I. POLICY STATEMENT:

It is the policy of Lifeline of Ohio Organ Procurement (LOOP) to follow pediatric guidelines for organ procurement. Pediatric donors differ from adults because they are smaller; have immature organ systems, fewer reserves and different vital signs. Due to these contrasts, the approach to managing pediatric organ donors can vary significantly.

II. PURPOSE STATEMENT:

To manage the pediatric donor according to pediatric guidelines, thus optimizing organ retrieval.

III. RESPONSIBLE PERSONS:

LOOP procurement coordinators, retrieval physicians, attending physicians

IV. PROCEDURE

Pediatric donors are defined as donors < 88 pounds
Neonate - birth to 1 month
Infant – 1 month to 1 year
Child – 1 year to 12 years

A. Serologies: draw 1 red top tube for serologies and one purple top tube for NAT testing to be performed at Community Blood Center. If the donor is one month of age or younger, blood must be obtained from the mother. (Refer to policy TD-270.)

B. HLA: Draw 1 yellow top tube for HLA to be performed at OSU Tissue Typing Lab if no organs are to be placed locally. Consult with Tissue Typing for number of yellow top tubes needed if organs may be transplanted locally. Tissue typing material must be sent on all local donors, in most instances blood will be sufficient; check with tissue typing, and if not nodes must be sent. If blood is not sufficient, tissue typing technician will inform procurement coordinator that nodes will be necessary for archiving.

C. Radiology – Stat Chest X Ray with stat wet read. Have copy of x-ray sent to floor for each thoracic team.
D. Laboratory
1. Urinalysis stat
2. Do i-STAT testing for Chem 8 every 2 hours using venous blood. Lactate, magnesium, and calcium stat and every 2 hours
3. Liver Function Studies stat and repeat x 1 in 2 hours. Obtain additional set of LFTs and coags within 6 hours of procurement if liver placed for transplant
   a. LDH
   b. Total Bilirubin
   c. Direct Bilirubin
   d. AST
   e. ALT
   f. GGT
   g. Alkaline Phosphatase
   h. Cholesterol
   i. Total protein
   j. Albumin
   k. Phosphorus
4. Blood and urine cultures
5. Amylase and Lipase stat and repeat in 2 hours
6. CK, CKMB, Index, Troponin stat
7. CBC stat and repeat in 2 hours
8. PT/PTT stat and repeat in 2 hours
9. Sputum Gram Stain and Culture/Mycology Smear for potential lung donors stat
10. Type and screen stat. Have blood on hold as needed.

E. Cardiac Evaluation
1. Stat 12 lead ECG
2. Cardiac echocardiogram stat with copy of tape sent to floor
3. Cardiac Consult stat to evaluate EKG and echo

F. Respiratory Therapy
1. Ventilator changes as directed in oxygenation section of this policy
2. ABG 15 minutes after all vent changes
3. O₂ challenge – place donor on 100% O₂ for 15 minutes then draw ABG; return donor to previous FiO₂ settings
4. ETT - suction every 2 hours
5. Bronchoscopy if indicated. Send secretions for gram stain.

G. Fluid Requirements - critically ill pediatric patients have increased glucose consumption, making it necessary to add dextrose to their maintenance intravenous (IV) fluid.
1. Maintenance IV fluids according to age are:
   a. Neonate -- D10 1/4 normal saline (NS)
   b. Infants -- D5 1/4 NS
   c. 12 months – 88 pounds - .45 NS with 20 meq KCL unless NA is >155 then use 0.2 NS with 20 meq KCL
(1.) For a potential Pancreas donor (age 5 and above), adding dextrose to IV fluid may not be recommended. Use .45 NS with 20 meq KCL for cc/cc urine replacement and fluid resuscitation.

(2.) Never use D5 W- fluid will leak into interstitial tissue

2. Calculating MIV Rate
   \[ \frac{4}{cc/kg/hr} \text{ for the 1}^{st} \text{ 10 kg of body weight} \]
   \[ +\frac{2}{cc/kg/hr} \text{ for the 2}^{nd} \text{ 10 kg of body weight} \]
   \[ +\frac{1}{cc/kg/hr} \text{ for each additional kg of body weight} \]

3. Urine Output Replacement – replace cc/cc q1hr with .45 NS with 20 meq KCL

4. Signs of hypovolemia include:
   a. Pale skin color
   b. Slow Capillary refill (>3 seconds)
   c. Weak and thready peripheral pulses
   d. Urine output < 1 cc/kg/hr
   e. Tachycardia

