What is new in the 2015 American Heart Association guidelines, what is recycled from 2010, and what is relevant for emergency medicine in Canada

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INTRODUCTION

The 2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care was published on October 15, 2015. Each time that these are published, health care providers from all over the nation seek to stay current by asking for a summary of what is new and what has changed. Twelve resuscitation scientists supported by the Heart and Stroke Foundation of Canada (HSFC) to take leadership roles in the International Liaison Committee on Resuscitation (ILCOR) as Taskforce Chairs (AD, FB, AT, MW) or Task Force members (BB, IB, SB, AMG, JJ, CV, KW) or supported by the AHA as a past chair (LJM) were involved in the derivation of the 2015 ILCOR Consensus on Science and Treatment Recommendations. Resuscitation Councils from all over the world use the Consensus on Science and Treatment Recommendations publication,[1] which is derived from systematic reviews of the literature to write national guidelines. The 2015 AHA Guidelines[2] is an update focusing the systematic reviews on areas where there was new knowledge. Thus, health care providers need to remember what was important in 2010 Guidelines and not reviewed in 2015, as well as learn new knowledge reported in the 2015 Guideline Update. To make it simpler, we have highlighted what is new in 2015 by subject area and what remains important from the 2010 Guidelines as a primer for Canadian health care providers.

FIRST AID

First aid was defined in 2015 as "helping behaviours and initial care provided for an acute illness or injury," a broader definition than was used in 2010.[3]

For all ill or injured persons who are unresponsive and normally breathing, it is reasonable to use the lateral side-lying recovery position, except if there is a suspected neck, back, hip, or pelvis injury, in which case they should be kept in the position found. If a person is having airway issues in the position found, then it is reasonable to move the person as required to relieve airway compromise.

For medical emergencies, first aid providers may encourage persons with chest pain suspected to be from

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a heart attack to chew and swallow one adult aspirin (325 mg) or two to four "baby" aspirin (81 mg). For conscious persons with suspected mild hypoglycemia, first aid providers may administer glucose tablets or other specified alternatives and, for persons with exercise-associated dehydration, provide carbohydrate-electrolyte drinks or specific alternatives. First aid providers should use stroke assessment systems.

For trauma emergencies, first aid providers may apply local cold therapy for closed extremity and scalp bleeding and tourniquets and hemostatic dressings for severe external bleeding not controlled with direct pressure. They should also seek evaluation by a health care provider for any person with a head injury that has resulted in a change in level of consciousness or concerning signs and symptoms. First aid providers should avoid the use of occlusive dressings for open chest wounds and avoid routinely applying cervical collars but encourage the person to remain as still as possible while awaiting emergency medical services (EMS) arrival.

New in 2015, first aid provider training delivered via a variety of means is specifically recommended and should be made universally available. The scope of care of the first aid provider is gradually expanding, which may result in more assessments and treatment by first aid providers prior to EMS or emergency department (ED) arrival. Canadian health care practitioners will play an important role in first aid program support and medical oversight.

ACUTE CORONARY SYNDROME

Prehospital 12-lead electrocardiograms (ECGs) should be acquired early for patients with possible acute coronary syndrome. Prehospital ST-elevation myocardial infarction (STEMI) recognition, with receiving hospital notification or catheterization laboratory activation, leads to substantial mortality reduction.[4] Non-physician ECG interpretation is reasonable if adequate education and oversight are ensured. Computerized interpretation should be used as an adjunct only. There is no clear benefit of early prehospital administration of either adenosine diphosphate receptor inhibitors or anticoagulants (in a planned percutaneous coronary intervention [PCI] approach). Normoxic patients with acute coronary syndrome (ACS) do not require oxygen supplementation.[5]

Troponin measurement at 0 and 2 hours should not be used alone to exclude the diagnosis of ACS. However, high sensitivity troponin I (hs-cTnI) can be used at 0 and 2 hours when combined with low-risk stratification (Vancouver rule or thrombolysis in myocardial infarction [TIMI] score 0 or 1) to predict a less than 1% chance of 30-day major adverse cardiac events (MACE) and allow discharge with outpatient follow-up. Serial measurements of non-high sensitivity troponin T or I (cTnT, cTnI) at 0 and 3-6 hours may be used together with a very low risk stratification (Vancouver rule, TIMI score 0, low-risk history, ECG, age, risk factors and troponin [HEART] score, or North American Chest Pain score 0 in patients <50 years of age) to allow discharge.[6]

Table 1. Reperfusion strategy for ST elevation myocardial infarction

PPCI delay (minutes)	Time from symptom onset: <2 hours	2-3 hours	3-6 hours*
<60	PPCI	PPCI or fibrinolysis	PPCI
60 to 120	Fibrinolysis	PPCI or fibrinolysis	PPCI
>120	Fibrinolysis	Fibrinolysis	Fibrinolysis

*If time from symptom onset is >6 hours, then PPCI is appropriate regardless of treatment delay.
PPCI = primary percutaneous coronary intervention.

