

Congenital Diaphragmatic Hernia Guidelines

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Background

Congenital diaphragmatic hernia (CDH) occurs in ~1 in every 2500-4500 live births. The diagnosis of CDH is now mainly made prenatally, but occasionally is a postnatal diagnosis. Survival rates are ~64% per Congenital Diaphragmatic Hernia Group. Survival rates of those with cardiac anomalies (hemodynamically significant=10% of the total CDH population) is ~40%. Survival for CDH patients who require ECMO is ~60% worldwide. Congenital herniation of the abdominal contents into the thoracic cavity can cause serious respiratory compromise. Herniation occurs most often on the left side and represents a failure of the pleuroperitoneal canal to close completely during fetal development. Thoracic entry of abdominal organs displaces the heart and lungs and can compromise cardiac output and pulmonary gas exchange. The lung on the effected side is hypoplastic, with varying degrees of hypoplasia on the contralateral side. Fetal MRI are increasingly being used to assess the severity of CDH and associated anomalies.

Pulmonary hypertension (PH) is often associated with infants born with CDH. It may be present preoperatively or after surgical repair. The etiology of PH in infants with CDH may be secondary to the hypoxemia caused by the hypoplastic lung, but it has also been noted that the pulmonary artery and branches are structurally abnormal with thickened muscular walls.

Recently, there has been a growing recognition of the role of ventricular dysfunction in patients with CDH with reports of worsening outcome in the setting of ventricular dysfunction.

Overall Treatment Goals

Treatment begins with antenatal care and progresses through delivery, transport, and NICU care. It has been shown that a structured, multi-disciplinary approach improves outcomes of patients with CDH. Optimal ventilator management with adequate management of associated cardiovascular compromise (pH and hypotension) is critical for good clinical outcomes. The overall treatment goal is to treat hypoxemia with pulmonary hypertension while minimizing ventilator induced lung injury. ECMO remains a consideration throughout the disease course.

- **Antenatal Care:**

Patients with a prenatal diagnosis of CDH should be referred to the FETAL Program at the time of diagnosis for multi-disciplinary consultation with Pediatric Surgeon, and Neonatologist. Maternal Fetal Medicine monitoring of pregnancy and fetal well-being at regular intervals.

- Induction by 38-39 weeks GA is generally indicated with delivery at a tertiary care center.
- Any CDH fetus at risk for delivery before 34 weeks of gestation should be given prenatal steroid. (Based on NIH consensus statement)
- Prenatal diagnostic evaluation and markers of severity used to guide counseling and anticipated management.
 - Level II US
 - Prenatal MRI
 - Fetal Echo
- ECMO candidacy and parental decisions regarding limits of care should be discussed during consultation. **None of the prenatal US/MRI criteria are used as strict guide as contraindication to ECMO use.**

Antenatal Marker Summary

Variable	Findings			
Lung to Head Ratio (LHR)	Huge variability: - 100% survival from 0.8-1.4 - 100% mortality from 0.5-1			
Observed/Expected LHR	O/E LHR	<25%	25-35%	>35%
	Survival	0-30%	25-65%	65-88%
Total Fetal Lung Volume (TFLV)	Mean TFLV (Survivors)		Mean TFLV (Non-Survivors)	
	11.6 - 37.88		7.6 - 14.7	
Observed/Expected TFLV	O/E TFLV	<25%	25-35%	>35%
	Survival	0-25%	25-69%	75-89%
Percentage of Predicted Lung Volume (PPLV)	Mean PPLV (Survivors)		Mean PPLV (Non-Survivors)	
	14.4 - 60		8.8 - 40	
Liver herniation by ultrasound	Odds of survival of 0.21 when liver was in the chest by US			
MRI Quantification of liver herniation - Liver intra-thoracic ratio - % liver herniation	Liver herniation by US or by MRI was found to be significantly associated with mortality			

Delivery Room Care

- Attending neonatologist should be present at every prenatally diagnosed CDH delivery with clearly defined team roles assigned during team huddle discussing plan of care defining roles and advance preparation of supplies and equipment.

