# Réanimation pédiatrique

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# Étiologies arrêts cardio-respiratoires

- Out-of-hospital
  - Respiratoire > cardiaque
- In-hospital
  - Cardiaque > respiratoire

# Taux de survie

- Adulte
  - In-hospital 22.3%
  - Out-of-hospital 14%
- Pédiatrie
  - In-hospital 35%
  - Out-of-hospital 3-16%

# Airway

- Avant IET, optimiser la ventilation
- Éviter multiples tentatives d'IET car augmente le temps de "no flow"
- Si ventilation au masque, attention à l'inflation gastrique
  - Risque d'aspiration secondaire
  - Distention abdominale pouvant compromettre la ventilation

# * Tubes endotrachéales avec ballon AHA 2020

- **2020 (Updated):** It is reasonable to choose cuffed ETTs over uncuffed ETTs for intubating infants and children. When a cuffed ETT is used, attention should be paid to ETT size, position, and cuff inflation pressure (usually <20-25 cm H2O).
- **2010 (Old):** Both cuffed and uncuffed ETTs are acceptable for intubating infants and children. In certain circum- stances (eg, poor lung compliance, high airway resistance, or a large glottic air leak) a cuffed ETT may be preferable to an uncuffed tube, provided that atten- tion is paid to [ensuring appropriate] ETT size, position, and cuff inflation pressure.
- **Why:** Several studies and systematic reviews support the safety of cuffed ETTs and demonstrate decreased need for tube changes and reintubation. Cuffed tubes may decrease the risk of aspiration. Subglottic stenosis is rare when cuffed ETTs are used in children and careful technique is followed.

# *Cricoid Pressure During Intubation AHA 2020

- **2020 (Updated):** Routine use of cricoid pressure is not recommended during endotracheal intubation of pediatric patients.
- **2010 (Old):** There is insufficient evidence to recommend routine application of cricoid pressure to prevent aspiration during endotracheal intubation in children.
- **Why:** New studies have shown that routine use of cricoid pressure reduces intubation success rates and does not reduce the rate of regurgitation. The writing group has reaffirmed previous recommendations to discontinue cricoid pressure if it interferes with ventilation or the speed or ease of intubation.