5. Treatment of hypovolemia/hypotension - maintain a CVP of 6-10mmHg pressure. (If CVP line above the diaphragm on CXR, the placement is correct for CVP reading.)
   a. Hypotension/hypovolemia may be treated with a bolus of 10-20cc/kg of LR. (If you would give an adult 1-liter bolus, give 10ccs/kg, if you would give an adult a 2-liter bolus, give 20cc/kg)
   b. If perfusion is still diminished, give an additional 10-20cc/kg/hr fluid.
   c. Hypovolemic shock may require 40-60cc/kg/hr in the first hour, up to 100-200cc/kg in the first few hours. Frequently reassess after each bolus.
   d. If crystalloids are not sufficient to maintain adequate perfusion, consider using albumin and vasopressors.
      (1.) Epinephrine at 0.1mcg/kg/min to a maximum of 1mcg/kg/min. Epinephrine is the pressor of choice in pediatric donors < 5 years of age
      (2.) Albumin dose is 0.5g/kg of 25% albumin
H. Diabetes Insipidus (DI)
1. DI is indicated if urine output is >5cc/kg/hr for two consecutive hours and/or specific gravity <1.005. Rehydrate according to maintenance fluid requirements in addition to cc/cc urine replacement.
   a. Give DDAVP if hypovolemia is not controlled by fluid replacement. Do not give two hours prior to OR.
   b. DDAVP dose: 0.2-0.4 mcg/kg
2. Vasopressin gtt – dose 0.5 milliunits/kg/hr, double q30min until effective. Max dose is 10 milli-units/kg/hr. Do not use on liver or intestine donors, and only with donor surgeon approval.

I. Oliguria
1. If the urine output remains <1cc/kg/hr after adequate hydration has been established, consider giving Lasix 0.5mg/kg intravenous push (IVP) up to 2mg/kg.
2. Remember to monitor patient's clinical status along with hemodynamics when considering using diuretics.
3. May repeat in 2 hours if needed.

J. Hemodynamics

Table 1 – Normal Vital Signs at Various Ages

<table>
<thead>
<tr>
<th>Age</th>
<th>Heart Rate (beats/min)</th>
<th>Blood Pressure (mm Hg)</th>
<th>Respiratory Rate (breaths/min)</th>
<th>MAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premature</td>
<td>120/170</td>
<td>55-75/35-45</td>
<td>40-70</td>
<td>55-42</td>
</tr>
<tr>
<td>0-3 months</td>
<td>80-160</td>
<td>65-85/45-55</td>
<td>35-55</td>
<td>65-52</td>
</tr>
<tr>
<td>3-6 months</td>
<td>90-120</td>
<td>70-90/50-65</td>
<td>30-45</td>
<td>73-57</td>
</tr>
<tr>
<td>6-12 months</td>
<td>80-120</td>
<td>80-100/55-65</td>
<td>25-40</td>
<td>77-63</td>
</tr>
<tr>
<td>1-3 years</td>
<td>80-130</td>
<td>90-105/55-70</td>
<td>20-30</td>
<td>82-67</td>
</tr>
<tr>
<td>3-6 years</td>
<td>80-120</td>
<td>90-110/60-75</td>
<td>20-25</td>
<td>87-72</td>
</tr>
<tr>
<td>6-12 years</td>
<td>70-110</td>
<td>100-120/60-75</td>
<td>14-22</td>
<td>90-73</td>
</tr>
<tr>
<td>12 + years</td>
<td>70-110</td>
<td>110-135/65-85</td>
<td>12-18</td>
<td>102-80</td>
</tr>
</tbody>
</table>
1. Signs of shock
   a. Poor skin turgor and dry mucous membranes
   b. Hypoxia may cause hypotension and bradycardia
2. Compressions should be started if an infant’s heart rate is less than 90 and is hemodynamically unstable. See table below for guidelines regarding CPR.

K. Antibiotic Therapy

1. 2-9 months of age: Zosyn 80 mg/kg IV q8hrs
2. 9 months to 40 kg: Zosyn 100 mg/kg IV 18 hrs > 40 kg: Zosyn adult dosing

L. Thermoregulation

1. Keep the donor covered at all times, using thermal blankets as needed. Maintain rectal temperature between 36-38 degrees Celsius.
2. To help achieve adequate temperature regulation, warm IV fluids and blood products.
3. Ventilator humidifier should be used on all pediatric organ donors and adjustments made to temperature to help maintain normal body temperatures.

Notes: Pediatric donors are susceptible to hypothermia due to their increase body surface area to body weight ratio.

<table>
<thead>
<tr>
<th>Age</th>
<th>Chest Compression Rate</th>
<th>Respiration Rate (breaths/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newborn</td>
<td>100/min; 1 in. deep</td>
<td>20-24</td>
</tr>
<tr>
<td>Child</td>
<td>100/min; 1.5 in. deep</td>
<td>16-20</td>
</tr>
<tr>
<td>Teen</td>
<td>100/min; 2 in. deep</td>
<td>12-18</td>
</tr>
</tbody>
</table>

Their extremities should always be warm and pink. Their periphery will become cyanotic quickly with hypoperfusion and hypo-oxygenation.