- Estimated weight to be used for calculations: 3kg for full term infants
- At present time, delayed cord clamping should be avoided to reduce the likelihood of spontaneous respiration occurring prior to endotracheal intubation.
- Placement of ECG leads and pre-ductal pulse oximetry
- Plan for **immediate** intubation after delivery by provider experienced in airway skills
 - Once intubated, T-piece (Neopuff) PPV delivery using pressures of <25/5 cmH₂O . Microcuff tube can be utilized as majority of our CDH undergo early repair and it will prevent change of tube by anesthesia team prior to surgery.
 - Initial FiO₂ at 0.5 with ideal goal pre-ductal SpO₂ >70% at 10 minutes of life.
 - ***In the first two hours after birth pre-ductal SpO₂ > 75% are acceptable if they are improving without the need for significant ventilator escalation, if organ perfusion is adequate (pH >7.2, lactate < 3) and if ventilation is adequate (PaCO₂ <65)***
 - Once chest wall movement is achieved, proceed to Gentle Ventilation strategy.
- Gastric decompression with 10F Replogle tube to low continuous suction ASAP
 - If Replogle not available, then 10 Fr OGT/NGT can be used. If a suction canister is not immediately available, manual aspiration of gastric content needs to be started at birth and continued until replogle can be connected to wall suction.
- Prepare for possible emergency UVC or PIV placement in severe CDH cases
- Anticipate need for fluid resuscitation (normal saline 10ml/kg)

NICU Care

The following procedures should be planned upon admission to the NICU:

- UVC / UAC placement for medications and IV fluids
 - Consider low UVC placement + PIV if first attempt unsuccessful and/or liver up. ***Early PICC placement should be a consideration, prior to the need for ECMO. The IR team/VAT at CMC should be considered for these patients.***
 - Start D10W or Starter TPN at 60 mL/kg/day
- Pre- and post-ductal saturation continuous monitoring. **Consider right radial ("pre-ductal") PAL placement for pre-ductal PaO₂ monitoring, especially in the setting of a "more severe" CDH**
- Once infant is stable and has central line access secured, faculty at parkland should initiate the transfer process. Attempt should be made to transfer CDH patients to CMC (Level IV NICU) within first four hours of life
- The first ABG after initial stabilization and line placement may be expectedly suboptimal
 - Use appropriate clinical discretion in deciding between aggressive escalation of care vs observing patience and repeating ABG after brief interval

Recommended admission lab/diagnostic orders:

- Arterial blood gas

- Point of care (POC) glucose
- CBC
- Coagulation panel (PT/INR, PTT, Fibrinogen)
- Cortisol level
- Blood cultures – if clinically indicated
- Lactate
- Type & Screen with subsequent confirmation of ABO
- Electrolytes at 12 hours of life
- Head Ultrasound
- ECHO – within the first few hours of life
- Send karyotype and microarray if not sent prenatally.
- Newborn Screen at 24 hrs or prior to PRBC, whichever occurs first.

Monitoring Goals - permissive hypoxemia and hypercarbia:

- **Pre-ductal saturations**
 - **First 10 minutes > 70%,**
 - **First 2 hours > 75%,**
 - **After 2 hours >85%, post-ductal > 70%**
- **There is no benefit, and a growing body of evidence of increasing harm to targeting preductal sats > 95%.** Hyperoxia may decrease the response to inhaled nitric oxide and aggravate pulmonary hypertension.
- PCO₂ target 50-65 mmHg, Ph > 7.25. Wean vent support for PCO₂ < 50 mmHg,
- Oxygenation Index trend (OI) = (FiO₂ x Mean Airway Pressure) / PaO₂
- Lactate: follow trend with gases
- PaO₂ target 40-80 if right PAL is functioning, UAC will be post-ductal

Respiratory

Goals of Gentle Ventilation ("gentilation") Strategy

- To provide lowest pressures while maintaining adequate lung aeration allowing for "permissive hypercapnia"
- **SIMV/PC Mode suggested gentilation settings:**
 - PIP 18-25 cmH₂O (targeted Tidal Volume 4-5 ml/kg)
 - PEEP 3-5 cmH₂O (overdistention of hypoplastic lung leads to decrease in dynamic compliance, increased risk for air leak, and increased pulmonary vascular resistance. Consider lowering PEEP, especially in post-operative period).
 - Rate: 20-60,
 - Low I-time 0.3-0.35s.
 - Goal PIP < 25 or MAP < 15 on conventional ventilator
- **High Frequency Jet Ventilator (HFJV)**
 - Consider transition to HFJV if:
 - Unable to maintain pCO₂ < 65, or
 - Persistent difficulty in oxygenation using MAP up to 15, or
 - Need for PIP > 28

