a minimum of 10 minutes, ideally 20 minutes.

- If cool or cold water is not available, applying a clean, cool or cold compress or cold pack as a substitute to cool thermal burns may be considered.

- Lay responders and healthcare professionals must monitor for hypothermia when cooling large burns or burns in small children.

- Cooling beyond 40 minutes should not be done due to risk of hypothermia.

- Ice should not be used to cool a burn, including an ice pack or bag of ice, due to a risk of worsening the injury.

- If cooling is not started immediately after a burn, lay responders and healthcare professionals may consider starting the cooling process up to 3 hours after the injury.

Evidence Summary

In the 2019 ARCSAC scoping review of cooling of thermal burns, two randomized control trials (RCT), four observational cohort (two prospective, two retrospective), and two statistical modeling studies were identified.[1] These studies support the use of cool water for the first aid treatment of burns. In these studies, cool water was able to improve pain scores, a reduction in skin grafting, decrease ICU admission rate and length of hospital stay. One observational cohort study demonstrated a dose-response relationship with length of cooling, with benefit anywhere from 10 minutes to 40 minutes.[1]

In addition, one statistical model highlighted the importance of clothing removal as fast as possible (in the first few seconds); the thickness of the clothing, skin thickness, and temperature of the water correlated with time to more severe injuries.[110]

Insights and Implications

Overall the ARCSAC review concurs with a 2020 ILCOR scoping review[8] of cooling of superficial burns, which supported the 2015 ILCOR recommendation[20] regarding the minimum time for cooling that may show benefit is 10 minutes. As most of the studies still use 20 minutes of cooling as the standard, there is more data available to support this 20-minute time period, although much of the data is from older studies and studies performed in animals.

There is some evidence of harm with cooling times over 40 minutes.[111] Thus, it is not recommended to cool a burn for longer than 40 minutes. In addition, children and those with large body surface area burns may lose heat more rapidly and have the potential to become hypothermic, so care should be taken to avoid hypothermia when treating these populations.

Environmental Emergencies

Exertional Hyperthermia and Heatstroke: Cooling Techniques

This topic has previously been reviewed by ARCSAC.[1] An ILCOR systematic review[112] and CoSTR[8] evaluated 12 different active and passive cooling techniques for adults and children with heatstroke or exertional hyperthermia. Outcomes included mortality, rate of body temperature reduction, and adverse effects.

Red Cross Guidelines

- For adults, children and infants with exertional hyperthermia or heatstroke, lay responders and healthcare professionals should move the individual from the hot environment, remove excess clothing, limit exertion, and, for lay responders, call 9-1-1 or the designated emergency number.

- For adults with exertional hyperthermia or heatstroke, lay responders and healthcare professionals should initiate immediate active cooling by using whole-body (neck down) cool- to cold-water immersion techniques (1°C–26°C; 33.8°F–78.8°F) when safe, until a core body temperature of less than 39°C (102.2°F) is reached or neurological symptoms resolve.

- For adults with exertional hyperthermia or heatstroke, lay responders and healthcare professionals may consider initiating other forms of active cooling, including commercial ice packs, cold showers, ice sheets and towels, cooling vests and jackets, evaporative cooling, fanning, or a combination of techniques, when water immersion is not available.

- For children and infants with exertional hyperthermia or heatstroke, lay responders and healthcare professionals should initiate immediate active cooling by using whole-body (neck down) cool- to cold-water immersion techniques (1°C–26°C; 33.8°F–78.8°F) when safe, until a core body temperature of less than 39°C (102.2°F) is reached or neurological symptoms resolve.

- For children and infants with exertional hyperthermia or heatstroke, lay responders and healthcare professionals may consider initiating other alternative forms of active cooling, including commercial ice packs, cold showers, ice sheets and towels, cooling vests and jackets, evaporative cooling, fanning, or a combination, when water immersion is not available.

- For exercise-associated muscle cramps, lay responders and healthcare processionals may consider having the person stop the activity associated with the cramping muscle(s) until all symptoms resolve, apply ice to the affected muscle(s), gently stretch and massage the affected muscle(s), and encourage the person to drink cool carbohydrate-electrolyte fluids.

- For exertional heat exhaustion, lay responders and healthcare professionals should remove the affected person from the hot environment, remove excess clothing or sporting equipment, have them lie down in a cool place while actively cooling with cool/cold water on the skin, and encourage drinking cool carbohydrate-electrolyte fluids or water. The affected person should refrain from exercise until all symptoms have resolved and they are well hydrated (usually 24 hours). If they are unable to tolerate hydration or if they develop a change in mental status, lay responders should immediately call 9-1-1 or the designated emergency number and prehospital professionals should transport the person.

Evidence Summary

Observational studies using multiple ranges of water temperature for cooling for adults with whole body, neck-down immersion were identified; water temperatures ranged from ice water to temperate. Important limitations of the review include the lack of RCTs; lack of studies evaluating outcomes of mortality, organ damage or adverse effects; lack of studies for non-exertional (classic) heatstroke or including children; and the use of healthy volunteers with exertional hyperthermia, leading to extrapolation of results to exertional heatstroke.

Of all modalities evaluated, the fastest cooling rates were achieved with the use of whole body/neck-down water immersion, with or without inclusion of the legs, using water temperatures between 1°C and 26°C/33.8°F and 78.8°F.[112] Shallow tubs or improvised inflatable pools were used for immersion. Cooling rates with use of water immersion were found to be faster than all other active cooling techniques, including commercial ice packs, cold showers, evaporative cooling, ice sheets and towels, and fanning cooling vests.

When considering water temperature ranges studied for immersion, weighted mean cooling rates suggest that "colder is better," although wide, overlapping confidence intervals for many of the different temperatures tested prevented development of a rank order list to guide first aid providers.[112]

Of note, cooling techniques that did not show a significant mean difference in rate of cooling included[112]:

- Colder water immersion (9°C/48.2°F) up to the iliac crest compared with passive cooling.[113]

- Colder water immersion (10°C–12°C/50.0°F–52.6°F) of the hands/feet compared with the use of colder water immersion of the torso.[114]

- Evaporative cooling compared with passive cooling[115,116]; use of ice packs applied to the neck, axilla and groin[115,117]; use of commercial ice packs applied to the whole body.[115]

- Evaporative cooling combined with the use of commercial ice packs to the neck, axilla and groin compared with passive cooling[115] and evaporative cooling alone.[115]

- Ice sheet application (bed sheets soaked in ice water kept at 3°C/37.4°F and towels soaked in ice water kept at 14°C/57.2°F, respectively) to the body compared with passive cooling.[118,119]

- Ice sheet application (sheets soaked in ice and water at 5°C to 10°C; 33.8°F to 41.0°F) to the body compared with colder water immersion (5°C to 10°C; 33.8°F to 41.0°F).[120]

- Commercial ice packs to the neck, groin and axilla compared with passive cooling.[115,121]

- Commercial ice packs to the whole body compared with passive cooling.[115]

An ARCSAC scientific review[1] from 2019 evaluated the characteristics and signs and symptoms of exertional heat illness that can be recognized by a lay responder and the recommended interventions. The review included 27 studies; none of these supports a change in the description of signs and symptoms of exertional heat illnesses.

A weak recommendation by ILCOR suggests the immediate active cooling using whole body (neck down) water immersion techniques (1°C to 26°C; 33.8°F to 78.8°F) until a core body temperature of less than 39°C (102.2°F) is reached (very low-certainty evidence).[8]

A weak recommendation by ILCOR suggests that where water immersion is not available, any other active cooling technique be initiated (weak recommendation, very low certainty of evidence).[8]

A weak recommendation by ILCOR suggests the immediate cooling using any active or passive technique available to care providers that provides the most rapid rate of cooling (very low certainty of evidence).[8]

For adults with classic heatstroke, ILCOR cannot make a recommendation for or against any specific cooling technique compared with an alternative cooling technique (no recommendation, very low-certainty evidence).[8]

For children with exertional or classic heatstroke, ILCOR cannot make a recommendation for or against any specific cooling technique compared with an alternative cooling technique (no recommendation, very low-certainty evidence).[8]

Insights and Implications

Heatstroke is characterized by extreme hyperthermia and organ dysfunction, most commonly manifested by central nervous system dysregulation. Immediate cooling to lower the core body temperature to less than 39°C (102.2°F) has been shown in multiple and large case series to reduce morbidity and mortality. Many different techniques have been described for cooling; this review summarizes the best evidence available for the rate of cooling, with the finding that whole-body water immersion cools the fastest of all modalities. While cooler water temperatures showed a trend for faster cooling, even temperate water showed rapid cooling rates, and there may not be a significant difference clinically. The systematic review findings have important first aid implications. Evaporative cooling, which has been promoted in the past, appears to be no better than passive cooling. Fanning and ice packs applied to the groin, axilla or torso, were similarly no faster than passive cooling. However, the reviewers acknowledge that passive cooling—that is, moving to a cooler environment—is an essential step in the management of both exertional hyperthermia and heatstroke and should be combined with active cooling. In addition, the combination of different active cooling techniques may lead to more rapid cooling and is considered a knowledge gap for future research. The Red Cross recommendations include the use of active and passive cooling techniques for children, based on expert opinion. Lay responders and health care professionals working at sporting events during periods of high ambient temperatures will need to consider having available tarps and ice or inflatable (children's) pools and water sources for active cooling.

Snakebites: Pressure Immobilization Bandaging

A scientific review by ARCSAC in 2020 evaluated the use of a pressure immobilization bandage (PIB) applied to an affected extremity following possible venomous snakebites in adults and children, within North America, compared with no PIB, or immobilization alone.[1] A second part of this review evaluated if lay responders are able to learn and retain the skill of pressure immobilization bandaging.

Red Cross Guidelines

- Following a snakebite, the bitten extremity should be immobilized or kept still. The person should not ambulate on the immobilized extremity unless no other option is available.

- Pressure immobilization bandaging should not be used following bites from a pit viper in the United States and Canada.

- Pressure immobilization bandaging, with the use of an elastic bandage, may be considered by those trained in proper application following the suspected bite of a coral snake in the United States if the transport time to the hospital may be prolonged.

- Keeping the injured area at or lower than the level of the heart may be considered following a snakebite.

- Washing the wound after a snakebite may be considered if this does not delay hospital transport.

Evidence Summary

Pit vipers are the cause of the majority of envenomations in the United States, and only a small percentage of bites are from coral snakes. There are very few deaths from venomous snakes each year in the United States and Canada, and the primary concern is morbidity from damage to local tissues. A 2010 ILCOR CoSTR found that PIB appeared beneficial in delaying mortality.[122] When analysis of the literature was performed, it was discovered that the data was not broken down by continent, region or type of snake. Less data was available to suggest that PIB would be beneficial to patients in the United States and Canada with venomous snake bites. This review concluded that while the data is limited, pressure techniques, including PIB, combined with immobilization appear to prevent systemic absorption of venom and improve mortality following both Elapidae and Viperidae envenomation. However, there are potential risks when using PIB.

There is some evidence identified in the ARCSAC review that localized necrosis may occur at the site of envenomation with necrotizing venoms, that PIB increases intra-compartmental pressures, potentially increasing the risk of compartment syndrome, and that some subjects experience increased pain, numbness and paresthesia when using PIB. For Elapidae, animal studies evaluating coral snake venom demonstrated improved survival with the use of PIB.[1]

PIB is a technique that must be applied in a specific manner to be effective. Evidence from a study using a radioactive tracer suggested that an improper pressure when using PIB does not prevent lymphatic flow,[123] and evidence suggests that PIB does not work well without proper immobilization.[123-125] Finally, studies demonstrate that PIB is often inadequately performed by both healthcare professionals and lay responders and that retention of training is poor.[126-128]

Insights and Implications

This is a change in Red Cross guidelines. The 2020 ARCSAC scientific review applied more stringent criteria and found insufficient data to recommend PIB for pit viper bites in the United States and Canada. PIB will remain an option for coral snake bites. There is consistent evidence of decreased mortality and little evidence of morbidity with proper application of PIB for a coral snake envenomation. Despite this, PIB is unlikely to offer benefit in the vast majority of cases of coral snake envenomation when transport to definitive care is readily available. Because hands-on training in the use of PIB was superior to using only written instructions, first aid courses should include PIB as an optional skill.

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Basic Life Support

Systems of Care

Assessment

Rapid assessment begins with a performing a visual survey, checking for responsiveness and life-threatening bleeding, opening the airway and simultaneously checking for breathing and a pulse. The use of a mnemonic can be helpful for learning and recalling the sequence for assessment and initial actions.

Red Cross Guidelines

- The A-B-C mnemonic, which has universal application in all settings, should be used for assessment and initial actions.

- Early assessment for life-threatening bleeding should be performed.

- In an adult, child or infant with no signs of life (unconscious/unresponsive) and with abnormal or no breathing, healthcare professionals should check a carotid pulse (adults and children) or a brachial pulse (infant) for no more than 10 seconds and if absent presume the person is in cardiac arrest.

Evidence Summary

The ARCSAC reviewed this topic in 2020[1] and a joint American Heart Association and American Red Cross statement on this topic was issued in 2012. These reviews showed no changes to this guidance.

Insights and Implications

Early assessment for life-threatening bleeding is performed with the check for responsiveness. The A-B-C mnemonic is a universal means to recall and perform assessment and initial action, including opening of the airway (A), checking for the presence or absence of normal breathing (B), and, for trained professionals, the simultaneous assessment for circulation (C) by a pulse check, or for lay responders, beginning compressions (C).

Dispatch Diagnosis of Cardiac Arrest

Specific call characteristics, such as words, language, idioms, or the emotional state of the caller, may affect the ability of dispatchers to recognize cardiac arrest.

Red Cross Guidelines

- Dispatch centers should employ standardized and evidence-based protocols for recognition of cardiac arrest.

Evidence Summary

The criteria or call characteristics for recognition of adult and pediatric out-of-hospital cardiac arrest (OHCA) by emergency medical dispatchers was the subject of a 2020 ILCOR systematic review and CoSTR.[2] The review assessed the accuracy of a variety of current algorithms and criteria used by dispatch centers to identify cardiac arrest for subsequent dispatch of appropriate responders. A sensitivity analysis of 46 observational studies with 84,534 adults with OHCA showed a median sensitivity of 0.79 (interquartile range, 0.69–0.83) and a false negative median rate (incorrectly identifying absence of cardiac arrest) of 0.21 (interquartile range, 0.17–0.32).[2] The median specificity rate (the proportion of patients correctly identified by dispatchers as not being in cardiac arrest) from 12 observational studies was 0.99 (interquartile range, 0.93–1.00).[2] No differences were found in subgroup analysis of studies using similar dispatch algorithms versus criteria-based dispatch and for comparing dispatcher background and training, although meta-analysis was not possible for any subgroup due to heterogeneity in studies.[2]

Use of standardized criteria or algorithms are recommended by ILCOR for dispatch centers to immediately determine if a person is in cardiac arrest.[2] It was also recommended by ILCOR that dispatch centers monitor and track diagnostic capability and look for means to optimize sensitivity (minimize false negatives) for identifying cardiac arrest.[2]

Insights and Implications

The immediate and accurate identification of cardiac arrest by emergency dispatchers has the potential to save lives through dispatcher-assisted bystander cardiopulmonary resuscitation (CPR) and dispatch of appropriate healthcare professionals to the scene. Unfortunately, the variability in algorithms and dispatch criteria for cardiac arrest prohibited the pooling of data to determine an overall diagnostic accuracy needed to make recommendations on specific algorithms.

Public Access AED Programs

The use of CPR and an automated external defibrillator (AED) within the first few minutes after cardiac arrest can improve survival rates. Public access defibrillation (PAD) programs exist to ensure that AEDs are immediately available for use by lay responders and healthcare professionals.

Red Cross Guidelines

- Public access AED programs should be an essential part of the management of out-of-hospital cardiac arrest.

- Community leaders may consider determining the locations with a high incidence of cardiac arrest in the local area and develop methods to have AEDs available at these locations at the time of arrests.

Evidence Summary

Systematic reviews demonstrating beneficial effects of public access defibrillation on survival following OHCA have been previously published.[3,4] An updated ILCOR systematic review and CoSTR[2] evaluated outcomes of

survival and return of spontaneous circulation following OHCA in emergency medical service (EMS) systems using public access defibrillator (PAD) programs compared with systems using traditional EMS response. In addition, the American Red Cross Scientific Advisory Council has conducted scientific reviews of public access AED programs and in 2017 evaluated public access AED placement.[1]

The updated ILCOR systematic review and CoSTR[2] included one randomized controlled trial (RCT) and 30 observational studies, primarily retrospective analyses using data from large registries. Moderate-certainty evidence from a single RCT with 235 OHCAs showed improved survival to hospital discharge with CPR plus PAD compared with CPR without PAD (RR, 2.0; 95% CI, 1.07–3.77).[5] The ILCOR review also reported 16 observational studies enrolling 40,243 patients showing improved survival associated with PAD programs (OR, 3.24%; 95% CI, 2.13–4.92).[2]

A strong recommendation is made by ILCOR for use of public access defibrillation programs for persons with OHCA.[2]

An ARCSAC review identified two studies showing only a weak correlation between accessibility of AEDs and the location of cardiac arrests.[1] There are multiple thoughts on locations without scientific evidence to show where they should actually be placed. Some studies of limited certainty suggest that community leaders should determine the locations with a high incidence of cardiac arrest in the local area and then place AEDs accordingly.

Insights and Implications

Despite the low-certainty evidence included with the ILCOR review, the authors made a strong recommendation reflecting the high value they place on the potential lifesaving capability of an AED for a shockable rhythm.[2] The one included RCT showed improved survival to discharge in the group receiving CPR plus AED, compared with CPR alone. Only one of the 30 observational studies included pediatric patients solely. Most of the observational studies included reported improved survival associated with implementation of PAD programs. No studies suggested harm with PAD. Finally, a recent cost effectiveness analysis study[6] concluded that PADs are a cost-effective public health intervention. Current and future technology may provide methods to better target placement and improve survival.

Cardiopulmonary Resuscitation

CPR Prior to Call for Help

The widespread availability of mobile phones with audio command and speaker capability now makes it possible to call 9-1-1 while simultaneously beginning CPR. This has changed the classic question of should CPR be started first or should help be called before beginning CPR (call first versus care first)?

Red Cross Guidelines

- A mobile phone with speaker, if available, should be used to call 9-1-1, allowing activation of emergency medical services to occur parallel to the beginning of CPR and to facilitate dispatcher guidance of CPR.

Evidence Summary

An ILCOR systematic review and CoSTR[2] included evidence of very low certainty (downgraded for very serious risk of bias) from a single cohort study[7] with 17,461 OHCAs identified from a national registry of 925,288 cases. Three groups of rescuers were compared for witnessed OHCA with CPR performed with dispatcher assistance: call and CPR first; call first; and CPR first. For the outcome of survival to hospital discharge, there was no benefit associated with a "CPR-first" strategy compared with a "call-first" strategy.[2]

For OHCA with a noncardiac etiology, subgroup analysis with adjusted data suggested survival benefits with favorable neurological outcome using a CPR-first strategy compared with a call-first strategy (aOR, 2.01; 96% CI, 1.39–2.98); a greater survival with favorable neurological outcome benefit was seen in younger populations (under 20 years of age) (aOR, 3.74; 95% CI, 1.46–9.61).[2]

A strong recommendation is made by ILCOR that a lone bystander with a mobile phone should dial EMS, activate the speaker or other hands-free option on the phone and immediately begin CPR, with EMS dispatcher assistance if required.[2]

Insights and Implications

The single study included in the ILCOR review was a retrospective analysis from national registry data recorded between 2005 and 2012,[7] admittedly with a number of potential confounders. Despite this very low-certainty evidence, ILCOR made a strong recommendation for a lone rescuer with a mobile phone to dial EMS, activate the speaker or other hands-free option, and begin CPR. Before the advent of mobile phones, a lone bystander was faced with the need to leave a cardiac arrest victim to call 9-1-1, delaying the initiation of CPR. Now, with widespread availability of mobile phones, it is possible to simultaneously perform CPR while calling 9-1-1, and this recommendation reflects these technological changes and shifts the focus to initiating CPR as quickly as possible.

CPR Period Prior to Defibrillation

Should a prolonged period of chest compressions, compared with a shorter period of chest compressions be performed before defibrillation in adults and children in any setting with cardiac arrest and a shockable rhythm at the start of CPR?

Red Cross Guidelines

- CPR should be performed prior to availability of an AED and analysis of rhythm.

Evidence Summary

An updated ILCOR systematic review and CoSTR included low-certainty evidence in adults from five RCTs evaluating survival to 1 year or hospital discharge with or without favorable neurological outcome.[2] CPR prior to defibrillation was not shown to provide a clear benefit for any of the critical outcomes. Four RCTs[8-11] with 10,424

OHCAs did not show a benefit from a prolonged period of chest compressions compared with a short period of chest compressions before defibrillation (RR, 1.02; 95% CI, -0.01–0.01) for the outcome of survival to hospital discharge with favorable neurological outcome.[2] For survival to 1 year, two RCTs[8,12] with 456 adult out-of-hospital cardiac arrests (OHCAs) likewise did not show a benefit from a prolonged period of chest ompressions compared with a short period of chest compressions prior to defibrillation (RR, 1.19; 95% CI, .69–2.04). For survival to hospital discharge, five RCTs[8-12] with 10,680 adults with OHCA did not show a benefit from a prolonged period of chest compressions compared with a short period of compressions prior to defibrillation (RR, 1.01; 95% CI, 0.90–1.15). For ROSC, the same five RCTs did not show a benefit from a prolonged period of chest compressions compared with a short period of chest compressions before defibrillation (RR, 1.03; 95% CI, 0.7–1.10).[2]

A short period of CPR is suggested by ILCOR until the defibrillator is ready for analysis and/or defibrillation in unmonitored cardiac arrest.[2]

Insights and Implications

This topic was last reviewed by ILCOR in 2015. The 2020 updated review[2] included only RCTs, although no new RCTs were identified, and the outcomes were updated. The optimal timing of defibrillation remains unclear and thus the current ILCOR recommendation is unchanged from 2015.

Starting CPR (A-B-C versus C-A-B)

For adults and children in cardiac arrest in any setting, should CPR begin with compressions first (C-A-B, 30:2), or with ventilations first (A-B-C, 2:30)?

Red Cross Guidelines

- Once cardiac arrest is recognized, resuscitation should begin with compressions.

- Healthcare professionals may consider ventilations first in pediatric patients with primary respiratory etiologies.

- For the drowning process resuscitation, once cardiac arrest is recognized, resuscitation should begin with ventilations (rescue breaths).

Evidence Summary

A 2020 review of this topic by Red Cross[1] did not identify additional direct evidence, but one systematic review in 2020[13] used data from the Cardiac Arrest Registry for Enhanced Survival (CARES) in a retrospective evaluation (over 4 years beginning January 1, 2013) of 548 cases of cardiac arrest following drowning on whom information was available on type of CPR performed. Compression-ventilation CPR in 5- to 15-year-olds was reported to be significantly associated with neurologically favorable survival (aOR, 2.68; 95% CI, 1.10–6.77; p=0.03) compared with compression-only CPR, supporting the need for ventilations in hypoxic cardiac arrest.

The ARCSAC review led to a recommendation to continue teaching the A-B-C approach for assessment in all emergencies, and to begin CPR for adult cardiac arrest and sudden pediatric arrests with compressions followed by breaths. For cardiac arrest from the drowning process, the sequence is airway and breathing first, then compressions.[1] In children and infants with a primary respiratory etiology of cardiac arrest, healthcare professionals may choose to begin with ventilations (rescue breaths).

The topic of beginning CPR with compressions first (C-A-B, 30:2) or beginning with ventilations first (A-B-C, 2:30) was the subject of a joint ILCOR Basic Life Support and Pediatrics Task Force systematic review in 2015 and update in 2019.[14] No new studies have been published since 2015.[2] Very low-certainty evidence (downgraded for very serious risk of bias and indirectness) from four manikin studies was identified in the 2015 review to help answer this question.[15] One RCT and two observational studies reported a decreased time to commencement of chest compressions, including a 24.12-second significant difference in favor of C-A-B shown in the RCT.[16] For time to commencement of rescue breaths, one randomized manikin study[16] of simulated pediatric resuscitation showed that an A-B-C approach significantly decreased the time to commencement of rescue breaths, while a second randomized manikin study[17] showed that the C-A-B approach decreased the time to start of rescue breaths. The study by Marsch et al.[17] also showed a decreased time to completion of the first CPR cycle with C-A-B.[2]

A weak recommendation by ILCOR suggests commencing CPR with compressions rather than ventilations in adults and children with cardiac arrest (very low-certainty evidence).[2]

Insights and Implications

Unfortunately, the outcomes of survival and ROSC could not be answered with the ILCOR systematic review of starting CPR with ventilations versus compressions. Indirect and very low-certainty evidence from manikin studies evaluated surrogate outcomes of time to start of chest compressions, rescue breaths and/or completion of the first CPR cycle.

The American Red Cross continues to recommend teaching the A-B-C approach for assessment in all emergencies. Not everyone in cardiac arrest has had an arrest due to a primary cardiac cause, and many may have very low levels of oxygen in the blood at the time of arrest. The priority for these victims is to get oxygen to the vital organs. This is particularly important in cases such as drowning, or with infants and children since cardiac arrest is most commonly the result of a respiratory issue. For adult cardiac arrest and sudden pediatric arrests, the correct resuscitation sequence is compressions first, followed by ventilations. For pediatric respiratory patients, healthcare professionals may consider providing breaths first; for lay responders, uniformity of approach outweighs the slight delay in ventilations when using compressions first. For resuscitation from drowning, it is vital to begin with ventilation due to the unique pathological process.

Firm Surface for CPR

A firm surface is necessary to deliver effective chest compressions. Persons in cardiac arrest are sometimes moved from the bed to the floor to improve the quality of CPR compressions.

Red Cross Guidelines

- Manual chest compressions should be performed on a firm surface when possible.

Evidence Summary

A systematic review by ILCOR[18] compared outcomes following CPR on a hard surface (including backboard, floor, inflatable or specialty mattress) with CPR performed on a regular mattress. This topic was first reviewed by ILCOR in 2010.[19] A 2020 updated ILCOR systematic review[18] and CoSTR[2] included seven RCTs along with four other RCTs from the 2010 review. All RCTs were performed using manikins and thus, no evidence was identified to address clinical outcomes. Outcomes were limited to compression depth. The included studies compared a compressed foam mattress with a standard mattress, a standard foam mattress with an inflated pressure-relieving mattress, and a foam mattress with different pressure-relieving mattresses, the floor and a bed with a hard foam mattress, the floor and a foam mattress on a bed, and various pressure-relieving mattresses. Only small differences in compression depth or no difference on meta-analysis were identified, of questionable clinical significance. For the comparison of CPR on a mattress/bed without and with a backboard, a meta-analysis of six studies showed improvement in chest compression depth with backboard use on a mattress/bed (mean difference 3 mm, 95% CI, 1–4).[18] However, three randomized crossover trials found no difference in compression depth when CPR was performed on manikins on a standard hospital mattress with and without a backboard,[20] an ICU mattress with and without a backboard, and on a memory foam mattress with and without a backboard.[21] The reviewers concluded that use of a backboard, marginally improved compression depth, while increasing mattress stiffness or moving the manikin from the bed to the floor did not improve compression depth.[18]

A weak recommendation by ILCOR suggests performing manual chest compressions on a firm surface when possible (very low-certainty evidence).[2]

During in-hospital cardiac arrest, it is suggested by ILCOR that if the patient is in a bed with CPR mode to increase mattress stiffness, it should be activated.[2] It is also suggested to NOT move a patient from a bed to the floor, and a conditional recommendation was made for the use of a CPR backboard during in-hospital cardiac arrest.[2]

Insights and Implications

The reviewers noted that effective compressions could be achieved in most studies even when performed on a soft surface if the overall compression depth was increased to compensate for mattress compression.[18] CPR feedback devices that account for mattress compressions can help ensure adequate compression depth. A marginal benefit in chest compression depth was found with use of a backboard. The conditional recommendation for the use of a CPR backboard during in-hospital cardiac arrest is made with the acknowledgement that backboard deployment may potentially interrupt compressions and/or displace tubes and lines. The limited improvement in compression depth and risk of harm may not justify their cost and increase in resource requirements or training.

Hand Position During Compressions

Is there a specific location on the chest for performing compressions that improves clinical outcomes in adults, children or infants?

Red Cross Guidelines

- Chest compressions should be performed on the lower half of the sternum for adults and children.

- Chest compressions should be performed just below the inter-mammary line (middle of the chest) on infants.

- For adults, the two-hand technique should be used for chest compressions.

- For children, either a two-hand or one-hand technique should be used for chest compressions.

- For infants, the two-thumb/encircling hands technique should be used for chest compressions. For infants, the two-finger technique (two or three fingers placed in the middle of the chest) may be considered. If the required depth cannot be achieved with either the two-thumb/encircling hands technique or the or two-finger technique in infants, a one-hand technique may be considered.

Evidence Summary

A 2020 ILCOR systematic review and CoSTR compared alternative locations for chest compressions with delivery of chest compressions on the lower half of the sternum in adults and children in any setting during cardiac arrest.[2] Three crossover studies of very low certainty were included, with one involving 10 children. None of the studies reported on critical outcomes of favorable neurologic outcome, survival or ROSC. One study with 17 adults with prolonged resuscitation from cardiac arrest reported higher peak arterial pressure during compression systole as well as higher end-tidal carbon dioxide levels when compressions were performed on the lower third of the sternum compared with the center of the chest; a difference was not found for arterial pressure during compression recoil, for peak right atrial pressure or coronal perfusion pressure.[22] No difference between end-tidal CO_2 ($ETCO_2$) levels and hand placement was reported in a second crossover study of 30 adults with cardiac arrest.[23] The crossover study[24] in children reported higher peak systolic pressure and mean arterial blood pressure when compressions were performed on the lower third of the sternum compared with compressions performed over the middle of the sternum.[2] A weak recommendation by ILCOR suggests that chest compressions be performed on the lower half of the sternum for adults in cardiac arrest (very low-certainty evidence).[2]

The single-rescuer two-finger technique for infant CPR is based on concerns that the two-thumb/encircling hands technique may interfere with ventilation performance, while the two-thumb technique is recommended for two rescuers due to higher quality compressions. A 2020 systematic review with meta-analysis by ARCSAC members compared the quality of chest compressions and ventilation parameters between the two-thumb and two-finger techniques for infants.[25] All studies identified were performed on a manikin. Pooled data from 16 observational studies using a random-effects model showed that use of the two-thumb technique resulted in greater compression depth compared with the two-finger technique (MD, 5.61 mm; 95% CI, 2.79–8.43) and 36.91% more compressions of adequate depth (95% CI, 10.07–63.74). No difference was found between the two compression techniques for ventilation parameters, although only five studies were able to be included in the ventilation volume meta-analysis. There was not enough data to abstract the total number of ventilations performed during a compression-to-ventilation sequence. The reviewers concluded that for CPR performed on a simulated infant manikin by a single rescuer, the two-thumb technique improves chest compression quality without compromising ventilation.[25] The ARCSAC scientific review on infant CPR techniques and sequences[1] noted that the precise location for the rescuer to place their fingers or thumbs is not clear.

Insights and Implications

This topic has been reviewed by ARSAC and also by ILCOR in 2010[19] and again in 2015.[15] The recommended actions are unchanged. The 2020 ILCOR review[2] excluded imaging studies, although the reviewers noted that imaging studies show that the maximum ventricular cross-sectional area underlies the lower third of the sternum/xiphoid junction, and that the ascending aorta and left ventricular outflow track lie under the center of the chest. Age, body mass index, congenital heart disease and pregnancy may create differences in anatomy such that a single specific hand location may not provide optimal compressions for all persons in cardiac arrest. This remains a gap in science, as do the outcomes of short- or long-term survival following cardiac arrest for hand positions.

The ARCSAC systematic review[25] with meta-analysis suggests that CPR quality is significantly greater when performed using a two-thumb/encircling hands technique compared with the two-finger technique, without compromising ventilation volume, and when performed by a single rescuer. Limitations include the heterogeneity in measures between studies, the inability to determine total number of ventilations in a given sequence, lack of certainty assessment for individual studies or across outcomes, and lack of studies in infants with clinical outcomes. Risk of bias was high for all studies. Despite the limitations, the unknown but potential survival benefit from increased quality of CPR supports the change in recommendations to the use of two thumbs with encircling hands for single-rescuer CPR, while retaining the option of two-finger compressions. Lay responders with thumb, finger, hand or wrist arthritis now have the option to use the technique that can be performed best, including the one-hand technique, within their physical limitations in order to deliver compressions of recommended depth.

Compression Depth, Rate, and Recoil

Red Cross Guidelines

- An adult chest should be compressed to a depth of at least 2 inches.

- A child and infant's chest should be compressed to a depth of at least one-third the anterior-posterior diameter of the chest. For children, a compression depth of about 2 inches, and for infants, about 1½ inches should be used.

- Chest compressions should be performed at a rate of 100 to 120 per minute for adults, children and infants.

- During compressions for adults, children and infants, the chest should be allowed to fully recoil, and compression and recoil times should be approximately equal.

Evidence Summary

This topic has not been systematically reviewed since 2015 and as such the current recommendations remain unchanged. A scoping review by ILCOR in 2020 did not find new published evidence related to the effectiveness of specific compression depths during CPR in infants and children.[26]

Duration of CPR Cycles (2 minutes versus other)

Does pausing chest compressions in adults and children in cardiac arrest in any setting at another interval compared with pausing compressions every 2 minutes to assess the cardiac rhythm change outcomes of survival to hospital discharge with good neurological outcome, survival to hospital discharge, or ROSC?

Red Cross Guidelines

- Chest compressions may be paused every 2 minutes for rhythm analysis and to allow for switching roles.