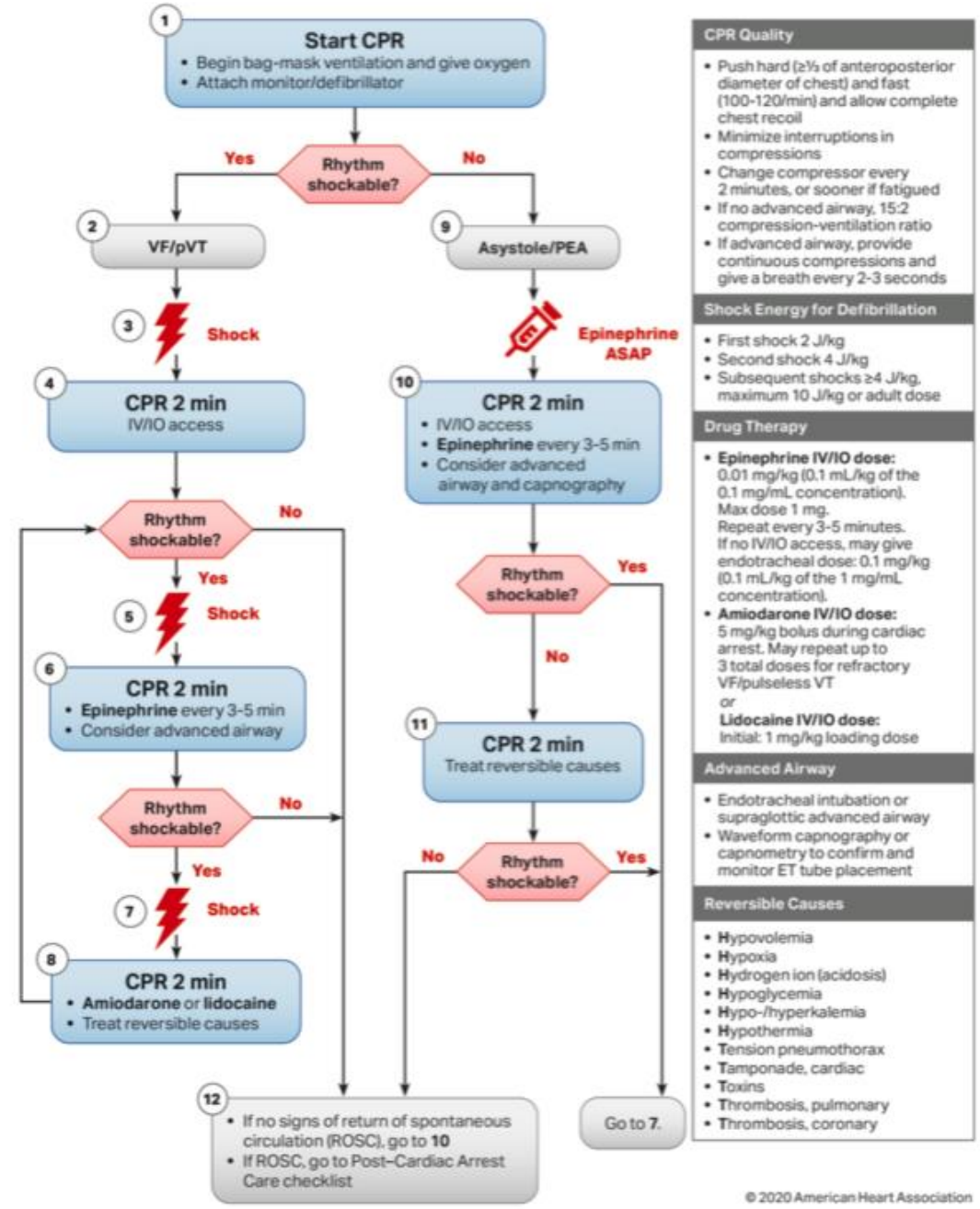
# Breathing

- Qualité de la ventilation au masque
  - Excursion thoracique appropriée
  - Auscultation satisfaisante
  - **if there is no chest movement, there is no ventilation**
    - R/O: obstruction VA haute, présence de corps étrangers, PTX bilatéraux, brochospasme, laryngospasme
- Attention à la surdistention
  - Réduction du retour veineux + du débit cardiaque

# Changes to the Assisted Ventilation Rate: Ventilation Rate During CPR With an Advanced Airway

- **2020 (Updated):** (PALS) When performing CPR in infants and children with an advanced airway, it may be reasonable to target a respiratory rate range of 1 breath every 2 to 3 seconds (20-30/min), accounting for age and clinical condition. Rates exceeding these recommendations may compromise hemodynamics.
- **2010 (Old):** (PALS) If the infant or child is intubated, ventilate at a rate of about 1 breath every 6 seconds (10/min) without interrupting chest compressions.
- **Why:** New data show that higher ventilation rates (at least 30/min in infants [younger than 1 year] and at least 25/min in children) are associated with improved rates of ROSC and survival in pediatric IHCA. Although there are no data about the ideal ventilation rate during CPR without an advanced airway, or for children in respiratory arrest with or without an advanced airway, for simplicity of training, the respiratory arrest recommendation was standardized for both situations.

**Figure 11. Pediatric Cardiac Arrest Algorithm.**



# CPR

- Perfusion des organes dépend de la qualité du massage cardiaque
  - 100 compressions/minutes
  - Profondeur de la compression: 1/3 du diamètre AP
  - Recoil complet
  - Minimiser interruptions
  - Changer de masseur q 2 min ou plus tôt
  - Surface assez dure permettant compressions efficaces
- Enfant en bas de 6 mois, technique circonférentielle
  - Pouce déprime le sternum et les autres doigts supportent le dos
- Bébé plus âgé: massage sternale avec 2 doigts
- Enfants: 1-2 mains

# Défibrillation

- Dépolarisation simultanée permettant un retour à une contraction cardiaque spontanée et coordonnée
- Si fibrillation ventriculaire ou tachycardie ventriculaire pas de pouls
  - *priorité* = défibriller
  - Retour à un rythme organisé diminue avec le temps de fibrillation
  - Ne pas retarder le premier choc pour IET
- Energie
  - Premier choc: 2J/kg
  - Deuxième choc: 4J/kg
  - Subséquents: 4J-10J/kg ad charge adulte