- HFJV may have improved hemodynamics and lower airway pressure than HFOV.
- **Recommended settings:** PEEP 6-8, PIP 20-25, Rate 360, i-time of 0.02 seconds.
- Ideally goal MAP <16 but may require MAP >18. If >18 for >6-12h, consider ECMO
- **High Frequency Oscillator Ventilation (HFOV)**
 - Can be used as rescue mode. If patient fails trial of HFOV then ECMO support will be considered and discussed with family
 - Recommended HFOV management parameters:
 - Initial MAP 13 cm H2O (TO MAX of 17)
 - Lower Frequency 8-10 Hz, iTime 0.3
 - Amplitude 30-50 cm H2O
 - Consider increasing sedation, and patient may need paralytics.

Oxygenation

- FiO2 should be titrated on pre-ductal, not post-ductal saturations
- *Goal Parameters: - should be the same as above monitoring goals when agreed upon.*
 - Once oxygenation stabilized (If PaO2 consistently >80 mmHg):
 - Consider weaning FiO2 by 2-3% every hour or 1% every 30 min
 - Continue frequent ABG q 1 hr until stable, then space to q2-4 hours
- In individual cases, Preductal SpO2 <85% may be accepted provided organs are well perfused. (signs of adequate tissue perfusion: good UOP > 1 ml/kg/h, low lactate < 3, pH >7.25)
- **Inhaled Nitric Oxide (iNO)**
 - For poor oxygenation increase cardio-respiratory support and consider trial of iNO at 20ppm (**usually for OI >20 especially if shunting across ASD is Right to left**)
 - If improved oxygenation, continue iNO (Please document response to iNO)
 - iNO responders defined as:
 - Increase in preductal SpO2 >5%,
 - Increase in PaO2 by 10 % (obtained from the same pre- or post-ductal source)
 - Decrease in pre/post ductal saturation gradient to <10%.
 - Increase in mean blood pressure > 10%
 - Inhaled nitric oxide should be weaned based upon patient classification as responder or non-responder.
 - In iNO responders, wean as per iNO protocol (**wean once FiO2 < 0.6**)
 - In iNO **NON**-responders – iNO can be weaned off in 2-4 hours.
 - Nitric use is discouraged if shunting is left to right across ASD or there is evidence for LV dysfunction.
 - Consider using **Milrinone** instead to treat for LV Dysfunction. Usually initiated at 0.25-0.5mcg/kg/min.

- Ensure that infant is not having low blood pressure prior to starting milrinone, if that's the case patient will benefit from starting low dose epi or dobutamine first.
- **Prostaglandins** may be helpful in severe pulmonary hypertension in patients with closing ductus arteriosus and right ventricular (RV) dysfunction and supra-systemic RV pressure. Use of prostaglandins can be discussed with pulmonary HTN team.
- **Sildenafil** should be considered in patients with refractory pulmonary hypertension (i.e., unresponsive to inhaled nitric oxide) or as an adjunct when weaning inhaled nitric oxide. Please consult PHTN team prior to initiation.
- Routine **surfactant** use is discouraged; only when there is strong evidence of surfactant deficiency and/or inactivation. If history of FETO or <34 weeks gestation, consider surfactant administration.

Cardiovascular

- Pulmonary Hypertension Team should be contacted immediately after delivery.
- Obtain echo within **4 hours of life** to assess for pulmonary hypertension, ventricular function, and structural defects.
- Blood pressure support should be given to maintain arterial blood pressure levels at normal levels for gestation (with signs of adequate tissue perfusion: good UOP > 1 ml/kg/h, low lactate < 3, pH >7.25)
- ***There is NO benefit to driving up the MBP to "exceed right-sided pressures" and expose patients to the risk of increasing PVR. Please avoid this practice!***
- Optimize calcium (iCal goal >1.2) and Magnesium (goal >2).
- Avoid excessive volume administration especially in first 24 hours of life (maximum of only two volume boluses of 10 ml/kg) to avoid fluid overload, anasarca, pulmonary edema, and cardiorespiratory decompensation; likelihood for ECMO support will increase.
- Blood products administrations are reserved for specific indications (coagulopathy, anemia, thrombocytopenia); not to be used as volume.
- Goal parameters: Keep Hct>35, Fibrinogen>100 and INR<1.6.
For platelets transfusion propose; following goals are considered:
< 25,000/ μ l without bleeding and post-surgery,
< 80,000/ μ l with active bleeding and prior to surgery
< 100,000/ μ l if treated with ECMO