Evidence Summary

An updated 2019 ILCOR systematic review and CoSTR[2] identified two additional older studies not included in the previous 2015 ILCOR review.[15] Post hoc analysis of published data from these two RCTs[8,9] was used to address the question. The first RCT[8] had a control group with refractory ventricular fibrillation/tachycardia (VF/VT) after immediate defibrillation for VF/VT who received 1 minute of CPR; those with a nonshockable rhythm after immediate defibrillation received 3 minutes of CPR. The intervention group received 3 minutes of CPR after immediate defibrillation for VF/VT regardless of post-shock rhythm. No benefit was observed in the 3-minute CPR intervention group compared with the control group for all outcomes.[2] The second RCT[9] included a control group of patients also treated under new guidelines with a single shock, 30:2 CPR and 2 minutes of CPR between shocks, compared with patients in a separate RCT enrolled before implementation of new guidelines who received stacked shocks, 15:2 CPR and 1 minute CPR cycles between shocks. No benefit was found for the 1-minute CPR intervention group compared with the 2-minute CPR control group for all outcomes.[2]

A weak recommendation by ILCOR suggests pausing chest compressions every 2 minutes to assess the cardiac rhythm (low-certainty evidence).[2]

Insights and Implications

Evidence included in the 2020 systematic review suffers from confounding and is of low certainty. No change to current guidelines is indicated.

Manual CPR Methods for Adults: Compression-Ventilation and Compression-Only CPR

Recommendations for the CPR compression-to-ventilation ratio changed in 2005 from 15:2 to 30:2 for single lay responder or healthcare professional CPR. In 2015, compression-only CPR (CO-CPR) was an alternative to conventional CPR in adult cardiac arrest, while it was suggested that trained lay responders provide ventilations in addition to compressions. Other recommendations have changed for dispatch CPR and EMS-delivered CPR. A comprehensive ILCOR systematic review on the topic of compression-to-ventilation ratios was completed in 2017,[27] with separate arms of the review described in four different CoSTRs. Compression-only CPR was reviewed by ARCSAC in 2019.

Red Cross Guidelines

- A compression-to-ventilation ratio of 30:2 should be used in adults with cardiac arrest without an advanced airway.

- A compression-to-ventilation ratio of 30:2 should be used in children and infants with cardiac arrest with one lay responder/healthcare professional and without advanced airway.

- A compression-to-ventilation ratio of 15:2 should be used in children and infants with cardiac arrest and two healthcare professionals trained in this technique.

- With an advanced airway in place, healthcare professionals should not pause compressions for ventilations.

Evidence Summary

A 2017 CoSTR[28] updated in 2020[2] evaluated patients of all ages with cardiac arrest from any cause and across all settings who received all-manual CPR methods including compressions only (CO-CPR; no ventilations), continuous compression CPR (CC-CPR; including compression with asynchronous ventilations or minimally interrupted cardiac resuscitation), and CPR with different compression-to-ventilation ratios. Comparators included at least two different CPR methods from eligible interventions, and outcomes included favorable neurological outcomes. Secondary outcomes included survival, ROSC and quality of life.

This ILCOR review arm, specific to adults, identified two cohort studies[29,30] that in meta-analysis showed improved favorable neurological function in patients who received 30:2 compression-to-ventilation CPR compared with 15:2 CPR (RR, 1.34; 95% CI, 1.02–1.72; RD, 1.72; 95% CI, 0.52–2.91). A meta-analysis of six cohort studies[29-34] reported an association between 30:2 CPR and improved survival when compared with 15:2 CPR (RR, 1.37; 95% CI, 1.19–1.59; RD, 2.48, 95% CI, 1.57–3.38).[27]

A meta-analysis of seven cohort studies[29-35] found an association between 30:2 CPR and a slightly higher return of spontaneous circulation (RR, 1.11; 95% CI, 1.00–1.23; RD, 10.48, 0.41–20.55) compared with 15:2 CPR.[27]

A weak recommendation by ILCOR suggests a compression-to-ventilation ratio of 30:2 compared with any other compression-to-ventilation ratio in patients with cardiac arrest.

Insights and Implications

The findings of this review suggest that the change to a compression ratio of 30:2 resulted in more lives being saved. Interestingly, the ILCOR review[28] included unadjusted data from a single cohort study[36] comparing CPR with a 50:2 CPR ratio compared with 15:2 CPR, finding improved survival and rates of ROSC, but this rate has not been compared with 30:2, and it would be difficult to maintain a 50:2 rate with manual CPR.

Compression-to-Ventilation Ratio: Healthcare Professionals

A 2017 ILCOR systematic review evaluated manual CPR methods and compression-to-ventilation ratios in patients of all ages and by provider level.[27] This arm of the review includes an updated CoSTR for EMS-delivered CPR.[2]

Red Cross Guidelines

For healthcare professionals:

- A compression-to-ventilation ratio of 30:2 should be used in patients with cardiac arrest.

- A compression-to-ventilation ratio of 15:2 should be used in children and infants with cardiac arrest and two healthcare professionals trained in this technique.

- With an advanced airway in place, healthcare professionals should not pause compressions for ventilations.

- EMS systems may consider alternative initial compression-only strategies for witnessed cardiac arrest.

Evidence Summary

Unadjusted data from one RCT[37] included in the ILCOR review showed no favorable neurological function benefit from positive pressure ventilations delivered without pausing chest compressions compared with conventional 30:2 CPR.[2] Data from one cohort study[38] reported improved favorable neurological function in patients receiving continuous chest compressions compared with 15:2 CPR, while another cohort study found no benefit for neurological function in patients who received minimally interrupted resuscitation using an initial series of 200 uninterrupted chest compressions before and after rhythm analysis with shock if appropriate, and when compared with conventional 30:2 and 15:2 CPR.[28]

Minimally interrupted cardiac resuscitation was found in one cohort study[39] to be associated with a survival benefit compared with conventional CPR (30:2 and 15:2) (RR, 2.37; 95% CI, 1.69–3.31; RD 5.24; 95% CI, 2.88–7.60). Unadjusted analysis of data from the included RCT[37] showed a RR of survival of 0.92 (95% CI, 0.84–1.00) for patients receiving positive pressure ventilation without pausing chest compressions, compared with those receiving conventional 30:2 CPR.[28]

A strong recommendation is made by ILCOR that EMS providers perform CPR with 30 compressions to 2 ventilations, or continuous chest compressions with positive pressure ventilations delivered without pausing chest compressions, until a tracheal tube or supraglottic device has been placed.[2]

A weak recommendation is made by ILCOR that where EMS systems have adopted bundles of care involving the initial provision of minimally interrupted cardiac resuscitation, the bundle of care is a reasonable alternative to conventional CPR for witnessed shockable out-of-hospital cardiac arrest (very low-certainty evidence).[2]

Insights and Implications

The systematic review concluded that the evidence reviewed found more adults receiving 30:2 CPR from EMS providers experienced improved favorable neurological outcomes and survival compared with those receiving 15:2 CPR from EMS providers.[27] The findings in the ILCOR review are considered by ARCSAC to be applicable to guidelines for healthcare professionals in an out-of-hospital setting.

Compression-to-Ventilation Ratio: Lay Responders

In 2019 ARCSAC conducted a review of compression-only CPR.[1] A 2017 ILCOR systematic review evaluated manual CPR methods and compression-to-ventilation ratios in patients of all ages and by provider level.[27] This arm of the review includes the 2017 CoSTR for bystander CPR.[28]

Red Cross Guidelines

For lay responders:

- CPR should be performed with ventilations, in a compression-to-ventilation ratio of 30:2.

- Compression-only (CO-CPR) may be used as an alternative to CPR with compressions and ventilations when someone is unwilling or unable to provide ventilations.

Evidence Summary

The ILCOR[28] review found no favorable neurological function benefit was found in a meta-analysis of two studies[40,41] comparing compression-only CPR with a 15:2 compression-to-ventilation ratio (RR, 1.34; 95% CI, 0.82–2.20; RD, 0.51; 95% CI, -2.16–3.18).[28] A study evaluating compression-only CPR for bystanders and dispatch recommendations led to improved bystander CPR rates and nationwide survival in Japan, but outcomes (favorable neurological function) among those receiving compression-only CPR were worse compared with those receiving conventional CPR (RR, 0.72; 95% CI, 0.69–0.76; RD, 0.478; 95% CI, 0.43–0.54).[42] A meta-analysis of three studies[43-45] of compression-only CPR compared with standard CPR during a period when the compression-to-ventilation ratio changed from 15:2 to 30:2 found no benefit for favorable neurological function with use of compression-only CPR.[28]

A meta-analysis of six cohort studies of compression-only CPR showed no survival benefit when compared with those who received compressions and ventilations during a period when the compression-to-ventilation ratio was 15:2.[28]

ILCOR continues to recommend that bystanders perform chest compressions for all patients in cardiac arrest (good practice statement).[28] A weak recommendation is made that those who are trained, able, and willing to give rescue breaths as well as chest compressions do so for all adult patients in cardiac arrest (very low-quality evidence).[28]

Insights and Implications

No significant differences were observed across all comparisons and outcomes for bystander CPR. The ILCOR review[28] noted that one cohort study showed in unadjusted analysis that fewer adults receiving bystander compression-only CPR experienced favorable neurological outcomes, survival, and ROSC compared with 30:2 CPR. In making the treatment recommendation, the reviewers acknowledged the potential gains from the simplicity of teaching compression-only CPR given the lack of drawbacks in true arrest patients, while acknowledging the potential additional benefits of conventional CPR by trained laypersons.[28]

Dispatcher CPR Instructions

A 2017 ILCOR systematic review evaluated manual CPR methods and compression-to-ventilation ratios in patients of all ages and by provider level.[27] This arm of the review includes a 2017 CoSTR for compression-only CPR compared with conventional CPR as instructed by EMS dispatchers.[28]

Red Cross Guidelines

- Dispatchers should provide instructions to perform compression-only CPR for suspected out-of-hospital cardiac arrest to those untrained in CPR or who are unable to recall CPR performance steps.

Evidence Summary

The ILCOR systematic review[28] identified one RCT[46] with low-certainty evidence that did not show a benefit for the outcome of favorable neurological function with instructions to give compression-only CPR compared with instructions to give compressions and ventilations at a ratio of 15:2 (RR, 1.25; 95% CI, 0.94–1.66; RD 2.86, -0.80–6.53). A meta-analysis of three RCTs[46-48] showed no survival benefit from instructions to give compression-only CPR compared with giving instructions for compressions and ventilations at a 15:2 ratio (RR, 1.20; 95% CI, 1.00–1.45; RD 1.88, 95% CI, -0.05–3.82).[28] A strong recommendation is made by ILCOR that dispatchers provide instructions to perform continuous chest compressions (i.e., compression-only CPR) to callers for adults with suspected out-of-hospital cardiac arrest (low-certainty evidence).[28]

Insights and Implications

The low-certainty evidence, when combined with the stakeholder value placed on initiating bystander CPR and compared with potential harms of CPR on patients not in cardiac arrest, support the discordant strong recommendation for use of dispatch CPR instructions.[28] In the era of COVID-19 and awareness of transmission of infectious disease, compression-only CPR has become even more relevant. See Chapter 9, Guidance During COVID-19 Pandemic.

Ventilations for Patients with Respiratory Insufficiency or an Advanced Airway

The rate at which ventilations are provided in the absence of sufficient respiratory effort but with perfusion and during CPR has been discussed in prior guidelines. There has also been debate about whether there should be a universal approach or whether there should be alterations for children and infants. Lastly, the use of bag-mask ventilation (BMV) and pocket masks have been a source of prior debate.

Red Cross Guidelines

- For adults, 1 ventilation should be provided every 6 seconds for a person with a pulse but insufficient respiratory effort, and during CPR with an advanced airway in place.

- For children and infants, 1 ventilation should be provided every 2 to 3 seconds for a child or infant with a pulse but insufficient respiratory effort, and during CPR with an advanced airway in place.

- Bag-mask ventilation (BMV) should be performed as a two-person technique.

- When there is only one healthcare professional to provide ventilation, a pocket mask should be preferred over bag-mask ventilation.

Evidence Summary

The ventilation rate and providing ventilations with an advanced airway have been the subject of prior ILCOR and ARCSAC evaluations. There have been no recent reviews by ARCSAC or ILCOR with regard to adult ventilation rates and providing ventilation with an advanced airway. For pediatric ventilation rates, the rate has changed over the years in subsequent guidelines issues. A recently published multicenter cohort study[49] evaluated ventilation rates in 52 events requiring at least 1 minute of CPR in 47 intubated children, finding that higher ventilation rates (at least 30 breaths/minute in children under 1 year of age and 25 or more breaths/minute in older children) were associated with higher odds of ROSC and survival to discharge. The use of pocket mask versus bag-mask ventilation have been the subject of prior ARCSAC reviews and no new evidence was found to change these recommendations.

Insights and Implications

This single study was weighed by ARCSAC against the benefit of education of single ventilation rate for all resuscitation. Findings from the specific study population of intubated children in a pediatric intensive care unit may not be generalizable. However, children have a higher baseline respiratory rate and cardiac arrests are more commonly triggered by respiratory issues than for adults. Additionally, because cardiac arrests are so rare in children, it will be difficult to replicate this study. For these reasons, a new recommendation is made by ARCSAC to provide increased ventilation rates for children and infants in respiratory arrest and in cardiac arrest with an advanced airway in place.

Feedback for CPR Quality

Performance of high-quality CPR is important for beneficial clinical outcomes. Feedback devices are a means to potentially improve CPR quality and survival from cardiac arrest. This topic was reviewed by ILCOR in 2015[15] and updated for 2020 with no change in the treatment recommendation.[2] This topic was also reviewed by ARCSAC in 2017 and the ILCOR update correlates with this ARCSAC update.[1]

- Training services and EMS systems may consider using feedback devices during CPR performance.

- Instructors may choose to incorporate feedback devices during CPR training to improve CPR performance.

Evidence Summary

The 2020 ILCOR review[2] focuses exclusively on real-time CPR feedback and prompt devices regarding the mechanics of CPR quality (i.e., rate and depth of compressions and/or ventilations) compared with no real-time feedback and does not include CPR quality improvement programs. Feedback techniques included audiovisual feedback with visual feedback and corrective audio prompts; audio feedback (i.e., audio and tactile haptic feedback) indicating adequate chest compression depth and release but without corrective instructions; and metronome guidance for chest compression rate. Due to heterogeneity across studies, meta-analysis was not possible for any of the outcomes.

For studies of real-time audiovisual feedback, overall there was no benefit in terms of clinical outcomes from the use of audiovisual feedback devices.[2] One cluster RCT with 1,586 patients did not show improved survival with favorable neurological outcome with use of real-time feedback when compared with no use of real-time audiovisual feedback.[50] Four observational studies including 1,100 adult cardiac arrests provided very low-certainty evidence that did not show any benefit from use of real-time feedback on survival with favorable neurological outcome at various intervals.[51-54]

For the outcome of survival to hospital discharge, no difference was found with use of real-time feedback compared with no real-time feedback in one cluster RCT enrolling 1,586 patients,[50] and in six observational studies[51-53,55,56] with 1,592 patients, including one study[57] in children.[2]

For the outcome of chest compression rate, one cluster RCT[50] with 1,586 patients showed a significantly lower rate of chest compressions with use of feedback (-4.7/min; 95% CI, -6.4 to -3.0/min). Thus, CPR feedback devices may help limit compression rates that are too fast. This same RCT found greater compression depth with feedback (1.6 mm; 95% CI, 0.5–2.7) (cluster adjusted), but this was of questionable clinical significance, and the included observational studies reported variable effects on compression depth with use of feedback devices.[2] For the outcome of chest compression fraction, the same cluster RCT[50] with a cluster-adjusted analysis found a difference of +2% (66% compared with 64%; p=0.016) when CPR prompt devices were used, which is of questionable clinical significance. Results from observational studies were reported to be variable. Overall, the included evidence does not indicate a strong signal for clinically significant differences in CPR fraction associated with the use of audiovisual feedback in the patient and provider populations studies.[2]

Real-time audio feedback using a handheld CPR audio feedback device related to compression depth and release was studied in one RCT[58] in 900 in-hospital cardiac arrests. This was reported as showing benefit from the device for the outcome of survival to hospital discharge (RR, 1.90; 95% CI, 1.60–2.25; p<0.001; aRR, 25.56%; 95% CI, 19.22%–1.60%, or 91 more patients/1000 survived with the interventions [95% CI, 61 more/1000 to 126 more/1000 survived]).[2] Two RCTs[58,59] with 980 patients showed that audio feedback for chest compression depth and release increased ROSC. The Goharani RCT found the device increased survival (RR, 1.57; 95% CI, 1.38–1.78; p<0.001; aRR 24.22%; 95% CI, 17.79–30.36%; 58 more patients/1000 survived with the intervention; 95% CI, 38 more patients/1000 to 79 more/1000 survived with the intervention).[58] The second RCT[59] found an increased survival RR of 2.07 (95% CI, 1.20–3.29; p<0.001; aRR 37.50%; 95% CI, 15.7–54.68%, or 108 more patients/1000 survived; 95% CI, or 20 more patients/1000 to 232 more patients/1000 survived).[2]

For use of a metronome rate guidance device, two observational studies[60,61] did not find a benefit in the outcome of survival to 30 days with use of a metronome compared with no metronome use. Two observational studies evaluating ROSC for OHCA found no benefit from use of a metronome.[2]

A weak recommendation is made by ILCOR against the routine implementation of real-time CPR feedback devices as a stand-alone measure to improve resuscitation outcome, or in isolation from more comprehensive quality improvement initiatives (very low-certainty evidence).[2] In systems currently using real-time CPR feedback devices, it is suggested the devices may continue to be used given that there is no evidence suggesting significant harm.[2]

A scientific review by ARCSAC in 2013 also identified evidence supporting the use of CPR feedback/prompt devices during CPR as a training strategy to improve CPR skill acquisition and retention.[1] No new evidence has been found that would change this recommendation.

Insights and Implications

The evidence evaluated in the ILCOR review was primarily observational and at high risk of bias, and most studies did not show a statistically significant association between use of real-time feedback devices and improved clinical outcomes. The included higher certainty RCTs were at risk for methodological concerns. One more recent RCT[58] found improvement in survival with use of a feedback device but did not include CPR metrics, and thus the large effect size may reflect baseline poor quality CPR. There are cost, resource and training considerations for CPR feedback devices. Despite this, there was no strong signal of harm associated with use of CPR real-time feedback devices. ILCOR has made recommendations for optimal CPR on the basis of chest compression metrics, and these can be measured with CPR feedback devices.[2] Real-time feedback devices can also be used for training with manikins and during debriefing following cardiac arrest.

Debriefing

Debriefing following delivery of CPR is a strategy to potentially increase the quality of resuscitation.

Red Cross Guidelines

- Debriefings following a resuscitation should be conducted to reinforce positive actions and to identify system issues for improvement.

Evidence Summary

The use of cardiac arrest debriefing has been associated with a significant improvement in CPR quality and ROSC[62] and associated with improved survival to discharge.[63] In addition, expert opinion and standard of performance improvement support the use of debriefing to reinforce team behavior and identify areas for improvement.

Insights and Implications

Two forms of debriefing are common. Immediate or "hot" debriefing occurs immediately following an event and may include individuals or teams. "Cold" debriefing is the delayed provision of feedback. Both strategies may be viewed as learning opportunities and useful for improving the quality of resuscitation.

Mechanical CPR Devices

A scientific review by ARCSAC updated in 2019 evaluated the use of mechanical CPR (mCPR) devices compared with standard CPR in adults with cardiac arrest for clinical outcomes.[1]

Red Cross Guidelines

- Healthcare professionals may consider the use of mechanical CPR (mCPR) devices if the response team is practiced and adept at rapid application with less than 10 second interruption in chest compressions.

- Application of mCPR should not delay initiation of manual chest compressions.

Evidence Summary

A total of 15 studies were included in the 2019 ARCSAC review. One identified systematic review[64] concluded that mCPR devices may improve outcomes for in-hospital cardiac arrest, but quality of evidence supporting this was very low. A second included systematic review from 2015[65] concluded that existing studies do not suggest that mCPR devices are superior to manual chest compression for OHCA.

Insights and Implications

Although there is no apparent survival benefit from use of mCPR devices and evidence suggests some worse outcomes with use of a mCPR device, there are some cases of OHCA that will likely benefit from prolonged CPR and resuscitation, such as hypothermia, toxicological and pulmonary embolism-induced cardiac arrest, and OHCA with prolonged transport times.

Harm from CPR to Persons Not in Cardiac Arrest

Does the provision of chest compressions by lay responders to adults and children who are not in cardiac arrest in the out-of-hospital setting, compared with not using chest compressions, change outcomes of survival, complications, major bleeding, or risk of complications?

Red Cross Guidelines

- Lay responders should begin CPR based on their assessment and without concern for harm to persons not in cardiac arrest.

Evidence Summary

A 2020 ILCOR systematic review and CoSTR[2] on this topic included four observational studies with 762 patients in the out-of-hospital setting who were not in cardiac arrest but received CPR by lay rescuers. Data pooled from three retrospective record reviews[66-68] of 345 patients identified a single case of rhabdomyolysis, a 1.7% (95% CI, 0.4–3.1%) incidence of rib and clavicle fracture, pain in the area of chest compression in 8.7% (95% CI, 5.7–11.7%), and no clinically relevant visceral injury. A fourth observation study[69] reported no injures in 417 patients based on fire department scene observations.[2] This 2020 ILCOR review is in agreement with prior ARCSAC reviews.[1]

A strong recommendation is made by ILCOR that lay persons initiate CPR for presumed cardiac arrest without concerns of harm to patients not in cardiac arrest.

Insights and Implications

The strong ILCOR recommendation, despite the limited and very low-certainty evidence, reflects the potential survival benefits from CPR initiated by lay responders for those in cardiac arrest, as compared with the low risk of injury should a person not be in cardiac arrest when CPR is performed. Lay responders who believe a person is in cardiac arrest should be encouraged and supported in their efforts to provide CPR.

Automated External Defibrillation Use in Children and Infants

An evidence update by ILCOR [26] in 2020 did not identify any significant new literature since 2010 related to the use of AEDs for children and infants with OHCA or provide evidence to change prior ARCSAC reviews and existing guidelines.

Red Cross Guidelines

- If a child or infant is in cardiac arrest, begin CPR and initiate AED use as soon as one is available.

- For infants and children 8 years of age or younger or 55 pounds (25 kg) or less, an AED with a pediatric attenuator or pediatric settings should be used if available.

- If an AED with a pediatric attenuator or pediatric settings is not available, a standard AED should be used for infants and children 8 years of age or younger or 55 pounds (25kg) or less.

Evidence Summary

No new evidence was identified by ARCSAC or ILCOR suggesting a need for systematic review or change in treatment recommendations. ILCOR recommends that for the treatment of infants in the out-of-hospital setting with ventricular fibrillation or pulseless ventricular tachycardia, use of an AED with demonstrated high specificity and sensitivity for detecting shockable rhythms in infants, using, in order of preference, a manual defibrillator, and AED with a dose attenuator, or an AED without a dose attenuator.[26]

Insights and Implications

The use of an AED remains a critical component of child and infant cardiac arrest care. AEDs work the same way regardless of the patient's age, but the setting used for children and infants differs, as does pad placement, based on the size of the child and infant.

Analysis of Rhythm During Chest Compressions

Typically, cardiac rhythm is checked during a pause in chest compressions. Does analysis of cardiac rhythm (such as with artifact-filtering algorithms) during compressions for cardiac arrest change clinical outcomes?

Red Cross Guidelines

- Compressions should be paused for rhythm analysis, even when using devices with artifact-filtering algorithms.

Evidence Summary

A 2015 ILCOR systematic review and CoSTR on this topic[15] was updated in 2020.[2] This review sought to determine the effect of analysis of cardiac rhythm during chest compressions, as compared with analysis of rhythm during pauses in chest compressions, on various clinical outcomes and CPR metrics. No human studies were identified addressing the outcomes of favorable neurological outcome, survival or ROSC, or metrics including CPR quality, time to commencing CPR or time to first shock. Only animal and simulation studies were identified evaluating artifact-filtering algorithms.

A weak recommendation is made by ILCOR against the routine use of artifact-filtering algorithms for analysis of electrocardiographic rhythm during CPR and that their usefulness be assessed in clinical trials or research initiatives.[15]

Insights and Implications

This ILCOR recommendation is a change from 2015, when it was suggested that it would be reasonable for EMS systems using integrated artifact-filtering algorithms in clinical practice to continue with their use.

Rhythm Check Timing

Prolonged pauses during CPR have been shown to be associated with lower odds for survival from ventricular fibrillation. Should cardiac rhythm be analyzed immediately after defibrillation, or should there be immediate resumption of chest compressions with delayed check of the cardiac rhythm?

Red Cross Guidelines

- Immediately after a shock is delivered, CPR should be resumed for 2 minutes before pausing compressions to conduct a rhythm check.

- Based on the clinical situation, performing rhythm analysis after defibrillation may be considered by healthcare professionals.

- After every 2 minutes of CPR, the rhythm should be reassessed (while minimizing interruptions to CPR).

- If there are physiologic signs of ROSC, briefly pausing compressions for rhythm analysis may be considered.

Evidence Summary

A 2019 ILCOR systematic review and CoSTR[2] evaluated a cardiac rhythm check immediately after defibrillation compared with the immediate resumption of chest compressions after defibrillation in adults with in-hospital cardiac arrest (IHCA) or out-of-hospital cardiac arrest (OHCA) and receiving a defibrillation attempt during CPR. Evidence included was of low or very low certainty due to risk of bias, indirectness, or imprecision. None of the included studies were from the in-hospital or pediatric setting. The review[2] identified one RCT with 415 OHCAs showing no improvement in survival with favorable neurologic outcome at discharge following interruption of chest compressions to check cardiac rhythm immediately after shock delivery (RR, 0.90; 95% CI, 0.7–1.15),[70] while three observational studies [39,71,72] of 763 OHCAs showed an association between decreased survival with favorable neurologic outcome at discharge and interrupting chest compressions for a rhythm check immediately after defibrillation. Similar findings were reported for the outcome of survival to hospital admission. Two RCTs[70,73] with 551 OHCAs did not show a reduction in the rate of recurrence of ventricular fibrillation with interruption of chest compressions to check cardiac rhythm immediately after defibrillation compared with the immediate resumption of compressions (RR, 1.08; 95% CI, 0.95–1.22).[2]

A weak recommendation is made by ILCOR for the immediate resumption of chest compressions after shock delivery for adults in cardiac arrest in any setting.[2] If there is alternative physiologic evidence of ROSC, chest compressions can be briefly paused for rhythm analysis.[2]

Insights and Implications

The interruption of chest compressions during CPR to perform rescue breaths, rhythm analysis, pulse checks and defibrillation all reduce chest compression fractions, leading to decreased coronary and cerebral blood flow and the potential for decreased survival[74]; this has led to the concept of continuous chest compressions (CPR without pauses) and research into artifact-filtering algorithms for analysis of electrocardiographic rhythm during CPR. This systematic review, although based on low-certainty and very low-certainty evidence, suggests potential harm associated with an immediate check for cardiac rhythm following defibrillation. There may be unique situations where an analysis is warranted. As such, healthcare professionals may in these cases consider rhythm analysis.

Alternative Techniques

Red Cross Guidelines

- A precordial thump and "fist pacing" should not be used for cardiac arrest.

- "Cough CPR" should not be used for cardiac arrest.

Evidence Summary

This topic was reviewed by ILCOR in 2010[19] and included use of "cough CPR," precordial thumps, and "fist pacing" compared with standard CPR. An updated review and CoSTR were completed in 2020[2] and were limited to adults.

For the use of cough CPR, one in-hospital cohort study[75] reported the use of cough CPR in six in-hospital patients to terminate ventricular tachycardia, and all six survived to hospital discharge. Additional case series from the cardiac catheter laboratory and CCU described the use of cough CPR to remain conscious during VF, asystole, or high-grade AV block until defibrillation or return of the patient's own rhythm.[2]

Evidence for the role of precordial thump comes from observational studies of very low certainty due primarily to a very serious risk of bias. As such, the individual studies were felt to be difficult to interpret and meta-analysis was not possible. Results varied but no association was identified between use of a precordial thump and outcomes of survival to hospital discharge and ROSC.[2] Very low-certainty evidence from one observational study suggested that the use of a precordial thump could compromise first shock success.[76]

Evidence regarding fist pacing was limited to case series of patients in asystole or bradycardia and reported ROSC with fist pacing, but were at very serious risk of bias and results are difficult to interpret.[2]

A strong recommendation is made by ILCOR against the use of cough CPR for cardiac arrest.[2] It is suggested that cough CPR may be considered as a temporizing measure in an exceptional circumstance in a witnessed, monitored, in-hospital setting, such as a cardiac catherization laboratory, if a non-perfusing rhythm is recognized promptly before loss of consciousness.[2]

A strong recommendation is made by ILCOR against the use of a precordial thump and against fist pacing for cardiac arrest.[2] It is suggested that fist pacing only be considered as a temporizing measure in an exceptional circumstance in a witnessed, monitored, in-hospital setting, such as a cardiac catheterization laboratory if a non-perfusing rhythm is recognized promptly before loss of consciousness.[2]

Insights and Implications

The ILCOR recommendations are unchanged from 2010, with the exception of clarifying the exceptional circumstances when cough CPR and fist pacing might be appropriate.

Termination of Resuscitation Rules

Termination of resuscitation (TOR) by prehospital professionals is often guided by a set of rules adopted by emergency medical service systems.

Red Cross Guidelines

- It is reasonable for prehospital systems to include termination of resuscitation (TOR) rules in their medical protocols.

Evidence Summary

A systematic review by ILCOR in 2020 evaluated the use of termination of resuscitation (TOR) rules for their ability to reliably predict in-hospital outcomes of death and unfavorable neurologic outcome following OHCA.[77] Studies included were reported to describe the derivation and internal validation of individual TOR rules, or the external validation of previously published TOR rules. Only a single study addressed clinical validation of a TOR rule.

Based on the consensus of science from this review, ILCOR made a conditional recommendation for the use of TOR rules to assist clinicians in deciding whether to discontinue resuscitation efforts out-of-hospital, or to transport to a hospital with ongoing CPR.[77]

Insights and Implications

Widespread implementation of TOR rules following cardiac arrest has occurred in many EMS systems. These rules typically include criteria such as, an unwitnessed arrest by EMS of bystanders; no bystander CPR; no defibrillation delivered; and no ROSC. The ability to discontinue resuscitation has the potential to preserve the dignity of recently deceased, to reduce EMS transport rates and risks for EMS professionals, to reduce stress on healthcare resources, and to provide a significant savings in healthcare costs. The potential for misclassifying eventual survivors with TOR rules is a legitimate concern for clinicians. A 2019 meta-analysis of nine different TOR rules addressed this concern by evaluating the accuracy of several TOR rules for OHCA.[78] The Basic Life Support (BLS) and European Resuscitation Council (ERC) TOR rules were found in this meta-analysis to identify a large proportion of candidates for TOR after OHCA (ERC, 95%; BLS, 97%) while having a very low rate of misclassifying eventual survivors (<0.1%), but it was felt that further prospective validation of the ERC TOR was needed, along with comparative studies with the BLS TOR rule.[78]

Mental Health Referral for Team Members Following a Resuscitation

Red Cross Guidelines

- Critical incident stress debriefing (CISD) and critical incident stress management (CISM) should not be used following a resuscitation.

- One should consider referral to a qualified mental health professional for lay responders and healthcare professionals after a resuscitation.

Evidence Summary

The ARCSAC initially reviewed this topic in 2010. The evidence since this review has not altered the recommendations.

Insights and Implications

Mental health treatment can be of benefit for some lay responders and healthcare professionals following a resuscitation or other stressful event and can help them to cope with stress and prevent anxiety or depression. Treatment should not be perceived as a weakness but rather an adjunct to other coping strategies.

Foreign Body Airway Obstruction Care

Are any techniques for removing a foreign body obstruction more effective and safer than other techniques?

Red Cross Guidelines

- Lay responders or healthcare professionals attempting to resolve a complete foreign body airway obstruction in a conscious adult or child should first provide up to 5 back blows until the foreign body is relieved or, if not relieved, transition to up to 5 abdominal and/or chest thrusts. If the foreign body is not relieved, they should continue with cycles of 5 back blows followed by 5 abdominal and/or chest thrusts until the obstruction is relieved.

- Lay responders or healthcare professionals attempting to resolve a complete foreign body airway obstruction in a conscious infant should first provide up to 5 back blows until the foreign body is relieved or, if not relieved, transition to up to 5 chest thrusts. If the foreign body is not relieved, they should continue with cycles of 5 back blows followed by 5 chest thrusts until the obstruction is relieved.

- Lay responders or healthcare professionals attempting to resolve a complete foreign body airway obstruction in an unconscious adult, child or infant should provide cycles of CPR (compressions and ventilations) with an additional step. After each set of compressions and before ventilations, open the mouth, look for an object, and if seen, remove it with a finger sweep. Never do a finger sweep if an object is not seen.

- Healthcare professionals with appropriate training may consider the use of Magill forceps to remove a foreign body obstructing the airway.

Evidence Summary

A 2020 ILCOR systematic review[79] and CoSTR[2] evaluated interventions to remove foreign body airway obstruction in adults and children with foreign body airway obstruction (FBAO) in any setting using finger sweeps, back blows/slaps, abdominal thrusts, chest thrusts and suction-based airway clearance devices. Outcomes included survival, survival with good neurological outcome, ROSC, relief of airway obstruction, injury, and complications. The 2020 ILCOR review agrees with existing ARCSAC reviews on this topic.