Primary percutaneous coronary intervention (PPCI) is generally the preferred reperfusion option for STEMI patients, but fibrinolysis may have advantages for early presenters and when PPCI is delayed (Table 1). Prehospital fibrinolysis is preferred to in-hospital fibrinolysis when transport time is greater than 30-60 minutes, which most commonly occurs in rural settings. Prehospital triage direct to PPCI is preferred to fibrinolysis when first medical contact to balloon time is less than 90 (up to 120) minutes, which corresponds to a travel time of up to 60 minutes. When a STEMI patient presents to a non-PCI capable hospital, there are two acceptable options: 1) transfer for PPCI (if door to balloon time will be less than 90-120 minutes) and 2) in-hospital fibrinolysis followed by transfer for angiography at 3-6 hours (or up to 24 hours). All patients who receive fibrinolysis should be considered for transfer for cardiac angiography at 3-6 hours (or up to 24 hours).

BASIC LIFE SUPPORT—ADULT

The crucial links in the basic life support adult chain of survival are unchanged from 2010, and scientific evidence published since 2010 provides additional support in favor of initiating the cardiopulmonary resuscitation (CPR) sequence with chest compressions–airway–breathing (CAB) and in favor of adopting a 30:2 chest compression to ventilation ratio. However, there is increased emphasis and clarity on the critical life-saving steps of basic life support, which include: 1) immediate recognition and activation of the emergency response system; 2) early high-quality CPR; and 3) rapid defibrillation for shockable rhythms.

The 2015 Guidelines include 35 new or updated topics (35 other topics from 2010 were not reviewed in 2015). Highlights include the critical role of dispatcher recognition and coaching the caller to perform chest compressions. High quality CPR is reemphasized with more precise recommendations for a simultaneous, choreographed approach to the performance of chest compressions, airway management, rescue breathing, rhythm detection, and shocks (if indicated) by an integrated team of highly trained rescuers in applicable settings. These include: 1) ensuring chest compressions of an adequate rate of 100 to 120 per minute (an upper limit has been introduced due to excessive rates resulting in inadequate depth); 2) ensuring chest compressions of adequate depth of at least 5 cm, for an average adult (with an upper limit of not exceeding 6 cm due to potential harm); 3) allowing full chest recoil between compressions (and avoiding leaning on the chest); 4) minimizing interruptions in chest compressions (total pre-shock and post-shock pauses in chest compressions should be as short as possible with a chest compression fraction as high as possible, with a target of at least 60%); and 5) avoiding excessive ventilation. There was insufficient evidence to provide a recommendation on the use of artifact-filtering algorithms for ECG analysis (known as see-through CPR) during CPR.

These guidelines highlight the importance of EMS systems, which employ bundles of care focusing on providing high-quality chest compressions while extricating the patient from the scene to the next level of care without worrying about ventilations or advanced airway control. Last, these recommendations reiterate the global importance of increasing the number of sites with public-access defibrillation programs, the importance of training lay rescuers to recognize abnormal/gasping breathing, the benefit of compression-only CPR when provided by untrained lay rescuers, and introduce new recommendations on the role of bystander naloxone education and administration, in addition to CPR, for known or suspected opioid life-threatening emergencies.

BASIC LIFE SUPPORT—PEDIATRICS

Continued emphasis remains for the circulation–airway–breathing (CAB) sequence as the preferred initial approach to pediatric cardiac arrest. Although the only existing supportive evidence is from simulation studies,[7-9] a shorter time to chest compressions and having a universal approach by all rescuers to all patients requiring CPR make intuitive sense.

There is still strong affirmation that the preferred approach to pediatric CPR by *all* rescuers continues to include assisted ventilation as an integral component. Pediatric cardiac arrests are predominantly asphyxial in etiology. Strong associations have been noted from several large observational studies in children that improved outcomes occur when assisted ventilation is included as part of CPR.[10,11] Where circumstances preclude the ability to provide ventilation as part of CPR, chest compressions alone should be provided.

Extrapolating from adult basic life support (BLS) guidelines, rescuers are advised to: 1) not exceed an upper limit of 6 cm for chest compression depth for adolescents; 2) maintain a chest compression rate between 100 and 120 per minute; and 3) audio or visual point-of-care feedback on the quality of CPR (rate, depth, hands-off time) should be used when available so as to enable targeting of the previously mentioned metrics of high-quality CPR.