Use of Inotropes for Hypotension

- Inotropes in patients with CDH help to maintain adequate cardiac output and systemic blood pressure; medications can be used alone or in combination. ECHO findings should be considered in managing inotropic support in CDH patients. **Refer to Figure 1**, a hemodynamic approach for CDH management.
- **Avoid alpha adrenergic agents** as they can increase pulmonary and systemic vasoconstriction; this can worsen pulmonary hypertension and acidosis.
- Inotropic support should be based on echo findings and can be added sequentially.

- ***For RV or LV Dysfunction:***
 - 1st Line: Low dose epi (up to 0.06 mcg/kg/min)
 - 2nd Line: Vasopressin (to max dose of 2 milli-Units/kg/min)
 - 3rd Line: Milrinone
 - 4th Line: Dobutamine
- ***For Intact Ventricular function:***
 - 1st Line: Vasopressin (to max dose of 2 milli-Units/kg/min)
 - 2nd Line: Hydrocortisone stress dosing (1 mg/kg Q6-8 hrs)
 - 3rd Line: Low dose Epi (up to 0.05 mcg/kg/min)
 - 4th Line: Dobutamine
- ***Dopamine: In general Dopamine should be avoided in CDH patient population***
- Vasopressin: May be helpful in catecholamine-resistant hypotension.
 - Dose range from 0.1-2 milli-Units/kg/min (monitor closely for hyponatremia)
- Dobutamine: Indicated when there is a decreased cardiac function.
 - Start at 5-10 mcg/kg/min; titrate as clinically indicated.

Use of Systemic Steroids

- Send a cortisol level at start of therapy; level of <10-15 is considered low. If the initial cortisol level is low – may give Hydrocortisone loading stress dose of 2mg/kg/dose
- Start maintenance therapy at 1mg/kg/dose every 8 hours.
- If the initial cortisol level is normal or elevated - consider starting Hydrocortisone only as maintenance therapy if needed
- Wean by 10-20% daily after 48-72hrs of hemodynamic stability and decreasing inotropic support.
- Weaning hydrocortisone may cause adrenal insufficiency
- Monitor lytes and renal function closely during wean
- Consider use of PPI while on hydrocortisone therapy if concerns for GI bleeding
- Monitor serum glucoses closely for steroid related hyperglycemia

Pulmonary Hypertension

General Principles of Management

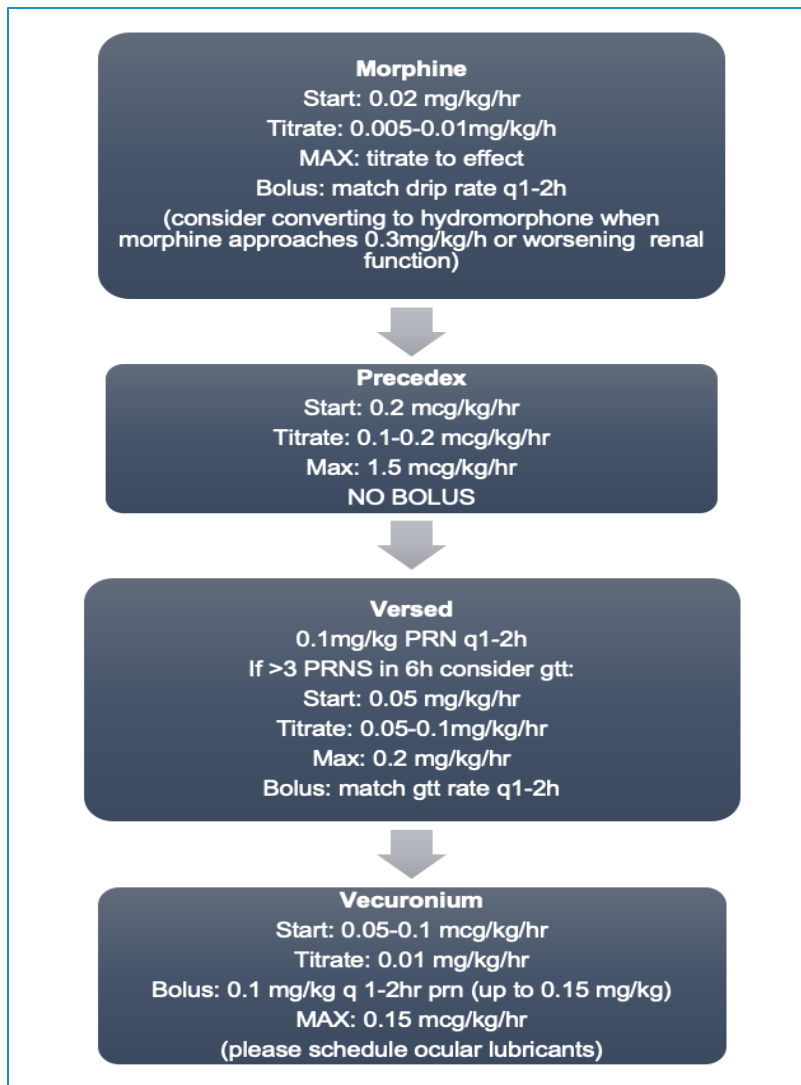
- Minimize common triggers for exacerbation of pulmonary hypertension:
 - Keep pH >7.25
 - Keep pCO₂ <65
 - Decrease metabolic acidosis
 - Consider early addition of Sodium Acetate to IV fluids
 - Consider Sodium Bicarbonate if pH < 7.0
- Optimize sedation and enforce minimal stimulation (see Neurologic management)