# Pad défibrillation

- Choix du pad de défibrillation
  - Le plus gros pad approprié pour le poids de l'enfant
    - Diminue la densité du courrant et par conséquent diminue les dommages myocardiques
  - Pad adultes: 10kg et plus
  - Pad pédiatrique: 10 kg et moins
- Bon contact/adhérence pour diminuer la densité focale du courant
- Interface entre pad et patient
  - Gel, crème
  - Attention, l'interface des 2 pads ne doivent pas se toucher, le courant suit le chemin de la plus faible résistance

# Pad défibrillation

- Position: myocarde entre les 2 pads
  - Option 1
    - 1 pad à droite de la partie supérieure du sternum, en dessous de la clavicule
    - 1 pad caudale et à gauche du mamelon gauche
  - Option 2
    - 1 pad précordium gauche
    - 1 pad postérieur, entre les scapulas

# Défibrillation thorax ouvert

- Chirurgie cardiaque ou post-op de coeur
- Pad interne
- Dimension (diamètre)
  - Adulte: 6 cm
  - Enfant: 4 cm
  - Nourisson: 2 cm
- Interface: pads trempés avec du salin
- Position
  - 1 pad derrière le ventricule gauche et 1 pad devant le ventricule droit

# Médication via tube endotrachéale

- Si pas de voie IV
  - Lidocaine
  - Atropine
  - Nalxone
  - Epinéphrine: dose recommendée = 10x la dose IV soit 0,1 mg/kg
    - Volume doit être inférieur à 10 mL chez l'enfant et 5 mL chez les nourrissons

# Épinéphrine

- Agoniste alpha et bêta
- Augmente la perfusion coronarienne par augmentation de la pression diastolique aortique
- Dose code = 10 mcg/kg
  - Dilution 1: 10 000 = 0,1 cc/kg
  - Dilution 1: 1 000 = 0,01 cc/kg

# Emphasis on Early Epinephrine Administration

- 2020 (Updated): For pediatric patients in any setting, it is reasonable to administer the initial dose of epinephrine within 5 minutes from the start of chest compressions.
- 2015 (Old): It is reasonable to administer epinephrine in pediatric cardiac arrest.
- Why: A study of children with IHCA who received epinephrine for an initial nonshockable rhythm (asystole and pulseless electrical activity) demonstrated that, for every minute of delay in administration of epinephrine, there was a significant decrease in ROSC, survival at 24 hours, survival to discharge, and survival with favorable neurological outcome. Patients who received epinephrine within 5 minutes of CPR initiation compared with those who received epinephrine more than 5 minutes after CPR initiation were more likely to survive to discharge. Studies of pediatric OHCA demonstrated that earlier epinephrine administration increases rates of ROSC, survival to intensive care unit admission, survival to discharge, and 30-day survival.

# Atropine

- Agent parasympatholytique
  - Bloque la stimulation cholinergique des récepteurs muscarinique du myocarde
  - Augmente le rythme sinusale et diminue le temps de conduction du noeud AV
- Dose 0.02 mg/kg
- Tachycardie souvent moins prononcée qu'en adulte
- Voies d'administration: IV, IO, endotrachéale, IM, SC

# Bicarbonate

- Utilisation de routine controversée
- Chez les patients avec de l'hypertension pulmonaire, considérer même si acidose légère
- Autres indications:
  - Intoxication antidépresseurs tricycliques
  - Hyperkaliémie
  - Hypermagnésémie
  - Intoxication aux bloqueurs canaux sodiques
- Effets délétères:
  - Alkalose métabolique
  - Hypercapnie
  - Hyperosmolalité

# Calcium

- En contexte de réanimation pour indication spécifique, pas d'indication de routine
  - Hypocalcémie
  - Hyperkaliémie
  - Intoxication BCC
  - Transfusion massive
- Dose
  - Chlorure de calcium: 20mg/kg, maximum 2g
  - Gluconate de calcium: 3 fois la dose de cacl2 (maximum quand même 2g)
- Administration en voie centrale idéalement, sinon voie de large calibre, sinon risque de nécrose tissulaire
- Si administré trop rapidement: bradycardie, bloc cardiaque