ADVANCED LIFE SUPPORT—ADULT

Standard-dose epinephrine (1 mg every 3 to 5 minutes) may be reasonable for patients in cardiac arrest.[12] High dose epinephrine is not recommended. In cardiac arrest patients with non-shockable rhythm and who are otherwise receiving epinephrine, the provision of epinephrine is suggested as soon as possible.[13] Vasopressin alone, or in combination with epinephrine, offers no advantage as a substitute for standard dose epinephrine alone in cardiac arrest. Accordingly, vasopressin has been removed from the advanced life support (ALS) adult cardiac arrest algorithm. The combination of steroids, vasopressin, and epinephrine is not recommended for routine use but can be considered in the treatment of in-hospital cardiac arrest.[14]

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In intubated patients, failure to achieve an $ETCO_2$ of greater than 10 mm Hg by waveform capnography after 20 minutes of CPR may be considered as one component of a multimodal approach to decide when to end resuscitative efforts but should not be used in isolation.

The routine use of the impedance threshold device (ITD) as an adjunct during standard CPR is not recommended.[15] The combination of ITD with active compression-decompression CPR may be a reasonable alternative to conventional CPR in settings with available equipment and properly trained personnel.[16,17]

Conventional manual chest compressions remain the standard of care for the treatment of cardiac arrest, but mechanical chest compression devices may be a reasonable alternative for use by properly trained personnel.[18-20]

When rapidly implemented, extracorporeal cardiopulmonary resuscitation (ECPR) can prolong viability for patients who are not resuscitated with conventional CPR. ECPR can provide time to treat potentially reversible conditions or arrange cardiac transplantation.

ADVANCED LIFE SUPPORT—PEDIATRICS

Pre-arrest

When caring for infants or children with febrile illnesses, early and rapid delivery of intravenous isotonic fluids continues to be common practice. This may not be appropriate when caring for certain patient populations, in particular in resource-limited settings where access to critical care support (including inotropes and assisted ventilation) may be limited.[21] Detailed patient reassessment during and following fluid boluses is important, to distinguish those patients who will benefit from continued fluid resuscitation from those who will not.

Intra-arrest

Observational data suggest that administering atropine prior to the intubation of critically ill (non-neonatal) infants and children may increase survival to an intensive care unit (ICU) discharge,[22] but the data are conflicting as to whether this reduces the incidence of peri-intubation arrhythmias or post-intubation shock.[23,24] The routine use of atropine pre-intubation is not indicated, but it may be considered in circumstances where there is a higher risk of associated bradycardia (e.g., with the use of fentanyl or succinylcholine for intubation). New literature also suggests that no minimum dose exists when administering atropine as a premedication for emergency pediatric intubation (i.e., use 0.02 mg/kg and not a minimum dose of 0.1 mg).[22,23]

While pediatric data remain limited, $EtCO_2$ monitoring during CPR helps evaluate the quality of chest compressions. Specific $EtCO_2$ values with which to guide therapy have not been established in children. Teaching materials will most likely recommend using the adult numbers, that is, shoot for greater than 10-15 mm Hg until pediatric data become available.

Pediatric observational data suggest that either amiodarone or lidocaine may be used to manage shock-refractory ventricular fibrillation or pulseless ventricular tachycardia.[25]

Observational data support the use of ECPR for infants and children in cardiac arrest (especially those with underlying cardiac disease) in the in-hospital critical care setting, when patients are refractory to conventional resuscitation, and when the necessary ECPR protocols, expertise, and equipment exist.[26,27] No evidence exists to support its routine use for cardiac arrest in the out-of-hospital setting.

While there are patient factors that are associated with better or worse outcomes from pediatric cardiac arrest, there is no single factor accurate enough to predict functional survival. Multiple variables should be used when considering termination or continuation of resuscitation.

POST ARREST—ADULTS

Avoid hypotension defined as systolic blood pressure (SBP) <90 mm Hg, mean arterial pressure (MAP) less than 65 mm Hg, and immediately correct hypotension. A target MAP or SBP post-arrest was not supported by the evidence other than what is normally followed in the ED and the ICU to achieve optimal organ and brain perfusion.

Physiological marker goals remain unchanged from 2010: normocarbia for $PaCO_2$ is 35-45 mm Hg and $ETCO_2$ is 30-40 mm Hg. Recommendations for oxygen were updated from 2010 to provide high concentrations until the partial pressure of oxygen can be measured, such as in the prehospital setting early after return of spontaneous circulation (ROSC). Once the inspired oxygen concentration can be titrated, it is reasonable to maintain oxygen saturation at >94% and to decrease the inspired oxygen concentration when oxygen saturation is 100%.

The term *therapeutic hypothermia* has been retired and replaced with *targeted temperature management* (TTM) with a recommended target temperature range of 32°C-36°C (89.6°F-96.8°F) for all comatose post-arrest patients with ROSC regardless of presenting rhythm for a minimum of 24 hours. Targeted temperature management means the patient receives active temperature management as part of a protocol involving sedation and tight temperature control and active prevention of any temperature greater than 36°C (96.8°F).[28] This has mistakenly been translated by some clinicians into providing acetaminophen instead of a TTM protocol as long as the temperature is 36°C (96.8°F), and this would not be consistent with the evidence and recommendations. Clinicians may use local preference/policy and patient characteristics in choosing their temperature of choice within this target.