Neurologic Management

- Pain and Agitation Management: See separate recommendations below
 - Infants should be maintained in a quiet, minimal stimulation environment at all times to include:
 - Private room, eye shields, earmuffs, reduce frequency of ETT suctioning, minimize ambient noise, window shades down
- Imaging
 - Repeat HUS should be obtained prior to ECMO cannulation (within 4 hours of ECMO cannulation). MRI recommended prior to discharge
- Follow up
 - CDH patients should be referred to Thrive clinic via EPIC based referral system on discharge for neurodevelopmental follow up
 - Parents should be made aware of the importance of neurodevelopmental follow up and timelines. Patients are followed from 6 months of age through 3 years of age with standardized cognitive, motor, and language testing performed at yearly intervals

- **Recommended sedation Pathway**

Fentanyl can be used for mild cases but for severe cases with higher probability of needing consider using morphine.



Additional analgesia and sedation considerations:

- Pain and sedation should be scored separately using age-appropriate scale (NPASS <37 weeks; FLACC + SBS >37weeks)
- Pain should be evaluated routinely, at least every 4 hours (and 30 minutes after escalation). The goal for pain management should always be no pain (score =0)
- Sedation (State behavioral scale, SBS) goal score should be reviewed with nursing and pharmacy staff and updated DAILY on rounds in EMR.
- Non-pharmacologic measures and evaluation of other reversible causes of agitation should be addressed before every escalation in medication
- PRN doses should be given one at a time and response assessed before administering second agent
- Patients receiving benzodiazepine and/or paralytic infusions must be monitored closely for hypotension with q30 min – 1 hr blood pressures.

- If patient is over-sedated, consider decreasing continuous sedation by 10-20% or incremental infusion change, whichever is greater (titrations should not occur more frequently than q6hr)
- Dexmedetomidine should be used with caution in preterm infants <37 weeks PMA. Although there is evidence to support its safety in this population in the short term, further studies that determine long term neurodevelopmental effects are needed. Monitoring for bradycardia is indicated for all patients receiving this medication.
- Paralytic agents should be reserved for cases with persistent difficulty in achieving stable oxygenation and ventilation after first, second-, and third-line agents have been optimized, or for ECMO cannulation.
- If a patient is requiring escalation of care with possibility of needing ECMO, then transition the patient from Fentanyl to Morphine.

