



# CHYLOTHORAX AFTER CARDIAC SURGERY

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PICU

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# REVIEW

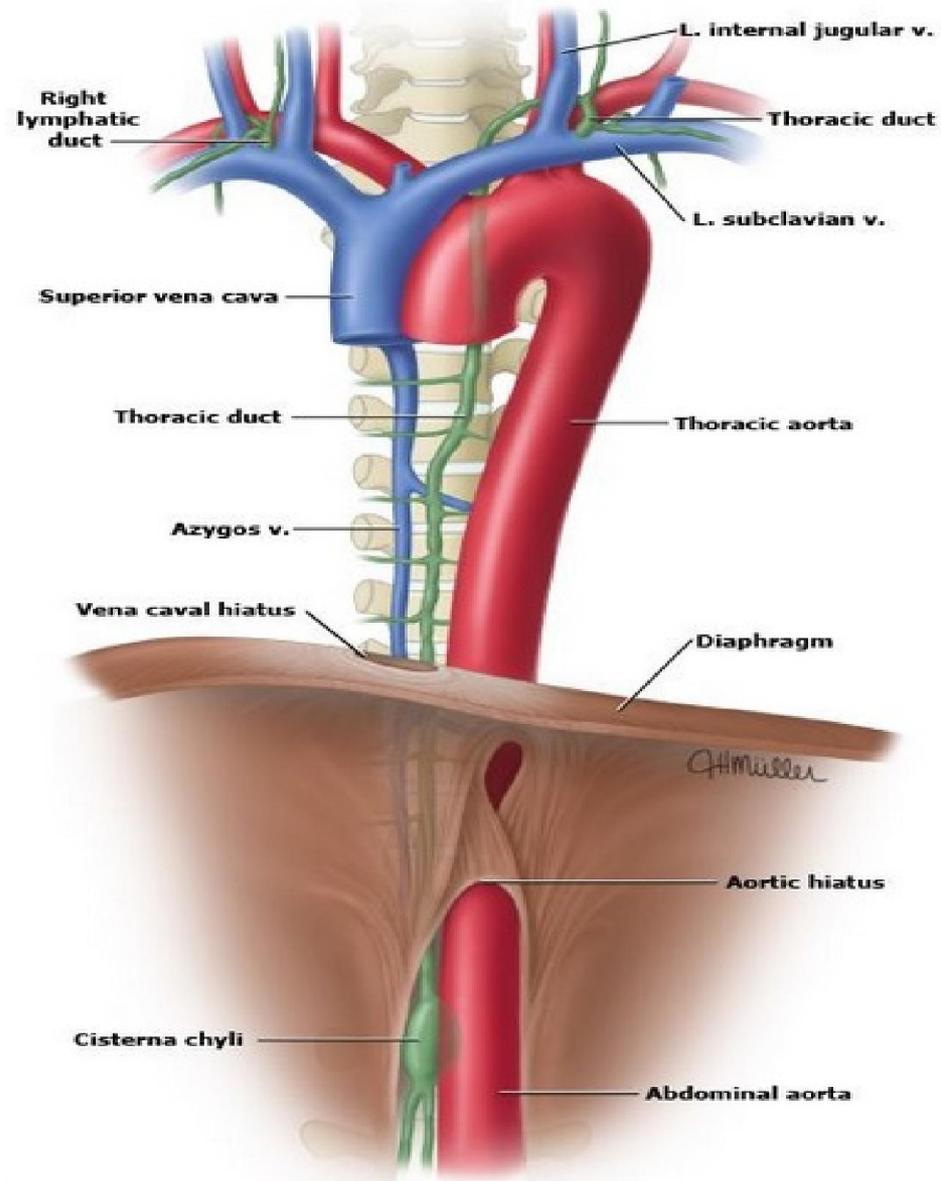
Lymphatic system functions:

- Collect fluid and proteins
- Transport lipids and lipid-soluble vitamins
- Return lymphocytes

=> to the systemic circulation

## Anatomy of the thoracic duct

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Course of the thoracic duct from cisterna chyli to left subclavian vein. The right lymphatic duct drains into the right subclavian vein.

