PedsCases Podcast Scripts

This is a text version of a podcast from Pedscases.com on "Pediatric Advanced Life Support." These podcasts are designed to give medical students an overview of key topics in pediatrics. The audio versions are accessible on iTunes or at www.pedcases.com/podcasts.

Pediatric Advanced Life Support

Developed by Colin Siu and Dr. Melissa Chan for PedsCases.com.
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Hi everyone, my name is Colin Siu and I'm a medical student at the University of Alberta. This podcast was developed with Dr. Melissa Chan, a pediatric emergency physician and Clinical Lecturer at the University of Alberta and Stollery Children's Hospital in Edmonton, Alberta, Canada. This PedsCases' podcast will go over the principles of pediatric resuscitation. The material presented in this podcast is based on the Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science developed by the American Heart Association (AHA), which was last updated in 2015. The material covered in this podcast may change with future revisions to these guidelines, and we ask that you refer to the guidelines developed by the Association for the most up to date information.

Case

Let's start off with a case to put everything into context. You are on hospital call during your rural rotation. You suddenly hear a Code Blue being called to a room nearby. You bolt down the hallway and find another nurse already in the room. The patient is a 6 year old boy that is not breathing. What is your approach to managing this patient? What do you do first? What tests are important to order? How do you save a life?

In this podcast, we will focus on two-person resuscitation procedures. While the AHA guidelines cover both 1- and 2-person resuscitation, in hospital it is unlikely that you will be the sole rescuer. We will begin with a brief introduction to cardiac arrest in the pediatric population followed by a description of the resuscitation process. We will then review in-depth the essential components to resuscitation including bag mask ventilation, advanced airways, defibrillation, and post-cardiac arrest care. The objectives of the podcast are to:

1) Review the basic principles of pediatric cardiopulmonary resuscitation
2) Review the proper technique and use of bag-mask ventilation
3) Describe the process of selecting and using an appropriate advanced airway
4) Outline the indications and process of defibrillation
5) Explain important features of post-cardiac arrest care

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Introduction

Let's begin now with our introduction. Cardiac arrest in the pediatric population is usually the result of respiratory failure or shock causing asphyxial arrest. Asphyxia presents with signs of hypercapnia, hypoxemia and acidosis with a progression to bradycardia and hypotension ending in cardiac arrest. Only approximately 5-15% of pediatric cardiac arrests result from ventricular fibrillations or pulseless ventricular tachycardias.

Cardiopulmonary Resuscitation

We will now take a look at resuscitation in pediatrics. The first thing that you do when you find an unresponsive patient who is not breathing is to get help. This usually means activating the emergency response system, often termed a Code Blue in most health centers. Remember, gasping is not considered breathing. If more than two health care providers are available, start with the basics: IV, O2 and monitors. Ask someone to attach ECG monitors to the patient, attach supplemental oxygen, prepare intravenous access, prepare resuscitation medications for delivery and acquire a defibrillator. The first person at the scene should run the code until a more experienced health care provider arrives to take over.

Next, check the pulse for 10 seconds feeling in the brachial or femoral artery in infants or the carotid artery in a child. If there is no pulse or if the pulse less than 60 beats per minute, immediately begin chest compressions. If the pulse is over 60 beats per minute but breathing is inadequate, begin rescue breathing at a rate of 1 breath every 3-5 seconds, reassessing the pulse every 2 minutes. A mnemonic for rescue breathing with a bag mask is that of "squeeze, release, release".

For infants under one-year-old, wrap your two hands around the chest, spread your fingers over the chest and place your thumbs in the lower third of the sternum. Press down on the sternum with your thumbs. If you are unable to encircle the chest, use the two-finger technique by compressing the sternum with two fingers just underneath the mammillary line with care to avoid the xiphoid and ribs. In children over one, do chest compressions using both hands and press downwards on the sternum at the nipple line with the force centered on the heels of both hands. Chest compressions should be conducted at a rate of approximately 100-120 compressions per minute with a compression depth of at least one third of the patient's AP diameter or roughly 1.5 inches in infants, 2 inches in children, and 2 to 2.4 inches in adolescents. Chest compressions should always be done on a firm surface such as a compression board and rescuers should allow for complete recoil of the chest prior to the next compression.