Feeding Guidelines

Parenteral Nutrition

- Early use of parenteral nutrition is recommended in CDH patients who are unrepaired to meet sufficient caloric and protein intake for the increased metabolic demand
- Parenteral nutrition should be initiated within 24 hrs of admission
- Goal caloric intake of 100-110 kcal/kg/day should be achieved per ELSO recommendations
 - Lipid goal: 3 g/kg/day of intra lipids (switch to SMOF if rising D-bili >2 mg/dL)
 - Protein goal: 3 g/kg/day minimum
- Patients on ECMO can be difficult to maintain caloric intake due to fluid restriction and multiple drips
 - Interventions to remove excess fluid should be considered early to meet nutritional goals and can be achieved by use of:
 - Diuretics
 - Slow continuous ultrafiltration (SCUF)
 - Continuous renal replacement therapy (CRRT): Early initiation is recommended in patients on ECMO

Enteral Nutrition

- Enteral feeding should NOT be initiated in unrepaired CDH patients
- For those infants who are repaired, enteral feeds should only begin if **ALL the following are met:**
 - Evidence of return of bowel function- passing stool, decreasing non-bilious gastric output
 - No longer requiring vasoactive agents with hemodynamic stability
 - Laboratory and clinical evidence of adequate tissue perfusion and oxygenation evidenced by normal lactate and appropriate urine output
- Post-CDH repair infants who remain on ECMO are not a contraindication to enteral feeds **if the above criteria are met**
- Goal caloric intake: 120-140 kcal/kg/day; target growth: 25-35 g/day

- Enteral feeds should be initiated with breast milk (expressed or donor)
- Mode of enteral feedings (continuous vs bolus) may be determined by CDH severity
 - Bolus feeds may be better tolerated in low-risk patients with small defects
 - Continuous feeds may be indicated in high-risk patients including large defects, liver involvement, on ECMO support, severe pulmonary HTN, or symptomatic GERD
 - Consider transpyloric feeding in high-risk patients if bolus and/or gastric feeds were not tolerated due to gastroparesis and severely delayed gastric emptying
 - Continuous transpyloric feeds may be considered in reducing the risk for aspiration in patients with symptomatic GERD
 - Use of hydrolyzed or amino acid-based formulas may be indicated if poor weight gain associated with symptomatic GERD
- Of note: prophylactic/preventative anti-reflux treatment is **NOT** recommended for infants with CDH or at the time of CDH repair unless patient has failed nutritional management or there are symptoms of GI bleeding

Other Therapies

- Other therapies: Use of Treprostinil/epoprostenol may be considered as rescue therapy. Discuss with Pulmonary Hypertension Team.
- **ECMO:** Rescue therapy for CDH patients. It should be considered if there is evidence of failure of medical therapy. (More information below)
- **Surgery:** After stabilization, the infant will be evaluated by Pediatric Surgery. Decision on timing of repair will be made between the surgeon and the neonatologist.

ECMO Criteria

Contraindications

- Patients with congenital heart disease will be discussed with CT Surgery. If a patient is not a candidate for repair of their congenital heart disease, the patient will not be an ECMO candidate.
- Significant chromosomal abnormalities
- Grade 3-4 intra-cranial hemorrhage
- Inability to ever at any point obtain a $\text{CO}_2 < 100$, $\text{pH} > 6.7$, in spite of maximal ventilator strategies is relative contraindication
- Weight < 2000 grams AND Gestational Age < 34 weeks is relative CI
- Severe HIE is a contraindication. Moderate HIE needing cooling should be discussed on case-by-case basis to assess eligibility. (Appendix A)

Indications

- o Failure of Oxygenation and Ventilation
- o High ventilatory pressures (PIP >28 or MAP >17) required to achieve Preductal SpO₂ > 85%
- o Sustained elevation of OI >30 for 4 hours
- o Persistent severe respiratory acidosis (paCO₂ >80 mmHg) despite increasing respiratory support, leading to pH < 7.2
- o Ventilator Induced Lung Injury (VILI) and/or severe refractory air leaks present, compromising ventilation and oxygenation
- o Cardiovascular failure requiring inotropes and/or severe refractory systemic hypotension. Fluid and catecholamine resistant systemic hypotension with UO < 0.5 ml/kg/h.
- o Inadequate oxygen delivery with metabolic acidosis: Lactate ≥ 5 mmol/l and pH <7.2
- o Persistent oliguria: UOP <1 ml/kg/hr, rising BUN and Cr
- o Acute clinical deterioration with intractable hypoxemia, hypercarbia and/or hemodynamic instability without rapid resolution
 - o PO₂ <40, Preductal SpO₂ <70, pCO₂ > 80

