

Usefulness and Limitation of Transesophageal Echocardiography

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The availability of TEE should in NO WAY
adversely influence TTE technical quality

Table 1. Doppler Echocardiography Capabilities in the Adult Patient

	Echocardiography		Spectral Doppler	Color Doppler	TEE
	M mode	2 D			
<i>Anatomy-Pathology</i>					
Chamber size	+++	+++	-	-	++
Thickness of walls	+++	+++	-	-	+++
Relation of chambers	+	+++	-	-	+++
Early closure of MV	+++	+	-	-	+
Systolic anterior motion of MV	+++	+++	-	-	+++
LV mass (g)	+++	+++	-	-	-
LV masses (tumor, clot, vegetation)	+	+++	-	-	+++
Masses in atria and right ventricle	+	++	-	-	+++
Anatomic valvular pathology	++	+++	-	-	+++
Septal defects	+	+++*	++	+++	+++
Pericardial effusion	++	+++	-	-	++
<i>Function</i>					
Global LV systolic function (EF)	++	+++	++	-	+++
Regional wall motion	+	+++	-	-	+++
Severity of valve stenosis	+	++	+++	+++	++
Severity of valve regurgitation	+	+	+++	+++	+++
Site of left-to-right, right-to-left shunt	-	+++* (together)	+++	+++ (together)	+++
RV and PA systolic pressure	-	-	+++	-	-
LV filling pressure	-	-	++	-	-
Stroke volume and cardiac output	+	++ (together)	+++	-	-
LV diastolic function	+	+	+++	-	-
Identify ischemia and viable myocardium with exercise or pharmacological stress	-	+++	-	-	-
Diseases of the aorta	-	++	-	++	+++
Prosthetic valve evaluation	+	++	+++	+++	+++

++++ indicates most helpful; +, least useful; -, not useful; 2D, two-dimensional; EF, ejection fraction; LV, left ventricular; MV, mitral valve; PA, pulmonary artery; RV, right ventricular; TEE, transesophageal echocardiography.

*With contrast (intravenous injection of agitated saline).

Where TTE is inadequate, TEE can usually obtain the desired information.

Advantages of TEE over TTE

- Better image quality, higher carrying frequency
 - Visualization of small structures (mass, tumor)
 - Visualization of left atrial (LAA) and valvular structures
 - Visualization of LA in MV prosthesis
 - Visualization of IAS, descending thoracic aorta and arch
 - Useful in patients with technically difficult TTE
 - Useful to monitor cardiac status and volume status and operative results in patients during thoracic surgery

Limitations of TEE Compared to TTE

- Windows limited to different esophageal levels and transgastric window (less uniformly helpful)
 - Doppler gradients may be falsely low
- Higher risk of complications
- Greater discomfort
- More expensive
 - Procedure
 - Equipment
 - Personnel (RN and physician in attendance)
 - Time

Indications for TEE

- Endocarditis and valvular disease
- Dyspnea, edema, and cardiomegaly
- Cardioembolic source
- Pre cardioversion
- Critically ill patients
- Imaging coronary ostia in congenital heart disease

Indications for TEE in Endocarditis

- “In most cases TEE is not indicated as the initial examination in the diagnosis of native valve endocarditis”
- TEE is indicated (Class I) when
 - TTE is diagnostically inadequate due to poor technical quality or windows
 - TTE is negative in setting of high clinical suspicion
 - Prosthetic cardiac valve (TEE may provide incremental value)
 - High suspicion such as Staphylococcal bacteremia or fungemia (If TTE is equivocal)
 - Elderly patient with underlying valvular abnormalities that make diagnosis difficult
 - “TEE may frequently provide incremental value in addition to information obtained by TTE. The role of TEE in first-line examination awaits further study”
- Persistent nonstaphylococcal bacteremia without source (IIa)
- Risk stratification in established endocarditis (IIa)

Indications for TEE in Valvular Heart Disease

- Native valve disease or mitral valve prolapse – no indication for TEE as initial test
- For intervention (Echo indication is Class I):
 - For selection of alternative therapies for MS/MR (valvuloplasty, repair, replacement)*
 - Guiding performance of valvuloplasty, repair or replacement*
 - Suspected prosthetic valve dysfunction (changing signs and symptoms)*

*TEE may provide incremental value in addition to TTE
ACC/AHA Practice Guideline, Echo 2003; p. 13-4.