# Glucose

- Indication: hypoglycémie documentée en arrêt cardio-respiratoire
- Effect délétère de l'hyperglycémie pour la protection cérébrale
- Dose
  - 0,5 g/kg
  - Nourrisson: 5 mL/kg de D10%
  - Enfant plus âgé: 1 mL/kg de D50%
    - D50% a une osmolarité de 2700 mOsm/L et est associé avec des hemorragies intraventriculaires (cérébrales) chez les néonats et les nourrissons

# Amiodarone

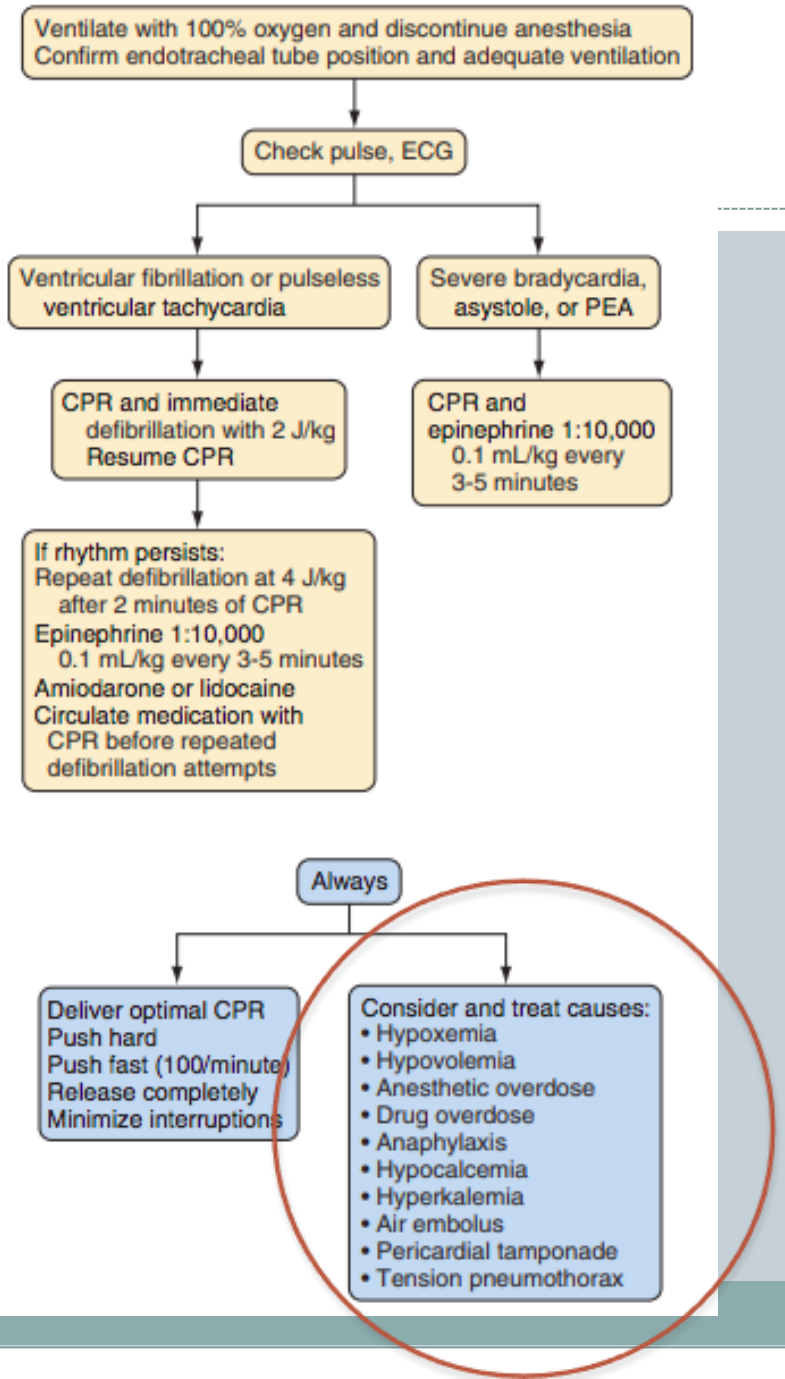
- Pharmacologie complexe, principalement classé antiarrythmique de classe III
- Médicament de première intention pour TV/FV réfractaire à la défibrillation
- Profile de sécurité suffisamment démontré en pédiatrie
  - Effet secondaire aigu: hypotension, torsade de pointe
  - Effet secondaire chronique: fibrose pulmonaire
- Dose
  - Charge 5 mg/kg
  - Perfusion 10-20 mg/kg/jour
  - Vitesse d'administration idéale: 20-60 minutes
    - Si TV sans pouls ou FV: en 2-3 minutes ad contrôle de l'arrythmie puis ralentir le bolus