# DIAGNOSIS

- Chest drain fluid  $> 10\text{ml/kg/day}$
- $> 1000$  cells per ml fluid,  $>70\%$  lymphocytes.
- Protein  $>2$  g/dl
- Triglyceride  $> 110$  mg/dl,  $>$  its level in serum.

# CAUSES

- Congenital chylothorax
  - Congenital lymphatic malformations:  
Lymphangiomas, Lymphangiectasia, atresia of thoracic duct
  - Associated with syndromes:  
Down, Noonan, Turner, Gorham-Stout syndrome,  
X-linked myotubular myopathy,  
Missense mutation in integrin  $\alpha_9\beta_1$ ,  
Hydrops fetalis, Yellow nail syndrome

- Associated with tumors:  
Neurogenic, Lymphoma, Teratoma, Wilms,  
Ovarian, Kaposi sarcoma
- Other: Granulomatous infection: Tuberculosis,  
Histoplasmosis, Sarcoidosis, Staphylococcal  
discitis, Henoch-Schönlein purpura

- Traumatic

- After Surgery:

Excision of lympho nodes,

Congenital Heart Disease

Scoliosis

Vascular ring

Diaphragmatic hernia

Subclavian vein catheterization

- High centre venous pressure: thrombosis of superior vena cana, post Fontan surgery.

Other trauma: Burn force or penetrating trauma to the chest, Hyperexpansion or stretching of chest wall or thoracic spine, coughing, vomitting, child birth, child abuse

# CHYLOTHORAX AFTER CARDIAC SURGERY

**TABLE 2. Incidence of chylothorax associated with selected procedures according to *International Classification of Diseases, Ninth Revision, Clinical Modification* procedure codes**

<b>Procedures (ICD-9-CM procedure codes)</b>	<b>Incidence (No. and %)</b>
Atriopulmonary and cavopulmonary anastomoses; Fontan (35.94, 39.21)	430/7589 (5.7)
Total correction of transposition of great vessels (35.84)	125/2887 (4.3)
Heart transplant (37.51)	53/1329 (4.0)
Repair of congenital aortic arch anomalies* (38.34, 38.35, 38.44, 38.45, 38.64, 38.65, 38.84, 38.85)	241/6515 (3.7)
Total repair of total anomalous pulmonary venous connection (35.82)	71/1916 (3.7)
Total repair of tetralogy of Fallot (35.81)	182/5322 (3.4)
Repair of endocardial cushion defect (35.54, 35.63, 35.73)	158/4682 (3.4)
Total repair of truncus arteriosus (35.83)	23/742 (3.1)
Systemic to pulmonary artery shunt† (39.0)	64/3396 (1.9)
Repair of ventricular septal defect (35.53, 35.55, 35.62, 35.72)	150/9299 (1.6)
Patent ductus arteriosus‡ (38.34, 38.45, 38.64, 38.85)	14/1241 (1.1)
Repair of atrial septal defect (35.51, 35.52, 35.61, 35.71)	59/6660 (0.9)

Incidence  
0.25 - 9.2%

Incidence and treatment of chylothorax after cardiac surgery in children: Analysis of a large multi-institution database (The American Association for Thoracic Surgery, 2013) n=2205

# EFFECTS OF CHYLOTHORAX ON OUTCOMES

Chylothorax increases :

- The **length of the hospital stay** ( $P < .0001$ )
- Risk for **in-hospital mortality**  
(**OR, 2.13**; 95% CI, 1.75-2.61).
- **Cost of hospitalization**, even after adjustment for significant covariates ( $P < .0001$ ).