Back Blows/Slaps

Observational studies were identified for the outcomes of survival, relief of FBAO, and injuries/complications but were judged to be at very serious risk of bias and to have a high degree of heterogeneity. Thus, meta-analysis was not performed, and results of individual studies were felt to be difficult to interpret. Very low-certainty evidence from one case series reported survival in 13 children under the age of 5 treated for FBAO with the use of back blows.[80] Three case series reported relief of FBAO in 75 persons with the use of back blows.[80-82] Four case reports[83-86] describe injuries/complications in persons who received back blows.[2]

Abdominal Thrusts

The review of abdominal thrusts for FBAO[2] identified observational studies evaluating outcomes of survival, relief of FBAO, and injuries or complications, with an overall very low certainty of evidence due primarily to very serious risk of bias due to confounding for the individual studies. No meta-analysis was performed because of this and heterogeneity. Two case series reported survival in 189 persons treated using abdominal thrusts; six case series reported relief of FBAO in 417 persons cared for using abdominal thrusts, and 49 case reports identified 52 reports of injuries/complications in those cared for using abdominal thrusts.[2]

Chest Thrusts/Compressions

Only observational studies were identified evaluating use of chest thrusts and compressions for the outcomes of survival with favorable neurological outcome, relief of FBAO, and injuries/complications.[2] Because of heterogeneity and very serious risk of bias due to confounding, meta-analysis was not performed, and results of individual studies were felt difficult to interpret. Very low-certainty evidence from one observational study[87] of 138 persons with FBAO was reported to show benefit for the outcome of survival with favorable neurological outcome with use of chest thrusts/compressions compared with control. One case series reported 28 cases with relief of FBAO using chest thrusts/compressions, while four studies reported five cases of injuries/complications following use of chest thrusts/compressions for FBAO.[2]

Finger Sweep

Only observational studies were identified for the outcomes of survival, relief of FBAO, and injuries/complications. Because of heterogeneity and very serious risk of bias due to confounding, meta-analysis was not performed, and it was felt that individual studies were difficult to interpret. One case series was included that reported survival in six FBAOs with use of a finger sweep, while two case series reported relief of 36 FBAOs with use of a finger sweep. Injuries/complications were reported in 10 cases of FBAO from eight case reports following blind finger sweeps.[2]

Magill Forceps

One observational study enrolled 240 FBAOs and reported an association with increased survival with favorable neurological outcome with the use of Magill forceps by EMS personnel compared with no use of Magill forceps (RR, 3.96; 95% CI, 1.12–13.00; 107 more/1000 survived with the intervention, 95% CI, 8 more persons/1000 to 324 more/1000 survived with the intervention).[88] This same study did not show a benefit from the intervention for the outcomes of survival. Four case series reported relief of FBAO in 417 patients treated with Magill forceps.[2]

Suction-Based Airway Clearance Devices

A single convenience sample case series with very low-certainty evidence reported survival and relief of FBAO in nine adults with use of a suction-based airway clearance device.[2]

FBAO Removal by Bystanders

A single observational study[81] with very low-certainty evidence from 41 patients with FBAO found benefit for the outcome of survival with favorable neurological outcome following FBAO removal by bystanders (74% versus 32% in the control, p=0.0075).[2]

A weak recommendation is made by ILCOR[2] for the initial use of back slaps in persons with FBAO and an ineffective cough. It is suggested that abdominal thrusts be used in adults and children with an FBAO and an ineffective cough where back slaps are ineffective.[2]

It is suggested by ILCOR that[2]:

- Rescuers consider the manual extraction of visible items in the mouth, and is it suggested to not use a blind finger sweep with FBAO.

- Appropriately skilled individuals consider the use of Magill forceps to remove FBAO in OHCA with an FBAO.

- Chest thrusts are used in unconscious persons with an FBAO.

- Bystanders undertake interventions to support FBAO removal as soon as possible after recognition.

An updated scientific review by ARCSAC[1] on FBAO completed in 2019 included additional case series and reports describing successful use of back blows/slaps, chest thrusts and abdominal thrusts, as well as one study in healthy volunteers that evaluated airway pressure changes during different methods of applying abdominal thrusts. No change was made to guidelines with this updated review.

Insights and Implications

The Red Cross guidelines and ILCOR recommendations are similar for the initial efforts to resolve a complete FBAO with use of back slaps/blows. Red Cross provides the option for abdominal and/or chest thrusts and provides guidance for management of unconscious patients with complete foreign body airway obstruction using CPR, similar to treating any other unresponsive person who is not breathing normally. The ILCOR systematic review noted reports of harm associated with use of back blows, abdominal thrusts, chest thrusts/compressions and blind finger sweeps and suggests that management should balance the benefits and harms of interventions.[79] In conscious individuals, ILCOR also notes that encouraging coughing at first may be effective and is felt unlikely to cause harm.[2] Use of CPR for an unconscious patient is a simple method to allow lay responders and healthcare professionals to incorporate the techniques of assessment, chest thrusts, finger sweeps as indicated, and re-assessment.

Opioid-Associated Emergency Resuscitation

Does lay responder naloxone administration in addition to standard CPR for adults and children with suspected opioid-associated cardio/respiratory arrest in the out-of-hospital setting compared with conventional CPR only improve outcomes of survival to hospital discharge (with/without good neurological outcomes) and ROSC?

Red Cross Guidelines

- CPR and AED use remain the first interventions for cardiac arrest in opioid overdose and should not be delayed or interrupted.

- For suspected cardiac arrest due to opioids, naloxone should be administered as soon as possible without disrupting or delaying CPR and AED use.

Evidence Summary

This topic was reviewed by ARCSAC in 2017.[1] The review found no specific literature on the subject, but expert recommendation concluded that If opioids are suspected, naloxone should be administered as soon as possible without disrupting or delaying any other resuscitation effort. High performance CPR and AED use are still the most important therapy for cardiac arrest and should not be delayed or interrupted. If opioids are suspected, administer naloxone at the first convenient break point (e.g., provider swap), provided the delivery system will not cause a longer than 10-second hands-off time.

A 2020 ILCOR systematic review and CoSTR did not identify any RCTs or nonRCTs that reported on the selected outcomes in any setting.[2]

A weak recommendation was made by ILCOR based on expert opinion that CPR be started without delay in any unconscious person not breathing normally, and that naloxone be used by lay rescuers in suspected opioid-related respiratory or circulatory arrest.[2]

Insights and Implications

Although no direct evidence was identified in the ILCOR review to support the treatment recommendation, the authors of the ILCOR review[2] noted a summary review that included four studies of naloxone lay administration effectiveness with 66 witnessed opioid overdose events.[89] Of the 66 witnessed events, 39 (59.1%) recovered following naloxone administration by a lay provider, 22 (33.3%) recovered without the administration of naloxone, and three deaths occurred among 27 instances when naloxone was not administered (an 11.1% mortality rate). The outcome of two (3%) witnessed events was unknown.[2]

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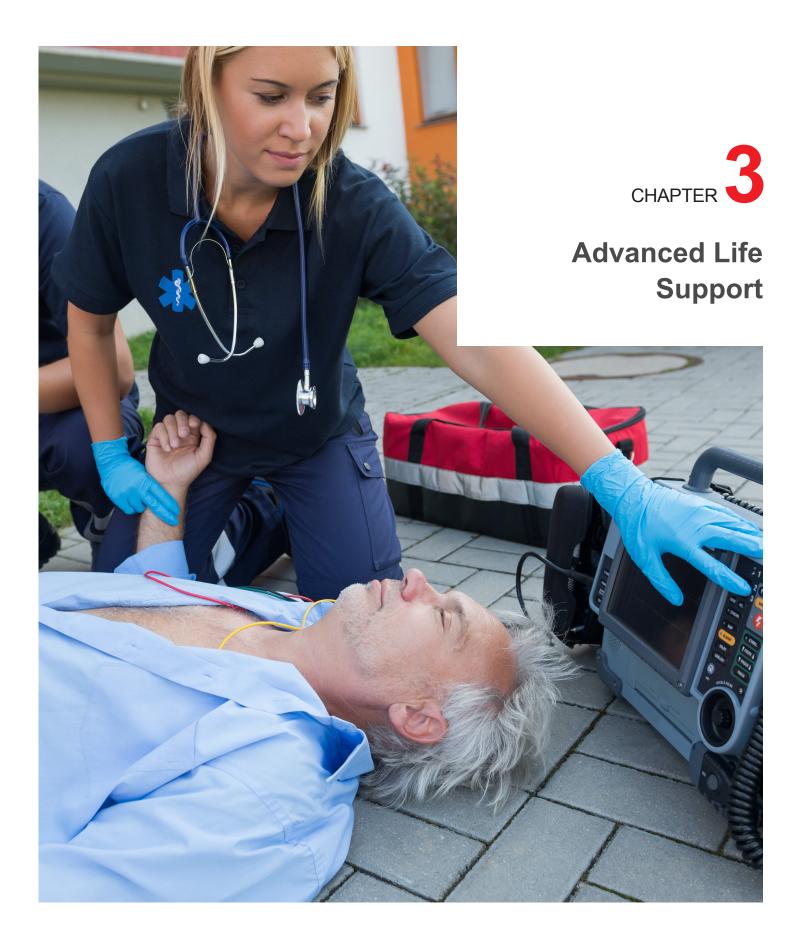
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Advanced Life Support

Cardiopulmonary Resuscitation

Assessment

Rapid assessment begins with performing a visual survey, checking for responsiveness and life-threatening bleeding, opening the airway and simultaneously checking for breathing and a pulse. The use of a mnemonic can be helpful for learning and recalling the sequence for assessment and initial actions.

Red Cross Guidelines

- The A-B-C mnemonic, which has universal application in all settings, should be used for assessment and initial actions.

- Early assessment for life-threatening bleeding should be performed.

- In an adult with no signs of life (unconscious/unresponsive) and with abnormal or no breathing, healthcare professionals should check a carotid pulse for no more than 10 seconds and if absent presume the person is in cardiac arrest.

Evidence Summary

ARCSAC reviewed this topic in 2020[1] and a joint AHA and Red Cross statement on this topic was issued in 2012. No change to the guidelines are needed based on this review.

Insights and Implications

Early assessment for life-threatening bleeding is performed with the check for responsiveness. The A-B-C mnemonic is a universal means to recall and perform assessment and initial actions, including opening of the airway (A), checking for the presence or absence of normal breathing (B), and, for healthcare professionals, the simultaneous assessment for circulation (C) by a pulse check, or for lay responders, beginning compressions (C).

Analysis of Rhythm During Chest Compressions

Typically, cardiac rhythm is checked during a pause in chest compressions. Does analysis of cardiac rhythm during compressions (such as with CPR artifact-filtering methods) for cardiac arrest change clinical outcomes?

Red Cross Guidelines

- Compressions should be paused for rhythm analysis, even when using devices with artifact-filtering algorithms.

Evidence Summary

A 2015 ILCOR systematic review and CoSTR on this topic[2] was updated in 2020.[3] This review sought to determine the effect of analysis of cardiac rhythm during chest compressions, as compared with analysis of rhythm during pauses in chest compressions, on various clinical outcomes and CPR metrics. No human studies were identified addressing the outcomes of favorable neurological outcome, survival or ROSC, or metrics including CPR quality, time to commencing CPR, or time to first shock. Only animal and simulation studies were identified evaluating artifact-filtering algorithms.

A weak recommendation is made by ILCOR against the routine use of artifact-filtering algorithms for analysis of electrocardiographic rhythm during CPR and that their usefulness be assessed in clinical trials or research initiatives.

Insights and Implications

The ILCOR recommendation is a change from 2015, when it was suggested that it would be reasonable for emergency medical services (EMS) systems using integrated artifact-filtering algorithms in clinical practice to continue with their use. There may be unique situations where an analysis is warranted. As such, healthcare professionals may in these cases consider rhythm analysis.

Rhythm Check Timing

Prolonged pauses during CPR have been shown to be associated with lower odds for survival from ventricular fibrillation. Should cardiac rhythm be analyzed immediately after defibrillation, or should there be immediate resumption of chest compressions with delayed check of the cardiac rhythm?

Red Cross Guidelines

- Immediately after a shock is delivered, CPR should be resumed for 2 minutes before pausing compressions to conduct a rhythm check.

- Based on the clinical situation, performing rhythm analysis after defibrillation may be considered by healthcare professionals.

- After every 2 minutes of CPR, the rhythm should be reassessed (while minimizing interruptions to CPR).

- If there are physiologic signs of return of spontaneous circulation (ROSC), briefly pausing compressions for rhythm analysis may be considered.

Evidence Summary

A 2019 ILCOR systematic review and CoSTR[3] evaluated a cardiac rhythm check immediately after defibrillation compared with the immediate resumption of chest compressions after defibrillation in adults with in-hospital cardiac arrest (IHCA) or out-of-hospital cardiac arrest (OHCA) and receiving a defibrillation attempt during CPR. Evidence included was of low or very low certainty due to risk of bias, indirectness, or imprecision. None of the

included studies were from the in-hospital or pediatric setting. The review[3] identified one RCT with 415 OHCAs showing no improvement in survival with favorable neurologic outcome at discharge following interruption of chest compressions to check cardiac rhythm immediately after shock delivery (RR, 0.90; 95% CI, 0.7 –1.15),[4] while three observational studies[5-7] of 763 OHCAs showed an association between decreased survival with favorable neurologic outcome at discharge and interrupting chest compressions for a rhythm check immediately after defibrillation. Similar findings were reported for the outcome of survival to hospital admission. Two RCTs[4,8] with 551 OHCAs did not show a reduction in the rate of recurrence of ventricular fibrillation with interruption of chest compressions to check cardiac rhythm immediately after defibrillation compared with the immediate resumption of compressions (RR, 1.08; 95% CI, 0.95–1.22).[3]

A weak recommendation is made by ILCOR for the immediate resumption of chest compressions after shock delivery for adults in cardiac arrest in any setting.[3] If there is alternative physiologic evidence of ROSC, chest compressions can be briefly paused for rhythm analysis.[3]

Insights and Implications

The interruption of chest compressions during CPR to perform rescue breaths, rhythm analysis, pulse checks and defibrillation all reduce chest compression fractions, leading to decreased coronary and cerebral blood flow and the potential for decreased survival[9]; this has led to the concept of continuous chest compressions (CPR without pauses) and research into artifact-filtering algorithms for analysis of electrocardiographic rhythm during CPR. This systematic review, although based on low-certainty and very low-certainty evidence, suggests potential harm associated with an immediate check for cardiac rhythm following defibrillation.

Physiologic Monitoring and Feedback for CPR Quality

Performance of high-quality CPR is important for beneficial clinical outcomes. Physiologic parameters may be used for monitoring during CPR as well as in the post-ROSC period.

Red Cross Guidelines

- Healthcare professionals may consider using end-tidal CO_2 and/or arterial blood pressure to evaluate CPR quality and adjust CPR performance.

Evidence Summary

A scoping review by ILCOR in 2020 searched for evidence related to the use of physiologic feedback in regard to CPR quality, including use of arterial catheters, $ETCO_2$ monitoring, pulse oximetry, and waveforms.[10] Evidence thus far is limited on whether use of these parameters improves outcomes.

The scoping review identified a single observational propensity-matched cohort study of adult IHCA that reported a higher rate of ROSC in those patients with physiologic monitoring by $ETCO_2$ or arterial catheter, but no difference in survival to discharge or survival with favorable neurological outcome.[10] An additional scoping review identified two systematic reviews that concluded that a higher cerebral oxygen saturation measured with near-infrared spectroscopy (NIRS) is associated with a higher chance of ROSC and survival, while a lower NIRS is associated with an increase in mortality.[10]

Details for use of oximetry and end-tidal CO_2 target levels in the post-arrest period can be found in the section, Oxygen and Carbon Dioxide Targets After Return of Spontaneous Circulation.

Insights and Implications

While the published evidence since the 2015 ILCOR review[11] has not altered this recommendation, there have been registry and other reported system data that further support this guideline.

Vasopressors During Cardiac Arrest

Epinephrine is recommended during adult CPR in a 1-mg dose IV or IO every 3 to 5 minutes. It is a potent vasoconstrictor and is believed to increase coronary and cerebral perfusion pressure during CPR, but because of potential increased myocardial oxygen demand, there is concern that it may be proarrhythmic.[12]

Red Cross Guidelines

- Epinephrine 1 mg intravenous (IV) or intraosseous (IO) may be administered after initial defibrillation attempts are unsuccessful for cardiac arrest with a shockable rhythm and may be repeated every 3 to 5 minutes.

- For cardiac arrest with non-shockable rhythms, epinephrine should be administered at 1 mg IV or IO as early as possible, and repeated every 3 to 5 minutes.

- Vasopressin should not be used in place of epinephrine nor in addition to epinephrine for cardiac arrest.

Evidence Summary

A 2019 ILCOR systematic review evaluated the use of vasopressors in adults during resuscitation from OHCA.[13,14] For use of epinephrine compared with placebo for any initial rhythm, meta-analysis of two placebo-controlled trials[15,16] with 8,538 OHCAs found an increase in ROSC (RR, 3.09; 95% CI, 2.8–3.39; aRD, 24.3%; 95% CI, 21.1%–26.7%) and survival to discharge (RR, 1.44; 95% CI, 1.11–1.86; aRD, 1%; 95% CI, 0.2%–1.9%) with the use of epinephrine.[17] However, this same meta-analysis found no benefit from the use of epinephrine compared with placebo for hospital discharge with favorable neurologic outcome (RR, 1.2; 95% CI, 0.90–1.62; aRD, 0.4%; 95% CI, 0.2%–1.2%). When meta-analysis of the same two RCTs was performed for a subgroup of OHCA with an initial shockable rhythm, a beneficial effect was shown with epinephrine for ROSC (RR, 1.68; 95% CI, 1.48–1.92; aRD, 18.5%; 95% CI, 13%–25%) but not for the outcome of survival to hospital discharge.[13,14] For the subgroup analysis of OHCA with an initial non-shockable rhythm, meta-analysis showed a beneficial effect with use of epinephrine for survival to hospital discharge and for ROSC (RR, 4.45; 95% CI, 3.91–5.08; aRD, 25.4%; 95% CI, 21.4%–30.1%).[13,14] The effect of epinephrine on ROSC was greater for OHCAs with an initial non-shockable rhythm compared with shockable rhythms.

For the initial use of vasopressin compared with epinephrine in any rhythm, or when separated by initial rhythm, low-certainty evidence from included RCTs did not show a benefit from use of vasopressin compared with epinephrine for rates of hospital discharge with favorable neurologic outcome, survival to hospital discharge, or for ROSC.[13]

For epinephrine plus vasopressin compared with epinephrine only, for any initial rhythm, low-certainty evidence from included RCTs did not show a benefit from use of epinephrine with vasopressin compared with epinephrine alone for outcomes of hospital discharge with favorable neurologic status, survival to hospital discharge, survival to hospital admission, and for ROSC. Subgroup analysis by initial rhythm found no difference in the effect of the intervention on any of these outcomes.[13]

A strong recommendation is made by ILCOR for the administration of epinephrine during CPR. For non-shockable rhythms (PEA/asystole), a strong recommendation is made for the administration of epinephrine as soon as feasible during CPR.[13]

For shockable rhythms (ventricular fibrillation/ventricular tachycardia) ILCOR suggests that epinephrine be administered after initial defibrillation attempts are unsuccessful during CPR.[13]

ILCOR suggests against the administration of vasopressin in place of epinephrine during CPR and suggests against the addition of vasopressin to epinephrine during CPR.[13]

Insights and Implications

Although there was no benefit or harm shown for the use of epinephrine plus vasopressin or vasopressin alone compared with epinephrine, the suggestion by ILCOR to use epinephrine only was made to minimize the complexity of treatment algorithms.[13] Concern has been expressed that the use of epinephrine for cardiac arrest may result in higher rates of ROSC, but with unfavorable neurological status. It is the opinion of ARCSAC that the potential survival benefit from use of epinephrine for OHCA is paramount, particularly as post-resuscitation care and techniques such as targeted temperature management evolve.

The standard dose of epinephrine used in the included RCTs was 1 mg. This review did not compare different doses of epinephrine. A previous 2015 ILCOR review compared standard (1 mg) dosing of epinephrine with high-dose epinephrine and recommended against the use of high-dose epinephrine.[11] Because the effect of epinephrine on ROSC and survival to hospital discharge appears more pronounced for non-shockable rhythms compared with shockable rhythms, and because there are limited alternative interventions, it was recommended by ILCOR that epinephrine be administered as soon as feasible for non-shockable rhythms.

No evidence was identified in this review to compare the use of epinephrine with placebo for in-hospital cardiopulmonary arrest.

Double Sequence Defibrillation

Does the use of double (or dual or sequential) manual defibrillation for adults with IHCA or OHCA and a shockable ventricular fibrillation/pulseless ventricular tachycardia (VF/pVT) arrest rhythm, compared with standard manual defibrillation, change clinical outcomes of survival, ROSC or termination of VF/pVT?

Red Cross Guidelines

- Standard defibrillation rather than double sequence defibrillation should be used for cardiac arrest with a shockable rhythm.

Evidence Summary

A 2020 ILCOR systematic review[18] and CoSTR[10] addressed this question. Observational studies were identified with very low-certainty evidence for all outcomes due primarily to a very serious risk of bias due to confounding. Additional heterogeneity prevented meta-analysis. Results from individual studies were not reported but were felt to show an association between double defibrillation and lower rates of survival and favorable neurological outcome.[18]

A weak recommendation is made by ILCOR against the routine use of dual (or double) sequential defibrillation strategy in comparison with a standard defibrillation strategy for cardiac arrest with a shockable rhythm.[18]

Insights and Implications

Survival from refractory VF is reported to have a functionally favorable survival rate of 8% to 15%, compared with a rate of 29% for VF/VT cardiac arrest.[19] Case reports of survival from refractory ventricular fibrillation using double sequential defibrillation are thus encouraging but likely to represent publication bias. In addition, the technique has no agreed standard approach, requires the availability of two defibrillators, and risks potential harm from excessive shock energy.

Intravenous Versus Intraosseous Administration of Drugs During Cardiac Arrest

The intraosseous (IO) route is commonly used for cardiac arrest when intravenous (IV) access is not readily available or following failed attempts at IV access.

Red Cross Guidelines

- Intraosseous access may be considered as an alternative to intravenous (IV) access in emergency situations when IV access is unsuccessful or not feasible.

Evidence Summary

An ILCOR systematic review[20] and CoSTR[10] compared placement of an IO cannula and drug administration through this IO access during cardiac arrest with placement of an IV cannula and drug administration through the IV access during cardiac arrest in adults in the in-hospital or out-of-hospital setting. Outcomes included ROSC and survival to hospital discharge.

Studies included in the review are all observational, providing very low-certainty evidence. Three studies[21-23] including 24,686 adult OHCAs were reported to show 61 fewer per 1,000 cardiac arrests with ROSC associated with use of IO access compared with IV access (aOR, 0.74; 95% CI, 0.67–0.81; aRD, -6.1%; 95% CI, -2.7 to -0.5). These same three studies showed 17 fewer per 1,000 cardiac arrests survived to hospital discharge (95% CI, 27 fewer to 5 fewer) with IO access compared with IV access (aOR, 0.79; 95% CI, 0.66–0.93; aRD, -1.7%; 95% CI, -2.7 to -0.5).[20]

A weak recommendation is made by ILCOR for the use of IV access compared with IO access as the first attempt for drug administration during adult cardiac arrest. If attempts at IV access are unsuccessful or IV access is not feasible, IO access is suggested as a route for drug administration during adult cardiac arrest.[10]

Insights and Implications

Very low-certainty evidence from three observational studies suggests improved outcomes with the administration of medications intravenously during resuscitation from cardiac arrest compared with intraosseous administration. Thus, for adults, the intraosseous route should be reserved for cases where IV access is difficult, impossible, or not readily available.

Prognostication with Point-of-Care Echocardiography During CPR

A 2020 ILCOR systematic review[24] and CoSTR[10] evaluated prognostication with use of point-of-care echocardiography during CPR in adults with nontraumatic in-hospital or out-of-hospital cardiac arrest.

Red Cross Guidelines

- Point-of-care ultrasonography may be considered for assessment of reversible etiologies of cardiac arrest.

- Point-of-care ultrasonography should not have a role in prognostication for cardiac arrest.

Evidence Summary

All 15 studies in the ILCOR review were observational, and the overall certainty of evidence was rated as very low for multiple reasons including a high risk of bias.[10] Meta-analysis was not performed due to this and heterogeneity. There was difficulty in terms of the definition of cardiac motion as seen during point-of-care (POC) echocardiography, and the reviewers noted that a standardized definition of cardiac motion is needed for future studies.[10] The studies reported a wide range of sensitivities (i.e., 0.06 to 0.91) and specificities for cardiac motion in association with outcomes such as favorable outcome at hospital discharge, survival to hospital admission or discharge, or ROSC.[24]

A weak recommendation by ILCOR suggests against using POC echocardiography for prognostication during CPR.[10]

Insights and Implications

Overall, this review did not identify a sonographic finding with sufficient and/or consistent sensitivity to apply to any clinical outcome for use as a sole criterion to terminate resuscitation. In addition, the use of POC echocardiography depends on the availability of both equipment and a skilled operator and introduces added cost and potential to interrupt compressions during a cardiac arrest. Despite this, POC echocardiography may be useful to diagnose certain causes of cardiac arrest that are treatable (i.e., tamponage, massive pulmonary embolism).

Post-Cardiac Arrest Care

Oxygen and Carbon Dioxide Target Levels After Return of Spontaneous Circulation

Following ROSC, the post-cardiac arrest period is a time when patients often require mechanical ventilation and when hypoxemia and hyperoxemia may be associated with brain injury.[25] Similarly, because carbon dioxide is a major regulator of cerebral blood flow and thus intracranial pressure, the targeting of oxygen and carbon dioxide levels through a ventilation strategy in intubated patients with ROSC may have a role in mitigating post-arrest brain injury and improving neurologic outcome.

Red Cross Guidelines

- High-flow supplemental oxygen should be provided until the oxygen saturation can be measured, and then should be provided at the minimal level of supplemental oxygen needed to maintain an oxygen saturation of at least 94% but not exceeding 99%.

- Ventilations should be provided, starting at a rate of 10 breaths per minute and adjusting as needed to keep the end tidal CO_2 between 35 and 40 mmHg and the $PaCO_2$ between 40 and 45 mmHg.

- The post-arrest patient should be monitored using capnography and pulse oximetry and, as available, PaO_2 and $PaCO_2$ to ensure ventilation and oxygenation levels are in the physiologic range.

Evidence Summary

Existing ARCSAC guidelines have provided direction regarding post-arrest oxygenation and ventilation targets. Recent reviews have not provided evidence to revise these guidelines. An ILCOR systematic review[26] and CoSTR[10] evaluated ventilation strategies with specific oxygen saturation (SpO_2), oxygen (PaO_2) and/or $PaCO_2$ targeted levels in unresponsive adults with sustained ROSC following cardiac arrest in any setting. Outcomes included survival with/without favorable neurological outcome at hospital discharge, 30 days after discharge, and at various intervals. A total of seven randomized trials and 36 observational studies were included in the systematic review.[26]

For oxygen strategies in the prehospital setting, pooled data from 89 adults in two trials[27,28] found no significant association between a low oxygen therapy and survival to hospital discharge (RR, 0.97; 95% CI, 0.68–1.37).[10] Individual trials of a lower oxygen strategy were reported to show no benefit from this strategy. Very low-certainty evidence from one small cluster randomized trial[29] enrolling 35 subjects from the prehospital setting found a higher chance of survival in the low-oxygen therapy group (RR, 3.15; 95% CI, 1.04–9.52). In the ICU setting, one trial[30] comparing a ventilation strategy targeting normoxemia compared with hyperoxemia found no benefit from the lower oxygen strategy for outcomes of survival to hospital discharge (RR, 1.07; 95% CI, 0.84–1.36) or survival with favorable neurologic outcome at 6 months (RR, 1.13; 95% CI, 0.87–1.47). A second RCT enrolling 1,000 adults undergoing mechanical ventilation in the ICU compared conservative (default lower limit 90% SpO_2, upper limit 97%) with usual oxygen therapy (no specific measures limiting FiO_2 or SpO_2) with the finding of no significant difference in the number of ventilator-free days between the groups.[31] A subgroup analysis of 164 post-cardiac

arrest patients in this trial was reported to show a survival benefit at 90 days in the conservative group (RR, 1.39; 95% CI, 1.01–1.92) that avoided hyperoxia, but this benefit was not present for survival to 6 months with a favorable neurological outcome. Results from the included observational studies were inconsistent.[26]

For ventilation strategies targeting carbon dioxide levels, pooled results from 203 ICU patients in two RCTs[30,32] were reported in the systematic review by Holmberg et al.[26] to find no association between hypercapnia and survival to hospital discharge (RR, 0.94; 95% CI, 0.78–1.14) or survival to discharge with favorable neurologic outcome at 6 months (RR, 0.96; 95% CI, 0.77–1.21). Results from six included observational studies on this topic were inconsistent.[26]

A strong recommendation is made by ILCOR to avoid hypoxemia in adults with ROSC after cardiac arrest in any setting.[10] A weak recommendation is made by ILCOR to avoid hyperoxia in adults with ROSC after cardiac arrest in any setting.[10]

It is suggested by ILCOR to use 100% inspired oxygen until the arterial oxygen saturation or the partial pressure of arterial oxygen can be measured reliably in adults with ROSC after cardiac arrest in any setting.[10]

There was insufficient evidence to suggest for or against mild hypercapnia compared with normocapnia in adults with ROSC after cardiac arrest, and it suggested against routinely targeting hypocapnia in this population.[10]

Insights and Implications

Low-certainty to very low-certainty evidence from one prehospital study and one ICU subgroup analysis found that a lower oxygen strategy (avoiding hyperoxia) after ROSC in adults showed a survival benefit,[29,31] however other RCTs did not find a similar benefit with this strategy. The suggested benefit from avoiding hyperoxemia, in combination with the observational studies' finding of harm or no benefit associated with hyperoxemia, supports the treatment recommendation to avoid hyperoxemia.

Post-Cardiac Arrest Seizure Prophylaxis and Treatment

Seizures or epileptiform activity on electroencephalograms occur in approximately 20% to 30% of comatose patients in the post-cardiac arrest period and are manifestations of post-cardiac arrest brain injury.[33]

Red Cross Guidelines

- Post-cardiac arrest seizures should be treated.

- Healthcare professionals may consider continuous electroencephalogram (EEG) monitoring post-cardiac arrest.

- Post-arrest prophylactic anticonvulsants should not be used.

Evidence Summary

An ILCOR systematic review and CoSTR evaluated strategies for seizure prophylaxis or treatment in unresponsive adults with sustained ROSC after cardiac arrest in any setting.[10] This review was an update of a systematic review and CoSTR from 2015.[11]

For seizure prophylaxis in the post-cardiac arrest period, two prospective RCTs[34,35] with 562 subjects found no benefit from seizure prophylaxis, while a nonrandomized prospective clinical trial[36] with historic controls enrolling 107 subjects also found no benefit from seizure prophylaxis. One trial[34] using thiopental compared with placebo within an hour of ROSC found 20% of those receiving thiopental within an hour of ROSC had 1-year survival with good cerebral function compared with 15% in the placebo group.[10]

Two prospective RCTs[34,35] showed no difference in the incidence of seizures with use of thiopental in the first study and diazepam with/without magnesium in the second study.[10]

No studies were identified in this systematic review that addressed post-cardiac arrest seizure treatment for the various survival outcomes.

A weak recommendation is made by ILCOR against seizure prophylaxis, and for treatment of seizures in adult post-cardiac arrest survivors.[10]

Insights and Implications

Although there is no direct evidence that prophylactic therapy with anticonvulsants prevents seizure or improves important outcomes in adult comatose cardiac arrest survivors, it was acknowledged by the reviewers that most comatose cardiac arrest survivors routinely receive sedatives that have known anticonvulsive effects.[10] In suggesting treatment of seizures in the post-cardiac arrest period, the reviewers considered that ongoing seizures have the potential to worsen brain injury, and that treatment of seizures or status epilepticus is the standard of care in other populations. It was also noted that results from recent retrospective and comparative studies of conventional anticonvulsants suggest that valproate and levetiracetam may be reasonable first line drugs in post-cardiac arrest seizure management.[10] On the other hand, use of sedatives and anticonvulsants has the potential to cause prolonged need for mechanical ventilation, may delay awakening, and may increase time in the ICU. Sedation and anticonvulsants may also cloud the clinical examination, including the presence of generalized myoclonus with epileptiform discharges that may be manifestations of Lance-Adams syndrome (compatible with a good outcome).[37,38]

Post-Cardiac Arrest Prophylactic Antibiotics

A new 2020 ILCOR systematic review and CoSTR evaluated the early prophylactic use of antibiotics compared with delayed, clinically driven administration of antibiotics in adults following ROSC from cardiac arrest in any setting.[10]

Red Cross Guidelines

- Prophylactic antibiotics should not be used in the management of the post-cardiac arrest patient.

Evidence Summary

Outcomes reviewed included survival, survival with good neurological outcome, critical care length of stay, infective complications, and duration of mechanical ventilation or of antibiotic administration.[10]

Two RCTs included in the systematic review[39,40] with 254 patients showed no benefit from use of prophylactic antibiotics compared with clinically driven administration of antibiotics (RR, 0.89; 95% CI, 0.71–1.12; p=0.31; RD, -0.06; 95% CI, -0.19–0.06) for outcomes of survival with good neurological outcome (up to day 30) at last recorded time point.[10] The same two RCTs did not show a benefit for survival up to day 30 with prophylactic antibiotics compared with clinically driven administration; conflicting results were reported for two observational studies. The RCTs[39,40] included showed no benefit from prophylactic antibiotic use compared with standard care for the outcomes of infective complications (pneumonia), for critical care length of stay, or for duration of mechanical ventilation.[10]

A weak recommendation is made by ILCOR against the use of prophylactic antibiotics in patients following return of spontaneous circulation after cardiac arrest.[10]

Insights and Implications

In making this recommendation, the reviewers note that it does not cover situations where antibiotics are used for confirmed or suspected infections, and that both of the included RCTs enrolled only OHCA patients who were treated with targeted temperature management (32°C to 35°C).[10] Another consideration noted is that pneumonia occurs in about 50% of ICU patients after cardiac arrest, but it is unlikely to contribute to mortality as most deaths are attributed to neurological, cardiovascular or multi-organ failure.[10] Additionally, the incidence of pneumonia after cardiac arrest would mean using prophylactic antibiotics in large numbers of patients without specific benefit.