# Lidocaïne

- Antiarrythmique de classe IB
  - Diminue automaticité des arrythmies ventriculaires
  - Pas d'effet sur le NAV, donc inutile pour arrythmique atriale ou atrioventriculaire
- Dose
  - Fonction cardiaque et hépatique normales
    - Bolus 1 mg/kg puis perfusion de 20-50 mcg/kg/min
  - Si débit cardiaque sévèrement diminué
    - Bolus 0.75 mg/kg puis perfusion de 10-20 mcg/kg/min
  - Si maladie hépatique
    - Diminution dose de 50%

# Arrêt cardiaque en périopératoire

- Étiologies
  - Cardiovasculaire: 41%
    - Hypovolémie
    - Hyperkaliémie (secondaire aux transfusions)
    - Causes de bradyarrythmie
      1. Hypoxie
      2. Overdose agents anesthésiques
      3. Reflexe vagale par stimulation chirurgicale ou IET
  - Respiratoire 27%
    - Laryngospasme
  - Relié à l'équipement
    - Installation de voie centrale
- Taux de réussite de la réanimation élevée


Ventilate with 100% oxygen and discontinue anesthesia
Confirm endotracheal tube position and adequate ventilation
Check pulse, ECG
Ventricular fibrillation or pulseless ventricular tachycardia
Severe bradycardia, asystole, or PEA
CPR and immediate defibrillation with 2 J/kg
Resume CPR
CPR and epinephrine 1:10,000 0.1 mL/kg every 3-5 minutes
If rhythm persists:
Repeat defibrillation at 4 J/kg after 2 minutes of CPR
Epinephrine 1:10,000 0.1 mL/kg every 3-5 minutes
Amiodarone or lidocaine
Circulate medication with CPR before repeated defibrillation attempts
Always
Deliver optimal CPR
Push hard
Push fast (100/minute)
Release completely
Minimize interruptions
Consider and treat causes:
• Hypoxemia
• Hypovolemia
• Anesthetic overdose
• Drug overdose
• Anaphylaxis
• Hypocalcemia
• Hyperkalemia
• Air embolus
• Pericardial tamponade
• Tension pneumothorax

# Anaphylaxie

- Triade
  - Cardiovasculaire
    - Tachycardie, hypotension, choc
  - Respiratoire
    - Oedème de voies aériennes, bronchospasme
  - Dermatologique
    - Urticaire, flushing
- Épinéphrine
  - Symptômes légers: 1-2 mcg/kg IV, doses répétitives ad stabilisation
  - Anaphylaxie sévère (code): dose code
- Autres médicaments
  - Bolus liquidiens 20 mL/kg
  - Diphenhydramine 1 mg/kg
  - Methylprednisolone (SoluMedrol) 2 mg/kg
  - Salbutamol (1 puff/3 kg)

# ECMO

- Doit être considérer
  - Lors des arrêts réfractaires
  - Cause de l'arrêt réversible
  - Période de "no flow" courte
- Au CHU Sainte-Justine, critères D'EXCLUSION à l'ECMO
  - Âge gestationnel < 34 semaines et poids de naissance < 2500 grammes
  - Présence d'une coagulopathie importante ou d'un saignement actif
  - Anomalie congénitale sévère
  - Dommages cérébraux irréversibles
  - Défaillance multi viscérale sévère.
  - Ventilation mécanique de plus de 10-14 jours