**TABLE 4. Effects of chylothorax on outcomes**

	<b>Hospital stay</b>		<b>Mortality (No. and %)</b>		<b>Cost (\$1000 US, median and interquartile range)</b>	
	<b>(d, median and interquartile range)</b>		<b>No chylothorax</b>	<b>Chylothorax</b>	<b>No chylothorax</b>	<b>Chylothorax</b>
	<b>No chylothorax</b>	<b>Chylothorax</b>	<b>No chylothorax</b>	<b>Chylothorax</b>	<b>No chylothorax</b>	<b>Chylothorax</b>
<b>Age</b>						
Neonates	20 (13-36)	47 (30-74)	849/17,648 (4.8)	87/771 (11.3)	99 (63-165)	210 (132-332)
Infants	7 (5-13)	17 (9-36)	276/26,628 (1)	38/886 (4.3)	42 (30-69)	82 (48-160)
Young children	5 (3-9)	17 (10-30)	98/17,831 (0.5)	5/456 (1.1)	34 (24-53)	74 (47-127)
Older children	4 (3-6)	14 (6-27)	33/6316 (0.5)	1/60 (1.7)	35 (25-53)	59 (26-162)
Teenagers	5 (4-7)	10 (7-41)	28/6249 (0.45)	0/32 (0)	41 (30-62)	50 (32-198)
<b>Type of procedure</b>						
<b>RACHS</b>						
1	4 (3-5)	8 (5-26)	46/8975 (0.5)	7/91 (7.7)	25 (19-35)	36 (25-70)
2	6 (4-10)	17 (9-38)	168/26,446 (0.6)	22/560 (3.9)	39 (29-59)	78 (50-151)
3	9 (5-17)	23 (14-40)	436/26,688 (1.6)	21/808 (2.6)	53 (35-89)	106 (63-187)
4	13 (6-23)	23 (10-47)	233/7980 (2.9)	22/374 (5.9)	70 (36-121)	116 (42-213)
5-6	26 (17-41)	46 (35-62)	179/2477 (7.2)	19/136 (14)	134 (92-200)	223 (151-314)
Heart transplant	36 (17-72)	92 (52-138)	27/1276 (1.2)	4/53 (7.6)	279 (196-449)	450 (347-809)
Multiple procedures	40 (19-87)	66 (42-106)	195/1730 (11)	36/183 (19.7)	196 (101-392)	316 (202-582)
<b>Neck or upper vein thrombosis</b>						
No	16 (4-16)	39 (12-49)	1264 (1.7)	120 (5.6)	82 (30-85)	186 (56-224)
Yes	70 (24-91)	80 (36-101)	20 (15.9)	11 (22.5)	366 (136-498)	447 (175-614)
<b>Hospital volume</b>						
First quartile	7 (4-17)	23 (11-48)	386/19,255 (2)	41/594 (6.9)	47 (31-85)	98 (56-206)
Second quartile	7 (4-16)	28 (13-52)	394/19,982 (2)	33/560 (5.9)	46 (30-87)	126 (66-263)
Third quartile	7 (4-16)	27 (13-49)	231/16,556 (1.4)	37/706 (5.2)	48 (30-94)	129 (62-229)
Fourth quartile	7 (4-15)	23 (12-51)	273/19,779 (1.4)	20/345 (5.8)	42 (28-79)	93 (45-226)

RACHS, Risk Adjustment for Congenital Heart Surgery-1.

# MANAGEMENT

- Drainage of the pleural fluid
- Prevention of recurrence by treatment of the underlying cause
- Prevention/treatment of malnutrition and immunodeficiency

# NONSURGERY

- **Low fat – MCT enriched diet**

MCT: absorbed directly into the portal venous system, bypassing lymphatic drainage.

- **Total Parenteral Nutrition, if patient:**

- not respond to an enteral regimen.
- increase chyle output on enteral nutrition.

Table 3. Reported Chylothorax Incidence and Treatment Outcomes in Children

Study	Cases (n)	Incidence (%)	Survival (%)	Treatment	Resolved on Enteral Nutrition	Resolved on Enteral or TPN		
					%	Mean Duration (days)	%	Mean Duration (days)
Puntis <sup>9</sup>	15	1 <sup>a</sup>	93	Low-fat diet + MCT	73	12	73	12
Allen <sup>7</sup>	18	0.9	94	Low-fat diet (Portagen)	67	11.3	39	7
Nguyen <sup>3</sup>	24	1.9	79	Low-fat diet + TPN	66	27	84	15.7
				Low-fat diet + MCT (Portagen or Vivonex) or TPN only				
Bond <sup>5</sup>	25	1.5	88	TPN only			73	11.9
Beghetti <sup>12</sup>	51	2.5	90	Low-fat diet for 1 week then TPN	Not stated	Not stated	80	24.7
Current study	25	4.7	92	Monogen	78	Median 3.5	75	Median 5.0

<sup>a</sup> One percent of patent ductus arteriosis procedures.