Surgery Criteria

Assessing Readiness for Surgical Repair

- Surgical repair of CDH (not requiring ECMO) should be performed after "Physiologic Stabilization". This will be defined as a patient who maintains Goal Clinical Parameters at the Comfort Zone of medical therapy and stable Cardiovascular/Oxygen Delivery Criteria for at least 24 hours.
- ***Goal Clinical Parameters***
 - o Preductal PaO₂ goal 40-80 mmHg
 - o Preductal SaO₂ goal >85%
 - o PCO₂ goal 50-65 mmHg
 - o pH goal > 7.25
 - o Lactate goal <3 mmol/L
 - o UOP goal >1 ml/kg/hr
- ***Comfort Zone Therapies***
 - o CMV PIP <25; HFOV/Jet MAP <17
 - o Low dose Epi/Vasopressin
 - o Hydrocortisone maintenance dosing
 - o Inhaled Nitric Oxide (5-20 ppm if responded)
- ***Cardiovascular/Oxygen Delivery Criteria***
 - o Stable hemodynamic status at Comfort Zone level of support
 - o No need for significant inotropic support
 - o Low dose vasopressor support is acceptable
 - o Mean BP normal for gestation at minimal support
 - o Sub-systemic Pulmonary Arterial Pressures on Echocardiogram

- o No significant metabolic acidosis at comfort zone support as supported by Lactate < 3 mmol/L and pH >7.25
- o Euvolemic fluid status; urine output consistently: 1-2 ml/kg/hr

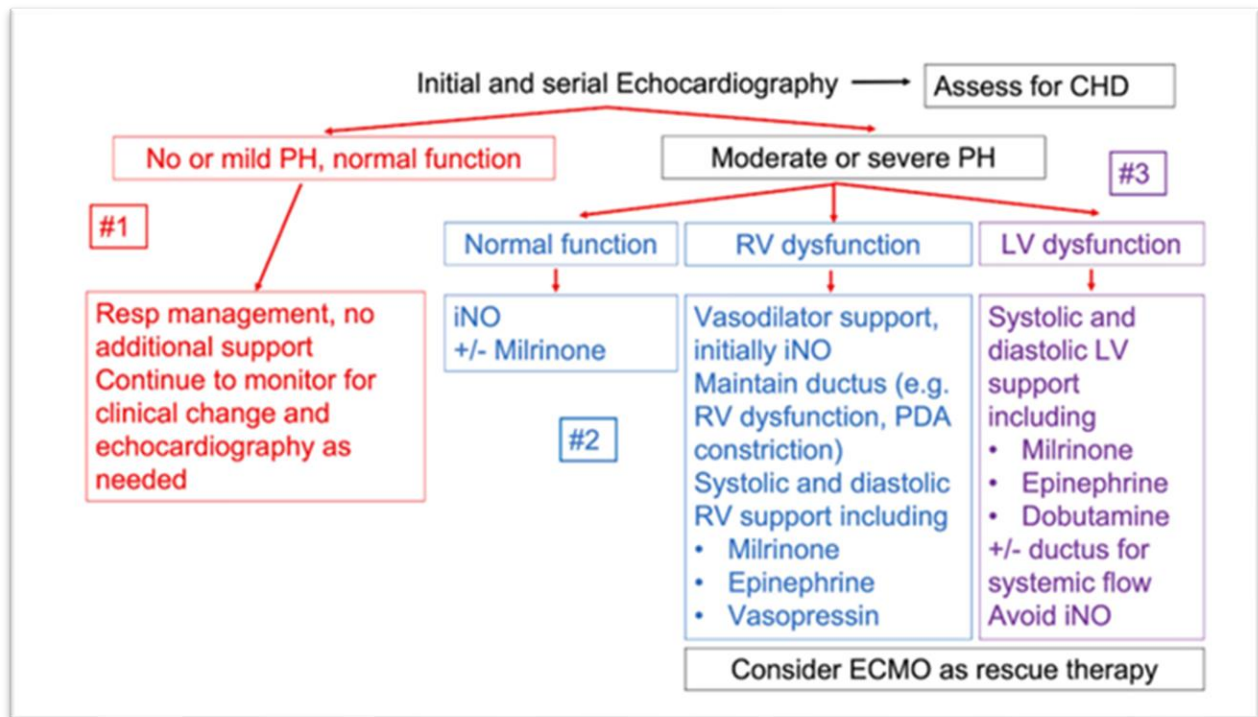
CDH Repair on ECMO:

Some centers will repair after ECMO run complete but more recent data suggests that repair early (36-72 hrs) on ECMO may be beneficial. CDH repair on or off ECMO should be discussed between Neonatologist and Pediatric Surgeon after clinical assessment of patients.