Another health care provider should be at the patient's head and responsible for ventilation, often this is a respiratory therapist. After 15 compressions, the patient should be ventilated using a bag mask. The process of alternating compressions and ventilation should be maintained at a ratio of 15 compressions to two breaths with minimal interruptions. The two rescuers should switch roles every two minutes to avoid

compression fatigue; this switch should be coordinated by the rescuer conducting compressions. Continue this process until return of spontaneous circulation, otherwise known as, ROSC is achieved or resuscitation efforts are stopped. It is important to ask if family members would like to be present during resuscitation efforts and to assign one person of the healthcare team to be with the family to answer questions and support the family.

We will now take a more in-depth look into the resuscitation mechanisms.

Bag Mask Ventilation

Bag mask ventilation has been shown to be as effective as and safer than endotracheal intubation for short periods of time. It is probably one of the most important skills for healthcare providers to learn. The hardest part of bag mask ventilation is making a proper seal. To create a tight seal between the patient's face and the mask, use the EC technique. With one hand use your 3rd, 4th and 5th fingers to lift the jaw upwards, thus creating the E with your digits. Then use your thumb and index finger to seal the mask against the patient's face, creating a C with your digits. If the chest does not rise, reposition the airway, check the seal of the mask-face interface, and try again.

In terms of equipment, a smaller bag of 450 – 500 mL may be used for infants while the standard adult bag of 1000 mL may be used in older children. To deliver a high oxygen concentration, attach an oxygen source to the bag reservoir. Ensure an oxygen flow of 10 – 15 L/min into the reservoir for infants and a flow of at least 15 L/min for older children.

Two-person bag-mask ventilation is sometime needed if there is difficulty creating a tight seal on the patient's face, or in situations of poor lung compliance or significant airway obstruction. One rescuer uses both hands to close the seal between the mask and the patient's face while the other rescuer ventilates with the bag. Do not forget to look for chest rise.

With bag mask ventilation, it is important to avoid the common mistake of hyperventilating the patient or inflating large volumes of air as both will delay ROSC; always ventilate only enough to see the chest rise. A nasogastric or orogastric tube may be required to relieve gastric inflation which often occurs as a complication of bag valve mask ventilation.

Woah, that's a lot of stuff, let's do a quick review. Remember to first activate the emergency response system if your patient is not breathing. If there is no pulse or if the pulse is less than 60 beats per minute, begin chest compressions and alternating ventilations at a ratio of 15 compressions to two breaths. To create a tight seal with the bag mask, use the EC technique and ventilate only enough to see the chest rise. Now, onwards to advanced airways.

Advanced airways

Advanced airways refer to equipment which creates a pathway between the patient's lungs and resuscitator ventilation efforts. Advanced airways are readily used in the hospital setting in the context of respiratory failure or arrest. The type of advanced airways, ordered from least to most invasive are: supraglottic airways and endotracheal intubation. Once an advanced airway is in place, there is no further need for cycling between chest compressions and ventilations. Instead, chest compressions should be continuous and ventilations should be given via the advanced airway every 6-8 seconds without interruption of chest compressions. Rescuers should still switch roles after 2 minutes to avoid compression fatigue.

Now, let's take a further look at our first type of advanced airway, the supraglottic airway. Supraglottic airway tubes refer to advanced airways that sit above the glottis. The most common example of a supraglottic airway would be the laryngeal mask airway. These may be easier to insert but do not pass below the vocal cords therefore patients are still at risk of aspirating stomach contents. Thus, laryngeal mask airways are usually only considered when bag-mask ventilation was unsuccessful and endotracheal tube insertion is not possible.