MCT = medium-chain triglyceride; TPN = total parenteral nutrition.

# NONSURGERY

- **Octreotide** : 1-10 mcg/kg/h
- **Somatostatin** : 3.5-10 mcg/kg/h
- Effective : 71%
  
- A randomized, controlled, multicenter trial is needed

Chylothorax after surgery on congenital heart disease in newborns and infants – risk factors and efficacy of MCT-diet. Biewer et al. Journal of Cardiothoracic Surgery 2010, 5:127  
Chylothorax in Infants and Children; James D. Tutor, American Academy of Pediatrics, 2014

# SURGERY

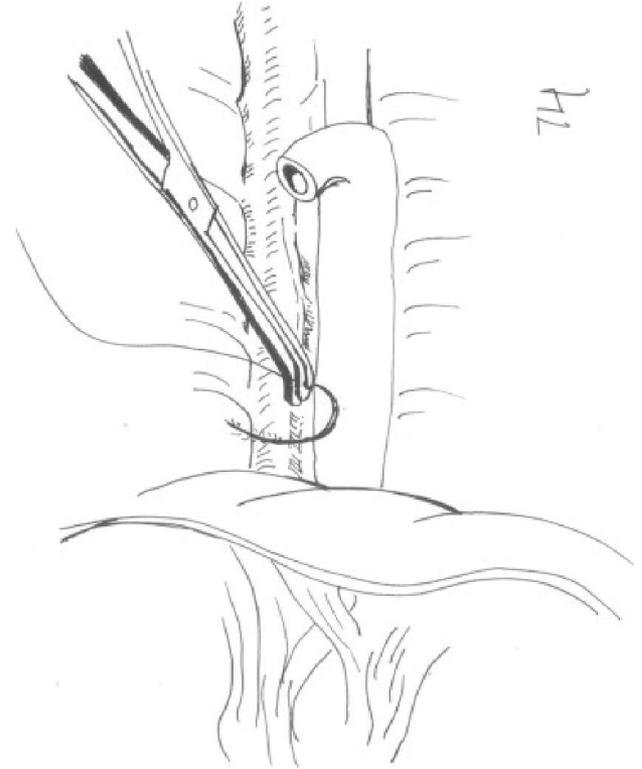
Recommend surgery

- If the effusion persists for more than 2 weeks.
- Others regard a particular volume  
>100 mL / year of age in children

Most recommend an extended period (3-4 weeks) of conservative management before surgery.

