Neonatal Resuscitation Part 2

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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. Chloe Joynt, a Neonatologist and an Associate Professor at the University of Alberta and Stollery Children's Hospital in Edmonton, Alberta, Canada.

This podcast is part two of a two-part series that focuses on neonatal resuscitation; the first podcast focused on initial resuscitation processes while this podcast will go over more extensive resuscitation. We strongly recommend that you review the material covered in the first podcast prior to listening to this podcast. The vast majority of neonates requiring resuscitation will respond to effective ventilation and only 1% will require further resuscitation such as chest compressions.

The material presented in these podcasts are based on the Neonatal Resuscitation Program, otherwise known as NRP from the American Heart Association, which is modified for Canadian practitioners by the Canadian NRP Steering Committee to reflect Canadian review of the evidence and practice. The latest revisions by the AHA were published in 2015 and the Canadian revisions will be out in 2016. The material covered in these podcasts may change with the near future revisions of the NRP, and we ask that you refer to the guidelines most appropriate for your country of practice.

Case Introduction

Let's re-visit the case from our first podcast – unfortunately, our patient will require more extensive resuscitation this time. You are a medical student on an Emergency Medicine rotation and a 16-year-old female at 37-weeks gestation arrives in a precipitous labour. On arrival she is already fully dilated and it is clear that there is no time to transfer her to a labour and delivery unit. She gives birth to a baby boy, with an estimated 3kg birthweight. There is no meconium but there is a considerable amount of bleeding around the time of delivery. The baby does not cry at birth, is limp and is taken by the nurse to a warmer.

You ask for NICU to be called. You place him under a heat source, dry the baby, remove the wet linens, clear his airway and attempt to stimulate breathing by rubbing his back. He remains apneic and limp and the heart rate on auscultation is 40 beats per minute. You immediately start positive pressure ventilation and put a saturation probe on his right hand. You begin assisted ventilation for the neonate at a rate of approximately 40-60 breaths per minute at 21% oxygen saturation. As you are providing positive pressure ventilation, you note that the HR is 65 and O2 sats are 60%, the latter of which is appropriate at 1 minute of life. However, the low heart rate is concerning as it is not rising above 65 beats per minute. Remembering that most neonatal compromise is due to ventilation difficulties, you remember to use MR. SOPA. M stands for mask readjustment, R is for repositioning the airway, S is suctioning the mouth, then nose, O is opening the mouth and P is pressure increase. You do all of these techniques and the chest appears to be rising, leading you to believe that your ventilation should be effective but the heart rate remains at 65 and you decide to go on to the last letter of MR. SOPA: A which stands for alternative airways. What do you do at this point?

This podcast will focus on the approach to advanced resuscitation of the neonate. The learning objectives of this podcast are to:

1) Outline the process of intubation for neonates.
2) Describe the indications for starting chest compressions and how to effectively administer compressions in the neonate.
3) Review medical management in neonatal resuscitation.
4) Summarize post-resuscitation care.

Intubation

Endotracheal intubation may be considered if positive-pressure ventilation is not resulting in an increase in heart rate or there is not adequate chest movement. Furthermore, if you anticipate having to continue positive pressure ventilation for more than a few minutes, you may choose to intubate in order to improve the efficacy of assisted ventilations. Lastly, endotracheal intubation is indicated when chest compressions are started, to allow for better coordination of chest compressions and ventilation cycles.

Before beginning intubation, ensure that you have all equipment ready. This includes a laryngoscope, straight blades, uncuffed endotracheal tubes, carbon dioxide monitor, suction set-up, waterproof tape to secure the endotracheal tube in place, scissors, oral airway, meconium aspirator, stethoscope, positive pressure device, and a pulse oximeter. In terms of blades, a no. 1 is preferred for term newborns while a no. 0 is preferred for preterm newborns. Choose the correct endotracheal tube size for the resuscitation based on the weight of the neonate. A 2.5mm tube should be used for newborns under 1kg, a 3mm should be used for those 1kg to 2kg, a 3.5mm should be used for those between 2kg to 3kg and a 4mm tube should be used for newborns more than 3kg in weight. Catheters for suctioning should be ready including a 10 French for suctioning the pharynx, and either a 5 or 6 French for suctioning within the endotracheal

tube. Make sure that you have extra personnel to help support you during the intubation process.