Endotracheal tubes are considered definitive airway devices. They are tubes which are inserted into the trachea and pass below the vocal cords, reducing the risk of aspiration. There two main types of endotracheal tubes: cuffed and uncuffed, referring to whether there is an inflatable region at the end of the tube. Cuffed endotracheal tubes may be preferred in situations with high airway resistance, anticipated air leaks, or poor lung compliance.

Preparation is key before intubation. Before starting, ensure that you have 0.5 mm smaller and 0.5 mm bigger ETT ready, in case the tube you have selected does not work. It is important to verify the accurate placement of the endotracheal tube in the mid-trachea immediately after placement, after anchoring the ETT in place, in transit and each time the patient is moved. To verify the accurate placement of the tube, look for bilateral chest movements, listen for breath sounds at the lung apices, listen for the absence of gastric insufflation sounds in the stomach, check end tidal CO2 and order an x-ray. After ascertaining the ETT location, secure it in place.

If an intubated patient clinically deteriorates, consider the mnemonic DOPE as a differential diagnosis:

- D for displacement of tube
- O for obstruction of tube
- P for pneumothorax
- E for equipment failure

Suction catheters may be used during endotracheal intubation. When suctioning, avoid extending the suction tube beyond the end of the endotracheal catheter to prevent injury to the mucosa.

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Cardiac Rhythms in Pulseless Patient

Cardiac rhythms during cardiac arrest may be categorized into shockable and non-shockable rhythms.

There are two shockable rhythms to recognize: ventricular tachycardias and ventricular fibrillation. In a pulseless patient with either ventricular tachycardia or fibrillation, defibrillation is indicated. After the shock is delivered via the defibrillator, immediately resume compressions. If ROSC is not achieved after two 2-minute cycles of compressions and shocks, give epinephrine 1:10,000 concentration IV at a dose of 0.01 mg/kg to a maximum of 1 mg while compressions are maintained. If ROSC is not achieved after three cycles, antiarrhythmic medications can be considered in consultation with experts.

For non-shockable rhythms in a pulseless patient, deliver epinephrine 1 in 10,000 IV 0.01 mg/kg to a maximum of 1 mg while compressions are being continued. Repeat the dose every 3 to 5 minutes and re-check for pulses and the heart rhythm every 2 minutes. It is important during resuscitation to consider possible causes of cardiac arrest in order to provide appropriate management. The mnemonic H's and T's is often used to remember the common causes of cardiac arrest. The 5 H's stand for hypovolemia, hypoxia, hydrogen ions excess or acidosis, hyper- or hypokalemia, and hypothermia. The 6 T's stand for tablets or toxins, cardiac tamponade, tension pneumothorax, thrombosis, thromboembolism, and trauma.

Defibrillation

As soon as you arrive at a resuscitation, ECG leads and a defibrillator should be attached to the patient as soon as it is available. Defibrillators are categorized into two types: automated and manual. Automated external defibrillators or AEDs are able to analyze the cardiac rhythm and deliver a shock automatically if a shockable rhythm is found. These are the type of defibrillators that are standard outside of healthcare facilities.

Manual defibrillators require a skilled operator to read the ECG and determine if the rhythm is shockable or not. Manual defibrillators have advantages in that they can facilitate pacing and cardioversion. In most hospitals, manual defibrillators with self-adhesive pads will be used. Use the largest pads that will fit on the child's chest and try to leave a 3 cm gap between the pads. Place one pad over the right side of the upper chest and the other pad over the left lower ribs, slightly lateral to the left nipple line.