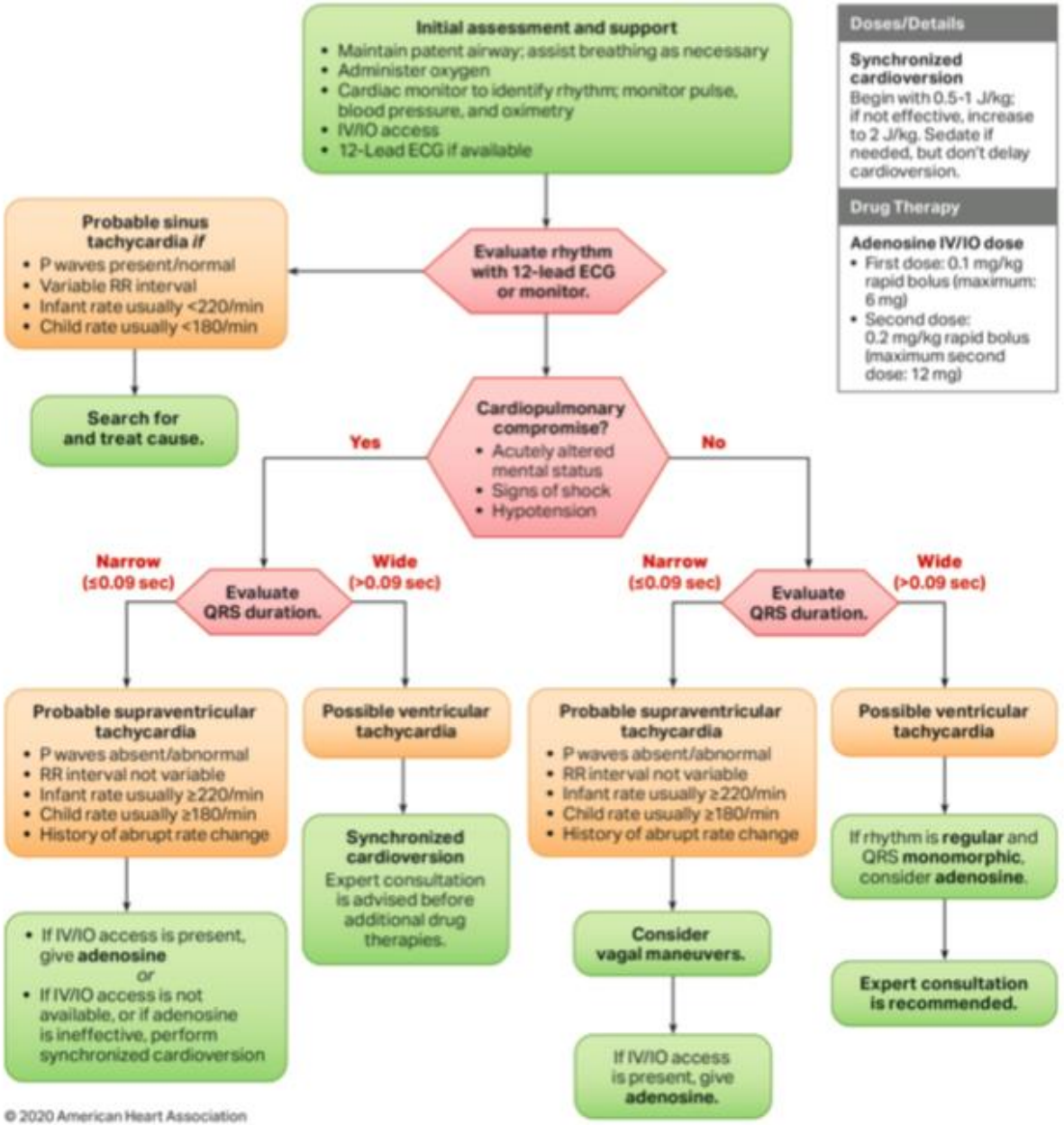
# Massage cardiaque thorax ouvert

- En salle d'urgence, salle d'opération ou USI
  - Per-op de chirurgie cardiaque ou thoracique
  - Trauma thoracique pénétrant
  - Post-op récent de chirurgie cardiaque
- Génère un plus grand débit cardiaque et une meilleure perfusion cérébrale et coronarienne

# Tachycardie supraventriculaire

- Peut être associée avec compromis HD et même arrêt cardiaque
- Conduite dépend du statut HD du patient
  - Si perfusion inadéquate
    - cardioversion synchronisée 0,5 J/kg
    - Adénosine
      - Première dose 0,1 mg/kg
      - Deuxième dose 0,2 mg/kg puis 0,4 mg/kg
      - Chez les transplantés cardiaques: diminution de 50% la dose
  - Si pas de compromis HD
    - Manoeuvre vagale
    - Adénosine