Palpate pulses to assess perfusion (femoral pulse).

Acidosis and hypoglycemia are two of the most severe consequences of hypothermia and should be considered potential emergency situations.

M. Hypoglycemia/Hyperglycemia

1. Hypoglycemia in pediatric donors may result in an emergency situation.
2. Signs of hypoglycemia mimic hypoxemia and present with signs of poor perfusion.
3. Potential liver donors need a minimum glucose of 80mg/dl
   a. Treatment of Hypoglycemia in infants: 2-4 cc/kg of D20 by central line only
b. Treatment of Hypoglycemia in children: 1-2 cc/kg of D50 by central line only

N. Oxygenation
1. Pediatric donors have smaller airways, so even a small amount of mucous or edema may decrease airway radius.
2. It is not uncommon for endotracheal tubes to advance into the right mainstem bronchus. This may occur because pediatric endotracheal tubes are not always cuffed (<6.0cm) and can easily become dislodged during repositioning or transport.
   a. Appropriate tube sizes
      (1.) Preemies: 2.5-3.0mm.
      (2.) Newborns to 6 months: 3.5mm
      (3.) 6 to 18 months: 4.0 to 4.5mm
      (4.) >2yr. old: (age +16) divided by 4 =Tube Size
3. If oxygenation problems occur:
   a. Auscultate breath sounds
   b. Suction
   c. Evaluate placement of endotracheal tube
   d. Check for kinks in tubing
   e. Obtain a chest x-ray to evaluate for changes if the donor's condition does not improve after these interventions and notify donor surgeon
4. As reviewed earlier, hypotension is often caused by hypoxemia.
5. While volume ventilation is the most common method of ventilation, neonates are occasionally maintained with pressure ventilation. The benefits and risks of using positive end-expiration pressure (PEEP) for pediatric donors are similar to those experiences with the adult population. Ventilator management and acid-base balance are also similar to adults. Prior to changing current vent settings obtain baseline ABG:
   a. Tidal volume (VT) obtain 7-8cc/Kg
   b. PEEP 5cm H₂O, except in infants who receive 4cm H₂O
   c. Respiratory rate 20 breaths per minute for pediatric donors under the age of 5 years. For donors > 5 years the rate should be 10-20 per minute. For infants, adjust rate to keep pH < 7.5
   d. Consult: intensivist, AOC, donor surgeon or transplant surgeon for changes in vent settings. Keep donor surgeon informed of changes

O. Blood Products
1. Packed red blood cells should be used to maintain a minimum serum hemoglobin (Hgb) level of 7.
2. Pediatric donors should be transfused with Leuko Reduced (LR) blood until CMV status is determined. If CMV is positive LR blood is not necessary. If donor is negative or CMV is unknown LR blood should be used.
<table>
<thead>
<tr>
<th>Blood Product</th>
<th>Dosages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packed red blood cells</td>
<td>10 cc/kg</td>
</tr>
<tr>
<td>Fresh frozen plasma</td>
<td>10 cc/kg</td>
</tr>
<tr>
<td>Platelets</td>
<td>1 Random Donor Equivalent/5kg of body weight. (amount to be calculated by blood bank)</td>
</tr>
</tbody>
</table>

*10cc/kg should increase the Hgb 1gm/dl and Hct by 3%
* 1 unit of platelets should raise the platelet count by 10,000

P. Hypokalemia
1. Treat for potassium <4. Add 20mEq of KCL to 1 Liter of MIV fluid.
2. Repeat serum potassium one hour after each KCL is added to MIV fluid.
3. When bolusing an infant or toddler, give KCL 0.5-1mEq/kg over 1 hour. The maximum infusion rate should not exceed 0.5-1mEq/kg/hr

Q. Hypomagnesaemia
1. Give 50 mg/kg magnesium sulfate for hypomagnesaemia or if they are having arrhythmias and the level is less than 2.0

R. Coagulopathy
1. Treat with IV Vitamin K if donor has been NPO > 48 hours, prior transfusions, and/or elevated PT/INR.
2. Infants < 10 days old receive 1 mg, pediatric donors >10 days receive 5-10 mg.