References:

1. Kitty G. Snoek, Irwin K.M. Reiss, Anne Greenough, Irma Capolupo, Berndt Urllesberger, Lucas Wessel, Laurent Storme, Jan Deprest, Thomas Schaible, Arno van Heijst, Dick Tibboel, for the CDH EURO Consortium; [Standardized Postnatal Management of Infants with Congenital Diaphragmatic Hernia in Europe: The CDH EURO Consortium Consensus – 2015 Update](#) . Neonatology 17 June 2016; 110 (1): 66–74. <https://doi.org/10.1159/000444210>
2. Puligandla P, Skarsgard E, Baird R The Canadian Congenital Diaphragmatic Hernia Collaborative, et al. [Diagnosis and management of congenital diaphragmatic hernia: a 2023 update from the Canadian Congenital Diaphragmatic Hernia Collaborative](#). Archives of Disease in Childhood - Fetal and Neonatal Edition 2024; 109:239-252.

Figure 1: CDH management based on phenotype



APPENDIX A: ECMO use in HIE patient population

ECMO Selection Flow Chart for Neonatal Encephalopathy

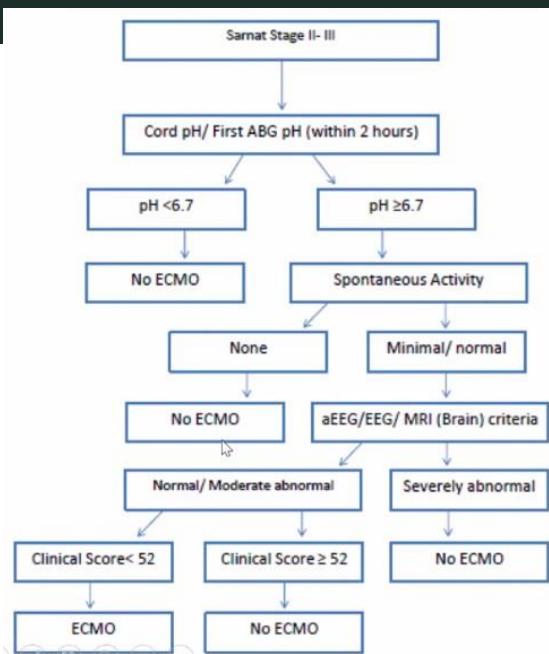


TABLE 3 Predictor Variables, Odds Ratios, and Scores Assigned to Each Variable for Death Scoring

Variable	Level of Variable	Odds Ratio
Posture	Normal	0.037
	Distal flexion	0.401
	Decerebrate	1
Spontaneous activity	Normal/decreased	0.147
	None	1
Base deficit of first postnatal blood gas analysis	<15 mmol/L	0.073
	15–22 mmol/L	0.304
	>22 mmol/L	1
Apgar score at 5 min	7–10	0.082
	4–6	0.676
	0–3	1
Chronic hypertension/preeclampsia/eclampsia	Yes	0.2
	No	1

The total score is obtained by adding the scores for each of the variables. Interpretation of the total score is as follows: 5–12: probable benefit from hypothermia; 13–18: moderate/severe disability even without hypothermia; 19–22: probable benefit from hypothermia; 23–28: possible benefit from hypothermia; 29–32: possible benefit from hypothermia; 33–36: possible benefit from hypothermia; 37–40: possible benefit from hypothermia; 41–44: possible benefit from hypothermia; 45–48: possible benefit from hypothermia; 49–52: possible benefit from hypothermia; 53–56: possible benefit from hypothermia; 57–60: possible benefit from hypothermia; 61–64: possible benefit from hypothermia; 65–68: possible benefit from hypothermia; 69–72: possible benefit from hypothermia; 73–76: possible benefit from hypothermia; 77–80: possible benefit from hypothermia; 81–84: possible benefit from hypothermia; 85–88: possible benefit from hypothermia; 89–92: possible benefit from hypothermia; 93–96: possible benefit from hypothermia; 97–100: possible benefit from hypothermia. *n* = 172; 33 infants were deleted because of missing values; range of scores: 5–65; Hosmer-Lemeshow goodness-of-fit test, $\chi^2 = 9.48$; *df* = 7; *P* > .2203.