Routine prehospital cooling outside of a current clinical trial after ROSC with rapid infusion of large amounts of cold intravenous fluids is not recommended because it has been associated in one trial with increased episodes of heart failure and re-arrest rates.[29]

Based on a large number of observational studies, emergent coronary angiography is recommended for patients with ROSC after out-of-hospital cardiac arrest (OHCA) with ST-elevation on ECG.[6] Emergent angiography is suggested for select patients who are comatose with ROSC after OHCA of presumed cardiac origin but no ST-elevation on ECG.[6,30] Patient selection for proceeding to angiography may take into account patients' hemodynamic instability, age, duration of CPR, and other factors.

Reinforced from 2010 is that neuroprognostication should wait until after 72 hours post-arrest and should not be done in the ED.

Most important, emergency physicians and critical care physicians should advocate in their communities for consideration of organ donation in all patients who are resuscitated from cardiac arrest but who progress to brain death because patients on waiting lists for organ donation can be affected in a positive way.

POST ARREST—PEDIATRICS

The focus is on measurement in 2015. For children who remain in a coma after an OHCA, a TTM strategy is recommended when initiated in the ED or ICU setting. Based on the current evidence,[31,32] clinicians may target 36°C [96.8°F] to 37.5°C (99.5°F) for 5 days or may target 32°C (89.6°F) to 34°C (93.2) for 2 days followed by 3 days of normothermia. Whereas, with respect to paramedics starting TTM in the prehospital setting after pediatric cardiac arrest, there is no clear guidance on which is the correct target temperature.

An SBP above the 5th percentile for age should be maintained with fluid and/or inotropes and vasopressors after return of circulation. Intra-arterial pressure monitoring should be used to continuously monitor blood pressure, to identify, and to treat hypotension.

The literature does not recommend any specific PaO_2 or $PaCO_2$ target in children after cardiac arrest, but it suggests that measuring these end points is a reasonable means to try to maintain normoxemia and normocarbia. It may be reasonable for rescuers to wean oxygen to target an oxyhemoglobin saturation of less than 100% but greater than 94% when the necessary equipment is available, that is, the ability to monitor oxygen saturation and titrate FIO_2.

EDUCATION AND IMPLEMENTATION

Striking disparities in survival rates exist for out-of-hospital and in-hospital cardiac arrest, despite scientific advances. Rapid recognition and response to patients at-risk for cardiac arrest and to those presenting in cardiac arrest are essential, as is access to high-quality post-arrest care. Thoughtful consideration of the education and implementation issues will help in optimizing outcomes.[33]

For lay providers, it is critical that they initiate CPR and use an automated external defibrillator when faced with a cardiac arrest victim. Though training is not required to do this, it may improve ease of use and help overcome fear and panic that limit action. BLS skills seem to be learned equally well through self-instruction (video- or computer-based) with hands-on practice compared to traditional instructor-led courses and may help increase the potential pool of rescuers because it is less resource intensive. Dispatchers of 911 services should be trained to recognize cardiac arrest and agonal respirations, providing compression-only CPR instructions to lay rescuers in need of support.[34-36] Additionally, there may be a role for dispatch systems to use social media technology such as geospatial activation of individuals who have downloaded a local application that indicates their readiness to respond as part of a system to notify registered lay rescuers of a nearby cardiac arrest.[37]

Training using CPR feedback devices facilitates learning the psychomotor skills of CPR. Devices that provide feedback on performance are preferred to devices that provide prompts only (such as a metronome). It is well recognized that our current 2-year retraining cycles are suboptimal. More frequent training of BLS and ALS skills may be helpful for providers likely to encounter cardiac arrest. For ALS training, high-fidelity manikins can be useful in programs that have the infrastructure, trained personnel, and resources to maintain the program. Standard manikins are acceptable for organizations that do not have this capacity. Health care providers should be trained in teamwork and receive data-driven performance-focused debriefing as part of a continuous quality improvement program.[38-40]

Finally, preventing cardiac arrest with medical emergency teams and early warning scores can be effective at reducing the incidence of in-hospital cardiac arrest.[41]

SUMMARY

Dissemination of knowledge starts with information sharing in multiple formats. We hope that this *CJEM* summary is just one step in the knowledge translation pathway to better informed rapid and effective resuscitation care.

Keywords: acute coronary syndrome, cardiac arrest, first aid, guidelines or recommendations, in-hospital cardiac arrest, out-of-hospital cardiac arrest, resuscitation, sudden death

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