Targeted Temperature Management

The use of targeted temperature management (TTM) may reduce global oxygen demand and improve overall outcomes after cardiac arrest. A 2015 ILCOR systematic review[11] recommended selecting and maintaining a constant target temperature between 32°C and 36°C, but noted that it was uncertain if subpopulations of cardiac arrest patients may benefit from lower or higher temperatures. An evidence update was performed in 2020 to determine if additional literature supported a new systematic review.[10] The new review and other evidence did not lead to a change in current ARCSAC guidelines.

Red Cross Guidelines

- The use of targeted temperature management (TTM), between 32°C and 36°C and for 24 hours, should be used for adults following out-of-hospital cardiac arrest (OHCA) with any initial rhythm who remain unresponsive following return of spontaneous circulation (ROSC).

- TTM may be considered for adults who remain unresponsive following ROSC after in-hospital cardiac arrest (IHCA) with any initial rhythm.

Evidence Summary

The ILCOR evidence update[10] identified one significant recent trial, the Therapeutic Hypothermia After Cardiac Arrest in Nonshockable Rhythm (HYPERION) trial, which evaluated clinical outcomes following TTM in 581 comatose adults following IHCA or OHCA and ROSC after an initial non-shockable rhythm using either a target temperature of 33°C or 37°C for 24 hours.[41] Moderate therapeutic hypothermia at 33°C for 24 hours was reported to lead to a higher percentage of patients who survived with a favorable neurologic outcome at 90 days, although no difference in mortality at 90 days was observed.[10] No change in ILCOR treatment recommendations or Red Cross guidelines were made based on this single trial.

Insights and Implications

The identified trial[41] supports the 2015 ILCOR suggestion to consider TTM in patients who remain unresponsive after resuscitation from IHCA or OHCA with an initial non-shockable rhythm.[11] A more recent review of therapeutic hypothermia (32°C to 34°C) used a random effect meta-analysis to estimate risk ratio with 95% CI.[42] Eight RCTs with 2,026 patients were included. Therapeutic hypothermia was associated with improved neurological outcomes in all patients following cardiac arrest irrespective of initial cardiac rhythm, but decrease in mortality was only shown in those with an initial shockable rhythm.[42]

Patient-specific factors should be considered when determining the target temperature; for example, a temperature at the lower end of the range may be preferred for patients with seizures or cerebral edema. A second recent systematic review with meta-analysis included 25 observational studies and five RCTs, with 4,023 patients receiving TTM and 6,680 receiving standard care.[43] This systematic review also found that patients with an initial non-shockable rhythm cardiac arrest who received TTM of 32°C to 34°C had significantly higher short-term and long-term survival odds and a cerebral performance category score of 1 to 2; however, a separate analysis of data from the included RCTs showed a nonsignificant trend toward better short-term and long-term survival.[43]

Prognostication

Most define four categories of predictors of neurological outcome after cardiac arrest with ROSC, including clinical examination, biomarkers, electrophysiology and imaging. A multimodal approach is suggested in all cases, with all supplementary tests considered in these sections and in the context of the clinical examination to predict neurological outcome in adults who are comatose after cardiac arrest.[10]

Biomarkers for Prognostication

A systematic review and CoSTR[10] was completed by ILCOR in 2020 on the use of the biomarkers neuron-specific enolase (NSE), S-100B, glial fibrillary acidic protein (GFAP), serum tau protein, and neurofilament light chain (NFL) assessed within one week from cardiac arrest in adults who were comatose after resuscitation from in-hospital or out-of-hospital cardiac arrest, regardless of target temperature.

Red Cross Guidelines

- The biomarker neuron-specific enolase (NSE) may be considered in adults who are comatose after cardiac arrest within 72 hours after return of spontaneous circulation (ROSC), in combination with other tests, for predicting neurological outcome.

- The biomarkers S-100B protein, serum levels of GFAP, serum tau protein, or NFL should not be used after ROSC for predicting neurological outcome.

Evidence Summary

Outcomes included in a systematic review by ILCOR included prediction of poor neurological outcome defined as cerebral performance categories (CPC) 3 to 5 or modified Rankin Score (mRS) 4 to 6 at hospital discharge/ 1 month later.[10] Only observational studies were identified and deemed of moderate- to very low-certainty evidence. For neuron-specific enolase (NSE), an association was found in 13 observational studies between NSE of 33 to 120 ug/L within 72 hours and hospital discharge to 6 months with poor neurological outcome.[10] For S-100B protein, low-certainty evidence from three observational studies reported a wide variability of thresholds for 100% specificity for predicting poor neurological outcome following ROSC from 3 to 6 months.[10]

One study reported an association between GFAP and serum tau protein and predicted poor neurological outcome at 1 month and 6 months, respectively. Two studies reported an association between serum neurofilament light chain levels and predicted poor neurological outcome at 6 months.[10]

For adults who are comatose after cardiac arrest, ILCOR makes a weak recommendation to use neuron-specific enolase (NSE) within 72 hours after ROSC, in combination with other tests, for predicting neurological outcome.[10]

A weak recommendation is made by ILCOR against using S-100B protein and against using serum levels of GFAP, serum tau protein, or NFL for predicting neurological outcome.[10]

Insights and Implications

Observational studies identified suggest an association between high levels of NSE measured at 24 to 72 hours after cardiac arrest and a poor neurological outcome (100% specificity). The evidence for S-100B, GFAP and serum NFL is very limited and while promising, does not support a recommendation for their use in prognostication.

Electrophysiology Tests for Prognostication

An ILCOR systematic review evaluated the use of electrophysiology studies assessed within one week from cardiac arrest on adults who are comatose after ROSC in any setting, regardless of target temperature.[10]

Red Cross Guidelines

- In the post-cardiac arrest adult patient, neither background reactivity alone nor seizures on electroencephalogram (EEG) or status epilepticus should be used to predict poor outcome.

- In the post-arrest adult patient, any of the following can be used to predict poor outcome:

  ◦ Presence of epileptiform activity on EEG

  ◦ Burst suppression on EEG in patients who are off sedation after cardiac arrest and comatose

  ◦ Highly malignant EEG patterns

- In the post-arrest adult, healthcare professionals can consider using a bilaterally absent somatosensory evoked potential (SSEP) wave in combination with other indices to predict poor outcome.

Evidence Summary

Outcomes reviewed included prediction of poor neurological outcome. Very low-certainty evidence from a total of 20 observational studies evaluated the use of somatosensory evoked potentials (SSEPs), with four studies noting that a bilaterally absent negative 20 (N2O) SSEP wave within 24 hours from ROSC predicted poor neurological outcome from hospital discharge to 6 months with 100% specificity, and with sensitivity between 33% and 58%.[10] A bilaterally absent SSEP N2O wave at 24 to 96 hours predicted poor neurological outcome from hospital discharge to 6 months in 18 studies, with a wide range of sensitivity and specificity.[10]

An unreactive electroencephalogram (EEG) within 72 hours was reported in 12 studies to be associated with poor neurological outcome from hospital discharge to 6 months, with wide ranges in specificity and sensitivity.[10] Rhythmic/periodic discharges within 24 hours were reported in two studies to predict poor neurological outcome from 3 to 6 months with 100% specificity and sensitivity of 2.4% to 7.9%, and when occurring within 48 hours, four studies reported an association with poor neurological outcomes from 3 to 6 months with specificity of 97% to 100% and widely ranging sensitivity. Other observational studies reported the presence of rhythmic/periodic discharges at 48, 72, and 76 to 77 hours, or within 5 days as being associated with poor neurological outcome at 6 months with high specificity and low or wide ranges in sensitivity.[10]

Sporadic, nonrhythmic/periodic discharges within 24, 48, 48 to 72, or 96 to 120 hours were reported in five observational studies to be associated with poor neurological outcome at various time points with good specificity and low sensitivity.[10] Seizures on EEG within 120 hours were reported in five studies to be associated with poor neurological outcome from hospital discharge to 6 months with 100% specificity and low sensitivity. Status epilepticus likewise was reported to be associated with poor neurological outcome from hospital discharge to 6 months with high specificities and lower sensitivities.[10]

Burst suppression within 24 hours (one study) and at 24 to 76 hours (four studies) was reported to be associated with pool neurological outcome at 6 months with high specificity and low sensitivity. Highly malignant EEG patterns within 36 hours were reported in nine studies to be associated with poor neurological outcome from hospital discharge to 6 months with specificities ranging from 91% to 100% and sensitivities from 0.4% to 97%. Other studies extended the time for the presence of highly malignant EEG patterns in predicting poor neurological outcome at 6 months to 120 hours.[10]

Recommendations by ILCOR[10] for adult patients who are comatose after cardiac arrest include suggestions:

- To use a bilaterally absent N2O SSEP wave in combination with other indices to predict poor outcome.

- Against using EEG background reactivity alone to predict poor outcome.

- To use the presence of epileptiform activity on EEG to predict poor outcome.

- Against using seizures on EEG or status epilepticus to predict poor outcome.

- To use burst suppression on EEG to predict poor outcome in adults who are off sedation after cardiac arrest and comatose.

- To use highly malignant EEG patterns to predict poor outcome in adults who are comatose and off sedation after cardiac arrest.

Insights and Implications

The electrophysiological tests that are suggested as part of a multimodal approach to predicting neurological outcome of adults who are comatose after cardiac arrest include bilaterally absent N2O wave of somatosensory evoked potential, the presence of seizure activity on EEG, and burst suppression on EEG. It is suggested to not use the absence of EEG background reactivity alone to predict poor outcome.

Clinical Examination for Prognostication

A 2020 ILCOR systematic review and CoSTR evaluated the use of clinical examination on adults who were comatose following resuscitation from either in-hospital or out-of-hospital cardiac arrest.[10]

Red Cross Guidelines

- In the adult post-cardiac arrest patient, healthcare professionals can consider using the following clinical examination findings to predict outcome:

  ◦ Pupillary light reflex at 72 hours or later after return of spontaneous circulation (ROSC)

  ◦ Quantitative pupillometry at 72 hours or later after ROSC

  ◦ Bilateral absence of corneal reflex at 72 hours or later after ROSC

  ◦ Presence of myoclonus or status myoclonus within 96 hours after ROSC
  (One should correlate these findings with electroencephalogram.)

Evidence Summary

The 2020 ILCOR review evaluated the use of pupillary light reflex (PLR), pupillometry, corneal reflex (CR), myoclonus and status myoclonus, as assessed within 1 week from cardiac arrest, on adults who were comatose following resuscitation from either in-hospital or out-of-hospital cardiac arrest, and regardless of target temperature.[10]

Outcomes included prediction of poor neurological outcome. For the standard pupillary light reflex, a total of 24 observational studies were included. These studies were reported to show an association between absent standard pupillary light reflex immediately after ROSC, at less than 24 hours, at 36 to 72 hours, at 48 to 72 hours, at 72 hours, and at 72 hours to 7 days and poor neurological outcome at various time points from hospital discharge, with a wide range of specificities and sensitivities.[10] Similar associations were reported in observational studies for automated pupillometry (qPLR) at 24 hours, 48 hours and 72 hours for poor neurologic outcome from hospital discharge to 12 months, and for automated pupillometry (Neurologic Pupil index; NPi) from hospital discharge to 3 months.[10]

Very low-certainty evidence from a total of 14 observational studies of absent corneal reflex at time points between immediately after ROSC and 72 hours to day 7 were reported to be associated with poor neurologic outcome to discharge or from hospital discharge to 12 months, with a wide range of sensitivities and specificities.[10]

Eight observational studies with very low-certainty evidence reported an association between the presence of myoclonus within 96 hours and poor neurological outcome from hospital discharge to 6 months. Specificities ranged between 77.8% and 97.8%, while sensitivity ranged from 18.2% to 39.6%.[10]

Weak recommendations are made by ILCOR[10] for predicting neurological outcome of adults who are comatose after cardiac arrest using:

- Pupillary light reflex at 72 hours or later after ROSC.

- Quantitative pupillometry at 72 hours or later after ROSC.

- Bilateral absence of corneal reflex at 72 hours or later after ROSC.

- Presence of myoclonus or status myoclonus within 96 hours after ROSC.

It is also suggested to record EEG in the presence of myoclonic jerks to detect an associated epileptiform activity.[10]

Insights and Implications

The highest specificity for prediction of poor neurological outcome was noted in this review to be at 72 hours or later after cardiac arrest, possibly partly as a result of the earlier effect of sedatives used for targeted temperature management (TTM) or ventilation. Despite limited evidence, pupillometry using NPi was associated with a 100% specificity for prediction of poor neurological outcome as early as 24 hours after cardiac arrest. The recommendation of 72 hours was based on evidence for s-PLR, a lower likelihood of effects at 72 hours from sedation, and increasing specificity noted for a qPLR between 24 and 72 hours. The recommended use of corneal reflex at 72 hours is also chosen because of potential confounding from initial use of sedatives or relaxants. Finally, although presence of myoclonus is included in the recommendations, reviewers noted that definitions were absent or inconsistent in most of the included studies and myoclonus may be associated with epileptiform activity on an EEG.[10]

Prognostication with Imaging

An updated 2020 ILCOR systematic review[10] evaluated imaging for prognostication in comatose adult survivors of cardiac arrest, regardless of target temperature.

- In adult post-cardiac arrest patients who are comatose, healthcare professionals can consider using grey matter/white matter (GWR) ratio on brain computerized tomography (CT) scan for predicting neurological outcome.

Evidence Summary

Imaging studies were assessed within 1 week from cardiac arrest, and outcomes included prediction of poor neurological outcome at hospital discharge/1 month or later. Observational studies were identified evaluating grey matter to white matter ratio (GWR)-average (GWR-AVG), GWR-basal ganglia (GWR-BG), GW-putamen/corpus callosum (P/CC), GWR-simplified (GWR-SI: putamen/posterior limb of internal capsule), GWR caudate nucleus/posterior limb of internal capsule (CN/PIC), GWR-cerebrum, GWR-thalamus/corpus callosum (GWR-T/CC), GWR-caudate nucleus/corpus callosum (GWR-CN/CC), GWR in cardiac versus non-cardiac etiology, diffusion-weighted imaging (DWI), and apparent diffusion coefficient (ADC). Some of these studies suggested an association between the imaging performed following ROSC at various intervals and poor neurological outcome at time intervals ranging from 1 hour to 6 months post-ROSC.[10]

A weak recommendation is made by ILCOR to use grey matter/white matter (GWR) ratio on brain CT for predicting neurological outcome of adults who are comatose after cardiac arrest. No GWR threshold for 100% specificity can be recommended.[10]

It is suggested by ILCOR to use diffusion weighted imaging (DWI) and/or apparent diffusion coefficient (ADC) on brain MRI for predicting neurological outcome of adults who are comatose after cardiac arrest.[10]

Insights and Implications

All studies included were of very low certainty and marked heterogeneity was noted for measurement techniques for GWR. Brain edema following cardiac arrest in patients who are unconscious predicts poor outcome. GWR is a means to provide a quantitative assessment of brain edema. Both DWI and ADC were described by the ILCOR reviews as having potential for predicting poor neurological outcome following cardiac arrest, but it was noted that the definition of a positive DWI MRI after cardiac arrest was inconsistent or not included in some studies, and there was wide heterogeneity of measurement techniques for ADC across studies.[10]

Mechanical Chest Compressions

A scientific review by ARCSAC updated in 2019 evaluated the use of mechanical CPR devices (mCPR) compared with standard CPR in adults with cardiac arrest.[1] With COVID-19 and limited availability of PPE, EMS systems that have mechanical chest compression devices and are trained in their use might consider usage in the setting of increased infection transmission risk.[44]

Red Cross Guidelines

- Healthcare professionals may consider the use of mechanical CPR devices (mCPR) if the response team is practiced and adept at rapid application with less than 10 seconds of interruption in chest compressions.

- Application of mCPR should not delay initiation of manual chest compressions.

Evidence Summary

The evidence summary for this topic can be found in the Basic Life Support chapter.

Insights and Implications

Insights and Implications for this topic can be found in the Basic Life Support chapter.

Management of Cardiac Arrest in Pregnancy

The management of cardiac arrest during pregnancy presents unique challenges and care pathways.

Red Cross Guidelines

- At least three healthcare professionals should perform CPR on a pregnant patient with associated modifications including chest compressions, airway/breathing, and left uterine displacement.

- Continuous left uterine displacement (LUD) should be performed when the uterine fundus is at or above the umbilicus to reduce compression of the great vessels and improve blood flow back to the heart.

- Defibrillation pads should be placed anterolateral or anteroposterior. Pads should not incorporate any breast tissue.

- Intravenous access should be placed above the diaphragm on a pregnant patient. If intravenous access cannot be established, intraosseous access should be performed above the diaphragm in the proximal humerus.

- A pregnant patient with out-of-hospital cardiac arrest should be transported to an appropriate facility while high-quality CPR, including airway management and continuous left uterine displacement (LUD), is performed.

- Electrocardiogram (ECG) rhythm interpretation should guide medication administration during a maternal code and does not differ from non-pregnant adults.

- Fetal monitors should be immediately removed after pulselessness in maternal cardiac arrest, to maintain focus on maternal resuscitation.

- Healthcare professionals should use the term "resuscitative cesarean (or vaginal) delivery" instead of "perimortem cesarean delivery" to more correctly describe the purpose/indication and increase the timeliness and sense of urgency for performing this procedure.

- Point-of-care ultrasound (POC-US) should be used in the management of maternal cardiac arrest for identification of an intrauterine pregnancy and quick determination of gestational age to guide decision-making on resuscitative cesarean delivery (RCD). Point-of-care ultrasound should not impede high-quality chest compressions.

- Responders should stay focused on maternal care, thereby improving the patient's chances of survival.

- Resuscitative cesarean delivery (RCD) should be performed within 5 minutes from the time of arrest in a pregnant patient in cardiac arrest with a uterus at or above the umbilicus, or greater or equal to 20 weeks gestation.

- Resuscitative cesarean delivery (RCD) may be considered earlier than 5 minutes and as soon as possible under the following circumstances:

  ◦ No return of spontaneous circulation (ROSC) after 2 cycles of CPR

  ◦ Intermittent ROSC after 2 cycles of CPR

  ◦ Non-shockable rhythm

  ◦ For out-of-hospital maternal cardiac arrest, immediately upon arrival to an emergency department without ROSC

- Extracorporeal CPR (ECPR) may be considered to manage maternal cardiac arrest when there is no ROSC after RCD, or for refractory CPR where the uterus has not yet reached the umbilicus and the patient is in an extracorporeal membrane oxygenation center with the capacity to care for critically ill pregnant patients.

- ECPR may be considered for organ procurement in pregnant patients, post-arrest with circulatory determination of death.

- Induction of cooling should not be routinely instituted in the out-of-hospital setting for cardiac arrest in a pregnant patient after ROSC.

- Targeted temperature management may be considered for post-arrest care of pregnant patients.

Evidence Summary

The unique considerations of resuscitation of the pregnant patient were reviewed by ARCSAC. In addition, following rigorous systematic scientific review, recommendations for performance of resuscitation specific to maternal cardiac arrest, resuscitation and post-cardiac arrest care were developed by and are credited to the Obstetric Life Support™ (OBLS™) curriculum.*

Insights and Implications

Resuscitative cesarean delivery requires the rapid mobilization of equipment and obstetrical and neonatal personnel. This planning needs to begin simultaneously with resuscitation, or upon first notification of the cardiac arrest of a pregnant woman. A key aspect of these guidelines and approach was to change the name from "perimortem cesarean delivery" to "resuscitative cesarean (or vaginal) delivery" (RCD) to more correctly describe

the purpose/indication and increase the timeliness and sense of urgency for performing this procedure, as well as to focus on maternal resuscitation and improved outcomes. As resuscitative cesarean delivery needs to be accomplished within 5 minutes and for certain indications as soon as possible, emphasis for EMS prehospital professionals and systems is on early transport as opposed to care on the scene of arrest. Because the focus is on maternal resuscitation, emphasis is given to removal of possible distractors to this focus, such as fetal heartbeat. An example of this is the recommendation to remove fetal monitors during resuscitation. Lastly, as determination of gestational age may not always be feasible or information not available at the time of arrest, many recommendations included other indications, such as fundal height, in addition to gestational age.

Management of Cardiac Arrest Associated with Pulmonary Embolism

Does an alteration in treatment algorithms (e.g., fibrinolytics) compared with standard advanced life support care for adults in cardiac arrest due to pulmonary embolism or suspected pulmonary embolism in any setting change survival outcomes?

Red Cross Guidelines

- Fibrinolytic therapy may be considered for patients with known or suspected pulmonary embolism.

Evidence Summary

A 2020 ILCOR systematic review and CoSTR addresses this question.[10] A subgroup of 37 patients with confirmed pulmonary embolism (PE) in one RCT showed no difference between fibrinolytics and placebo during cardiac arrest for the outcome of survival with favorable neurologic status at 30 days,[45] while one observational study with very low-certainty evidence reported an association between fibrinolytics and improved survival.[46] Three other retrospective observational studies were reported to show no association between fibrinolytics and survival to hospital discharge compared with control.[10] A single observational study likewise did not show an association with thrombolysis and survival at 24 hours compared with the control group.[10]

For surgical embolectomy and percutaneous mechanical thrombectomy, only case series were identified with no control groups.[10]

A weak recommendation is made by ILCOR to administer fibrinolytic drugs for cardiac arrest when PE is the suspected cause. The use of fibrinolytic drugs or surgical embolectomy or percutaneous mechanical thrombectomy is suggested by ILCOR for cardiac arrest when PE is the known cause of cardiac arrest.[10]

Insights and Implications

The ILCOR reviewers considered the increased risk of bleeding from fibrinolysis in cases where there is no PE along with the 2% to 7% rate of OHCA due to a PE (likely higher for IHCA).[10] They also acknowledged that extracorporeal (eCPR) techniques are commonly used in cardiac arrest from suspected PE where feasible.[10]

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Pediatric Advanced Life Support

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Pediatric Cardiopulmonary Resuscitation

Assessment

Rapid assessment begins with performing a visual survey, checking for responsiveness and life-threatening bleeding, opening the airway and simultaneously checking for breathing and a pulse. The use of a mnemonic can be helpful for learning and recalling the sequence for assessment and initial actions.

Red Cross Guidelines

- The A-B-C mnemonic, which has universal application in all settings, should be used for assessment and initial actions.

- Early assessment for life-threatening bleeding should be performed.

- In a child or infant with no signs of life (unconscious/unresponsive) and with abnormal or no breathing, healthcare professionals should check a carotid pulse (children) or a brachial pulse (infant) for no more than 10 seconds and if absent presume the child or infant is in cardiac arrest.

Evidence Summary

ARCSAC reviewed this topic in 2020[1] and a joint AHA and Red Cross statement on this topic was issued in 2012. These reviews showed no changes to this guidance.

Insights and Implications

Early assessment for life-threatening bleeding is performed with the check for reponsiveness. The A-B-C mnemonic is a universal means to recall and perform assessment and initial actions, including opening of the airway (A), checking for the presence or absence of normal breathing (B), and, for healthcare professionals, the simultaneous assessment for circulation (C) by a pulse check, or for lay responders, beginning compressions (C).

Compression and Ventilation Sequence

Should the sequence of CPR in children and infants begin with ventilations or with compressions? Cardiac arrest in children and infants is frequently the result of a respiratory issue and hypoxemia, and this has led to a debate about whether breaths should be provided first to treat the etiology or if compressions should be provided to aid retention by teaching one CPR sequence to all. The educational benefit due to ease in remembering technique may be more relevant to the lay responders but still has some value in healthcare settings especially for areas of low performance of resuscitation.

Red Cross Guidelines

- Once cardiac arrest is recognized, resuscitation should begin with compressions.

- Healthcare professionals may choose to provide ventilations prior to the first compressions for presumed respiratory etiologies of arrest.

- For the drowning process resuscitation, once cardiac arrest is recognized, resuscitation should begin with ventilations (rescue breaths).

Evidence Summary

The topic of beginning CPR with compressions first (C-A-B, 30:2) or beginning with ventilations first (A-B-C, 2:30) was the subject of a joint ILCOR Basic Life Support and Pediatrics Task Force systematic review in 2015 and was updated in 2019.[2] No new studies have been identified in the pediatric population since 2015. Very low-certainty evidence (primarily downgraded for very serious risk of bias and indirectness) from one randomized manikin study of simulated pediatric resuscitation was identified in the 2015 review. For time to commencement of rescue breaths, this study showed that an A-B-C approach significantly decreased the time to commence rescue breaths.[2]

A review of this topic by Red Cross[1] did not identify additional direct evidence, but one systematic review in 2020[3] used data from the Cardiac Arrest Registry for Enhanced Survival (CARES) in a retrospective evaluation of 548 cases of cardiac arrest following drowning on whom information was available on type of CPR performed over four years beginning January 1, 2013. Compression-ventilation CPR in 5- to 15-year-olds was reported to be significantly associated with neurologically favorable survival (aOR, 2.68; 95% CI, 1.10–6.77; p=0.03) compared with compression-only CPR, supporting the need for ventilations in hypoxic cardiac arrest. A weak recommendation is made by ILCOR to commence CPR with compressions rather than ventilations (very low-certainty evidence).

The ARCSAC review led to a recommendation to continue teaching the A-B-C approach for assessment in all emergencies, and to begin CPR for adult cardiac arrest and sudden pediatric arrests with compressions followed by breaths. For cardiac arrest from the drowning process, the sequence is airway and breathing first, then compressions. In children and infants with a primary respiratory etiology of cardiac arrest, healthcare professionals may choose to begin with ventilations (rescue breaths).

Insights and Implications

Unfortunately, the outcomes of survival and ROSC cannot be answered with the ILCOR systematic review. Very low-certainty evidence from indirect manikin studies evaluated surrogate outcomes of time to start of chest compressions, rescue breaths and/or completion of the first CPR cycle.

Not everyone in cardiac arrest has had an arrest due to a primary cardiac cause, and many may have very low levels of oxygen in the blood at the time of arrest. The priority in this case is to get oxygen to the vital organs. This is particularly important with children and infants since cardiac arrest is most commonly the result of a respiratory issue. For sudden pediatric arrests, the correct resuscitation sequence is compressions first, followed by ventilations by the healthcare professional and, if trained and able, the lay responder. For all other pediatric arrests, based on only slight delay and benefits of uniformity for CPR sequence in less trained and less frequent providers of CPR, the sequence is also compressions followed by breaths, but healthcare professionals understanding the etiology may provide breaths prior to compressions. For resuscitation from drowning, it is vital to begin with ventilation due to the unique pathological process.

Pediatric CPR Techniques

Past guidelines advised using two fingers for compressions during single-rescuer infant CPR and using two thumbs and hands encircling the chest for compressions for two-rescuer infant CPR. The single-rescuer two-finger technique has been historically taught based on concerns that the two-thumb/encircling hands technique may interfere with ventilation performance, while the two-thumb technique has been recommended for two healthcare professionals due to higher quality compressions. A 2020 systematic review has led to a change in Red Cross recommendations.[4]

Red Cross Guidelines

- For children and infants, a compression-to-ventilation ratio of 30:2 should be used by one healthcare professional and a ratio of 15:2 should be used by two healthcare professionals, while a ratio of 30:2 should be used by a lay responder.

- Chest compressions should be performed at a rate of 100 to 120 per minute for children and infants.

- A child's and infant's chest should be compressed to a depth of at least one-third the anterior-posterior diameter of the chest. For children, a compression depth of about 2 inches, and for infants, about 1½ inches should be used.

- Chest compressions should be performed on the lower half of the sternum with one or two hands for a child.

- For infants, the two-thumb/encircling hands technique should be used for chest compressions. For infants, the two-finger technique (two or three fingers placed in the middle of the chest) may be considered. If the required depth cannot be achieved with either the two-thumb/encircling hands technique or the two-finger technique in infants, a one-hand technique may be considered.

- If the recommended depth in infants cannot be achieved with either the two-thumb/encircling hands technique or the two-finger technique, a one-hand technique with the heel of the hand may be considered.

- For children and infants with an advanced airway in place, healthcare professionals should deliver 1 ventilation every 2 to 3 seconds (20 to 30 breaths/minute) with continuous compressions.

Evidence Summary

A 2020 systematic review with meta-analysis by ARCSAC Resuscitation Subcouncil members compared the quality of chest compressions and ventilation parameters between the two-thumb and two-finger techniques.[4] All studies identified were performed on a manikin. Pooled data from 16 observational studies using a random-effects model showed that use of the two-thumb technique resulted in greater compression depth compared with the two-finger technique (MD, 5.61 mm; 95% CI, 2.79–8.43) and 36.91% more compressions of adequate depth (95% CI, 10.07–63.74).[4] No difference was found between the two compression techniques for ventilation parameters, although only five studies were able to be included in the ventilation volume meta-analysis. There was not enough data to abstract the total number of ventilations performed during a compression-to-ventilation sequence. The reviewers concluded that for CPR performed on a simulated infant manikin by a single rescuer, the two-thumb technique improves chest compression quality without compromising ventilation.[4] An ARCSAC scientific review on infant CPR techniques and sequences[1] noted that the precise location for the rescuer to place their fingers or thumbs is not clear.

A scoping review by ILCOR in 2020 did not find new published evidence related to the effectiveness of specific compression depths during CPR in children and infants.[2] The ILCOR recommendations remain unchanged, with a suggestion that rescuers compress an infant's chest by at least one-third the anteroposterior dimension, or approximately 1½ inches.[2]

Insights and Implications

This systematic review with meta-analysis suggests that CPR quality is significantly greater when performed using a two-thumb/encircling hands technique compared with the two-finger technique, without compromising ventilation volume, and when performed by a single rescuer.[4] Limitations include the heterogeneity in measures between studies, the inability to determine total number of ventilations in a given sequence, lack of certainty assessment for individual studies or across outcomes, and lack of studies in infants with clinical outcomes. Risk of bias was high for all studies. Despite the limitations, the unknown but potential survival benefit from increased quality of CPR supports the change in recommendations to the use of two thumbs with encircling hands for single-rescuer CPR, while retaining the option of the two-finger technique. Lay responders with thumb, finger, hand or wrist arthritis now have the option to use the technique that can be performed best, including the one-hand technique, within their physical limitations in order to deliver compressions of recommended depth.

Ventilations for Patients with Respiratory Insufficiency or an Advanced Airway

The rate at which ventilations are provided in the absence of sufficient respiratory effort but with perfusion and during CPR has been discussed in prior guidelines. There has also been debate about whether there should be a universal approach or allow alterations for children and infants. Lastly, the use of bag-mask ventilation (BMV) and pocket masks have been a source of prior debate.

Red Cross Guidelines

- For children and infants with a pulse but insufficient respiratory effort, and during CPR with an advanced airway in place, 1 ventilation should be provided every 2 to 3 seconds.

- Bag-mask ventilation (BMV) should be performed as a two-person technique.

- When there is only one healthcare professional to provide ventilation, a pocket mask may be considered over bag-mask ventilation.

Evidence Summary

The ventilation rate and providing ventilations with an advanced airway have been the subject of prior ILCOR and ARCSAC evaluations. Traditionally, ventilation rates for children and infant have been 1 breath every 2-3 seconds, which is consistent with normal physiological rates. In past guidelines from ILCOR and others, the rate was changed to the same as adults with no new evidence but an expert opinion that one rate across resuscitation would help retention and performance. While there was no new evidence, ARCSAC made this change to be consistent with

American Red Cross
Training Services

other international and national resuscitation organizations to avoid confusion among the public. There have been no recent reviews by ARCSAC or ILCOR with regard to pediatric ventilation rates and providing ventilation with an advanced airway. For pediatric ventilation rates, the rate has changed over the years in subsequent guidelines issues. A recently published multicenter cohort study[5] evaluated ventilation rates in 52 events requiring at least 1 minute of CPR in 47 intubated children, finding that higher ventilation rates (at least 30 breaths/minute in infants and 25 or more breaths/minute in older children) were associated with higher odds of ROSC and survival to discharge. A prior ARCSAC review evaluated BMV versus pocket mask for a single rescuer providing ventilation and for one- versus two-person BMV.[1] No new evidence has changed these recommendations.

Insights and Implications

This single study regarding pediatric ventilation rates was weighed by ARCSAC against the benefit of education of a single ventilation rate for all resuscitation. Findings from the specific study population of intubated children and infants in a pediatric intensive care unit may not be generalizable. However, children and infants have a higher baseline respiratory rate and cardiac arrests are more commonly triggered by respiratory issues than for adults. Additionally, because cardiac arrests are so rare in children and infants, it will be difficult to replicate this study. Lastly, as ARCSAC has felt that pediatric respiratory rates should be closer to physiological rates and different than adults, while the new evidence is limited, expert opinion and this evidence outweighs the theoretical benefit of one rate for adults and pediatrics. For these reasons, a new recommendation is made by ARCSAC to provide increased ventilation rates for children and infants in respiratory arrest and in cardiac arrest with an advanced airway in place.

Automated External Defibrillation Use

An evidence update by ILCOR in 2020 did not identify any significant new literature since 2010 related to the use of AEDs for infants with out-of-hospital cardiac arrest (OHCA).[2] This review was consistent with ARCSAC reviews and existing Red Cross guidance. The ARCSAC review of the literature has shown no new evidence that would change these guidelines.

Red Cross Guidelines

- If a child or infant is in cardiac arrest, CPR should be started and an AED should be used as soon as one is available.

- For infants and children 8 years of age or younger or 55 pounds (25 kg) or less, an AED with a pediatric attenuator or pediatric settings should be used, if available.

- If an AED with a pediatric attenuator or pediatric settings is not available, a standard AED should be used for infants and children 8 years of age or younger or 55 pounds (25kg) or less.

Evidence Summary

No new evidence was identified by ILCOR suggesting a need for systematic review of change in treatment recommendations. ILCOR recommends that for the treatment of infants in the out-of-hospital setting with ventricular fibrillation or pulseless ventricular tachycardia, use of an AED with demonstrated high specificity and sensitivity

for detecting shockable rhythms in infants, using, in order of preference, a manual defibrillator, an AED with a dose attenuator, or an AED without a dose attenuator.[2]

Insights and Implications

The use of an AED remains a critical component of child and infant cardiac arrest care. AEDs work the same way regardless of the patient's age, but the setting used for children and infants differs, as does pad placement, based on the size of the child and infant.