Some people prefer to use a stylet to provide rigidity to the endotracheal tube during intubation. When using the stylet, ensure that the stylet tip is secured and does not protrude beyond the endotracheal tube to avoid injury to the tissues. Prepare suctioning equipment by turning suctioning pressure to 80 to 100 mmHg. Connect a 10F catheter to the suctioning tube to suction oral or nasal secretions. A resuscitation bag and mask should be available to ventilate the newborn between intubation attempts or if intubation is unsuccessful. The resuscitation bag without the mask can be used to assess tube placement and for ventilation post-intubation. Tubing should connect the oxygen blender to the resuscitation bag in order to provide 21 – 100% oxygen as needed. Oxygen flow through the blender should be set at 5 – 10 liters per minute.

During attempts at intubation, both ventilation and compression have to be stopped. To minimize the newborn's hypoxia, attempts at intubation should not extend beyond 30 seconds. If you are unable to intubate within 30 seconds, remove the laryngoscope and ventilate the patient with a bag-mask. Ensure that the newborn is stable before re-attempting intubation. Once the endotracheal tube has been inserted, attach a ventilation bag or T-piece resuscitator to the tube and take steps to ensure the correct placement of the tube in the trachea. This includes carbon dioxide monitoring and watching for colour change, looking for an increase in the patient's heart rate and oxygen saturation, and auscultating with your stethoscope for breath sounds in bilateral lungs and the absence of sounds in the abdomen. Be sure to auscultate in the bilateral axilla for the presence of equal-intensity breath sounds in both lungs to ensure that the tube is not so far down the trachea that only one lung is being ventilated. A less accurate estimate is that of adding 6 to the newborn's weight in kilograms to determine approximately the distance that you need to insert the endotracheal tube, as measured at the level of the newborn's mouth. If the marking on your tube is greater than this estimate, it may mean that you have extended the tube beyond the carina and into the right main bronchus. If this occurs, slowly withdraw the endotracheal tube while auscultating over the left lung and listen for an increase in the intensity of left breath sounds. Once you have ascertained the placement of the tube, secure the tube in place using tape and order a chest x-ray to visualize tube placement.

Chest Compressions

Chest compressions are the next step in the NRP algorithm after ventilations and MR SOPA techniques have been ineffective in elevating the baby's heart rate. Chest compressions are indicated if the heart rate remains below 60 beats per minute despite effective positive-pressure ventilation. Endotracheal tube intubation is strongly recommended at this point if it has not already been done, to facilitate the cycling of chest compressions with ventilations. Furthermore, when chest compressions begin, oxygen should always be increased to 100% concentration.

Compressions should be given on the lower third of the sternum (at the nipple level) at a depth of approximately 1/3 of the anterior-posterior diameter of the neonate's chest. You want to avoid compressing on the xiphoid process of the baby. Your two thumbs should press down on the sternum while your other fingers encircle the neonate's body and support the back. Allow the chest to re-expand following each compression. The compression to ventilation ratio is 3 to 1 with the cadence of 1 n 2 n 3 n breathe. Each set of 3 compressions to 1 Breath should take 2 seconds such that there are 120 events per minute. Assess the heart rate after a minute of compressions and every 45-60 seconds after that. At this time, additional personnel should be securing vascular access and preparing for the administration of medications, including epinephrine and volume, in case compressions and ventilations are ineffective at improving the heart rate.

Medical Management

If the heart rate remains below 60 beats per minute despite adequate ventilation, oxygenation and chest compressions, epinephrine and/or volume expansion is indicated. The preferred route of epinephrine administration is intravenous, often through an umbilical venous catheter at a dose of 0.1 mL/kg; double-check the epinephrine container to ensure that it is a concentration of 1 to 10,000. If you are giving epinephrine via the umbilical venous catheter, remember to always flush the line with 5 to 10 mL of saline after epinephrine administration. However, as there is often a delay in achieving IV access during a resuscitation and an endotracheal tube is often easier to secure, the first dose of epinephrine is often given via the endotracheal tube at a dose of 1 mL/kg (to a maximum of 3 mL/kg). This method is less effective than intravenous as there is unreliable absorption. The endotracheal epinephrine should be given directly into the Endotracheal tube and bagged in using your PPV device. There should be no flush given down the ETT.

Volume expansion is indicated if there is an obstetrical history suggestive of blood loss, if there are clinical signs of blood loss such as poor perfusion, pale skin and a weak pulse, or if all other measures have been attempted. An isotonic crystalloid solution such as normal saline or Ringer's Lactate, or uncross-matched O negative blood can be given at a dose of 10mL/kg over 5 to 10 minutes. Judicious infusion rates of solutions should be performed to try and minimize the risk of intraventricular hemorrhage.