# SURGERY

- Thoracic duct ligation
- Obliteration of the pleural space: Pleurodesis



# SURGERY

- Pleuroperitoneal shunt: 75% to 90% effective

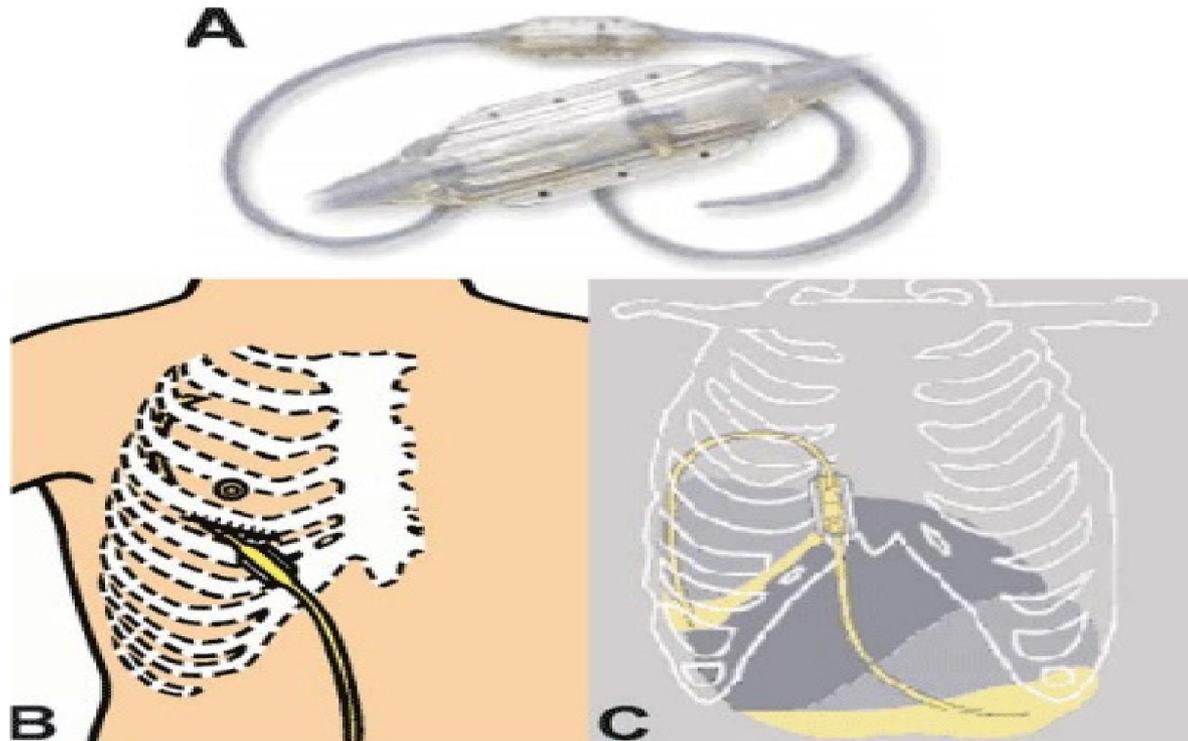


Figure 2 - "Pleuroperitoneal shunt": A) catheter with interposed receptacle (unidirectional valve); B) insertion of one of the extremities into the pleural cavity; and C) shunt in position, draining fluid from the pleural cavity and directing it toward the abdominal cavity

# Utility of a Clinical Practice Guideline in Treatment of Chylothorax in the Postoperative Congenital Heart Patient

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-Institution of Clinical Practice Guideline (CPG) 06/2010