Intraosseous Access

Is the intraosseous route an acceptable route for vascular access in children and infants in cardiac arrest?

Red Cross Guidelines

- Intraosseous access may be considered as an acceptable alternative to intravenous access in children and infants.

Evidence Summary

A 2020 ILCOR systematic review[6] and CoSTR[2] evaluated the evidence for placing an intraosseous (IO) cannula and drug administration through this IO during adult, pediatric and neonatal cardiac arrest compared with placing an intravenous (IV) cannula and drug administration through this cannula during cardiac arrest. No evidence was identified regarding IO versus IV placement in neonates with severe bradycardia and inadequate perfusion requiring chest compressions in any setting for any of the predetermined outcomes.

With no new evidence, the 2010 ILCOR treatment recommendations remain unchanged and state that IO cannulation is an acceptable route of vascular access in children and infants with cardiac arrest. It should be considered early in the care of critically ill children and infants whenever venous access is not readily attainable.[7]

Insights and Implications

Intravenous access in children and infants during cardiac arrest is challenging. No evidence was found for children or neonates beyond case reports of complications in neonates from IO access. (See Chapter 5, Neonatal Life Support, Intraosseous Versus Umbilical Vein Routes of Fluid and Drug Administration During Newborn Resuscitation.) The systematic review noted a recent study of post-mortem computed tomography in pediatric cadavers showing that IO needles were malpositioned in 39% of children.[8] It was unclear if these IO needles were used for drug administration, but the results of this study should be considered in skills training.

Pediatric Advanced Airway Techniques

When caring for children and infants in any setting who have received chest compressions or a defibrillation dose during CPR, does placing an advanced airway device (i.e., tracheal intubation or supraglottic airway), compared with bag-mask ventilation (BMV) alone or with non-advanced airway interventions, or compared with use of another advanced airway device, change any clinical outcome?

Red Cross Guidelines

- Bag-mask ventilation (BMV) should be used over advanced airway placement for the initial resuscitation of children and infants with out-of-hospital cardiac arrest.

Evidence Summary

A 2019 systematic review by ILCOR[9] and CoSTR[2] was updated in 2020. This update corresponds to prior reviews by ARCSAC and a summary of the evidence is presented.

Tracheal Intubation Compared with Bag-Mask Ventilation

Low-certainty evidence from one pseudo-randomized trial of 591 children with OHCA found no difference in survival with good neurologic outcome with tracheal intubation (TI) compared with BMV (aRD, -1.5%, or 15 fewer children surviving with good neurologic outcome per 1,000 randomized to TI; 95% CI, 48 fewer to 17 more).[10] However, meta-analysis of additional propensity-adjusted cohort studies[11-13] provided very low-certainty evidence reporting reduced survival with good neurological outcome (i.e., harm) associated with TI (aRD, -4.9% or 49 fewer survivors per 1,000 resuscitations; 95% CI, 77 fewer to 21 fewer).[9] For the outcome of survival to hospital discharge, the pseudo-randomized trial[10] did not demonstrate superiority of TI compared with BMV-only resuscitation, while pooled propensity-adjusted cohort studies including 4,155 children showed 53 fewer survivors per 1,000 patients with TI compared with BMV (95% CI, 86 fewer to 20 fewer).[9]

Supraglottic Airway Compared with Bag-Mask Ventilation

No RCTs were identified for this comparison.[9] Very low-certainty evidence from two propensity-matched cohort studies[12,13] with 1,657 children were reported to have conflicting associations between supraglottic airway (SGA) placement and BMV for survival to hospital discharge, while observational studies of 3,904 children reported no statistical association of harm or benefit between SGA and survival.[9]

Tracheal Intubation Compared with Supraglottic Airway

No RCTs were identified for this comparison.[9] Very low-certainty evidence pooled from two propensity-adjusted cohort studies[13,14] including 1,288 children were reported to show no statistical association of harm or benefit between TI and SGA for likelihood of survival with good neurologic outcome.[9] Similar findings were reported for use of advanced airway techniques and survival to hospital discharge.

A weak recommendation by ILCOR suggests the use of bag-mask ventilation rather than tracheal intubation or supraglottic airways in the management of children during cardiac arrest in the out-of-hospital setting (very low certainty of evidence).[2] Due to limited evidence, ILCOR is unable to make a recommendation about the use of tracheal intubation or use of supraglottic airways in the management of children with cardiac arrest in the in-hospital setting.[2]

Insights and Implications

The findings for studies comparing TI to BMV for resuscitation for cardiac arrest in pediatric patients suggest that resuscitation with TI is not superior to resuscitation with BMV for critical outcomes. Some data suggested an association with harm with TI for outcomes of survival with good neurological outcome and survival to hospital discharge. Conclusions regarding SGA versus BMV are uncertain due to conflicting study results but overall described as most consistent with no treatment effect for critical outcomes in the resuscitation of pediatric patients in cardiac arrest. For the comparison of TI with SGA in resuscitation, very low-certainty evidence also suggests no significant difference between modalities.

Feedback for CPR Quality

Performance of high-quality CPR is important for beneficial clinical outcomes. Physiological parameters may be used for monitoring. This was last reviewed in 2015.[2]

Red Cross Guidelines

- End-tidal CO_2 and/or arterial blood pressure may be considered to evaluate CPR quality and adjust CPR performance.

Evidence Summary

While the published evidence since the 2015 review has not altered this recommendation, there have been registry and other reported system data that further support this guideline.

Insights and Implications

There is a paucity of data on potential target values for PaO_2 and $PaCO_2$ in children and infants following ROSC, and no pediatric RCTs. More recent evidence identified by ILCOR in an evidence update suggests that post-arrest hypotension below the fifth percentile for age is associated with poorer outcomes compared with post-arrest normal blood pressure.[2]

Resuscitation of Pediatric Patients with Congenital Heart Disease and Acute Cardiac Disease

The management of children and infants before repair, during staged repair, and after surgical repair poses unique resuscitation challenges. In addition, children and infants with acute cardiac disease such as myocarditis also pose unique management challenges.

Red Cross Guidelines

- In pediatric patients with congenital heart disease (CHD) who are unrepaired, during a staged repair, or who are post-surgical repair (with the exception of certain CHD lesions where normal cardiac anatomy and physiology has been restored) and who require resuscitation, early consultation of healthcare professionals experienced in the intensive care management of these patients and cardiology should be obtained.

- In pediatric patients with acute cardiac disease (i.e., myocarditis) requiring resuscitation, early consultation of healthcare professionals experienced in the intensive care management of these patients and cardiology should be obtained.

- In pediatric patients with unrepaired, during staged repair and repaired congenital heart disease with single ventricle physiology requiring resuscitation, early consideration of extracorporeal life support (ECLS) may be warranted.

- In pediatric patients with myocarditis requiring resuscitation, early consideration of ECLS may be warranted.

Resuscitation of Pediatric Patients with Pulmonary Hypertension

The management of children and infants with pulmonary hypertension poses unique resuscitation challenges.

Red Cross Guidelines

- In pediatric patients with pulmonary hypertension who require resuscitation, early consultation of healthcare professionals experienced in the intensive care management of these patients and cardiology should be done.

- In pediatric patients with an acute pulmonary hypertensive crisis, supplemental oxygen and alkalosis as the initial therapy in combination with administration of pulmonary vasodilators may be considered.

- Inhaled nitric oxide or prostacyclin may be considered for the treatment of pulmonary hypertension.

- For resuscitation of the pediatric patient with pulmonary hypertension, acidosis and hypoxia should be avoided.

Termination of Resuscitation Rules

Termination of resuscitation (TOR) for adults by prehospital professionals is often guided by a set of rules adopted by emergency medical service systems.

Red Cross Guidelines

- Termination of resuscitation (TOR) in children and infants should be decided by clinical judgment.

Evidence Summary

A systematic review by ILCOR in 2020 evaluated the use of TOR rules for their ability to reliably predict in-hospital outcomes of death and unfavorable neurologic outcome following adult OHCA.[15] Studies included were reported to describe the derivation and internal validation of individual TOR rules, or the external validation of previously published TOR rules. Only a single study addressed clinical validation of a TOR rule. A retrospective cohort review evaluated the extent to which existing TOR criteria can be transferred to pediatric OHCA patients, with only 48% sensitivity for BLS TOR criteria predicting death, and 10% sensitivity for ALS TOR criteria for death.[16]

Insights and Implications

Both BLS and ALS TOR rules in this retrospective review appear not to be transferable to the pediatric population. Decisions to terminate resuscitation should be made individually and based on clinical decision rather than current BLS and ALS TOR rules.

Pediatric Post-Cardiac Arrest Care

Oxygen and Carbon Dioxide Target Levels

A systematic review of a ventilation strategy aimed at specific oxygen and carbon dioxide target levels in unresponsive adults and children with sustained return of spontaneous circulation (ROSC) after cardiac arrest in any setting was performed by ILCOR in 2020.[17] This corresponded to work done by ARCSAC in prior years.

Red Cross Guidelines

- Post-cardiac arrest oxygen and carbon dioxide levels should target normal physiological levels. Hyperoxia, hypoxia, hypercarbia, and hypocarbia should all be avoided.

- Post-cardiac arrest oxygenation may be guided by oxygen saturation targeting levels of 94% to 99%.

Evidence Summary

Evidence from the pediatric literature was used to inform this CoSTR.[2] No pediatric RCTs were identified. Observational studies enrolling 618 children were included; all were judged to be at serious risk of bias and provided evidence of very low certainty.[18-20] One study[19] with 153 pediatric ROSC patients in any setting found no increase in survival to hospital discharge with good neurologic outcome from hyperoxemia compared with no hyperoxemia. Unadjusted analysis of data[17] from a study of 164 pediatric patients with ROSC after in-hospital cardiac arrest reported no benefit from hyperoxemia compared with normoxemia for survival to hospital discharge.[18] A second study evaluating survival to hospital discharge in 200 pediatric patients with ROSC after cardiac arrest showed no association between a post-ROSC pO_2 greater than 200 mmHg and the outcome.[20] A registry-based study[21] reported an association between hyperoxemia and higher mortality compared with normoxemia but was deemed at critical risk of bias.[2]

For carbon dioxide targets, two observational studies were included in the 2020 systematic review,[17] with one[18] showing both hypocapnia after ROSC and hypercapnia after ROSC being associated with hospital mortality. The second study reported an association between hospital mortality and both hypocapnia and hypercapnia 1 hour after ROSC compared with normocapnia.[22]

A weak recommendation by ILCOR suggests that rescuers measure PaO_2 after ROSC and target a value appropriate to the specific patient condition. In the absence of specific patient data, it is suggested that rescuers target normoxemia after ROSC. Targeting an oxygen saturation of 94% to 99% with pulse oximetry may be a reasonable alternative to measuring PaO_2 and titrating oxygen when feasible to achieve normoxia.[2]

It is also suggested by ILCOR that rescuers measure $PaCO_2$ after ROSC and target normocapnia and consider adjustments to the target $PaCO_2$ for specific patient populations where normocapnia may not be desirable (such as chronic lung disease with chronic hypercapnia or congenital heart disease with single ventricle).[2]

Insights and Implications

The targeting of normoxemia post-ROSC has not been studied in the pediatric prehospital setting, and the ILCOR review commented on the risk of inadvertent hypoxemia from overzealous weaning of oxygen and risks of hypoxemia versus uncertain risks of hyperoxia.

EEG Monitoring and Seizure Management

Seizures or epileptiform activity on electroencephalograms (EEGs) are common in comatose patients in the post-cardiac arrest period and are manifestations of post-cardiac arrest brain injury.

Red Cross Guidelines

- Post-cardiac arrest seizures should be treated.

- Continuous electroencephalogram (EEG) monitoring post-cardiac arrest may be considered.

- Post-arrest prophylactic anticonvulsants should not be used.

Evidence Summary

There are no recent reviews of post-cardiac arrest seizures in children or infants. A recent ILCOR review of post-arrest seizures in adults did not find direct evidence that prophylactic therapy with anticonvulsants prevents seizure or improves important outcomes in adult comatose cardiac arrest survivors, although most survivors routinely receive sedatives with known anticonvulsant effects.[23]

Insights and Implications

Seizure activity substantially increases cerebral metabolic demand and may worsen post–cardiac arrest brain injury. Accordingly, seizures should be promptly detected and treated after ROSC. EEG may be used continuously to detect subclinical seizure activity, especially in patients receiving neuromuscular blockade, or when indicated based on suspected seizure activity. No evidence supports prophylactic treatment of seizures after cardiac arrest.

Pediatric Shock Care

General Approaches to Fluid Resuscitation

The management of pediatric shock has been reviewed in prior years by ARCSAC. There was no new literature identified in a recent evidence update to alter the general approaches to fluid management in pediatric shock.

Red Cross Guidelines

- For children and infants in shock, a bolus of 20 ml/kg intravenous fluid should be administered for resuscitation. It is reasonable to consider repeating these fluid boluses as clinically indicated.

- A lower volume of fluid, 5 to 10 ml/kg, may be considered for children and infants with heart failure.

- A lower volume of 10 ml/kg may be considered for neonates.

- Fluid resuscitation should target restoring normovolemia.

- After each bolus there should be reassessment for signs of hypervolemia.

- Fluid resuscitation should begin with a crystalloid fluid and use either a balanced or unbalanced solution.

Pediatric Hemorrhagic Shock Care

The management of pediatric hemorrhagic shock was previously reviewed by ARCSAC and updated management was provided by the American College of Surgeons in the latest Advanced Trauma Life Support Program. These recommendations have not changed since the last review.

Evidence Summary

An ILCOR scoping review in 2020 sought to identify evidence about the effectiveness of graded volume resuscitation (restrictive volume resuscitation and permissive hypotension) for traumatic hemorrhagic shock.[2] Retrospective studies from trauma registries were identified, with only one study that assessed the volume of fluid administered for traumatic injuries in the prehospital setting. No studies reported on survival at 30 days; there was a suggestion from these studies of a possible advantage to using limited volume resuscitation.[2]

Insights and Implications

The main goal of fluid resuscitation is to restore intravascular volume to reverse cellular hypoxia and ischemia before irreversible end-organ damage occurs. Monitoring of patient response to fluid resuscitation should be ongoing. Always assess the child or infant after each fluid bolus and discontinue fluid administration if clinical signs or symptoms of hypervolemia develop. Packed red blood cells (PRBCs) or whole blood may be indicated in combination with isotonic crystalloids for volume resuscitation in hemorrhagic shock, to optimize hemoglobin concentration and hence oxygen delivery in shock.

Pediatric Cardiogenic Shock Care

Children and infants who remain in shock despite adequate fluid resuscitation or who cannot tolerate ongoing aggressive fluid therapy (e.g., those in cardiogenic shock) are candidates for other supportive (namely, vasoactive) therapies.

Red Cross Guidelines

- A fluid bolus of 5 to 10 ml/kg of crystalloid fluid should be administered for cardiogenic shock over 10 to 20 minutes.

- After each bolus, the child or infant should be reassessed for signs of hypervolemia and worsening cardiac failure.

- Milrinone may be considered as clinically indicated, and epinephrine, dopamine, or dobutamine additively or independently may be considered as clinically indicated for cardiogenic shock.

Evidence Summary

An evidence update was completed by ILCOR in 2020 on the topic of vasoactive drugs for cardiogenic shock in the first hours of treatment.[2] Insufficient evidence was identified to consider a systematic review of change in recommendations. The ILCOR recommendation states that the catecholamine dose for inotropic support in cardiogenic shock must be titrated for each individual because there is wide variability in the clinical response to vasoactive drugs.[2] It is reasonable to use epinephrine, levosimendan, dopamine, or dobutamine for inotropic support in infants and children with cardiogenic shock. Milrinone may be beneficial for the prevention and treatment of low cardiac output following cardiac surgery. There are insufficient data to support or refute the use of norepinephrine in pediatric cardiogenic shock.[2]

The management of pediatric cardiogenic shock was previously reviewed by ARCSAC. These recommendations have not changed since the last review.

Insights and Implications

The central physiologic abnormality in cardiogenic shock is decreased cardiac output. In most cases, this decrease is due to impaired contractility of the heart. Children and infants in cardiogenic shock may be hypo-, normo- or hypervolemic. Therefore, fluid resuscitation should be carried out with caution, starting with smaller-than-usual boluses of 5 to 10 mL/kg and closely monitoring response and for signs of pulmonary edema and signs of worsening perfusion.

Pediatric Septic Shock Care

A complex review of evidence related to care for children and infants with septic shock and other sepsis-associated organ dysfunction was published in 2020 by the Surviving Sepsis Campaign (SSC), a collaboration by the Society of Critical Medicine, the European Society of Critical Care Medicine (ESICM) and the International Sepsis Forum.[24] A total of six strong recommendations, 52 weak recommendations and nine best-practice statements were provided for infants and children from 37 weeks gestation at birth to 18 years old. While a review of the science informing all recommendations is beyond the scope of this 2020 Red Cross update, selected topics of resuscitation and ventilation in septic shock are included here.

Fluid Therapy

Hypovolemia in septic shock is the result of capillary leak, vasodilation, and fluid losses, leading to decreased cardiac output and reduced organ perfusion. Fluid resuscitation corrects hypovolemia.

Red Cross Guidelines

- Up to 40 to 60 mL/kg in bolus fluid (in 10 to 20 mL/kg aliquots) should be administered over the first hour, titrated to clinical markers of cardiac output, and discontinued if signs of fluid overload develop for the initial resuscitation of children and infants with septic shock or other sepsis-associated organ dysfunction.

    ◦ In the absence of intensive care availability, a decreased fluid bolus of up to 40 mL/kg (in 10 to 20 mL/kg aliquots) over the first hour should be considered, titrated to clinical markers of cardiac output and discontinued if signs of fluid overload develop.

    ◦ In the absence of both hypotension and intensive care availability, maintenance fluids should be administered instead of bolus fluids.

- Balanced/buffered crystalloids, rather than 0.9% saline, should be used for the initial resuscitation of children and infants with septic shock or another sepsis-associated organ dysfunction.

- Albumin should not be used in the initial resuscitation of children and infants with septic shock or another sepsis-associated organ dysfunction.

- Starches should not be used in the acute resuscitation of children and infants with septic shock or other sepsis associated organ dysfunction.

Evidence Summary

The SSC review[24] included three RCTs[25-27] of different volume resuscitation strategies for 316 children with septic shock in advanced care settings and found no difference in mortality between the restrictive and liberal fluid resuscitation groups. The suggestion of "up to 40 mL/kg" was included for care in low-resource settings on the basis on the FEAST study[28] of children with severe hypotension. It was noted that the World Health Organization recommends isotonic crystalloid over 30 to 60 minutes, followed by an additional 10 mL/kg over 30 minutes if there is no improvement and no signs of fluid overload, cardiac failure, or neurologic deterioration. No pediatric RCTs compared balanced/buffered crystalloids to 0.9% saline, however two observational studies in a total of 30,532 children with sepsis[29,30] found that of 2,100 who received only balanced/buffered crystalloids for the first 72 hours of hospitalization and 28,432 who received normal saline, the use of balanced/buffered crystalloid was associated with lower mortality (OR, 0.79; 95% CI, 0.65–0.95). Recommendations from SSC for fluid therapy are tiered by settings based on availability of ICU care.

In healthcare systems with availability of intensive care, the SSC suggests administering up to 40 to 60 mL/kg in bolus fluid (10 to 20 mL/kg per bolus) over the first hour, titrated to clinical markers of cardiac output and discontinued if signs of fluid overload develop, for the initial resuscitation of children with septic shock or other sepsis-associated organ dysfunction.[24]

In healthcare systems with no availability of intensive care and in the absence of hypotension, a strong recommendation is made against bolus fluid administration while starting maintenance fluids.[24]

In healthcare systems with no availability of intensive care, if hypotension is present, SSC suggests administering up to 40 mL/kg in bolus fluid (10 to 20 mL/kg per bolus) over the first hour, titrated to clinical markers of cardiac output and discontinued if signs of fluid overload develop.[24]

The SSC suggests using balanced/buffered crystalloids, rather than 0.9% saline, for the initial resuscitation of children with septic shock or other sepsis-associated organ dysfunction.[24]

Insights and Implications

Similar results are being identified for outcomes in adults with sepsis suggesting that resuscitation with crystalloid containing high chloride concentrations (i.e., 0.9% normal saline) is associated with hyperchloremic acidosis, systemic inflammation, acute kidney injury, coagulopathy, and mortality as compared with use of balanced, buffered crystalloids such as lactated Ringer's and Plasma-Lyte.[31]

Vasoactive Medications

Vasoactive medications, such as norepinephrine and epinephrine, are useful in septic shock unresponsive to fluid therapy. SSC evaluated the choice of vasoactive medications in children with septic shock.[24]

Red Cross Guidelines

- Norepinephrine or epinephrine should be used as the initial vasoactive medication in children and infants with fluid-refractory septic shock.

- Dopamine should not be used as the initial vasoactive medication in children and infants with septic shock, but it may be considered if epinephrine and norepinephrine are not available.

- Adding vasopressin may be considered for children and infants with septic shock who require high-dose catecholamines.

- Further titration of catecholamines may be considered in children and infants with septic shock that is fluid-and initial catecholamine-refractory.

- Adding an inodilator (i.e., milrinone) may be considered in children and infants with septic shock and cardiac dysfunction despite other vasoactive agents.

Evidence Summary

The SSC review[24] identified two RCTs comparing epinephrine with dopamine in children with fluid-refractory septic shock,[32,33] both showing that epinephrine was associated with a lower risk of mortality (RR, 0.63; 95% CI, 0.40–0.99). Although norepinephrine has not been studied in children with septic shock, one RCT of norepinephrine compared with saline in mechanically ventilated children did not show a difference in mortality between groups.[34] However, improved blood pressure and higher urine output suggested improved perfusion compared with saline.

Three RCTs[35-37] evaluating vasopressin-receptor agonists in children and others in adults informed the SSC recommendation on use of vasopressin.[24]

A weak recommendation, based on low-quality evidence, is made by SSC that suggests using epinephrine, rather than dopamine, in children with septic shock. SSC also suggests, based on very low quality of evidence, using norepinephrine, rather than dopamine, in children with septic shock.[24]

SSC is unable to issue a recommendation for a specific first-line vasoactive infusion for children with septic shock. However, in the practice of SSC panel members, they select either epinephrine or norepinephrine as the first-line vasoactive infusion guided by clinician preference, individual patient physiology, and local system factors.[24]

A weak recommendation is made by SSC (low-certainty evidence) that suggests either adding vasopressin or further titrating catecholamines in children with septic shock who require high-dose catecholamines.[24]

Insights and Implications

Data from adult trials comparing norepinephrine with dopamine show a lower mortality rate and lower incidence of arrhythmias with norepinephrine than dopamine and contribute to the recommendations for children and infants with septic shock.[38] There is insufficient data to recommend epinephrine or norepinephrine as the initial vasoactive agent, and SSC panel members surveyed were split on which agent they use, depending on presence or absence of myocardial dysfunction and low cardiac output or the need to increase systemic vascular resistance.[24] There was no consensus on the optimal threshold for initiating vasopressin, and the decision is left to clinician preference.

Ventilation

Pediatric patients with fluid-refractory and catecholamine-resistant septic shock may progress to respiratory failure or may benefit from early mechanical ventilation. The SSC review evaluated evidence related to management of respiratory failure and sepsis-induced pediatric acute respiratory distress syndrome.[24]

Red Cross Guidelines

- Etomidate should not be used when intubating children and infants with septic shock or another sepsis-associated organ dysfunction.

- A trial of noninvasive mechanical ventilation (over invasive mechanical ventilation) may be considered in children and infants with sepsis-induced pediatric acute respiratory distress syndrome (PARDS) without a clear indication for intubation and who are responding to initial resuscitation.

- A trial of prone positioning may be considered in children with sepsis and severe PARDS.

Evidence Summary

Etomidate is used as a sedative for tracheal intubation in patients with unstable hemodynamics, but there are concerns noted by SSC regarding the effect of the drug on adrenal function in adults.[24] There are no RCTs comparing etomidate with other sedatives in the pediatric population with or without sepsis. A recent small observational study of children with meningococcal sepsis or septic shock intubated with etomidate as compared with any other combination of sedatives reported an association with higher mortality after use of etomidate (pooled OR, 4.51; 95% CI, 1.82–11.16).[39] Additional studies from the adult population were used to inform the treatment recommendation for etomidate.[24]

The SSC review authors performed a meta-analysis of three observational studies[40-42] that evaluated the association of noninvasive mechanical ventilation with mortality in a pediatric ICU population. Unadjusted estimates found noninvasive ventilation to be associated with a decreased risk of death (RR, 0.21; 95% CI, 0.09–0.47).[24]

Pooled data from two RCTs[43,44] in pediatric acute respiratory distress syndrome (PARDS) patients showed an RR of 0.99 (95% CI, 0.36–2.69) for mortality with prone compared with supine positioning and with no reported serious adverse events. The recommendation for consideration of prone positioning as a potentially lifesaving strategy is additionally supported by RCTs in adults.[24]

A weak recommendation based on low quality of evidence is made by SSC against the use etomidate when intubating children with septic shock or other sepsis-associated organ dysfunction.[24]

A weak recommendation based on very low quality of evidence is made by SCC for a trial of noninvasive mechanical ventilation (over invasive mechanical ventilation) in children with sepsis-induced PARDS without a clear indication for intubation and who are responding to initial resuscitation.[24]

A weak recommendation based on low of quality evidence is made by SCC, suggesting a trial of prone positioning in children with sepsis and severe PARDS.[24]

Insights and Implications

Noninvasive mechanical ventilation with continuous positive airway pressure or bi-level positive airway pressure ventilation is a means of reducing the work of breathing and increasing oxygenation and thus avoiding intubation in PARDS. Although there are no RCTs comparing noninvasive ventilation with mechanical ventilation in children and infants with sepsis, the meta-analysis by SSC,[24] while very low-certainty evidence, suggests benefit from noninvasive ventilation. It is emphasized that patients with noninvasive ventilation should be monitored closely and should not have evidence of ongoing or worsening end-organ dysfunction.

The prone position is of particular interest during the COVID-19 pandemic, and when combined with high-flow nasal cannula, has been found to help avoid intubation, especially in patients with moderate PARDS and baseline SpO_2 greater than 95%.[45]
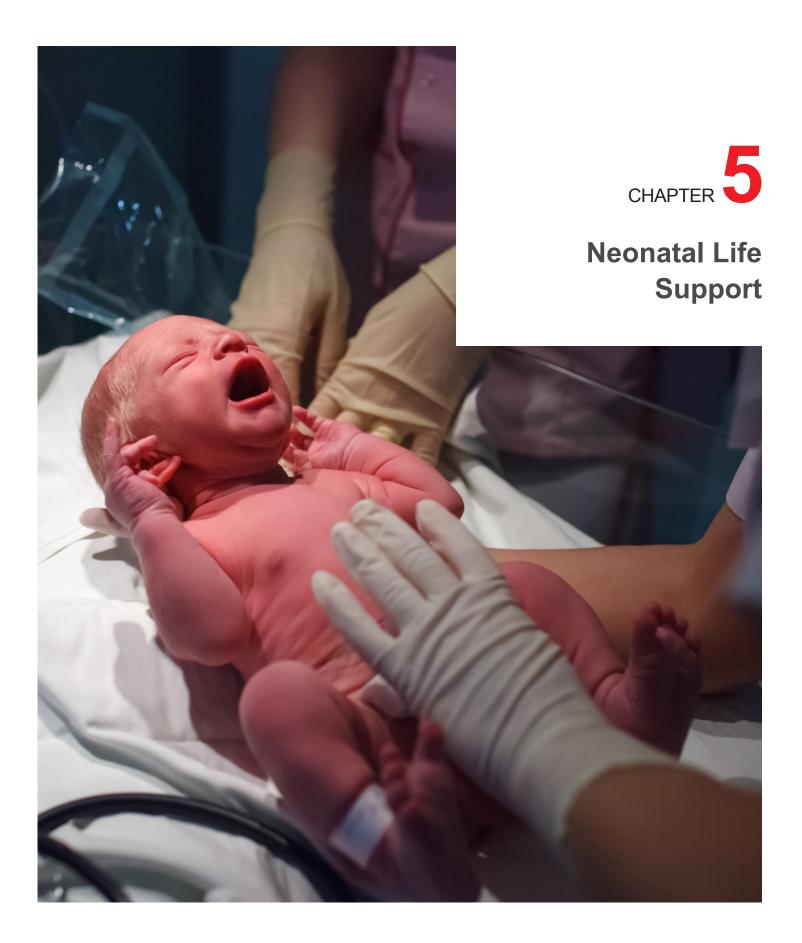
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CHAPTER **5**

Neonatal Life Support

Neonatal Resuscitation

Initial Oxygen Concentration for Preterm Newborns

Does use of a lower initial oxygen concentration for respiratory support of preterm newborn infants (less than 35 weeks estimated gestational age), compared with use of a higher initial oxygen concentration, change short-term mortality and other clinical outcomes?

Red Cross Guidelines

- When resuscitating a preterm newborn (less than 35 weeks gestation), healthcare professionals should start with an oxygen concentration between 21% and 30% (close to atmospheric concentration) and titrate oxygen concentration using pulse oximetry.

Evidence Summary

A systematic review and meta-analysis by ILCOR in 2019[1] and CoSTR[2] summarized the evidence regarding initial oxygen concentrations (FiO_2) in preterm newborns (less than 35 weeks gestation) who receive respiratory support at birth. Ten RCTs and four cohort studies enrolling 5,697 patients were included. Certainty of bias was rated as very low for all outcomes. For all preterm gestational ages combined (less than 35 weeks gestation), there was no statistically significant benefit or harm from use of an initial lower oxygen concentration compared with a higher oxygen concentration for all-cause short-term mortality (RR, 0.83; 95% CI, 0.50–1.37), long-term mortality (1 to 3 years), long-term neurodevelopmental impairment (moderate-severe, 1 to 3 years), retinopathy of prematurity (Grade III, IV, V), necrotizing enterocolitis (Bell's Grade II, III), bronchopulmonary dysplasia (moderate-severe), and major intraventricular hemorrhage (Grade III, IV).[1]

Subgroup analyses of RCTs of newborns (32 weeks gestation or less and 28 weeks gestation or less) found similar lack of benefit or harm with use of initial lower oxygen concentration compared with higher oxygen concentration for the outcomes of short-term or long-term mortality.[1]

Similar lack of benefit or harm was shown from subgroup analysis for infants less than 35 weeks gestation when comparing FiO_2 0.21 with FiO_2 1.00, FiO_2 0.21–0.30 compared with FiO_2 0.80–1.00, FiO_2 0.30 compared with FiO_2 0.90–1.00, FiO_2 0.30 compared with FiO_2 0.60–0.65, and FiO_2 0.50 compared with FiO_2 1.00.[1]

A weak recommendation by ILCOR suggests starting with a lower oxygen concentration (21% to 30%) compared with a higher concentration (60% to 100%) for preterm newborns (less than 35 weeks gestation) who receive respiratory support at birth with subsequent titration of oxygen concentration using pulse oximetry.[2]

Insights and Implications

Although it remains unclear what the ideal FiO_2 is for preterm newborns requiring respiratory support, the ILCOR reviewers noted that their recommendation reflects the value placed on avoiding exposure of preterm newborns to additional oxygen without proven benefit for critical outcomes, and they are aware of harm in preterm animals and increased neonatal mortality in term infants exposed to a high initial oxygen concentration at birth.[2]

Initial Oxygen Concentration for Term and Late Preterm Neonatal Resuscitation

Does use of a lower initial oxygen concentration for respiratory support of term or late preterm (35 weeks gestation or more) newborn infants, compared with use of a higher initial oxygen concentration, change short-term mortality and other clinical outcomes?

Red Cross Guidelines

- When resuscitating a term or late preterm newborn, healthcare professionals should start with atmospheric oxygen concentration (21%) and titrate oxygen concentration using pulse oximetry.

- A concentration of 100% should not be used as the starting level for initial resuscitation of the term or late preterm newborn.

Evidence Summary

An ILCOR systematic review[3] and CoSTR[2] compared administration of a lower initial oxygen concentration with administration of a higher initial oxygen concentration in newborn infants (term or late preterm) who receive respiratory support at birth. Late preterm was defined as 35 weeks gestation or more. Seven RCTs and quasi RCTs[4-10] including 1,469 term and late preterm newborns receiving respiratory support at birth showed a lower short-term mortality when starting with 21% oxygen compared with 100% oxygen (RR, 0.73; 95% CI, 0.57–0.94; 46/1000 fewer babies died when respiratory support at birth was started with 21% oxygen compared with 100% oxygen [95% CI, 73/100 fewer to 10/1000 fewer]).[3] For long-term neurodevelopmental impairment among survivors who were assessed and for hypoxic-ischemic encephalopathy (HIE), very low-certainty evidence assessed showed no benefit or harm when respiratory support at birth was started with 21% oxygen compared with 100% oxygen.[3]

A weak recommendation by ILCOR suggests starting with 21% oxygen for term and late preterm newborns (35 weeks gestation or more) receiving respiratory support at birth.[2]

A strong recommendation is made by ILCOR against starting with 100% oxygen for term and late preterm newborns receiving respiratory support at birth.[2]

Insights and Implications

Although the evidence was of low certainty, this review found a large reduction in short-term mortality (number needed to treat = 22) without demonstrated adverse effects with the initial use of 21% oxygen and thus favors the use of room air for initial resuscitation in term and late preterm newborns. The recommendation to commence resuscitation with room air does not imply continued use of room air if a newborn does not respond to interventions. Additional research is needed regarding titration of oxygen to SpO_2 targets, use of intermediate oxygen concentrations, and the effect of delayed cord clamping on oxygen exposure.

Laryngoscopy and Suctioning of Meconium at Birth for Non-Vigorous Newborns

Does performing immediate laryngoscopy (with or without tracheal intubation) and suctioning at the start of resuscitation of non-vigorous infants born at 34 weeks or later through meconium-stained amniotic fluid, compared with performing immediate resuscitation without direct laryngoscopy at the start of resuscitation, change outcomes including survival to hospital discharge, neurodevelopmental impairment, and meconium aspiration syndrome (MAS)?