Post-Resuscitation Care

If the heart rate goes above 60 beats per minute, chest compressions can be stopped. Positive pressure ventilation can be stopped once heart rate is above 100 beats per minute and there is adequate and effective breathing from the neonate. If either one of these conditions are not met, PPV should be continued. Oxygen supplementation can be weaned once the recommended saturation values are met. After resuscitation, if neonates required chest compressions as part of their resuscitation, they should be admitted for evaluation and/or observation in the NICU. A pediatrician or neonatologist should be consulted for neonates who required resuscitation and neonates with ongoing

medical concerns to determine the location of post resuscitation care and if there are any other therapeutic interventions or investigations that need to be conducted.

Cord clamping should be delayed for at least 30 seconds in term and pre-term babies that do not require resuscitation. However, “there is insufficient evidence to recommend an approach to cord clamping for infants who require resuscitation at birth” (American Heart Association, 2015).

Case Conclusion

Let’s now return to our case. Our 3kg patient has a heart rate of 65 so you decide to intubate with an endotracheal tube. You prepare all materials and proceed on to intubation using a 3.5mm inner diameter catheter. After 10 more seconds of PPV with intubation, the HR falls to 55. You confirm your endotracheal tube placement is correct through end tidal CO2 and auscultation. You remember that incorrect endotracheal tube placement, dislodgement, or blockage of the endotracheal tube is the most common reason for decompensation after intubation. Remembering the NRP algorithm and noting that the HR is below 60, you go on to chest compressions. You begin chest compressions at a rate of 3 compressions to 1 ventilation. At the same time, a colleague secures IV access through an emergent umbilical venous catheter, while you ask a nurse to begin to draw up the IV and endotracheal tube doses of epinephrine as well as a normal saline bolus in anticipation of further interventions. After a minute, you assess the heart rate and it is at 57 beats per minute. As the heart rate remains below 60, you continue with alternating chest compressions and ventilations but also ask the nurse to administer 0.3mL (approximately 0.1 mL / kilogram birthweight) of 1:10,0000 concentration epinephrine through the umbilical venous catheter as a rapid bolus. You remember to give a flush of 5mL of NS to ensure that the epinephrine has cleared the distance of the UVC and entered the circulation. After 45 seconds, you re-assess and the HR is now at 70 beats per minute. You stop compressions but continue with positive pressure ventilation as you note that the baby is not making any effort to breathe. After another 60 seconds of PPV, the heart rate increases to 100 but the baby is quite pale with weak pulses. Given the history of significant vaginal blood loss at the time of delivery, you give a 10mL/ kg bolus of Normal saline through the UVC over 5-10 minutes.

You continue with PPV through the endotracheal tube while you continue to monitor heart rate, respiratory rate and effort, color and tone of the baby. A nurse puts a temperature probe on the baby as you have had a prolonged resuscitation. After 6 minutes you auscultate and hear the occasional bilateral breath sound and observe some voluntary chest movement indicating that the baby is starting to breathe on its own. You continue to support the baby’s breathing efforts with PPV until you are convinced that the HR is > 100, the baby’s breathing effort is regular and sustained and their tone is improving. As long as the child in intubated, you MUST provide a source of PPV. You continue to wean the oxygen as per the NRP targeted saturations. You consult with the pediatrician or the neonatologist and decide to remove the ETT as the baby is now breathing well, vigorous and has a heart rate of 150. As part of post-

resuscitation care, you continue monitoring the child, and given the high risk delivery, help facilitate admission to the NICU. After consultation with NICU, the pediatrician and the obstetrician, as well as careful consideration of the underlying etiology for the baby's presentation at birth, the baby is admitted with his mother for observation and any further interventions.

Summary

Let's end off with a few summary notes from what we covered today:

1) The approach to neonatal resuscitation in chronological order is: preparation for resuscitation, initial stabilization followed by ventilation and oxygenation, chest compressions, epinephrine and/or volume expansion (with IV/ UVC access), and post-resuscitation care.
2) Chest compressions should be started if the heart rate remains below 60 despite effective ventilation. A 3 to 1 chest compression to ventilation ratio should be used and the two thumbs technique should be applied with neonatal chest compressions.
3) Medical management, including administration of epinephrine and volume expansion, should be considered if the heart rate remains below 60 with chest compressions and ventilations. 1:10000 Epinephrine can be given at a dose of 1 mL/kg down the ETT or at a bolus dose of 0.1 mL/kg intravenously (through a UVC) followed by a 5-10cc normal saline flush through the catheter (but not the ETT). Volume should be given over 5-10 minutes at a dose of 10mL/kg if there is a history that the baby is not volume replete.
4) Post-resuscitation care involves monitoring the patient with special attention to glucose and temperature and should involve a consultation with a pediatrician or neonatologist.

This marks the end of our second podcast in our series on neonatal resuscitation, thanks for listening!

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