If a non-shockable rhythm is identified, continue chest compressions and ventilations for another two minutes before re-assessing the rhythm to see if shockable rhythm is found. If no shockable rhythm is found, continue this cycle. If a shockable rhythm is identified, then an initial dose of 2 Joules per kg is applied. If this fails, after the next cycle of CPR, a dose of 4 Joules per kg can be used. Further doses can increase to up to 10 Joules per kg if needed. Chest compressions and ventilation should be restarted

immediately after a shock is given. CPR should be continued for 2 minutes until the next rhythm check prior to repeating defibrillation.

Throughout the resuscitation effort, the patient's cardiac rhythm should be monitored. However, CPR should not stop until the two minute cycle is complete for a pulse and rhythm check. If IV access is obtained, blood work should be sent off urgently including complete blood count, extended electrolytes, blood gas, glucose, etc.

Okay, let's take another quick breather and review advanced airways and defibrillation. Remember that once an advanced airway is in place, you no longer need to alternate between chest compressions and ventilations but instead have continuous chest compressions and ventilate at a rate of 1 breath every 3 to 5 seconds. To verify the accurate placement of an ETT, look for bilateral chest movements, listen for breath sounds at the lung apices, listen for the absence of gastric insufflation sounds in the stomach, check end tidal CO2, check end tidal CO2, and order an x-ray. If an intubated patient's condition deteriorates with an advanced airway, consider the mnemonic DOPE. Patients should additionally be put on 100% oxygen as soon as possible, ideally as soon as bag mask ventilation is started.

For pediatric patients with a pulseless cardiac arrest with a non-shockable rhythm, known as asystole or pulseless electrical activity (PEA), give epinephrine every 3-5 minutes during CPR. For patients with a pulseless cardiac arrest with a shockable rhythm, namely ventricular fibrillation and ventricular tachycardia, deliver a shock and immediately resume compressions. An initial shock of 2 Joules per kg should be used. Now let's move on to the last part of this podcast: post-resuscitation care.

Post-Cardiac Arrest Care

After return of spontaneous circulation has been achieved through resuscitation efforts, complete a detailed respiratory and cardiovascular assessment, including monitoring the patient's heart rate, respiratory rate, oxygen saturation, blood pressure, temperature and rhythm. As part of post-cardiac arrest care, use the lowest inspired oxygen concentration to maintain oxygen saturation above 94%. Fluids, inotropes or vasopressors should be used to maintain a systolic blood pressure above the 5th percentile for the patient's age. If the patient was intubated, consider obtaining an arterial or venous blood gas; if the patient was not intubated, consider placing an advanced airway. Consider a 12-lead ECG to determine the cause of the cardiac arrest. As the final steps in post-cardiac arrest care, continue monitoring serum electrolytes, calcium and glucose. Consider a chest x-ray to evaluate the position of the endotracheal tube, heart size and pulmonary status. Monitor the patient's temperature regularly and treat any fevers promptly.

Case Review

Okay, now let's go back to our case with the 6-year-old boy with a respiratory arrest. You run into the room and see that the patient is indeed apneic and immediately ask the

nurse to assess for a pulse; the heart rate is 40 beats/minute. You ask him to start chest compressions. Another nurse runs in and you ask her to start bag-mask ventilation with high-flow oxygen. As more people arrive, you inform them that you are running the code and ask for someone to prepare the defibrillator, someone to set up and monitor vitals and ECG leads, and someone to obtain IV access and draw bloodwork for electrolytes and glucose. A respiratory therapist secures an advanced airway and chest compressions are now continuous. You see a non-shockable rhythm on the monitor and so ask for epinephrine 1 in 10,000 IV 0.01mg/kg to a maximum of 1mg to be drawn. Epinephrine is given and after two minutes of chest compressions and good bag mask ventilation the patient's heart rhythm becomes regular with a palpable pulse. Blood work comes back and electrolytes and glucose are normal. As the patient is now stable, you conduct a thorough physical exam and continue to monitor the patient.

This ends our PedsCases podcast on pediatric resuscitation principles. For the most up to date information, please refer to the American Health Association's Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science.

References

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