Red Cross Guidelines

- For non-vigorous newborns delivered with meconium-stained amniotic fluid, healthcare professionals should not perform immediate laryngoscopy after birth with or without tracheal suctioning.

- For non-vigorous newborns delivered with meconium-stained amniotic fluid, healthcare professionals should perform immediate resuscitation.

- In the presence of airway obstruction, healthcare professionals may consider laryngoscopy and suctioning for newborns delivered with meconium-stained amniotic fluid and requiring resuscitation.

Evidence Summary

An ILCOR systematic review with meta-analysis[11] and CoSTR[2] included four RCTs[12-15] with 581 non-vigorous newborns delivered through meconium-stained amniotic fluid. All RCTs were considered to be at high risk for bias. The pooled estimate for survival was not found to be significantly different for the immediate laryngoscopy/suctioning group compared with the immediate resuscitation without laryngoscopy group (RR, 1.01; 95% CI, 0.960–1.06; p=0.69; aRR, -0.9%; 95% CI, -3.7%–5.6%).[11]

For meconium aspiration syndrome, pooled estimate from the same four RCTs showed no significant difference in the incidence of MAS between the laryngoscopy intervention group and the comparator group (RR, 1.00; 95% CI, 0.80–1.25; p=0.98; aRR, 0.0%; 95% CI, -6.9%–8.6%).[11]

Other outcomes that with meta-analysis did not show a difference between laryngoscopy with suctioning and no laryngoscopy/suctioning included hypoxic-ischemic encephalopathy, use of mechanical ventilation, respiratory support excluding mechanical ventilation, chest compressions, use of epinephrine in the delivery room, endotracheal intubation for positive pressure ventilation (PPV) in the delivery room, and length of hospitalization.[11]

A weak recommendation by ILCOR for non-vigorous newborns delivered through meconium-stained amniotic fluid suggests against routine immediate direct laryngoscopy after delivery with or without tracheal suctioning when compared with immediate resuscitation without direct laryngoscopy.[2]

It is noted that meconium-stained amniotic fluid remains a significant risk factor for receiving advanced resuscitation in the delivery room. Rarely, an infant may require intubation and tracheal suctioning to relieve airway obstruction.[2]

Insights and Implications

Non-vigorous infants were defined as heart rate under 100 beats per minute, decreased muscle tone and/or depressed breathing at delivery. In summary, the systematic review and meta-analysis showed that an approach based on immediate laryngoscopy with tracheal suctioning did not improve survival at discharge compared with immediate resuscitation without laryngoscopy. The ILCOR reviewers noted that in making their recommendation, they place value in both harm avoidance (i.e., delays in initiating bag-mask ventilation, potential harm of the procedure) and the unknown benefit of routine tracheal intubation and suctioning.[2] In light of a lack of evidence for benefit from routine suctioning, they state that emphasis to be on initiating ventilation within the first minute of life for non-breathing or ineffectively breathing infants, even when born through meconium-stained amniotic fluid.[2] A caveat is that tracheal intubation may be needed in some newborns to clear a blocked airway or for subsequent ventilation.[16,17]

Sustained Inflation at Birth

For newborn infants who receive positive pressure ventilation for bradycardia or ineffective respirations at birth, does initiating positive pressure ventilation (PPV) with sustained inflation(s) greater than 1 second compared with initiating PPV with intermittent inflations lasting 1 second or less per breath change clinical outcomes?

Red Cross Guidelines

- For preterm newborn infants receiving positive pressure ventilation due to either bradycardia or ineffective respirations at birth, healthcare professionals should not use initial sustained inflation(s) greater than 5 seconds.

Evidence Summary

A 2020 ILCOR systematic review[18] and CoSTR[2] evaluated this question, with outcomes including death before hospital discharge, death in the delivery room, death within the first 48 hours, or death at latest follow-up.

For death before discharge, this review identified low-certainty evidence from nine RCTs,[19-27] including 1,406 preterm newborns who received PPV for bradycardia or ineffective respirations at birth, not showing a significant benefit or harm from initiating PPV with sustained inflations (SI) greater than 1 second compared with PPV with intermittent inflations lasting 1 second or longer per breath (RD, 3.6%; 95% CI, -0.7%–7.9%).[18] Similar findings were shown for the outcomes of death in the delivery room, death within the first 48 hours after birth, bronchopulmonary dysplasia, intraventricular hemorrhage grade 3 or 4, retinopathy of prematurity stage 3 or higher, use of mechanical ventilation during hospitalization, and air leak during hospitalization.[2]

Subgroup analyses by age for the outcome of death before discharge found that for newborns less than 28+0 weeks, preterm newborns who received PPV for bradycardia or ineffective respirations at birth showed evidence of potential harm from initiating PPV with SI longer than 1 second compared with PPV with intermittent inflations lasting 1 second or longer per breath (RR, 1.38; 95% CI, 1.00–1.91; 46 more patients/1000 died before discharge with the SI [95% CI, 0 fewer to 110 more per 1000]).[2] For the subgroup of newborns 28+1 weeks to 31+6 weeks, and the outcome of death before discharge, no significant benefit or harm was shown from initiating PPV using SI

longer than 1 second compared with intermittent inflations 1 second or longer per breath.[2] Subgroup analyses for death before discharge using sustained inflation of longer than 15 seconds duration and using sustained inflation with inspiratory pressure greater than 20 mmHg similarly found no significant benefit or harm, while a subgroup with first sustained inflation with inspiratory pressure 20 mmHg or more could not exclude benefit or harm.[2]

A weak recommendation by ILCOR for preterm newborn infants who receive positive pressure ventilation due to bradycardia or ineffective respirations at birth suggests against the routine use of initial sustained inflation(s) greater than 5 seconds.[2]

Due to very low confidence in the estimates of effect, it was not possible to recommend any specific duration for initial inflations for term or late preterm infants who receive positive pressure ventilations due to bradycardia or ineffective respirations at birth.[2]

Insights and Implications

It was noted by the ILCOR reviewers that inadequate patency of the larynx in preterm infants (similar to what has been seen in preterm rabbit pups with closure of the larynx other than during a spontaneous breath) could explain the absence of benefit from sustained inflation immediately after birth.[2] It is recognized that larger multicenter trials are needed and the total number of infants in studies so far is insufficient to have confidence in the estimate of effect. Studies were not identified comparing short duration SI (less than 5 seconds) with intermittent inflations with an inspiratory time of 1 second or longer.

Dose, Route, and Interval of Epinephrine for Neonatal Resuscitation

What are the evidence-based recommendations for epinephrine dosing, dose interval, and route of delivery for neonates of any gestation less than 28 days of age and who have no detected cardiac output, asystole or a heart rate less than 60 beats/minute despite ventilation and chest compression?

Red Cross Guidelines

- For resuscitation of the newborn if the heart rate has not increased to more than 60 beats per minute after optimizing ventilation and chest compressions, intravascular epinephrine should be administered at 0.01 to 0.03 mg/kg. If intravascular access is not available, healthcare professionals may consider endotracheal epinephrine at a dose of 0.05 to 0.1 mg/kg. While epinephrine can be given via endotracheal tube, healthcare professionals should not delay attempts to establish vascular access to give epinephrine via the endotracheal tube.

- Healthcare professionals should administer repeat doses of epinephrine every 3 to 5 minutes, preferably intravascularly, if the heart rate remains less than 60 beats per minute.

- If epinephrine has been administered via the endotracheal route with inadequate response, an intravascular dose may be considered as soon as vascular access is obtained, regardless of the interval.

Evidence Summary

A 2019 ILCOR systematic review and CoSTR[2] evaluated any non-standard dose, interval or route of epinephrine compared with use of epinephrine doses of 0.01 to 0.03 mg/kg intravenously at intervals of every 3 to 5 minutes in neonates of any gestation less than 28 days of age who have no detected cardiac output or who have asystole or heart rate less than 60 beats per minute despite ventilation and chest compressions.

Two observational studies were identified, both in term and preterm infants, that addressed the comparisons.[28,29] Both studies were from a single neonatal unit, with participants from different time periods.

Very low-certainty evidence (downgraded for very serious risk of bias and very serious imprecision) from one observational study in 50 neonates treated with epinephrine reported no significant difference between the initial administration of epinephrine by endotracheal tube (0.03 mg/kg/dose) compared with initial IV administration (0.01 mg/kg/dose) for the outcome of death before hospital discharge.[28] This same study showed no difference in the time to ROSC for endotracheal versus intravenous epinephrine.

Very low-certainty evidence (downgraded for very serious risk of bias and very serious imprecision) from two observational studies[28,29] with 97 neonates treated with epinephrine showed no significant difference between the initial endotracheal administration of epinephrine compared with initial IV administration for the outcome of failure to achieve ROSC (RR, 0.97; 95% CI, 0.38–2.48; p=0.96; aRD, 7 fewer; 95% CI, 135 fewer to 322 more per 1,000 neonates did not achieve ROSC).[2]

No other eligible studies were identified for comparing different routes of administration, different doses or intervals of epinephrine administration, or other pre-specified outcomes.

If the heart rate has not increased to more than 60 beats per minute after optimizing ventilation and chest compressions, ILCOR suggests the administration of intravascular epinephrine, 0.01 to 0.03 mg/kg.[2]

If intravascular access is not yet available, ILCOR suggests administering endotracheal epinephrine at a larger dose (0.05 to 0.1 mg/kg).[2] A weak recommendation is made that administration of endotracheal epinephrine should not delay attempts to establish vascular access.[2]

A weak recommendation by ILCOR suggests the administration of further doses of epinephrine every 3 to 5 minutes, preferably intravascularly, if the heart rate remains less than 60 beats per minute.[2]

If the response to endotracheal epinephrine is inadequate, ILCOR suggests that an intravascular dose be given as soon as vascular access is obtained, regardless of the interval.[2]

Insights and Implications

The recommendations are based on very low-certainty evidence from two cohort studies that showed similar survival and ROSC following administration of epinephrine by endotracheal versus intravenous routes. The ILCOR CoSTR reviewers note, however, one neonatal animal study of asphyxia arrest that reported higher and faster epinephrine concentrations, shorter time to ROSC, and higher rates of ROSC after central venous epinephrine administration compared with endotracheal epinephrine.[2]

Intraosseous Versus Umbilical Vein Routes of Fluid and Drug Administration During Newborn Resuscitation

What is the best route of access for fluids and drugs during newborn resuscitation from cardiac arrest?

Red Cross Guidelines

- Umbilical venous catheterization should be the primary method of vascular access during newborn resuscitation in the delivery room. If umbilical venous access is not feasible, healthcare professionals may consider the intraosseous route for vascular access during newborn resuscitation.

- Healthcare professionals should use either umbilical venous access or the intraosseous route depending on their training, equipment availability and/or local protocols outside of the delivery room to administer fluids and medications during newborn resuscitation.

Evidence Summary

A 2020 ILCOR systematic review[30] and CoSTR[2] evaluated the evidence for placement of an intraosseous (IO) cannula and drug administration through this IO during neonatal cardiac arrest (including severe bradycardia/inadequate perfusion requiring chest compressions) compared with placement of an intravenous (IV) cannula or umbilical vein cannula in newborns) and drug administration through this cannula during cardiac arrest. Outcomes included death during the event, within 24 hours and before hospital discharge; long-term neurodevelopmental outcomes; ROSC with HR greater than 60 beats per minute and time to ROSC; brain injury; time to secure access; and morbidity related to the IO or IV cannula.

For all outcomes, no evidence was identified on the placement of an IO cannula compared with IV placement and drug administration in neonates with severe bradycardia and inadequate perfusion requiring chest compressions in any setting.[30] Six case reports (very low-certainty evidence) were noted that described serious adverse effects of IO access in neonates, such as tibial fractures or extravasation of fluid and medications resulting in compartment syndrome and amputation.[31-36] No reports of adverse effects or complications from umbilical vein catheterization were remarked on.[30]

A weak recommendation by ILCOR suggests use of umbilical venous catheterization as the primary method of vascular access during newborn resuscitation in the delivery room. If umbilical venous access is not feasible, the intraosseous route as vascular access is a reasonable alternative during newborn resuscitation.[2]

Outside of the delivery room setting, it is suggested that either umbilical venous access or the intraosseous route may be used to administer fluids and medications during newborn resuscitation, and the route use may depend on local availability of equipment, training and experience.[2]

Insights and Implications

The recommendation is made in the absence of data from studies of neonates supporting any advantage of intraosseous over umbilical venous access and in light of case reports of complications in neonates from the IO approach. Umbilical access is the technique most commonly taught for neonates although it is acknowledged in the consensus review that in the out-of-hospital setting or in pediatric or neonatal intensive care units, an intraosseous approach may be helpful.

Prognostication: Impact of Duration of Intensive Resuscitation

In newborn infants presenting with at least 10 minutes of asystole, bradycardia (less than 60 beats per minute) or pulseless electrical activity after birth for which CPR is indicated, does ongoing CPR for incremental time intervals beyond 10 minutes after birth compared with CPR discontinued at 10 minutes after birth change survival or neurodevelopmental outcomes?

Red Cross Guidelines

- Healthcare professionals should consider a discussion with the clinical team and family regarding discontinuation of resuscitative efforts after 20 minutes of CPR and all the indicated resuscitative actions following birth.

Evidence Summary

An ILCOR systematic review[18] and CoSTR[2] evaluated if, in newborn infants presenting with at least 10 minutes of asystole, bradycardia (heart rate less than 60 beats per minute) or pulseless electrical activity after birth for which CPR is indicated, continuing CPR for incremental time intervals beyond 10 minutes after birth compared with discontinuing CPR at 10 minutes after birth changes survival or long-term neurodevelopmental outcomes. Evidence included was from observational studies, including retrospective record reviews, and of very low certainty due to risk of bias and inconsistency.

Outcomes were reported in 16 identified studies with 579 newborns, with individual studies reporting 2% to 100% of infants surviving to last follow-up (hospital discharge through 12 years).[18] Among 579 newborns reported across studies, 237 (40%) survived to last follow-up.[18]

Neurodevelopmental outcomes among survivors were assessed in 13 observational studies, including 277 infants. Of these infants, 30 (10.8%) survived without moderate or severe neurodevelopmental impairment.[18] The reviewers concluded that failure to achieve ROSC in newborns after 10 to 20 minutes of intensive resuscitation is associated with a high risk of mortality and moderate to severe neurodevelopmental impairment among survivors, but there is no evidence that any specific duration of resuscitation predicts mortality or moderate-severe neurodevelopmental impairment among survivors.[2]

If a newborn infant requires ongoing CPR after birth despite completing all the recommended steps of resuscitation and excluding reversible causes, ILCOR suggests initiating discussion of discontinuing resuscitative efforts with the clinical team and family.[2] A reasonable time frame for this change in goals of care is around 20 minutes after birth.[2]

Insights and Implications

The reviewers recognized the need to balance the risk of ceasing resuscitation too early, when ROSC and long-term survival may be achievable, and continuing resuscitation for too long, when ROSC may occur, but survival is associated with a high risk of severe neurologic injury. The review discussed the number of survivors without moderate or severe neurodevelopmental impairment after 10 minutes or more of resuscitation and case series of favorable outcomes among newborn infants with Apgar scores of 0 to 1 at 10 minutes after birth who achieved ROSC and received therapeutic hypothermia.[2]

Post-Resuscitation Care

Rewarming of Hypothermic Newborns

Does rapid rewarming (0.5°C/h or greater) compared with slow rewarming (0.5°C/h or less) of newborn infants who are hypothermic (less than 36.0°C) on admission change clinical outcomes?

Red Cross Guidelines

- Healthccare professionals may consider either a rapid (0.5°C/h or greater) or slow (0.5°C/h or less) rewarming strategy for newborn infants who are hypothermic on admission.

Evidence Summary

An evidence update was performed by ILCOR in 2020 and included two additional retrospective studies in the literature for this review.[2] The included studies both found that the rewarming rate, after adjustment for confounders, was not associated with critical clinical outcomes, although one study[37] suggested a reduced risk for respiratory distress syndrome with rapid rewarming.[2]

Insights and Implications

The 2015 ILCOR review[38] resulted in a "no recommendation," but the neonatal task force notes in the current evidence update that a repeat systematic review will be prioritized and will likely allow development of a weak recommendation in relation to the rate of rewarming newborn infants.[2]

Induced Hypothermia in Settings With Limited Resources

In newborns with hypoxic-ischemic encephalopathy managed in limited-resource settings, does the use of therapeutic hypothermia delivered by passive hypothermia and/or ice packs compared with standard care change outcomes or survival or neurodevelopmental impairment? This topic was reviewed by ILCOR in 2015[38] and an evidence update performed for 2020.[2]

Red Cross Guidelines

- Healthcare professionals should consider cooling a newborn with hypoxic-ischemic encephalopathy within 6 hours of initiation of resuscitation to a temperature control of 33°C to 34°C for 72 hours and with rewarming over at least 4 hours in a NICU setting, using clear protocols and a multidisciplinary care team.

Evidence Summary

The 2020 evidence update by ILCOR identified 13 new studies, but they were not considered to add sufficient evidence to consider a new systematic review and would not add to the level of certainty of evidence from 2015.[2]

The ILCOR recommendation remains unchanged and suggests that newborn infants at term or near-term with evolving moderate to severe hypoxic-ischemic encephalopathy in low-income countries and/or other settings with limited resources may be treated with therapeutic hypothermia.[38]

Cooling should only be considered, initiated, and conducted under clearly defined protocols with treatment in neonatal care facilities with the capabilities for multidisciplinary care and availability of adequate resources to offer intravenous therapy, respiratory support, pulse oximetry, antibiotics, anticonvulsants, and pathology testing. Treatment should be consistent with the protocols used in the randomized clinical trials in developed countries, that is, cooling to commence within 6 hours, strict temperature control at 33°C to 34°C for 72 hours, and rewarming over at least 4 hours.[38]

Insights and Implications

While additional studies have been reviewed, none of these were considered sufficient to alter current guidelines.

Post-Resuscitation Glucose Management

A 2010 ILCOR systematic review[39] asked, in newborn infants who have received drugs for resuscitation, does glucose infusion compared with no glucose infusion change survival to hospital discharge, seizures, pulmonary hemorrhage or other important outcomes?

Red Cross Guidelines

- Intravenous glucose infusion should be started as soon as practical after resuscitation as clinically indicated to avoid hypoglycemia.

Evidence Summary

An evidence update in 2020 added an additional 13 studies to the evidence base.[2] The literature identified was reported to suggest the need to maintain vigilance for neonatal hypoglycemia and hyperglycemia following

resuscitation, and that protocols for glucose management may help avoid large swings in blood glucose as well as hypoglycemia and hyperglycemia.

The treatment recommendation from 2010[39] remains unchanged. Intravenous glucose infusion should be considered as soon as practical after resuscitation, with the goal of avoiding hypoglycemia.

Insights and Implications

An updated systematic review is planned by ILCOR on the topic of blood glucose management.

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Drowning

Drowning is a leading cause of unintentional death for children and adults in the United States and the second leading cause of injury-related death for children ages 5 to 14 years old.[1] In addition to the nearly 3,600 unintentional drownings that happen annually in the United States, another 330 people die each year in boating-related incidents.[1]

CPR in Cardiac Arrest Following Drowning

Does CPR using compressions and ventilations (CV-CPR) compared with compressions only (CO-CPR) improve survival with favorable neurological outcomes for cases of cardiac arrest following drowning?

Red Cross Guidelines

- It is reasonable to initiate compression-ventilation CPR (CV-CPR) for cardiac arrest following drowning in children. If CV-CPR is not possible or lay responders are not willing, compression-only CPR (CO-CPR) should be performed.

Evidence Summary

A systematic review in 2020[2] by members of the Aquatics Subcouncil of ARCSAC used data from the Cardiac Arrest Registry for Enhanced Survival (CARES; MyCares.net) in a retrospective evaluation of 548 cases of cardiac arrest following drowning in which information was available on type of CPR performed over four years beginning January 1, 2013. CV-CPR in 5- to 15-year-olds was reported to be significantly associated with neurologically favorable survival (aOR, 2.68; 95% CI, 1.10–6.77; p=0.03), and CV-CPR was reported to be significantly associated with survival to hospital discharge in all age groups (aOR, 1.54; 95% CI, 1.01–2.36; p=0.046). A nonsignificant trend toward neurologically favorable survival in all age groups was also noted (aOR, 1.35; 95% CI, 0.86–2.10, p=0.19).[2]

Insights and Implications

CV-CPR appears to offer improved neurologically favorable survival in a subgroup population of 5- to 15-year-olds with cardiac arrest following drowning. The included study from the CARES registry is the largest analysis to date of bystander CPR performed following drowning and suggests that when cardiac arrest is from a primarily respiratory etiology (e.g., children), the use of CV-CPR may offer improved neurologically favorable survival.

Beginning CPR with Compressions or Breaths

The drowning process poses a unique pathology and may require a unique approach to resuscitation.

Red Cross Guidelines

- For adults, children, and infants with the drowning process and after determining the presence of cardiac arrest, resuscitation should start by opening the airway, providing 2 rescue breaths, and then continuing CPR by providing cycles of 30 compressions followed by 2 rescue breaths/ventilations.

Evidence Summary

The ARCSAC initially reviewed the evidence in 2010 and then again in 2015.[3] Since that review no new evidence has been published that would change the guidelines.

Insights and Implications

For CPR there has been debate over whether to begin with rescue breaths/ventilations or compressions. This debate involves discussion of the etiology which is primarily cardiac in adults and primarily respiratory in children. A systematic review[2] with data from the CARES registry suggests that when cardiac arrest is from a primarily respiratory etiology (e.g., children), the use of CV-CPR compared with compression-only CPR may offer improved neurologically favorable survival. This indirectly supports the need to support ventilations during resuscitation from drowning and is consistent with the approach to deliver 2 breaths at the start of CPR.

In-Water Resuscitation

In-water resuscitation (IWR) is the technique of providing rescue breaths/ventilations while in the water. A 2019 review by ARCSAC[3] evaluated available evidence describing the technical feasibility and clinical utility of in-water resuscitation.

Red Cross Guidelines

- In-water resuscitation can be considered in cases where a lifeguard has proper training in the technique and is comfortable performing it without causing an unsafe environment for the lifeguard or the person.

- Though in-water resuscitation can be performed without the aid of additional equipment, floating and propelling equipment should be considered.

Evidence Summary

The concept of resuscitating a person while still in the water gained little attention in peer-reviewed literature until the 1980s. In 1980, March and Matthews reported their findings of a manikin-based feasibility study describing the use of chest compressions and ventilations provided by a SCUBA regulator while in the water.[4,5] This study was followed by multiple letters and editorials highlighting the weaknesses of the study methods and probable

lack of applicability to real-life resuscitations.[6,7] Since then, no high-quality study has been found in the literature describing the use of chest compressions in the water and the technique is currently not recommended. The use of ventilations in the water, however, has gained acceptance over the decades and does have some data to support its use. For the remainder of this evidence summary, the term in-water resuscitation (IWR) is used to describe the technique of providing rescue ventilations while in the water. IWR specific to open water lifesaving was first discussed in detail in peer-reviewed literature in a 1988 study by Manolios and Mackie.[8] In their study on fatal and non-fatal drownings on Australian beaches, the authors of this paper noted that this technique has been used in New Zealand, especially with the use of a rescue board, since the 1970s. Out of the 262 cases described in this study, 14 involved the lifeguard providing IWR with the assistance of a board, buoy, or fins. No high-quality analysis could be made on these cases other than the fact that 6 of the 14 patients survived, but the authors were led to conclude that IWR "…appears not only feasible but highly successful."[8]

Since this early work, only one other study has described human outcome data on the effects of IWR during open water rescues. This study was based in Brazil and analyzed five years of ocean lifeguard data.[9] From this data, 46 patients who were found unconscious and apneic in the water were included, of which 19 received IWR. After analysis it was found that those patients who received IWR had significantly lower prehospital and hospital mortality when compared to those who did not. Although small and despite its inherent design weaknesses, it remains the only study in peer-reviewed literature to specifically evaluate IWR from a patient outcome perspective.[9] Following this, all of the IWR-specific studies since have utilized simulated rescue scenarios with manikins. Pooled together, these studies have found the following[10-13]:

- IWR is feasible, by mouth-to-mouth, bag-mask, and laryngeal tube ventilation.

- IWR increases the time and perceived difficulty of a rescue.

- IWR increases the amount of measured water aspiration on the part of the patient.

- Lifeguards perform IWR more effectively and efficiently than laypersons.

The most important point highlighted by all of these studies is that IWR is feasible but difficult. Studies have been performed to show objectively that performing a rescue is physically and metabolically taxing to a rescuer.[14,15] This may be easily exacerbated by adding in IWR if the rescuer is not properly trained or physically fit to efficiently perform the rescue. What has also been found is that this physical and metabolic demand, as well as rescue time, is decreased by using rescue equipment such as buoys, fins, and boards. This finding supports the use of this equipment to lessen the physical demands of IWR and create a safer working environment for the rescuer.

In general, the data surrounding the use of IWR during open water rescues is lacking. The primary study driving opinion is the 2004 Brazilian study, which was based on a small number of patients and retrospective analysis.[9] Despite this, the International Life Saving Federation's current Medical Position Statement supports the use of IWR for properly trained professional lifeguards; these are in line with the 2015 European Resuscitation Council guidelines for resuscitation.[16,17] This is primarily due to the understanding that the earlier the physiologic insults of drowning can be reversed, the greater the chances are for survival with good neurologic outcome for the patient. While both of these documents differentiate between rescues performed in shallow and deep water, this is based purely on expert opinion and consensus without data; the conclusions in this review will, therefore, not include this differentiation.

Insight and Implications

During the process of drowning, the most significant physiologic insult and, therefore, primary cause of morbidity and mortality is systemic hypoxemia. It stands to reason that the earlier an intervention can be applied to reverse this insult and reverse the drowning process, such as with IWR, the greater the chances would be for survival

with minimal morbidity following drowning. Although most studies have primarily been manikin- and simulation-based, they demonstrate that IWR is feasible and performed better with proper training and equipment. They also demonstrate that while water rescues are inherently physically demanding, the use of rescue equipment may decrease those demands.

Drowning and Prognostic Factors

In adults and children who are submerged in water, does any particular factor in search-and-rescue operations change outcomes?

Red Cross Guidelines

- Submersion duration should be used as a prognostic indicator when making decisions surrounding search and rescue resource management/operations.

- Age, EMS response time, water type (fresh or salt), water temperature, and witness status should not be used when making prognostic decisions.

Evidence Summary

A 2015 ILCOR systematic review[18] and CoSTR[19] updated review in 2020[20] evaluated prognostic factors from search and rescue operations for adults and children submerged in water.

For the factor of age, no new studies were included in the 2020 review; observational studies from the 2015 ILCOR review found that young age was not associated with favorable neurologic outcome, while for the outcome of survival, results related to age were conflicting.[19]

For the prognostic factor of EMS response interval, no new studies were included in the 2020 update. The 2015 review found that EMS response intervals of less than 10 minutes were associated with better survival.[19]

For the prognostic factor of salinity, six observational studies were included.[20] Survival with favorable neurologic outcome was positively associated with salt water in two studies, while water type was not associated with this outcome in four other studies. Similar conflicting results were reported for the outcome of survival.[20]

For the prognostic factor of submersion duration, no new studies were identified for short submersion intervals (less than 5 to 6 minutes). In the 2015 review, worse outcomes for survival with favorable neurologic outcome were reported in all studies for submersion durations exceeding 5 minutes, although persons submerged for short durations compared with longer durations had good outcomes.[18] For intermediate submersion intervals (less than 10 minutes), no new studies were included; worse survival with favorable neurologic outcomes was previously reported among persons with prolonged submersion duration compared with intermediate duration. No new studies were identified for evaluation of prolonged submersion intervals (less than 15 to 25 minutes). In general, shorter submersion intervals were previously reported as associated with better outcomes than longer submersion intervals.[18]

For the prognostic factor of water temperature, no new studies were included in the 2020 ILCOR review. Of the two studies included in the 2015 review, the larger study found no difference in survival with favorable neurologic outcome with water temperature, while a second smaller study found better outcomes associated with submersion in the winter compared with submersion in spring or summer.[18]

For the prognostic factor of witnessed status, one additional observational study was included.[21] Two studies reported an association of better neurological outcomes with witnessing the event (aOR, 11.8; 95% CI, 2.84–49.08)[22] and (aOR, 3.27; 95% CI, 2.0–5.36)[21]; although it was noted by the reviewers that submersion duration was not reported and several studies have reported it as an independent predictor. Four observational studies reported on survival for witnessed status with conflicting results.[20]

A strong recommendation is made by ILCOR that submersion duration be used as a prognostic indicator when making decisions surrounding search and rescue resource management/operations.[20]

ILCOR suggests against the use of age, EMS response time, water type (fresh or salt), water temperature, and witness status when making prognostic decisions.[20]

Insights and Implications

The 2015 ILCOR CoSTR[19] received significant feedback regarding the need for dynamic risk assessments that consider likelihoods of favorable outcomes in light of risks related to rescue. The systematic review found that submersion durations of less than 10 minutes were associated with a very high chance of favorable outcome, while durations greater than 25 minutes were associated with a low chance of favorable outcomes.[18] Findings from the new observational studies included for 2020 are consistent with the 2015 treatment recommendation. Previously identified limitations of the review, including a lack of prospective validation of submersion duration as a clinical decision rule, persist. Finally, because of continued rare case reports of survival after prolonged submersion, ILCOR notes that case-by-case decisions that balance risk and the potential for benefit will be needed.[20]

First Aid for Aquatic Environmental Emergencies

Jellyfish Stings

Stings from jellyfish are common, particularly during summer months when vacationers flock to beaches on the east and gulf coasts. The management of jellyfish stings has been reviewed by ARCSAC several times with the most recent update being 2019.[3]

Red Cross Guidelines

- Adults and children with jellyfish stings, should be assessed for responsiveness, signs of shock, or anaphylaxis. If any of these are present, 9-1-1 should be called. CPR should begin as indicated.

- Hot water immersion should be used or a heat source should be applied to relieve pain from a jellyfish sting following removal of remaining tentacles. The temperature of the water or heat source should be approximately 106°F to 113°F, or as hot as tolerated (not scalding), for 20 minutes or until pain is relieved.

- Any remaining tentacles should be removed while avoiding manual contact. Lifting or pulling may be considered over scraping. The affected area can also be rinsed with seawater to remove remaining tentacles.

- Vinegar (acetic acid) should not be applied to most jellyfish stings in U.S. coastal waters.

- Topical lidocaine cream or gel may be considered for pain control.

Evidence Summary

The initial ARCSAC scientific review recommended the application of heat to the affected area of the sting to decrease pain following jellyfish envenomation. The 2019 review sought to identify any new scientific literature in regard to first aid for jellyfish stings, with an emphasis on species found in coastal and territorial waters of the United States.[3]

Since the first ARCSAC scientific review, four additional studies have been included in the evidence base. Evidence is still varied on whether or not vinegar is an appropriate first aid treatment; one new study indicates that vinegar can induce discharge of stinging cells, while others indicate it inhibits stinging cell discharge.[3]

Insights and Implications

The evidence supporting treatment recommendations for management of jellyfish stings is considered low to very low certainty and often based on experimental studies in volunteers or case series. This review first identified the most common species of jellyfish found in coastal and territorial waters of the United States. As efficacy of vinegar may be dependent on the species involved and it is thought that the person will not be able to reliably identify the type of jellyfish that stung them, we continue to recommend against the use of vinegar to treat jellyfish stings. Increasing evidence indicates that heat may decrease local tissue damage and suggests that cold packs can increase local tissue damage, therefore, cold packs or cold water are no longer recommended for treatment. In addition, evidence suggests that scraping off any remaining tentacles with a sharp object may increase nematocyst discharge and worsen local tissue damage. Any remaining tentacles should be gently lifted off, while avoiding touching the tentacle. Alternatively, seawater could be used to wash off the remaining tentacle.

Exposure to Pool Chemicals

It is estimated that over 4,500 visits to emergency departments related to pool chemicals occur annually in the United States.[23] A 2020 joint First Aid and Aquatics Subcouncil ARCSAC review was used to answer the question, what is the recommended first aid for exposure to pool chemicals?[3]

Red Cross Guidelines

- Following eye, skin, or inhalational exposure to pool chemicals, the injured person should be removed from the source, taken to an area with fresh air, and contaminated materials (e.g., clothing, contact lenses) should be removed.

- Irrigation of the exposed area should take place immediately with fresh water for at least 15 minutes.

- If symptoms do not resolve during that time or are worsening, the person should be evaluated by trained medical personnel.

Evidence Summary

The incidence of pool chemical injuries in the United States between 2008 and 2017 was reported by the CDC.[24] Most injuries were relatively minor, with 93.9% treated and released from the emergency department. No deaths were reported. Of the reported injuries, 90% were inhalational with the remaining including chemical burns, conjunctivitis and dermatitis.

An observational study reported that first aid with water irrigation between 5 and 60 minutes resulted in significantly shorter healing time and lower degree of injury for caustic eye injury, compared with those without initial eye irrigation.[25] Evidence for inhalational injury is from case studies and a retrospective chart review of patients with chlorine exposures from swimming pools, treated with supplementary oxygen and bronchodilators.[26] Evidence for dermal injury comes from observational studies following caustic injury, with treatment using immediate irrigation within 10 minutes with large volumes of water for at least 15 minutes.[27]

Insights and Implications

Chemicals used in pool treatments are typically caustic, with the primary agents being chlorine or sodium hypochlorite and bromine being an alternative. In addition, pure hydrochloric acid or other acids may be needed to help regulate the pH under certain conditions. The generated caustic chemicals are irritants to the skin, eyes and mucous membranes and, when aerosolized, form gases that are irritants to the respiratory tract. This ARCSAC Answer contains an appendix for safe handling of pool chemicals.