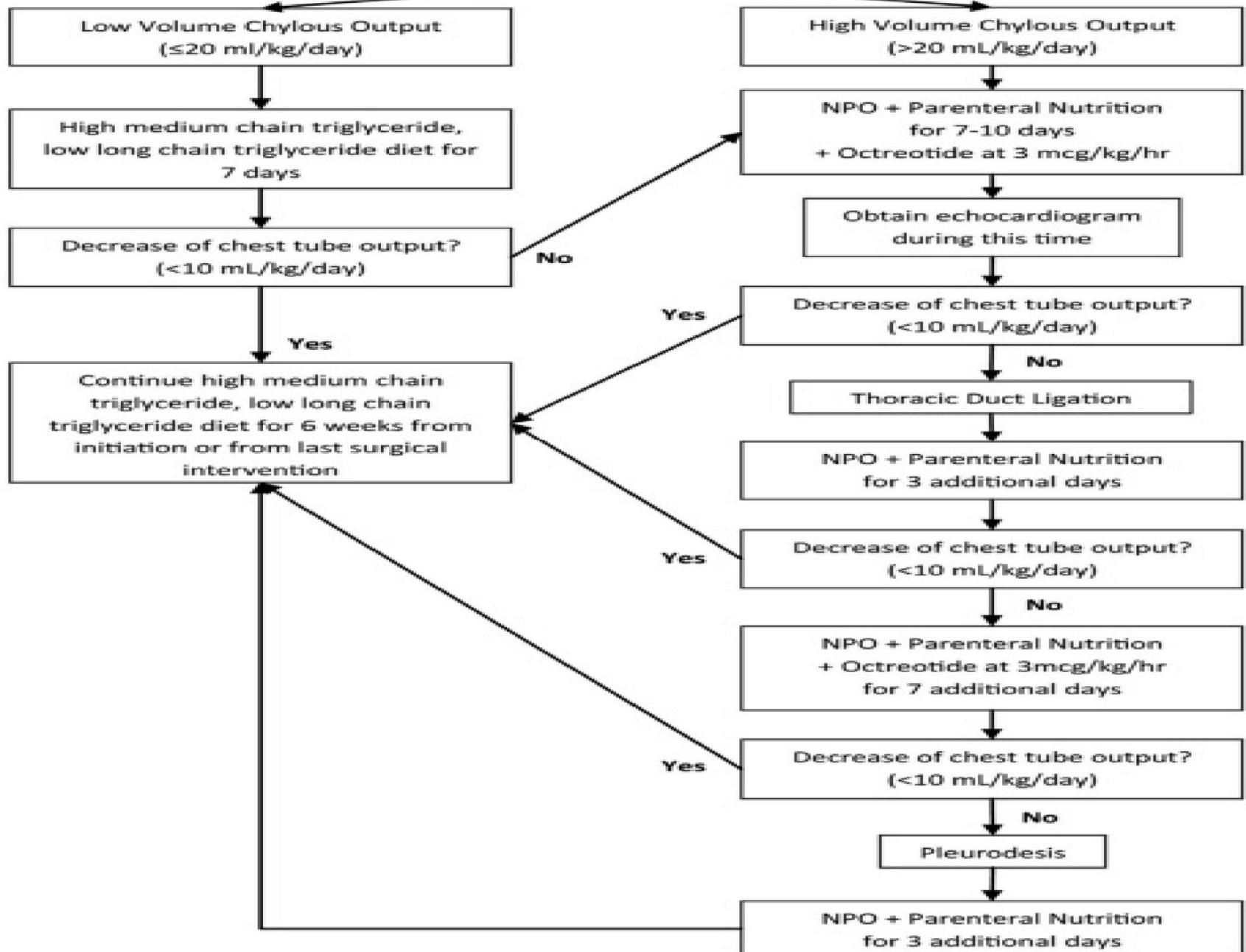
-Retrospective 2 cohort

Chylothorax 01/2008-05/2010 (n=118) (Early cohort)

Chylothorax 06/2010-08/2011 (n= 45) (Late cohort)

-> Effect of CPG ?

# Management Guidelines for Post-Operative Chylothorax



*Table 1. Demographic and Clinical Characteristics in Patients Diagnosed and Treated for Chylothorax Before and After Initiation of Clinical Practice Guideline (n = 163)*

Characteristic	All	Early Cohort (n = 118)	Late Cohort (n = 45)	p Value <sup>a</sup>
Weight at admission, kg	4.4 (3.2–8.9)	4.1 (3.1–9.2)	5.2 (3.5–7.9)	0.24
Male sex	99 (60.7)	71 (60.2)	28 (62.2)	0.81
Age at surgery, days	90 (7–278)	72 (7–354)	123 (9–229)	0.55
Number of patients with age at surgery ≤30 days	67 (41.1)	52 (44.1)	15 (33.3)	0.21
Primary diagnosis/procedure				
Single ventricle without arch repair	52 (31.9)	38 (32.2)	14 (31.1)	0.92
Single ventricle with arch repair	26 (16.0)	20 (17.0)	6 (13.3)	
Two ventricles without arch repair	70 (42.9)	49 (41.5)	21 (46.7)	
Two ventricles with arch repair	15 (9.2)	11 (9.3)	4 (8.9)	
RACHS-1 classification				
1–3	99 (60.7)	69 (58.5)	30 (66.7)	0.43
4–6	61 (37.4)	46 (39.0)	15 (33.3)	
Zero	3 (1.8)	3 (2.5)	0 (0.0)	
Age at chylothorax diagnosed, days	95 (18–288)	79 (18–387)	127 (24–237)	0.84
Time from surgery to chylothorax diagnosis, days	8 (5–11)	9 (5–12)	6 (4–8)	0.004
Chest tube output, mL/kg/day	16.2 (8.8–28.1)	17 (8.5–28.5)	15.1 (9–27)	0.94
Patients with bilateral chylothorax	90 (55.2%)	68 (57.6%)	22 (48.9%)	0.32
Low/high output				
Low	97 (59.5)	70 (59.3)	27 (60.0)	0.98
High	65 (39.9)	47 (39.8)	18 (40.0)	
Missing data	1 (0.6)	1 (0.8)		
Patients with measured triglyceride levels	56 (34.4)	41 (34.7)	15 (33.3)	0.87
Pleural triglyceride levels, mg/dL	309.5 (228–462.5)	311 (235–426)	286 (227–600)	0.83
Clinical practice guidelines followed	N/A	N/A	39 (86.7)	N/A