**Figure 13. Pediatric Tachycardia With a Pulse Algorithm.**



# Detecting and Treating Seizures After ROSC

- **2020 (Updated):** When resources are available, continuous electroencephalography monitoring is recommended for the detection of seizures following cardiac arrest in patients with persistent encephalopathy.
- **2020 (Updated):** It is recommended to treat clinical seizures following cardiac arrest.
- **2020 (Updated):** It is reasonable to treat nonconvulsive status epilepticus following cardiac arrest in consultation with experts.
- **2015 (Old):** An electroencephalography for the diagnosis of seizure should be promptly performed and interpreted and then should be monitored frequently or continuously in comatose patients after ROSC.
- **2015 (Old):** The same anticonvulsant regimens for the treatment of status epilepticus caused by other etiologies may be considered after cardiac arrest.
- **Why:** For the first time, the Guidelines provide pediatric-specific recommendations for managing seizures after cardiac arrest. Nonconvulsive sei- zures, including nonconvulsive status epilepticus, are common and cannot be detected without electroenceph- alography. Although outcome data from the post–cardiac arrest popula- tion are lacking, both convulsive and nonconvulsive status epilepticus are associated with poor outcome, and treatment of status epilepticus is beneficial in pediatric patients in general.

# *Invasive Blood Pressure Monitoring to Assess CPR Quality

- **2020 (Updated):** For patients with continuous invasive arterial blood pressure monitoring in place at the time of cardiac arrest, it is reasonable for providers to use diastolic blood pressure to assess CPR quality.
- **2015 (Old):** For patients with invasive hemodynamic monitoring in place at the time of cardiac arrest, it may be reasonable for rescuers to use blood pressure to guide CPR quality.
- **Why:** Providing high-quality chest compressions is critical to successful resuscitation. A new study shows that, among pediatric patients receiving CPR with an arterial line in place, rates of survival with favorable neurologic outcome were improved if the diastolic blood pressure was at least 25 mm Hg in infants and at least 30 mm Hg in children.

# Choice of Vasopressor
## in septic shock

- **2020 (New):** In infants and children with fluid-refractory septic shock, it is reasonable to use either epinephrine or norepinephrine as an initial vasoactive infusion.
- **2020 (New):** In infants and children with fluid-refractory septic shock, if epinephrine or norepinephrine are unavailable, dopamine may be considered.

# *Myocarditis

- **2020 (New):** For children with myocarditis or cardiomyopathy and refractory low cardiac output, prearrest use of ECLS or mechanical circulatory support can be beneficial to provide end-organ support and prevent cardiac arrest.
- **2020 (New):** Given the challenges to successful resuscitation of children with myocarditis and cardiomyopathy, once cardiac arrest occurs, early consideration of extracorporeal
- **Why:** Although myocarditis accounts for about 2% of sudden cardiovascular deaths in infants,11 5% of sudden car- diovascular deaths in children,11 and 6% to 20% of sudden cardiac death in athletes, previous12,13 PALS guidelines did not contain specific recommendations for management. These recommenda- tions are consistent with the 2018 AHA scientific statement on CPR in infants and children with cardiac disease.14

# *Pulmonary Hypertension

- **2020 (Updated):** Inhaled nitric oxide or prostacyclin should be used as the initial therapy to treat pulmonary hyper- tensive crises or acute right-sided heart failure secondary to increased pulmo- nary vascular resistance.
- **2020 (New):** For the initial treatment of pulmonary hypertensive crises, oxygen administration and induction of alkalosis through hyperventilation or alkalization .
- **2010 (Old):** Consider administering inhaled nitric oxide or aerosolized prostacyclin or analogue to reduce pulmonary vascular resistance.
- **Why:** Pulmonary hypertension, a rare disease in infants and children, is associated with significant morbidity and mortality and requires specialized management. Previous PALS guidelines did not provide recommendations for managing pulmonary hypertension in infants and children. These recommen- dations are consistent with guidelines on pediatric pulmonary hypertension published by the AHA and the American Thoracic Society in 2015,16 and with recommendations contained in a 2020 AHA scientific statement on CPR in infants and children with

# Références


- A Practice of Anesthesia for Infants and Children. Book, Sixth Edition, 2019. Charles J. Coté, Jerrold Lerman and Brian J. Anderson
- Highlights of the 2020 american heart association guidelines for CPR and ECC