Safety and Prevention

Pool Fences

Drowning is a leading cause of death for children in the United States. Among children ages 1 to 4 years old, most drownings occur in home swimming pools. In nearly every case, these drownings are preventable. When home pools or spas are where the drownings occurred, young children typically access the water without the awareness of the parent or caregiver and when they were not expected to be in or near the water. An evidence-based position statement advocating for pool and spa fencing was completed by the ARCSAC Aquatics Subcouncil in 2020.[3]

Red Cross Guidelines

- Residential pools and spas should have four-sided fencing with self-closing and self-latching gates

- In addition to isolation fencing, there should be a secondary barrier, such as door alarms and locks that are out of the reach of a child on all doors and windows with direct access to the pool or spa area, as well as lockable covers.

- For above-ground pools, steps or ladders must be secured, locked or removed whenever the pool is not in use and actively supervised by an adult.

Evidence Summary

A Cochrane review identified case control studies that evaluated pool fencing interventions and reported an association between pool fencing and reduced risk of drowning (OR, 0.27; 95% CI, 0.16–0.47) for a fenced pool compared with an unfenced pool.[28] Isolation fencing (enclosing pool only) was superior to perimeter (property and pool) fencing (risk of drowning OR, 0.17; 95% CI, 0.07–0.44). The Consumer Product Safety Commission's Barrier Guidelines for Residential Pools provides comprehensive guidance that should be considered in the drafting of any legislation or policies.[29] It is the position of the American Red Cross that effective pool and spa fencing and barriers can prevent drowning in young children.

Insights and Implications

The American Red Cross strongly supports legislation and policies that require proven effective barriers at pools and spas at private homes. Laws requiring four-sided fencing with self-closing and self-latching gates of residential pools have been proven to decrease toddler/preschooler drowning deaths. Legislation and policies should:

- Apply to in-ground, above-ground and portable pools.

- Require four-sided isolation fencing with a self-closing and self-latching gate that is out of the reach of a child. A four-sided isolation fence (separating the pool area from the house and yard) reduces a child's risk of drowning 83% compared to three-sided property-line fencing.

- Require a secondary barrier, such as door alarms and locks that are out of the reach of a child on all doors and windows with direct access to the pool or spa area, as well as lockable covers.

- For above-ground pools, require that steps or ladders be secured, locked or removed whenever the pool is not in use and actively supervised by an adult.

Layers of protection are essential to help prevent drowning. The critical layer is appropriate barriers to prevent children from accessing pools and spas without their parent or caregiver's awareness. See Circle of Drowning Prevention.

Circle of Drowning Prevention

Layers of protection are essential to help prevent drowning. Plan ahead for aquatic activities:

Provide close and constant attention to children you are supervising in or near water

Always swim in a lifeguarded area

Fence pools and spas with adequate barriers, including four-sided fencing

Children, inexperienced swimmers, and boaters should wear U.S. Coast Guard-approved life jackets

Learn swimming and water-safety survival skills

Life Jackets

A critical layer of protection to prevent drowning is the use of life jackets.

Red Cross Guidelines

- U.S. Coast Guard-approved life jackets, also known as personal flotation devices (PFDs), must be worn while on boats and be made available and allowable for children and inexperienced swimmers in all types of recreational aquatic facilities.

- Life jackets should be:

  ◦ U.S. Coast Guard-approved.

  ◦ In good serviceable condition.

  ◦ Properly fitted to the size of the user.

  ◦ Properly worn, with buckles, zippers and straps fastened for a snug fit.

  ◦ Appropriate for the water activity.

Evidence Summary

A review of life jacket use, benefits and regulations was completed by the Aquatics Subcouncil of the ARCSAC.[3] Federal law requires that a boat must have a U.S. Coast Guard-approved life jacket for each person aboard. Boats 16 feet and over must have at least one Type IV throwable device as well. All states have regulations regarding life jacket use for children, mostly requiring that they be worn by children under 13 years of age. Still, according to the U.S. Army Corps of Engineers (USACE), the nation's largest provider of water-based recreation, almost 90% of the 150 people who drown every year at Corps parks were not wearing a life jacket, with more than half of all drowning deaths being swimming related. In addition to natural water (such as lakes, rivers, oceans), life jackets should be available and allowable at water parks and pools.[3]

Insights and Implications

It is the position of the American Red Cross that use of appropriate life jackets can prevent drowning in children and adults.

The American Red Cross strongly supports legislation and policies that require children and adults to wear U.S. Coast Guard-approved life jackets. These should be worn while on boats and be made available and allowable for children and inexperienced swimmers in all types of recreational aquatic facilities.

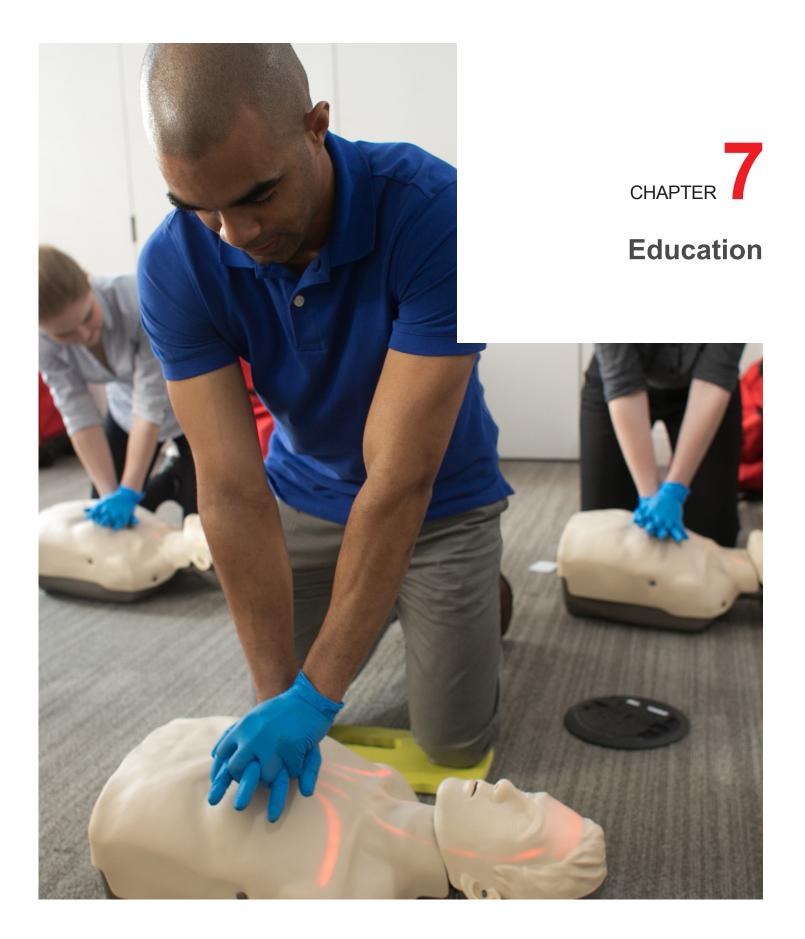The American Red Cross Circle of Drowning Prevention advises that children, inexperienced swimmers and all boaters wear U.S. Coast Guard-approved life jackets. The U.S. Coast Guard provides information about the different types of life jackets as well as proper wear and fitting. This information should be consulted when drafting legislation or policies regarding life jacket use at aquatic facilities and when boating.

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CHAPTER **7**

Education

Cognitive Aids and Technology

Cognitive Aids in Resuscitation

Resuscitation organizations commonly provide pocket card flowcharts, algorithms, and other cognitive aids to resuscitation course participants and healthcare organizations.

Red Cross Guidelines

- Healthcare professionals may consider using cognitive aids during resuscitation.

- Lay responders should not use cognitive aids during initiation of CPR.

Evidence Summary

An extensive ILCOR systematic review and CoSTR[1] evaluated cognitive aids in resuscitation to determine if they are effective in improving multiple patient outcomes or provider performance outcomes during resuscitation. Evidence from this review suggests that cognitive aids may improve performance and patient outcomes by decreasing the cognitive load of individuals or teams collectively.[2] Limitations to working memory, systems decision-making, or cognitive processes and the impact of stress and distraction in resuscitation may impair rapid, accurate decision-making.[3] Standardizing communications between resuscitation team members[4] and allowing better situation awareness among team members[5] may improve team performance. The review also identified issues resulting from use of cognitive aids, including fixation errors, impaired team member communication, and distraction.[1]

A weak recommendation by ILCOR suggests against the use of cognitive aids for the purposes of lay providers initiating CPR (low-certainty evidence).[1]

A weak recommendation by ILCOR suggests the use of cognitive aids for healthcare providers during trauma resuscitation (very low-certainty evidence).[1]

A weak recommendation by ILCOR suggests the use of cognitive aids for training of healthcare leave providers in resuscitation (very low-certainty evidence).[1]

Insights and Implications

The reviewers acknowledged the conflicting evidence for routine use of cognitive aids during resuscitation and training, but noted that for lay responders, there was consistent evidence for potential clinically important delays in initiating CPR, supporting the recommendation against use of cognitive aids for this purpose. ARCSAC also felt the data from healthcare professionals both in resuscitation and extrapolated from trauma showed benefit for cognitive aid usage in actual resuscitation but no benefit and potential problems with learning when used in training programs.

First Responder Engaged by Technology

A 2020 ILCOR systematic review and CoSTR[1] evaluated the role of citizens as first responders, defined as all individuals who were engaged/notified by a smartphone's app with mobile positioning system (MPS) or text message (TM) alert system to respond to out-of-hospital cardiac arrest (OHCA) and begin early CPR and defibrillation.

Red Cross Guidelines

- Medical and disaster event notification systems via mobile positioning system or text message alerts should be used for individuals.

- Individuals who are in close proximity to a suspected out-of-hospital cardiac arrest and are willing to be notified by a smartphone app with mobile positioning system or text message alert system should be notified.

Evidence Summary

The ILCOR review[1] identified two observational studies provided low-certainty evidence from 2,149 OHCAs showing no association between citizen CPR responder notification of the event by technology or social media and survival with favorable neurological outcome at discharge.[6,7] Meta-analysis of adjusted data from one RCT[8] and four observational studies[6,7,9,10] that included 2,905 OHCAs showed higher rates of survival to discharge with event notification to citizen CPR responder via smartphone app with mobile positioning system (MPS) or text message (TM) alert systems compared with no alert notifications (aRR, 1.70; 95% CI, 1.16–2.48; 98/1000 more patients benefited with the intervention; 95% CI, 22 more patients/1000 to 208 more patients/1000).[1]

One RCT[8] with 667 OHCAs and three observational cohort studies[6,7,10] with 2,571 OHCAs were reported to show no difference in rates of ROSC with citizen responder notification via technology or social media compared with no such notification.[1]

High-certainty evidence from one RCT[8] with 667 OHCAs and one before-after study[6] with 1,696 OHCAs was reported to show higher rates of bystander CPR with smartphone app MPS or TM alert notification of citizen responders compared with no such notification (aRR, 1.27; 95% CI, 1.10–1.46 for the RCT; aRR, 1.20; 95% CI, 1.20–1.37 for the observational study).[1] Very low-certainty evidence from four observational studies with 1,833 OHCAs[7,9,11,12] showed lower (i.e., faster) median response times with citizen responder event notification via technology or social media compared with no such notification.[1]

A strong recommendation is made by ILCOR that citizens/individuals who are in close proximity to a suspected out-of-hospital cardiac arrest and willing to be engaged/notified by a smartphone app with mobile positioning system or text message alert system should be notified (very low-certainty evidence).[1]

Insights and Implications

The ILCOR review evaluated programs in cities where citizen responders are located within a certain radius, such as 55 meters, from an OHCA, with findings of improved outcomes with first responder notification by smartphone

MPS or text message alert for OHCA.[1] Additional well-designed prospective studies are needed to evaluate long-term survival. The use of mobile phone technology and alert systems has potential associated costs and may result in reduced health equity. The Red Cross has used mobile apps for several years to facilitate just-in-time instructions in first aid, swimming safety, pet first aid, as well as apps to alert citizens of impending severe weather, tornadoes, hurricanes, earthquakes and floods (https://www.redcross.org/get-help/how-to-prepare-for-emergencies/mobile-apps.html).

Testing and Training

First Aid Education in Primary and Secondary Schools

First aid education is considered mandatory in primary and secondary schools in many countries. An evidence-based position statement supporting first aid education in primary and secondary schools was completed by ARCSAC in 2020.[13]

Red Cross Guidelines

- First aid and CPR education should be provided in primary and secondary schools.

Evidence Summary

Multiple studies have shown that young children can successfully acquire and retain first aid skills.[14-17] Children as young as 4 years old can assess a victim's consciousness and breathing, call the correct emergency telephone number and give the pertinent information, and place the person in a recovery position.[16-18] Instruction has been provided in short sessions (less than 1 hour) or as single multi-hour sessions taught by classroom teachers or first aid instructors. There is evidence that children can learn first aid knowledge and skills from web-based platforms, with no reported adverse consequences of first aid education in younger age groups.

Insights and Implications

Increasing exposure to first aid education by providing it in schools will help to integrate essential skills into daily life for much of the population and may increase bystander willingness to help in those crucial first moments. Additionally, providing first aid within a public-school setting makes it accessible to a large portion of the population and may help decrease health disparities in underserved communities.

Spaced Learning Versus Massed Learning in Resuscitation Training

An ILCOR systematic review[19] and CoSTR[1] evaluated the use of "spaced learning" compared with "massed learning," or training provided at one single time with all learners taking all resuscitation or first aid course types.

Red Cross Guidelines

- Course directors and planners may consider providing spaced learning (training or retraining distributed over time including blended formats and adaptive learning) instead of massed learning (training provided at one single time point) for resuscitation education.

Evidence Summary

In the ILCOR review,[1,19] spaced learning included the separation of training into several discrete sessions over a prolonged period with measurable intervals between training sessions, while a second type of spaced learning included the use of booster training, or distributed practice after initial completion of training, such as for CPR. Booster training included just-in-time training, just-in-place training, and refreshers. Seventeen RCTs and nonRCTs were included in a narrative synthesis involving Basic Life Support, Pediatric Advanced Life Support, and Neonatal Life Support courses using manikins and simulation. Certainty of evidence was very low for all outcomes and heterogeneity prohibited meta-analysis.[19] The narrative review overall noted[20]:

- Improved skill performance at 1 year after course completion for spaced learning in basic life support.

- A greater number of participants able to provide chest compressions of adequate depth at intervals up to 1 year with use of booster training.

- Improved CPR performance with spaced learning and monthly practice.

- Improved clinical performance scores among healthcare professionals in pediatric advanced life support with spaced learning compared with massed learning; decreased median time to start compressions following IHCA training sessions compared to standard course training.

- Improved neonatal intubation performance with booster training (once weekly or four consecutive days) compared with standard training.

No evidence was found reporting performance at clinical resuscitation, but one observational study reported an association with decreased mortality in newborns at 24 hours following booster training on delivery room management of the newborn.[21]

A weak recommendation by ILCOR suggests that for learners taking resuscitation courses, spaced learning may be used instead of massed learning.[1]

Insights and Implications

Very low-certainty evidence supports the use of spaced learning in resuscitation education. It is likely that the benefit of spaced learning would be observed in other courses, such as First Aid or adult Advanced Life Support, although no studies were identified. There was some suggestion of difficulty maintaining ongoing motivation with spaced learning, and it may be challenging to engage students in repeated (spaced) learning. Spaced learning can be provided in methods that may gain the benefit and negate some of the challenges. Educators can use blended methods of online courses in single or multiple sittings combined with in-person sessions, based on student choice. Educators can also use blended with adaptive to provide spaced learning.

Hemorrhage Control Trainer Requirements

Although hemorrhage control trainers are currently available to help educate learners, little is known about the ideal characteristics of an optimal hemorrhage control trainer. The 2020 ARCSAC review evaluated features of currently available hemorrhage control trainers to assess best practices.

Red Cross Guidelines

Low-fidelity hemorrhage control trainers should:

- Contain durable product that will withstand hundreds of uses.

- Not contain latex.

- Have average dimensions of an adult human arm.

- Be portable to allow for transport.

- Be priced in an affordable range that would allow for widespread distribution to resources that would benefit from training.

- Employ technologies that do not encumber the educational mission of the device.

High-fidelity hemorrhage control trainers should:

- Have material that has realistic tissue densities, does not contain latex, and allows for decontamination.

- Have a circumference that allows for adequate tourniquet application.

- Allow for application of a tourniquet proximally and for direct manual pressure.

- Have anatomic landmarks, weight, and other characteristics (such as articulating joints) to allow for a realistic simulation experience.

- Have a real-time feedback mechanism that demonstrates the need for continuous appropriate pressure.

- Have a real-time feedback mechanism that demonstrates appropriate application of a tourniquet.

- Have the ability to detect force from both direct pressure and a tourniquet.

- Be preprogramed to allow for varying scenario bleeding presentations.

- Provide a multisensory experience that simulates the presence of bleeding and barriers to application (such as voice prompts, presence of fluids).

Evidence Summary

An ARCSAC Answer was completed in 2020 to assess the best practices in design of hemorrhage control trainers.[13]

A literature search did not identify any reviews of best practices for hemorrhage control trainers. Several studies showed that tourniquet training and hemorrhage control training on a manikin allowed for subsequent successful application.[22-24] Hands-on training with the use of a hemorrhage control manikin has shown improved skills of wound packing and tourniquet application compared with didactic-only education.[25] CPR feedback devices are recommended for training in CPR and are shown to improve quality of CPR. Hemorrhage control manikin trainers are available with biofeedback on proper pressure application, with dimming of red lights to demonstrate enough pressure has been applied to stem the flow of blood, and with a palpable femoral pulse. Other hemorrhage control trainer designs currently available on the market were described in this review.

Insights and Implications

Both the American Red Cross and the Stop the Bleed campaign advocate for the use of direct manual pressure, hemostatic dressings, and tourniquets to treat life-threatening hemorrhage as appropriate.[13] Similar to other first aid and CPR training, practicing the psychomotor aspects of hemorrhage control can help in successful application of these methods and can help motivate the learner to act when faced with life-threatening bleeding. This review evaluates features of currently available hemorrhage control trainers and features available on CPR feedback trainers, and it suggested low- and high-fidelity features for design of a hemorrhage control trainer.

CPR Feedback Devices in Training

An ILCOR systematic review and CoSTR evaluated the use of a CPR feedback device or guidance device for students receiving resuscitation training.[1] In addition ARCSAC has reviewed this topic and the ILCOR review is consistent with the findings of ARCSAC.

Red Cross Guidelines

- Prompt/feedback devices should be used during training for CPR to enable immediate feedback to students and improve the quality of CPR performance.

Evidence Summary

For laypersons trained with a CPR feedback device compared with no device, the ILCOR review[1] identified one RCT[26] that reported no difference in CPR performance at 1 year post-training. A second RCT[27] with healthcare providers found that both the feedback group and the control group improved CPR performance at 1 year post-training, with no improvement difference between the groups. Improvements in retention of CPR skills with use of feedback devices were reported at 7 days to 3 months post-training by four RCTs[26,28-30] for laypersons or healthcare professionals. For the outcome of CPR performance at the end of training, conflicting results from eight RCTs were reported on the use of feedback devices, with a trend towards improved CPR skills at the end of training.[1]

A weak recommendation by ILCOR suggests the use of feedback devices that provide directive feedback on compression rate, depth, release, and hand position during CPR training (low-certainty evidence). It is suggested that if feedback devices are not available, to use tonal guidance (music or metronome) during training to improve compression rate only (low-certainty evidence).[1]

Insights and Implications

The studies included generally showed positive short-term effects on retention of CPR skills with the use of feedback devices.

Team and Leadership Training

A 2020 ILCOR systematic review and CoSTR evaluated the inclusion of specific leadership or team training compared with no such training among students taking Advanced Life Support courses in an educational setting.[1]

Red Cross Guidelines

- Educators should include team dynamics education in resuscitation courses.

- Educators should provide specific team leader education for those whose roles include leadership of a resuscitation team or who will be in a position to direct a resuscitation.

Evidence Summary

The ILCOR review[1] identified three observational studies[31-33] that reported improved survival following team training for pediatric cardiac arrest, decreased hospital mortality in surgical patients following a surgical team training program, and increased ROSC for OHCA with second-tier paramedic response. Multiple other studies were reported to show improved CPR skills, neonatal resuscitation, team communication, deployment times of mechanical devices, patient tasks, task management, and other skills measured at different intervals.[1]

A weak recommendation by ILCOR suggests that specific team and leadership training be included as part of advanced life support training for healthcare providers (very low-certainty evidence).[1]

Insights and Implications

Advanced life support is a team effort, but typically under a leader. Leadership skills appear to be associated in multiple studies in this review with team performance, hence the recommendation. A limitation of this CoSTR is the lack of explanation of the type of leadership or team training provided in the studies (i.e., video-based, instructor demonstration, low- or high-fidelity simulation). This and heterogeneity prevented any meta-analysis based on training modality.

Opioid Education and Naloxone Distribution

A position statement was completed by ARCSAC in 2020 on overdose education programs and naloxone distribution programs in the community.[13]

Red Cross Guidelines

- Overdose education programs and naloxone distribution programs should be widely available to the community.

- Overdose education programs should include training on naloxone administration, the potential complications of naloxone administration, and the management of these complications.

Evidence Summary

The age-adjusted rate of drug overdose deaths in the United States has increased over 17 years from 6.1 per 100,000 in 1999 to 21.7 per 100,000 in 2017, leading the U.S. Department of Health and Human Services to declare the opioid epidemic a public health emergency.[34,35] Those with opioid addiction are also at risk for contracting infectious diseases, adding to the burden on society. Opioid education and naloxone distribution (OEND) programs are associated with a reduced mortality from opioid overdose.[36,37] Programs that distribute naloxone widely in communities and provide education show that the lay public can be taught to recognize opioid overdose and administer naloxone. This can lead to a measurable reduction of mortality in the population.[36-41]

Insights and Implications

Overdose is the leading cause of unintentional death in the United States, with opioids accounting for about two-thirds of those deaths. The American Red Cross provides public educational programs that teach opioid overdose education, including the recognition of opioid overdose, use of the overdose reversal agent naloxone, and the importance of activating emergency services.

Resuscitation Performance: Debriefing

A 2020 ILCOR systematic review and CoSTR evaluated outcomes from debriefing of rescuers who cared for patients in cardiac arrest in any setting, compared with no debriefing.[1]

Red Cross Guidelines

Debriefing should be performed after resuscitation of adults, children, and infants. The debriefing should be focused on performance improvement and at a minimum include:

- Review of the resuscitation etiology, assessment, and interventions.

- Reinforcing correct assessment, decisions, actions, and communication.

- Discussion of areas for improvement and to whom to communicate these.

- Allowing all participants in the resuscitation to participate and have an opportunity to provide input.

Evidence Summary

The ILCOR review[1] included three in-hospital studies and one out-of-hospital observational study. For outcomes of survival with favorable neurological outcome, survival to discharge, ROSC, chest compression depth, chest compression rate, and chest compression fraction, results from included studies were conflicting.

A weak recommendation by ILCOR suggests data-driven, performance-focused debriefing of rescuers after IHCA and OHCA for adults and children.[1]

Insights and Implications

While evidence was limited and of very low certainty and results were conflicting, the recommendations from ILCOR were based on the suggested positive effects of debriefing on patient and process-related outcomes for cardiac arrest.[1]

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Disaster Health

American Red Cross
Training Services

Older Adults and Disaster Planning

Disaster/emergency preparedness and response efforts have predominantly focused on the large-scale evacuation of persons to prevent harm, ways to provide basic shelter and nutrition, and precautions to control the spread of infectious diseases. However, older adults experience a greater proportion of disaster-related mortality, disaster-related declines in health, and low rates of preparedness for disasters.

Red Cross Guidelines

Individuals and Caregivers

- Older adults and their caregiver(s) should be provided with easy-to-access information related to disaster/emergency preparedness and guidance on how to develop customized disaster plans. Include disaster preparedness recommendations that consider the relevant health, function, financial and social circumstances that are common among older adults (that is, chronic health conditions, limited financial resources and social isolation).

- Older adults who are reliant on mobility aids should remove or minimize barriers toward their evacuation and safety within their surroundings.

- Older adults and/or their caregiver(s) should register with their local emergency response agencies if special needs registries have been established to better assist/support these persons during disasters/emergencies.

- Older adults who have a sensory impairment, such as a visual or hearing impairment, should take additional precautions to better prepare themselves to attend to and respond to disasters.

- Older adults who live with chronic health conditions should maintain a readily accessible list of their current medical conditions, treatments (medications, equipment, supplies and other healthcare needs), personal healthcare providers, and emergency contacts including substitute decision makers.

- Older adults who take medications should work with their personal healthcare providers to ensure they have access to at least a 30-day supply of medications during an emergency.

- Older adults and caregivers of older adults who are reliant on medical devices that require electricity should ensure they have back-up power supplies in place, especially if required while sheltering-in-place. Contact your/their electricity company in advance to discuss your/the client's needs and ensure options for alternative power sources.

- Older adults should be encouraged to continually maintain an adequate local support network that can be called upon during impending disasters and unexpected emergencies, especially if they live independently or far away from relatives.

- Caregivers of persons with Alzheimer's disease and related dementias should know how to identify signs of distress, anxiety or confusion and how to redirect their attention or calm them down during these times. In addition, caregivers should be prepared to prevent wandering and locate their care recipients if they do wander away during a disaster.

Community Services and Programs

- Community services and programs should increase accessibility to community-based programs that educate older adults and their caregivers about disasters/emergencies that affect their region and how best to prepare and respond to them.

- Programs that provide essential community services, such as Meals on Wheels, and daily living assistance for older people (that is, financial, medical, food and transportation) should develop plans and protocols related to responding adequately to the needs of their clients during disasters/emergencies.

- Local governments should create a repository of registries that identify the most vulnerable groups to enable emergency responders to more easily prioritize their search and rescue efforts following a disaster or emergency.

Healthcare Professionals

- Healthcare professionals should obtain training around providing geriatric care relevant to their discipline and how best to assist older adults and their caregivers during disasters.

- Healthcare professionals should strive to mitigate psychological distress among older patients during and after disasters by making an effort to assess the psychological well-being of older adults and provide appropriate treatments as needed.

Care Institutions and Organizations

- Care institutions and organizations should include disaster/emergency preparedness and response training courses. Multi-modality educational tools and practices should be used to better facilitate knowledge acquisition and behavioral change.

- Additional patient handoff strategies should be adopted into standardized patient handoff procedures to better facilitate effective patient tracking and the relocation of the patient identification and their medical history during a disaster.

Evidence Summary

A scientific review of the evidence of factors that make older adults and caregivers more vulnerable to adverse outcomes during disasters was completed by the Preparedness and Disaster Health Subcouncil of ARCSAC with the goal of developing recommendations to improve disaster-related outcomes for older adults.[1] A policy expert round table, Emergency/Disaster Preparedness for Older Adults, was hosted by members of ARCSAC and the American Academy of Nursing. A consensus decision-making process was used to critique the existing scientific evidence from the review for development of evidence-informed expert recommendations.

A white paper[2] was developed with 25 recommendations that aim to implement disaster preparedness-related changes among the following relevant emergency management domains: (1) individuals and caregivers; (2) community services and programs; (3) healthcare professionals and emergency response personnel; (4) care institutions and organizations; (5) legislative/policy reforms; and (6) research.

Insights and Implications

Older adults consistently experience more casualties after natural disasters compared to younger age groups. Numerous factors—chronic health conditions, dependence on assistive devices (walkers, glasses, etc.), social isolation, gaps in caregiver preparation—make seniors more vulnerable. In *Closing the Gaps: Advancing Disaster Preparedness, Response and Recovery for Older Adults*, the ARCSAC Preparedness and Disaster Health Subcouncil and the American Academy of Nursing (AAN) presented findings related to disaster preparedness among older adults and made recommendations to help this population prepare for the immediate dangers and aftermath of catastrophes.

Recommendations made in the Closing the Gaps white paper that are specific to future legislation or policy include:

- Include at least two older adults and representation from the private sector to sit on the committee for the U.S. Congress 2017 Bill S. 1834 "Protecting Seniors During Disasters Act" that enacts the establishment of a national advisory committee on activities related to disaster preparedness for older adults.

- Agencies with the Department of Health and Human Services (HHS) should provide change-funding guidance to allow Centers for Independent Living to use their contingency funds to provide food and water to their clients during disasters to support recovery.

- All states and/or local governments should support the implementation of tax-free emergency preparedness weekends during specific times of the year or in anticipation of a disaster. Items covered should include disaster/emergency supplies such as batteries, portable generators, additional mobility aids (canes and walkers), hurricane shutters, rescue ladders, radios and ice packs.

- The Licensure Compact that provides multi-state licenses for nurses, physicians and emergency medical service personnel should be adopted by all states.

- Ensure that all citizens are able to obtain at least a 30-day supply of emergency prescription medications prior to and during a disaster. All state governments should pass legislation that allows for the provision of at least a 30-day supply of emergency prescription refill during disasters. Inter-organizational collaboration should be established between pharmaceutical providers and relief agencies to ensure an adequate supply of prescription medications is available at relief shelters.

- In support of the state of Florida's Environmental Control for Nursing Homes legislation, all U.S. nursing homes and assisted living facilities should be mandated to include additional contingencies in their disaster/ emergency plans to ensure that, in the event of a power outage, temperatures are kept at reasonable levels to avoid the exacerbation of existing health issues among nursing home and assisted living facility residents.

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CHAPTER **9**

Guidance During the COVID-19 Pandemic

American Red Cross
Training Services

Introduction

The SARS-CoV-2 virus is responsible for the 2020 pandemic with COVID-19 disease. The pandemic has impacted healthcare professionals, lay responders and organizations that create and teach curriculums in first aid, CPR, basic life support, advanced life support, pediatric advanced life support, disaster medicine, and aquatics health.

Several organizations have performed their own reviews to evaluate the risk of transmission to healthcare professionals, lay responders, instructors, and students including:

- The Surviving Sepsis Campaign (SSC)[1]

- The World Health Organization (WHO)[2]

- The International Liaison Committee on Resuscitation (ILCOR)[3]

- The Centers for Disease Control and Prevention (CDC)[4]

This has led to different guidance documents intended to both lower the risk of transmission of disease to all healthcare professionals and lay responders and to improve care and outcomes for individuals with COVID-19.

The American Red Cross Scientific Advisory Council has reviewed the evidence and guidance documents from these organizations to inform the interim guidelines for providing care to potential and confirmed COVID-19 patients and allow for continued education of essential workers, healthcare professionals, and those seeking training to help save a life.[5] The guidelines that follow are intended to help healthcare professionals and lay responders treat suspected or confirmed COVID-19 patients who are in cardiac arrest, respiratory distress, or in need of first aid, while minimizing the risk of COVID-19 transmission and allowing continued education in resuscitation, first aid, and aquatics. Reviews and recommendations from organizations that ARCSAC has used to inform recommendations are also found in this section. Although these guidelines reflect the current science at the time of release, with the rapid evolution of knowledge about SARS-CoV-2 and COVID-19, all are directed to the Red Cross Learning Center for the latest materials as this guidance may change at a more rapid rate than other guidelines.

Minimizing the Risk of COVID-19 Transmission

Guidance for Healthcare Professionals

The following guidance aims to help healthcare professionals minimize the risk of COVID-19 transmission during assisted ventilation, intubation, other aerosol-generating procedures, and resuscitation for suspected or confirmed COVID-19 patients.

Red Cross Guidelines

General COVID-19 Transmission Precautions

- Emergency medical dispatchers should screen calls to identify possible COVID-19 patients and notify healthcare professionals prior to arrival if COVID-19 is suspected or confirmed.

- Healthcare professionals should follow current CDC guidance[6] for personal protective equipment (PPE), including standard and transmission-specific precautions, such as:

  ◦ Gloves should be worn and hand hygiene should be performed before and after providing care.

  ◦ A face mask should be worn at all times in healthcare facilities, by prehospital professionals when on duty, and by healthcare professionals when providing care. An N95 respirator (or equivalent or higher-level respirator) should be worn for all COVID-19 patients; or, a face mask should be worn if a respirator is not available. If N95 supply is a concern, healthcare professionals may consider using N95 respirator selectively for aerosol generating procedures and surgical procedures with higher risk of transmission in COVID-19 patients.

  ◦ Eye protection should be worn. Ideally, the device used should protect the eyes, nose, and mouth. Eyeglasses are insufficient protection.

  ◦ A liquid-resistant gown should be worn. If there is a shortage of gowns, they should be reserved for aerosol-generating procedures and those activities with high contact or where splashes or sprays are anticipated.

  ◦ As feasible, personnel in the hospital resuscitation area should be limited to only essential personnel.

  ◦ After providing care, healthcare professionals should remove and dispose of PPE per local guidelines and facility guidance. After removing PPE, hand hygiene should be performed.

- After contact with patients with suspected or known COVID-19, healthcare professionals should monitor themselves for symptoms of COVID-19. If these symptoms occur, they should self-evaluate and immediately contact their personal healthcare provider.

COVID-19 Transmission Precautions During Assisted Ventilation, Intubation, and Advanced Airway Management

- All settings:

  ◦ PPE should include at minimum an N95 respirator (or equivalent or higher level respirator), face shield, gown, and gloves.

  ◦ When providing assisted ventilations, duration of bag-mask ventilation (BMV) should be minimized.

  ◦ A high-efficiency particulate air (HEPA) filter between the self-inflating bag and airway should be used to minimize the risk of virus spread.

  ◦ Two hands should be used to hold the mask on the face to ensure a good seal for bag-mask ventilation. This requires two healthcare professionals to perform; in the out-of-hospital setting, the healthcare professional performing compressions can squeeze the bag when compressions are paused after 30 seconds.

  ◦ Use of a supraglottic airway should be considered rather than a face mask, as it may provide a better airway seal.

  ◦ Early intubation and mechanical ventilation should be considered as opposed to BMV to minimize possible aerosols in the resuscitation area and to potentially reduce the number of individuals in the resuscitation area.

- In the setting of respiratory failure, healthcare professionals may consider endotracheal intubation and ventilator use early to avoid aerosol-generating interventions such as noninvasive ventilation.

- Rapid sequence intubation, including preoxygenation and use of paralytics to ensure apnea, and early ventilator management should be considered.