<sup>a</sup> p value from  $\chi^2$  test for categoric variables and Wilcoxon rank sum test for continuous variables on comparison of each characteristic between patients in both cohorts.

*Table 2. Comparison of Medical and Surgical Treatments for Chylothorax in Patients Diagnosed and Treated for Chylothorax Before and After Initiation of Clinical Practice Guideline (n = 163)*

Treatment	All	Early Cohort (n = 118)	Late Cohort (n = 45)	p Value <sup>a</sup>
<b>Surgical intervention</b>				
Mechanical pleurodesis	7 (4.3)	6 (5.1)	1 (2.2)	0.67
Time from surgery to mechanical pleurodesis, days	32 (20–54)	31 (20–33)	54	0.36
Time from chylothorax diagnosis to mechanical pleurodesis, days	24 (10–46)	22.5 (10–25)	46	0.36
Thoracic duct ligation	21 (12.9)	16 (13.6)	5 (11.1)	0.68
Time from surgery to thoracic duct ligation, days	20 (19–27)	21.5 (19.5–31.5)	20 (15–27)	0.57
Time from chylothorax diagnosis to thoracic duct ligation, days	13 (10–20)	13 (10–22)	14 (9–19)	0.90
<b>Octreotide</b>				
Treated with octreotide	29 (17.8)	18 (15.3)	11 (24.4)	0.17
Time from surgery to octreotide treatment, days	14 (10–23)	20.5 (14–29)	9 (6–10)	0.007
Duration on octreotide, days	10 (6–16)	11 (7–20)	7 (6–14)	0.28

<sup>a</sup> p value from  $\chi^2$  test or Fisher exact test for categoric variables and Wilcoxon rank sum test for continuous variables on comparison of each characteristic between patients in both cohorts.

Data presented as n (%) for categoric variables and median (interquartile range) for continuous variables.

Table 3. Comparisons of Clinical Outcomes in Patients Diagnosed and Treated for Chylothorax Before and After Initiation of Clinical Practice Guideline (n = 163)