S. Medications
1. Discontinue all medications except vasopressors.
2. In an arrest or near arrest situation, epinephrine should be started and titrated until desired effect achieved.
3. Thyroxine Protocol:
   a. If K+ <4.0, treat hypokalemia while simultaneously beginning Thyroxine protocol.
   b. Give D50 IVPB 0.7cc/kg to a maximum of 50cc. Substitute D20 for infant.
   c. Regular insulin 0.25 u/kg to a maximum of 20u.
   d. Solumedrol 15 mg/kg to a maximum of 1g.
   e. Thyroxine 0.25mcg/kg IVP to a maximum of 20mcg.
   f. Start Thyroxine gtt (200mcg in 500cc 0.9% NaCl) at 0.36cc/kg/hr.
4. Dopamine 72mg/100ml D5W gives 1 ml/hr, or 1 mcg/kg/hr.
5. Start renal dose Dopamine (3mcg/kg/min) for all donors requiring vasopressor support.
6. Epinephrine is the drug of choice if the donor is not on vasopressor support. Dosage is 0.03-0.05mcg/kg/min up to .1 mcg/Kg may bolus with 5-20 mcg/kg prior to initiating drip.
7. Dopamine and Dobutamine rates are the same as for adults.
<table>
<thead>
<tr>
<th>Medication</th>
<th>Rate</th>
<th>Additional Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epinephrine</td>
<td>0.1mcg/kg/min-1.0mcg/kg/min</td>
<td>Titrate to desired effect</td>
</tr>
<tr>
<td>Neosynephrine 1% injection</td>
<td>0.1-0.5mcg/kg/min</td>
<td>Bolus first with 5-20mcg/kg Q15 minutes, titrate drip prn</td>
</tr>
<tr>
<td>Nitroprusside</td>
<td>0.5-8mcg/kg/min</td>
<td>Titrate to desired effect</td>
</tr>
<tr>
<td>Bicarbonate</td>
<td>1-2mEq/kg</td>
<td></td>
</tr>
<tr>
<td>Calcium chloride</td>
<td>Give 10-20mg/kg</td>
<td>Mix in 1 hour of IVF</td>
</tr>
<tr>
<td>Furosemide</td>
<td>.5mg/kg IV</td>
<td>May repeat in 2 hours</td>
</tr>
<tr>
<td>Mannitol</td>
<td>1gm/kg IV</td>
<td></td>
</tr>
<tr>
<td>Solumedrol</td>
<td>30mg/kg IV</td>
<td></td>
</tr>
<tr>
<td>Vitamin K-neonate</td>
<td>0.5-2mg</td>
<td>one dose slow IV</td>
</tr>
<tr>
<td>Vitamin K-child to adult</td>
<td>5-10mg IV</td>
<td></td>
</tr>
<tr>
<td>Lidocaine drip</td>
<td>1-3mg/kg/hr</td>
<td>Loading dose = 1 mg/kg</td>
</tr>
<tr>
<td>Dopamine</td>
<td>1-20 mcg/kg/min</td>
<td>Renal 1-3 mcg/kg/min</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BP 4-10mcg/kg/min</td>
</tr>
</tbody>
</table>

T. OR Medications

The following are standard dosages for reference. The donor surgeon will decide what dosages to give and communicate them to the anesthesiologist.

<table>
<thead>
<tr>
<th>Medication</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heparin</td>
<td>400units/kg</td>
</tr>
<tr>
<td>Mannitol</td>
<td>7cc/kg</td>
</tr>
<tr>
<td>Furosemide</td>
<td>0.5mg/kg (max 10mg)</td>
</tr>
<tr>
<td>Solumedrol</td>
<td>30mg/kg</td>
</tr>
<tr>
<td>Vecuronium</td>
<td>0.1mg/kg</td>
</tr>
</tbody>
</table>

U. Patient Care

1. NG to low continuous wall suction
2. Turn and reposition every 2 hours
3. Consult surgery to place arterial line and central line as necessary above the waist

V. Additional considerations:

1. Infants who receive up to 30 minutes of CPR may still be viable heart donors.
2. When reporting cardiac echo results, make note of the shortening fraction as well as the ejection fraction.
3. Report all rhythm disturbances and valve abnormalities. Defects like ASD and VSD may be acceptable when placing the heart for transplant.
4. Due to immaturity of organ systems, liver metabolism may be slowed in an infant.
5. If placing lungs for transplantation, report any colds on admission and any fevers after brain death has been declared.
6. Some lung transplant centers may request a Respiratory Antigen panel (RSV, Adenovirus, Influenza) in addition to sputum gram stain and culture.
7. If a pediatric donor was breastfeeding, obtain the mother's medical/social history as well. While this is not required for organ donors, the mother's history may provide vital information to transplant centers and tissue banks.

8. When drawing blood for ABO, serologies and tissue typing please check first with respective areas for amount of blood required. If no organs are kept locally, tissue typing material may be sent when the organ is exported. Remember to discuss this when placing the organs for transplant.

9. Remember that the Donor Surgeon will ultimately guide donor management and these recommendations should be used as a reference. Pediatric intensivists, respiratory therapists, and nursing staff are often excellent resources and can be utilized as well.

10. For Intestinal donors who have never been fed, the LOOP procurement coordinator may need to consult with recipient center for instructions on feeding per NG.

References: AOPO Standards: CL.4E.0-CL.4E.5.3
UNOS Standards: 2.2-2.2.7.6; 2.3-2.3.5; 2.5.5