- Healthcare professionals should employ strategies to maximize intubation success with minimal attempts and techniques to protect the healthcare professional performing intubation and the team. This may include pausing chest compressions during airway interventions, having the most skilled healthcare professional perform airway interventions to ensure a high first attempt success rate, and using techniques (e.g., video laryngoscopy) that allow providers to remain further from the patient's mouth.

- The duration of exposure for any aerosolizing procedure should be minimized for healthcare professionals and those in proximity to the patient during the procedure.

- Ventilatory equipment should have a high-efficiency particulate air (HEPA) filtration in the exhalation path per manufacturer recommendations.

- In-hospital setting:

  - An airborne isolation room should be used, when possible, for aerosol-generating procedures including intubation, placement of supraglottic airways, bag-mask ventilation, and continuous positive airway pressure (CPAP) or bilevel positive airway pressure (BiPAP) use.

- Out-of-hospital setting:

  - Prehospital professionals should perform procedures outdoors and/or run ambulance ventilation systems and open rear ambulance doors when feasible.

  - Heating, ventilation, and air conditioning (HVAC) systems should be maximized as much as possible and if feasible, use HEPA filters.

COVID-19 Transmission Precautions During Resuscitation from Cardiac Arrest

- All settings:

  - If status is unknown, all patients should be presumed COVID-19 positive and appropriate PPE should be worn during resuscitation efforts.

  - Immediate defibrillation should be considered before donning PPE or additional PPE in situations where the healthcare professional assesses that benefits may exceed the risks.

  - The number of healthcare professionals involved in a resuscitation attempt should be minimized.

  - A mechanical compression device should be considered to reduce the number of personnel required for resuscitation if equipment is available, processes are in place, personnel are properly trained, and it is appropriate for the patient.

Guidance for Lay Responders

The following recommendations aim to minimize COVID-19 transmission to lay responders during CPR and first aid.

Red Cross Guidelines

Lay responder CPR and first aid for a person with suspected or confirmed COVID-19 is unchanged except for the following modifications:

- PPE should be worn as recommended by CDC, including respiratory protection (e.g., N95 respirator), eye protection, disposable gloves, and a disposable isolation gown, if possible.

- Per CDC guidance, face masks are acceptable if respiratory protection (e.g., N95 respirator) is not available. It is a recognized that some lay responders may not have this type of equipment but will most likely be providing CPR and first aid to those in their household. If a face mask is not available, use a face cover.

- Assessment of responsiveness should not be changed during the COVID-19 pandemic, including the use of the tap-shout-tap sequence and looking for a response.

- When assessing breathing, lay responders should not place their face next to the person's mouth/nose; instead, they should look for breathing.

- The person should be asked to wear a face mask or one should be placed over the person's mouth and nose before providing care.

- When providing first aid, a distance of 6 feet should be maintained, if the person's condition allows for this.

- For adults in cardiac arrest, compression-only CPR (CO-CPR) should be provided until prehospital professionals arrive. If the person is in the same household as the lay responder, they may consider conventional compression-ventilation CPR (CV-CPR).

- If cardiac arrest is due to hypoxia (which is often the case in infants and young children, drowning, and/or drug overdoses), standard CPR with compressions and rescue breaths should be provided. However, if the lay responder is unable or unwilling to provide rescue breathing with CPR, compression-only CPR may be initiated.

- If an AED is available, it should be used for an adult in cardiac arrest according to manufacturer's guidelines while waiting for emergency personnel to arrive.

- After providing care, PPE should removed and disposed of per local guidelines and facility guidance. After removing PPE, hand hygiene should be performed.

- After contact with persons known or suspected to have COVID-19, lay responders should monitor themselves for symptoms of COVID-19. If these symptoms occur, they should self-evaluate and immediately contact their personal healthcare provider.

Evidence Summary

The Red Cross COVID-19 guidelines[5] are based on review of evidence evaluation or guidance by organizations such as the World Health Organization,[2] the Centers for Disease Control and Prevention,[6] the International Liaison Committee on Resuscitation,[3] and the Surviving Sepsis Campaign.[1] The Red Cross guidance can be found on the Red Cross Learning Center and is regularly updated. Summaries of evidence and guidance review are presented below.

World Health Organization

A scientific brief was published by the World Health Organization (WHO) in March 2020 and updated in July 2020[2] on modes of transmission of the virus causing COVID-19 and implications for infection prevention and control precaution recommendations. This brief is not a systematic review but a summary of expert panel discussion and rapid study reviews, including some from non-peer-reviewed manuscripts on preprint servers; thus, this review should be interpreted with caution. Information regarding modes of transmission is important to understand for all levels of rescuers and healthcare providers who provide resuscitation to adults, children or neonates.

The 2020 SARS-CoV-2 virus is transmitted through multiple modes, including contact, droplet, airborne, fomite, fecal-oral, bloodborne, mother-to-child, and animal-to-human. Contact and droplet transmission is by direct, indirect, or close contact with infected people through infected secretions such as saliva and respiratory secretions or their respiratory droplets expelled through coughing, sneezing, talking, or singing.[2] Droplet transmission can occur with contact within 1 meter with an infected person with respiratory symptoms, with droplets reaching the moth, nose, or eyes of a susceptible person. Indirect contact is via a contaminated object or surface. Droplets 5 μm in diameter are considered aerosols, and airborne transmission can occur during medical procedures that generate aerosols. Several experimental models have recently shown that healthy individuals can produce aerosols by talking and coughing, but transmission of SARS-CoV-2 by this type of aerosol route has not been demonstrated.[7,8] However, outbreak reports related to crowded and poorly ventilated indoor spaces such as restaurants, gyms, and choir practice suggest the possibility of aerosol transmission, combined with droplet transmission. Studies in healthcare facilities have not found viable virus in air samples, but some studies in a healthcare setting where symptomatic COVID-19 patients were cared for without performance of aerosol-generating procedures reported SARS-CoV-2 RNA in air samples.[2] This does not mean that viable virus could be transmitted and be capable of causing infection. In addition, clinical reports of healthcare workers exposed to COVID-19 cases, without aerosol-generating procedures, did not show nosocomial transmission when contact and droplet precautions were appropriately used, including medical masks. SARS-CoV-2 RNA and viable virus have been detected in the urine and feces of some patients, but there are no published reports of transmission of SARS-CoV-2 through feces or urine. The role of bloodborne transmission is uncertain, but low viral titers in plasma and serum suggest the risk of transmission by this route may be low.[2]

International Liaison Committee on Resuscitation

The International Liaison Committee on Resuscitation (ILCOR) performed a systematic review in March 2020 to evaluate the risk to rescuers from patients in cardiac arrest[9] accompanied by a three-part CoSTR updated in October 2020.[10] The ILCOR basic life support, advanced life support, and pediatric task forces completed a parallel review of existing treatment recommendations.[3]

The first question evaluated evidence for the generation of aerosols during chest compressions, defibrillation, and all CPR interventions that include chest compressions. Two case reports[11,12] were identified providing evidence of very low certainty due to serious risk of bias and indirectness that reported the generation of aerosols with performance of suctioning and tracheal intubation.[9]

The second question evaluated evidence for transmission of infection to individuals wearing any or no PPE during delivery of chest compressions, defibrillation, and all CPR interventions that include chest compressions.[9]

Three observational studies were identified; two did not report an association between CPR-related activities and infection, while one case control study[13] reported an association between delivery of chest compressions and SARS infection in healthcare workers (aOR, 4.52; 95% CI, 1.08–18.81). This study did not adjust for other potential contacts.[10]

The final question evaluated the impact of wearing of PPE by individuals while delivering chest compressions, defibrillation, and/or CPR in any setting on the development of infection with the same organism as the patient. PPE effectiveness and quality of CPR were additional named outcomes.[10] No evidence was found that evaluated the outcome of infection with the same organism. For PPE effectiveness, low-certainty evidence (downgraded for serious risk of bias and serious indirectness) from one RCT performed on manikins with 20 healthcare providers reported difference in adequacy of protection from three different mask types during provision of chest compressions (cup type, 44.9% +/- 42.8%; fold type, 93.2% +/- 21.7%; valve type, 59.5% +/- 41.7, p<0.001).[10] This same study reported no difference in chest compression quality between the evaluated mask types. Treatment time was evaluated in two RCTs with manikins.[10]

One RCT[14] of simulated pediatric cardiac arrest reported a longer time to complete tracheal intubation and intraosseous access when paramedics wore PPE (no PPE, 261 +/- 12 sec; full face mask, 275 +/- 9 sec; hood, 286 +/- 13 sec, p<0.001).[10]

It is suggested by ILCOR that chest compressions and CPR have the potential to generate aerosols.[10] In the current COVID-19 pandemic, it is suggested by ILCOR that lay rescuers consider chest compressions and public access defibrillation, and that lay rescuers who are willing, trained and able to do so, consider providing rescue breaths to infants and children in addition to chest compressions (good practice statement).[10]

In the current COVID-19 pandemic, a weak recommendation is made by ILCOR that healthcare professionals use PPE for aerosol-generating procedures during resuscitation.[10] A good practice statement was made by ILCOR that it may be reasonable for healthcare providers to consider defibrillation before donning personal protective equipment for aerosol-generating procedures in situations where the provider assesses the benefits may exceed the risks.[10]

Surviving Sepsis Campaign

An international panel of experts from the Surviving Sepsis Campaign (SSC) published an evidence-based set of recommendations related to management of critically ill ICU adult patients with COVID-19.[1] Specific topics reviewed included infection control, laboratory diagnosis, hemodynamic support, ventilatory support, and COVID-19 therapy.

Recommendations and suggestions by SSC for infection control are similar to those by other organizations for rescuers and healthcare workers involved in resuscitation. The Surviving Sepsis Campaign (SSC) notes that healthcare workers should follow any infection control policies and procedures in place at their healthcare institutions and that the following recommendations and suggestions are considerations, rather than a requirement to change infection control policies. They include but are not limited to[1]:

- Use of a fitted respirator mask as opposed to a surgical/medical mask, in addition to other PPE, when performing aerosol-generating procedures on patients with COVID-19 in the ICU.

- Performing aerosol-generating procedures on ICU patients with COVID-19 in a negative pressure room.

- Using surgical/medical masks when providing usual care for non-ventilated COVID-19 patients, in addition to other PPE.

- Using video-guided laryngoscopy rather than direct laryngoscopy on patients with COVID-19 for endotracheal intubation.

- Having the healthcare worker who is most experienced with airway management perform endotracheal intubation of COVID-19 patients in order to minimize the number of attempts and risk of transmission.

The recommendations by SSC related to use of a fitted N95 face mask are based on a consensus of recommendations from the Centers for Disease Control, WHO, and other organizations, taking into account epidemiologic data showing increased risk to healthcare workers during the SARS epidemic from aerosol-generating procedures.[1] When N95 masks are in short supply or for healthcare workers who fail fit testing, powered air purifying respirators (PAPRs) can be used. Negative pressure rooms are engineered to keep a pathogen inside and avoid its diffusion and are proven to be an effective measure that helped avoid cross-contamination during the SARS epidemic.[15] Recommendations for use of surgical/medical masks while providing usual care for non-ventilated COVID-19 patients and for non-aerosol-generating procedures on closed-circuit mechanically ventilated patients with COVID-19 are based on an updated systematic review.[16] Four RCTs in this review randomized healthcare workers to use of N95 respirators or medical masks, finding no increase in lab-confirmed respiratory infection with use of medical masks. The recommendation for use of video laryngoscopy is based on the risk related to direct laryngoscopy and a systematic review of 64 studies showing that video-laryngoscopy reduced the risk of failed intubation (OR, 0.35; 95% CI, 0.19–0.65).[17]

Insights and Implications

Lay responder fear of the potential transmission of SARS-CoV-2 has likely impacted bystander willingness to perform CPR, and the new Red Cross guidelines balance the emergent needs of those in cardiac arrest with the safety of rescuers. The ILCOR recommendations include the provision of rescue breathing for household contacts, infants, and children, if the rescuer is willing. Most children with cardiac arrest have a respiratory problem preceding the arrest. These arrests often occur at home or near a parent or relative who would likely be willing to provide ventilations.

Despite hands-only guidelines for lay responder CPR, there are concerns that compressions will cause aerosolization of respiratory droplets and allow transmission of SARS-CoV-2. A study from four Italian provinces during the peak of the COVID-19 outbreak seems to confirm this concern.[18] The ILCOR review[9] noted that this study showed a 58% increase in OHCA compared to the previous year, while the provision of bystander CPR decreased by 15% in a region that previously reported a rate of 47% for bystander CPR.[18] Covering the face of a cardiac arrest victim with a cloth or face mask is one means of potentially reducing aerosolization of respiratory droplets. Fear of disease transmission has likely led to a decline in enrollments for CPR classes; new guidance has been issued for teaching classes in a physically distanced manner, wearing face masks, using personal masks for ventilation, and for regular disinfection of manikins.

Management of Suspected and Confirmed COVID-19 Patients

Ventilatory Care

The Red Cross guidelines for minimizing the risk of transmission of COVID-19 apply when providing ventilatory care to suspected and confirmed COVID-19 patients in all settings. The guidelines include using a HEPA filter between the self-inflating bag and the airway to minimize the risk of virus aerosolization; using two hands to

hold a mask on the face to ensure a good seal for bag-mask ventilation; minimizing the duration of bag-mask ventilation; and, in the setting of respiratory failure, considering early intubation and mechanical ventilation as opposed to BMV or other aerosol-generating forms of ventilation.

Red Cross Guidelines

- Supplemental oxygen should be provided if the peripheral oxygen saturation (SpO_2) is less than 92%.

- High-flow nasal canula (HFNC) may be considered over conventional oxygen therapy for acute hypoxemic respiratory failure despite conventional oxygen therapy and over noninvasive positive pressure ventilation (NIPPV) for acute hypoxemic respiratory failure.

- For acute hypoxemic respiratory failure, if HFNC is not available and an urgent indication for endotracheal does not exist, a trial of NIPPV with close monitoring and short-interval assessment for worsening of respiratory failure should be provided.

- For mechanically ventilated adults with COVID-19 and acute respiratory distress syndrome (ARDS), a low-tidal volume ventilation strategy of 4 to 8 mL/kg of predicted body weight should be used.

- For mechanically ventilated adults with COVID-19 and ARDS, a conservative fluid strategy over a liberal fluid strategy should be used.

- For mechanically ventilated adults with COVID-19 and moderate to severe ARDS, a trial of prone ventilation for 12 to 16 hours may be considered.

Evidence Summary

The SSC review[1] notes that hypoxic respiratory failure occurs in 19% of COVID-19 patients in one study[19] with 14% developing severe disease requiring oxygen and 5% requiring ICU admission and mechanical ventilation. The SSC panel used indirect evidence from acutely ill patients to inform their recommendations, including a systematic review and meta-analysis showing an increased risk of hospital mortality with a liberal oxygen strategy, and a meta-regression showing a linear association between risk of death and higher pO_2 targets.[20] In making the recommendation for HFNC, the panel considered indirect evidence from a systematic review with meta-analysis showing that HFNC reduces intubation compared with conventional oxygen (RR, 0.85; 95% CI, 0.74–0.99).[21] Evidence supporting other recommendations and suggestions regarding the use of mechanical ventilation and low-volume ventilations are likewise from indirect evidence from patients with acute respiratory failure in ICUs.[1]

Recommendations and suggestions by SSC for ventilation in adults with COVID-19 include but are not limited to[1]:

- Starting supplemental oxygen if the peripheral oxygen saturation (SpO_2) is less than 92% (suggested) or less than 90% (recommended).

- Using high-flow nasal canula (HFNC) over conventional oxygen therapy for acute hypoxemic respiratory failure despite conventional oxygen therapy.

- Using HFNC over noninvasive positive pressure ventilation (NIPPV) for acute hypoxemic respiratory failure.

- For acute hypoxemic respiratory failure, if HFNC is not available and an urgent indication for endotracheal intubation does not exist, use a trial of NIPPV with close monitoring and short-interval assessment for worsening of respiratory failure.

- For mechanically ventilated adults with COVID-19 and ARDS, using low-tidal volume ventilation (4 to 8 mL/kg of predicted body weight) over higher tidal volumes.

- For mechanically ventilated adults with COVID-19 and ARDS, using a conservative fluid strategy over a liberal fluid strategy.

- For mechanically ventilated adults with COVID-19 and moderate to severe ARDS, using prone ventilation for 12 to 16 hours, over no prone ventilation.

Fluid Therapy and Vasoactive Agents

Recommendations for fluid therapy and vasoactive agents for resuscitation of adults with COVID-19 and shock in all settings follow.

Red Cross Guidelines

- Dynamic parameters of skin temperature, capillary refill time, and/or serum lactate should be used over static parameters to assess fluid responsiveness.

- When providing fluid resuscitation for patients with COVID-19 and shock, a conservative fluid strategy should be used over a liberal fluid strategy. Crystalloids should be used over colloids and buffered/balanced crystalloids should be used over unbalanced crystalloids.

- For fluid-refractory shock in COVID-19 patients, using norepinephrine as the first-line vasoactive agent over other agents may be considered. If norepinephrine is not available, using either vasopressin or epinephrine as the first-line vasoactive agent should be considered. Dopamine should only be used when norepinephrine and epinephrine are not available.

Evidence Summary

Recommendations and suggestions by the SSC for hemodynamics and acute resuscitation of adults with COVID-19 and shock include but are not limited to[1]:

- Using dynamic parameters of skin temperature, capillary refill time, and/or serum lactate over static parameters to assess fluid responsiveness.

- Using a conservative over a liberal fluid strategy.

- Using crystalloids over colloids.

- Using buffered/balanced crystalloids over unbalanced crystalloids.

- Using norepinephrine as the first-line vasoactive agent over other agents.

- If norepinephrine is not available, using either vasopressin or epinephrine as the first-line vasoactive agent.

- Not using dopamine if norepinephrine is available.

Insights and Implications

There is no direct evidence from patients with COVID-19 and shock. The SSC panel used indirect evidence from critically ill sepsis and ARDS patients to inform these recommendations.[1] Medical care for COVID-19 is changing rapidly as new studies are completed and will help guide future care.

End-of-Life Planning and Termination of Resuscitation

Recommendations for end-of-life planning and termination of resuscitation follow.

Red Cross Guidelines

- In-hospital settings:

  ◦ End-of-lie decision-making should be discussed with patients or their legal proxies as early as possible and protocols regarding resuscitation of COVID-19 patients should be put in place. These should include crisis standards of care with specific guidance regarding resuscitation and use of ventilators.

- Out-of-hospital settings:

  ◦ Prehospital systems should put in place protocols to determine when to start resuscitation and termination of resuscitation in the setting of COVID-19. These should include crisis standards of care with specific guidance regarding resuscitation.

  ◦ For all on-scene cardiac arrest patients for whom return of spontaneous circulation (ROSC) is not obtained, prehospital professionals should consider termination of resuscitation (TOR) rules and follow local TOR protocols or contact medical control for guidance before a transport decision is determined.

Evidence Summary

ARCSAC has reviewed the issue of end-of-life decision-making and termination of resuscitation. While there is little published evidence, expert opinion has guided these recommendations.

Insights and Implications

Prehospital systems and healthcare institutions should put in place protocols to determine when to start resuscitation and termination of resuscitation in the setting of COVID-19. These should include crisis standards of care with specific guidance regarding resuscitation. It is recognized that crisis standards of care protocols will often be based on government-issued crisis standards of care guidelines and executive orders.

This discussion is important to help avoid transporting medically futile patients to the hospital and avoidable transmission of COVID-19.

Lay Responder CPR and First Aid During the COVID-19 Pandemic

Even in the setting of COVID-19, high-quality CPR is still essential for optimal outcomes but may require modifications for lay responder safety.

Red Cross Guidelines

- Providing chest compressions and using public access defibrillation should be considered.

- For adults in cardiac arrest, compression-only CPR (CO-CPR) should be provided until prehospital professionals arrive. If the person is in the same household as the lay responder, they may consider conventional compression-ventilation CPR (CV-CPR).

- If cardiac arrest is due to hypoxia (which is often the case in infants and young children, drowning, and/or drug overdoses), standard CPR with compressions and rescue breaths (CV-CPR) should be provided. However, if the lay responder is unable or unwilling to provide rescue breathing with CPR, compression-only CPR (CO-CPR) may be initiated

- A mobile phone with hands-free speaker capability to call 9-1-1 and receive instructions for lay responder CPR should be used when possible.

- Defibrillation including public access defibrillation should be performed on patients with COVID-19 and in cardiac arrest as soon as available.

- First aid for life-threatening conditions remains unchanged during the COVID-19 pandemic; lay responders should follow CDC guidance and use PPE where possible and place a face mask on the person in need of care. First aid for non-life-threatening conditions, if feasible, may be deferred to the person's personal healthcare provider.

- For assessment, a distance of 6 feet should be maintained when possible.

- When providing first aid for members of the same household, lay responders should attempt to follow COVID-19 precautions; however, because close contact has already occurred, if needed, care can be provided as would normally be done.

Evidence Summary

ARCSAC has continuously reviewed the topic of CPR in the setting of COVID-19 throughout the pandemic. There is data that CPR has the potential to generate aerosols.[2,6,12] It is also well established that CPR is more likely to be performed on a person you know and often may occur with someone in the same household for which there is no new exposure risk from performing CPR. The application of adhesive pads and use of an AED involves little or no direct contact between a lay responder and a person in cardiac arrest. Delaying potentially lifesaving treatment until arrival of EMS with PPE may cause significant harm. Thus, it is suggested that lay responders consider chest compressions and public access defibrillation, and if willing, trained, and able to do so, consider providing rescue breaths to infants and children in addition to chest compressions. As those in the same household would likely have already had close contact, greater flexibility is given to care guidance.

Insights and Implications

While CPR with breaths has been shown to be beneficial when compared to compression-only CPR, in the setting of COVID-19 and possible risk of transmission, it is currently recommended that no rescue breaths be performed for adult cardiac arrest patients with confirmed or suspected COVID-19 due to the risk of disease transmission. The Red Cross recommends that adult victims of sudden cardiac arrest receive at least compression-only CPR from lay responders until emergency personnel arrive. Compression-only CPR saves lives compared to no CPR. If available, a face mask or cloth can be placed over the mouth and nose of the person in cardiac arrest to lower the potential risk of transmission of COVID-19.

Cardiac arrests that occur after a breathing problem (which is often the case in infants and young children, drowning, and drug overdoses), may benefit from standard CPR that includes compressions and rescue breaths. It is recognized that in some of the cases the victim may also have COVID-19. However, if a lay responder is unable or unwilling to provide rescue breathing with CPR, compression-only CPR should be initiated.

COVID-19 and Aquatics

An ARCSAC Answer was completed by the Aquatics Subcouncil for over a dozen questions related to pool operations, COVID-19 risk, and risk reduction.[1] Answers were based on recommendations from CDC,[22] ILCOR,[5] and ARCSAC Aquatics Subcouncil expert opinion.

Red Cross Guidelines

Facility Operations

- Facilities should plan reopenings and put in place proper policies and procedures that address operations, emergencies, staff, and patrons, including social distancing/spacing, sanitizing and disinfecting, use of personal protective equipment, symptom screening, and addressing a sick staff member or patron.

- Facility activities should be resumed based on the facility's ability to properly adhere to state and local orders and good practices, which include but are not limited to adjusting the numbers of patrons, distancing patrons for each activity, and adaptation of operational approaches.

- Chlorine should be used at the ideal levels of free chlorine from 2 ppm to 4 ppm with a maximum of 10 ppm or bromine at the ideal levels of 4 ppm to 6 ppm with a maximum of 8 ppm to help ensure that all areas of circulating water in the swimming pool or spa are disinfected.

In-Service Education

- For in-service training, facilities should optimize distance learning and limit class sizes to comply with state and local guidelines.

- Classroom settings should maintain proper social distancing of at least 6 feet.

Aquatic Rescues and Resuscitation

- For aquatic rescues, direct contact and face-to-face interactions with a person needing help should be

minimized and out-of-water rescue techniques should be employed as feasible to allow lifeguards to continue wearing a face mask.

- When lifeguards enter the water, face masks must be removed.

- Lifeguards should use maneuvers to reach the person while remaining on the deck, by way of extending or throwing a rescue device if possible.

- For rescues requiring entry into the water, lifeguards should use equipment to distance the rescuer from victim when possible. If direct contact is necessary, lifeguards may consider a rear approach and rescue to return the person to the deck to minimize rescuer exposure to the person's face.

- Facilities incorporating in-water resuscitation providing positive pressure ventilations in the water may consider temporarily discontinuing this practice on the basis that it requires the use of mouth-to-mouth or mouth-to-mask ventilations.

- Facilities should modify rescue protocols to rapidly extricate the patient to the deck and initiate ventilations with a bag-valve-mask with a two-handed mask seal and in-line HEPA filter.

Evidence Summary

There is currently no evidence to suggest that COVID-19 is spread person to person via the water in environments such as pools or spas. The primary spread in these environments is by close proximity of individuals. There is risk of transmission for lifeguards during rescues and removals from the water where the guard may be in close proximity to the victim. It is believed that free chlorine and bromine as primary disinfectants are adequate to deactivate SARS-CoV-2 at acceptable levels to allow safe swimming.

Insights and Implications

The Red Cross guidelines for the aquatics setting are based on the latest information from the CDC. Aquatic facility operators and lifeguards should be aware that state and local officials may put in place orders that would further affect operations.

The Red Cross has developed social distancing guidance for resuscitation education and interim virtual skills training for portions of its Lifeguarding courses. Facilities with access to instructor updates should review this material when planning and implementing courses. Knowledge about COVID-19 and best practices for risk reduction are evolving and the latest information is available at both CDC.gov/COVID19 and the Red Cross Learning Center.

COVID-19 and Educational Programs

COVID-19 has created many challenges regarding care. But it has also created questions of how one can maintain educational programs, which is a high priority as many of these programs support a sufficient healthcare and essential workforce. ARCSAC reviewed CDC and other sources to develop specific guidance for education.

Red Cross Guidelines

This guidance is for instructors and organizations who, based on state and local orders and guidelines, can offer courses following this guidance. For more information, please refer to Scientific Advisory Council COVID-19 Instructor Information.[5] As the COVID-19 situation evolves, these guidelines may change based on additional requirements from federal, state, and local public health agencies and recommendations from the Red Cross Scientific Advisory Council.

COVID-19 Health Screening

- Instructors should include the following language in pre-class communication (e.g., letters, emails, registration). A student should not attend class and should reschedule if:

  ◦ They have a cough, fever, shortness of breath, difficulty breathing, fatigue, muscle or body aches, loss of taste or smell, sore throat, congestion or runny nose, nausea or vomiting, diarrhea, or other symptoms of illness.

  ◦ They have had close contact with someone suspected or confirmed as having COVID-19 In the past 14 days

  ◦ They have confirmed or suspected COVID-19, have had a fever in the past 24 hours, have symptoms that are not improving, or it has been less than 10 days since the onset of symptoms.

- Instructors should perform day-of-class screening of students, preferably prior to entering the class, and during the opening/introduction, reinforce the pre-class communication about not attending class if students have any symptoms or have had contact with someone who has suspected or confirmed COVID-19.

Standard Precautions and Current Guidance for Minimizing Risk of COVID-19 Transmission

- As always, when teaching classes, instructors must implement standard precautions and procedures and follow the guidance in the course-specific instructor's manual in order to prevent the spread of infection every day and to provide protection from COVID-19.

- Instructors and students must wear a face mask for class.

- Instructors and students must perform hand hygiene using either soap and water for at least 20 seconds or an alcohol-based hand sanitizer that contains at least 60% alcohol if soap and water are not available at a minimum:

  ◦ At the beginning and end of class.

  ◦ Before and after meals and snacks.

  ◦ Before and after skills practice sessions. (When wearing gloves, perform hand hygiene before putting on gloves and after removing them.)

- Students must wear gloves during skill practice and assessment and perform hand hygiene before putting on and after removing gloves.

- Instructors should implement the following social distancing approaches:

  ◦ Maximizing blended learning course offerings should be considered.

  ◦ The in-person session of blended learning courses should be deferred for those students who do not have a current need for skills or certification requirements.

- In-person sessions should be structured so that students maintain a 6-foot separation from each other.

- Scheduling smaller classes or one-on-one sessions should be considered when feasible for in-person components.

- Opportunities for students to gather during class should be discouraged. At a minimum, students should be asked to remain at their location during breaks except to use the bathroom or have a meal. Only one student at time should use the bathroom. Students should have meals outside or at the their location in classroom while maintaining a 6 foot separation.

- Instructors must conduct skill practice and use equipment (e.g., manikins, AEDs and breathing barriers) in accordance with the course-specific instructor's manual and the following COVID-19 modifications:

  - Instructors must use a 1:1 student to manikin/training aids model.

  - Manikins that have lungs with one-way valves should be preferred.

  - Instructors must ensure that all students have and use their own breathing barrier and that CPR breathing barriers have a one-way valve.

- Instructors should modify the teaching of certain skills practices and assessments:

  - Students must be evaluated one at a time. They should not partner when indicated in the instructor's manual.

  - Students should demonstrate assessment of a responsive and/or unresponsive person/patient on a manikin.

  - Students should separately demonstrate the aspects of two-handed BMV position, seal and airway opening. Students should also demonstrate sealing the mask and maintaining an open the airway with one hand while giving ventilations with the other hand. While demonstrating ventilation with one hand, instructors should tell students that in actual care a two-person technique should be used for BMV.

  - Students should demonstrate multiple-provider CPR/AED by arranging the manikins 6 feet apart from each other with one student per manikin and with all the necessary equipment so they can coordinate actions; instructors should direct each student to perform their given role (i.e., giving compressions, ventilations, AED use) on their own manikin and with their own equipment and verbalize when there is a handoff of action to the next student.

  - Students should demonstrate correct hand position for abdominal thrusts on themselves and practice back blows on their outstretched hand.

  - Students should practice direct pressure to control life-threatening bleeding on themselves or a simulation device.

- Students and instructors should avoid touching surfaces and objects that have been touched by others.

- Instructors should provide disposable wipes so that commonly used surfaces in the class can be wiped down by students and instructors before and after each use.

Equipment Cleaning and Decontamination

Instructors must clean and decontaminate training equipment per CDC guidance and manufacturer recommendations.

- Instructors must clean manikins and other training devices touched by students between each student use with the cleaning product routinely used for this purpose according to manufacturer's directions.

  ◦ This may include cleaning solutions, sprays, and wipes, which should be labeled as effective against SARS-CoV-2. Per the CDC, most common EPA-registered disinfectants should be effective.

  ◦ Per the CDC, cleaning products with an EPA-approved emerging viral pathogens claim are expected to be effective against SARS-CoV-2 based on data for harder-to-kill viruses.

  ◦ CDC guidance does not recommend additional disinfection beyond routine cleaning at the time of this publication.

- Instructors must mark manikins and other training devices touched by students as dirty after student use. After class, instructors must clean and disinfect manikins per the manufacturer's guidelines. Once cleaned, they should then be marked as clean and dated.

- Instructors must use indicated PPE for cleaning and disinfecting and follow standard precautions and the manufacturer's guidance for cleaning and disinfecting.

Evidence Summary

The recommendations in this document are based on information from the Centers for Disease Control and Prevention (CDC) and will be updated as the CDC guidance is updated on the Red Cross Learning Center (www.RedCrossLearningCenter.org).

Insights and Implications

The emergence of coronavirus disease 2019 (COVID-19) has raised questions among instructors and students about the delivery of American Red Cross courses during this public health emergency. The Red Cross recognizes that in many cases the training provided is essential as it supports healthcare workers and essential workers' ability to continue to work, and it allows new, greatly needed workers to enter the workforce.

The Red Cross recommendations provide guidance for course conduct and information for instructors and students on topics including but not limited to SARS-CoV-2 transmission, COVID-19 prevention, face masks, social distancing, care of COVID-19 individuals, and cleaning disinfection. Students in Red Cross courses may have questions about how they can prevent COVID-19 in themselves or their family, or while caring for someone who may have COVID-19.

While the Red Cross has always had practices in place to reduce the risk of disease transmission and our guidance has always adhered to CDC guidelines, we recognize that there is still significant concern among the public about potential COVID-19 exposure. Therefore, this guidance reinforces existing CDC guidance, which has been followed, and further explains the CDC COVID-19 specific guidance being followed, including screening students and instructors, social distancing principles, and face masks.

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Appendix A: Abbreviations in Focused Updates and Guidelines 2020

Commonly Used Abbreviations

AED   automated external defibrillator

ARCSAC   American Red Cross Scientific Advisory Council

BMV   bag-mask ventilation

CCU   coronary care unit

CDC   Centers for Disease Control and Prevention

CO-CPR   compression-only CPR

CoSTR   Consensus on Science with Treatment Recommendations

CPR   cardiopulmonary resuscitation

CV-CPR   compression-ventilation CPR

eCPR   extracorporeal CPR

EMS   emergency medical services

$ETCO_2$ end-tidal carbon dioxide

FBAO   foreign body airway obstruction

FiO_2 fraction of inspired air

ICU   intensive care unit

IHCA   in-hospital cardiac arrest

ILCOR   International Liaison Committee on Resuscitation

IM   intramuscular

IN   intranasal

IO   intraosseous

IV   intravenous

mCPR   mechanical cardiopulmonary resuscitation

NICU   neonatal intensive care unit

OHCA   out-of-hospital cardiac arrest

$PaCO_2$ partial pressure of carbon dioxide

PAD   public access defibrillation

PaO_2 partial pressure of oxygen

PCM   physical counterpressure maneuver

PEA   pulseless electrical activity

POC   point of care

pVT   pulseless ventricular tachycardia

ROSC   return of spontaneous circulation

SSC   Surviving Sepsis Campaign

TOR   termination of resuscitation

TTM   targeted temperature management

VF   ventricular fibrillation

VT   ventricular tachycardia

WHO   World Health Organization

Abbreviations in Statistical Analyses

aOR   adjusted odds ratio

aRR   adjusted risk ratio

aRD   adjusted risk difference

CI   confidence interval

MD   mean difference

SMD   standardized mean difference

OR   odds ratio

p   probability

RR   relative risk

RD   risk difference

RCT   randomized controlled trial