Outcome	All	Early Cohort (n = 118)	Late Cohort (n = 45)	p Value <sup>a</sup>
<b>ICU stay</b>				
Total number(s) of ICU admission				
1	128 (78.5)	92 (78.0)	36 (80.0)	0.78
≥2	35 (21.5)	26 (22.0)	9 (20.0)	
ICU length post-extubation, days	3 (1–5)	3 (1–6)	3 (2–4)	0.71
Total ICU length of stay, days	16 (6–31)	18 (7–39)	9 (5–18)	0.01
<b>Hospital stay</b>				
Total hospital length of stay, days	28 (18–53)	30 (22–54)	23 (14–34)	0.005
Weight at discharge, kg	5.2 (3.7–9.5)	5.0 (3.6–9.6)	5.5 (4.1–8.1)	0.63
<b>Mortality</b>				
Death during initial ICU stay	10 (6.1)	9 (7.6)	1 (2.2)	0.29
Hospital death	13 (8.0)	10 (8.5)	3 (6.7)	1.00
<b>Mechanical ventilation</b>				
Total number of intubations				
1	89 (54.6)	57 (48.3)	32 (71.1)	0.01
>2	74 (45.4)	61 (51.7)	13 (28.9)	
Total duration of mechanical ventilation, days	9 (3–20)	11 (3–24)	5 (3–12)	0.02
<b>Chest tubes</b>				
Total number of chest tubes placed				
1	11 (6.8)	4 (3.4)	7 (15.6)	0.01
≥2	152 (93.2)	114 (96.6)	38 (84.4)	
Total duration of chest tubes, days	18 (11–27)	20 (12–30)	14 (10–23)	0.01
Chest tube removal to discharge, days	6 (2–17)	8 (3–20)	4 (1–13)	0.08
<b>Central venous lines</b>				
Total number(s) of central venous lines				
None	1 (0.6)	1 (0.9)	0 (0.0)	0.94 <sup>b</sup>
1	65 (39.9)	47 (39.8)	18 (40.0)	
≥2	97 (59.5)	70 (59.3)	27 (60.0)	
Total duration of central venous lines, days	23.5 (12–50)	27 (16–54)	15 (8–26)	0.001
<b>NPO</b>				
Total number(s) of time(s) NPO				
1	65 (39.9)	44 (37.3)	21 (46.7)	
2	42 (25.8)	28 (23.7)	14 (31.1)	0.08
≥3	56 (34.4)	46 (39.0)	10 (22.2)	
Treated with NPO for chylothorax	76 (46.6)	58 (49.2)	18 (40)	0.30
Total duration NPO, days	9 (3–18)	9.5 (4–19)	6 (2–14)	0.04
Interval from surgery to NPO treatment, days	13 (10–20.5)	15 (11–22)	9 (7–13)	0.006
Resumption of enteral nutrition to discharge, days	14 (8–27)	16 (10–30)	11 (6–19)	0.02
<b>Total parenteral nutrition</b>				
Total duration on total parenteral nutrition, days	12 (5–22)	13 (5–24)	10 (4–21)	0.29

### Chylothorax Management Protocol- PICU

In order to confirm diagnosis  
Chest drain Fluid; >10ml/kg/day; TG>1.1mmol/l and > than serum concentration; >1,000 cells per ml fluid; >70% Lymphocytes;  
Protein>20gm/dl (110 mg/dL)

Is enteral feeding contra-indicated?

No

YES

**MCT or Minimal LCT diet for 5-day trial**  
Monitor Chest drain output ml/kg/day  
Start replacing fluid if >30mls/kg/day  
Replace ½ losses with Albumin 5% and ½ Hartman's Solution Consider over all fluid balance

**Total Parenteral Nutrition**  
Monitor Chest drain output ml/kg/day  
Start replacing fluid if >30mls/kg/day  
Replace ½ losses with Albumin 5% and ½ Hartman's Solution-Consider over all fluid balance

Drain decreasing and <20ml/kg/day on day 5

Drain not decreasing or >30ml/kg/day on day 5

**Investigate for residual lesions**  
ECHO +/- Cardiac Cath  
Ultrasound of neck veins

Daily blood gas. Weekly Serum Immunoglobulin and coagulation screen  
**Replace losses with Octoplas, Bicarbonate and IVIG if immunoglobulin levels <normal**

*Correct abnormality  
IVIG 0.5g/kg weekly  
after levels checked*

**After Day 5 if losses >30mls/kg/day**  
Start Octreotide infusion (1-10microgram/kg/hr). Start at 3microgram/kg/hr and increase daily to 5, 7 10microgram/kg/day if losses not decreasing.

**After Day 8 if losses >50mls/kg/day**  
Consider PIC line insertion and TPN  
If this fails Consider pleurodesis and /or Thoracic Duct ligation

YES

**MCT or Minimal LCT diet for 4 weeks after last drain removed**  
Consider restarting breast milk at 1 week once drain removed. If after 2 weeks on Octreotide and no effect demonstrated -discontinue as above

# CONCLUSIONS

Chylothorax after cardiac surgery:

- Incidence: 0.25-9%
- Treatment: Nonsurgery/ Surgery
- Establish a Guideline for more effective management.

Thank for Your Attention!