TEE in Dyspnea, Edema, or Cardiomegaly

- When TTE is nondiagnostic
 - Clinical diagnosis of HF or suspected DCM – for LV size and function
 - Edema and clinical signs of elevated CVP and clinical suspicion of heart disease is high
 - Unexplained hypotension, especially in Intensive Care setting
 - Pulmonary emboli and suspected clots in PA, RA or RV (IIa)

Table 13. Transthoracic Versus Transesophageal Echocardiography for Detection of Potential Cardioembolic Source

Diagnosis by TTE*	Diagnosis by TEE (primarily or alone)
Mitral stenosis	Left atrial thrombus
Dilated cardiomyopathy	Left atrial spontaneous contrast
Left ventricular aneurysm	Atrial septal aneurysm
Left ventricular thrombus	Patent foramen ovale
Mitral valve prolapse	Aortic atheroma
Vegetation	
Atrial septal defect	

TEE indicates transesophageal echocardiography; TTE, transthoracic echocardiography.

*TTE is sufficient; TEE may be additive but not essential. “TTE sufficient” identifies disease entities for which TTE is sufficient to establish a diagnosis and for which TEE is unlikely to provide additional information. When detected with TTE, further evaluation by TEE is not necessary in all patients. “TEE additive” identifies entities for which documented incremental diagnostic yield can be obtained by performing TEE after negative TTE or entities for which the likelihood of unique TEE-identified abnormalities is high enough to warrant TEE even after adequate TTE.

Class I Indications for TEE in Anticipation of Cardioversion

- Urgent cardioversion where extended precardioversion anticoagulation is undesirable
- Prior cardioembolic events related to intra-atrial thrombus
- Anticoagulation is contraindicated and decision about cardioversion will be affected by TEE results
- Intra-atrial thrombus by prior TEE
- AFib of <48 hr but other heart disease (IIa)
- AFib of <48 hr and no other heart disease (IIb)

Conditions and Settings in Which TEE Provides the Most Definitive Diagnosis in the Critically Ill and Injured

- **The hemodynamically unstable patient with suboptimal TTE images**
- **The hemodynamically unstable patient on a ventilator**
- **Major trauma or postoperative patients (unable to be positioned for adequate TTE)**
- **Suspected aortic dissection Class I**
- **Suspected aortic injury Class I**
- **Other conditions in which TEE is superior (see section on valvular disease)**

Preparation for TEE Examination

- Patient preparation
 - Contraindications: Esophageal pathology (stricture, varices, tumors, diverticula, scleroderma), severe atlantoaxial joint disease, prior XRT to chest, perforated viscus; hemodynamic instability, respiratory compromise
 - Fasting 4-6 h (urgent: only clear fluids for 2 hr*); hx of prior endoscopy or gastroesophageal sx; IV access; suction; crash cart; monitor; O2, pulse oximeter
- Local anesthesia peak effect 2-5 minutes
 - Gargle 2% viscous xylocaine
 - 10% Cetacaine spray
 - NPO for at least 30 minutes after procedure

Preparation for TEE Examination - 2

- Anticholinergic is optional
 - Atropine 0.5 mg SQ or Glycopyrrolate (Robinul) 0.1-0.2 mg
 - Blurred vision so no driving, increase HR
- Sedation and Analgesia
 - Midazolam 0.5-5.0 mg (initial dose ≤ 2 mg IV over 1-2 min, 0.05 mg/kg) or Diazepam 5-10 mg
 - Meperidine with acetaminophen or morphine can be used for associated discomfort
- Antibiotics for endocarditis prophylaxis are debatable, many laboratories use with prosthetic valves or intracardiac prostheses, poor dentition or prior endocarditis

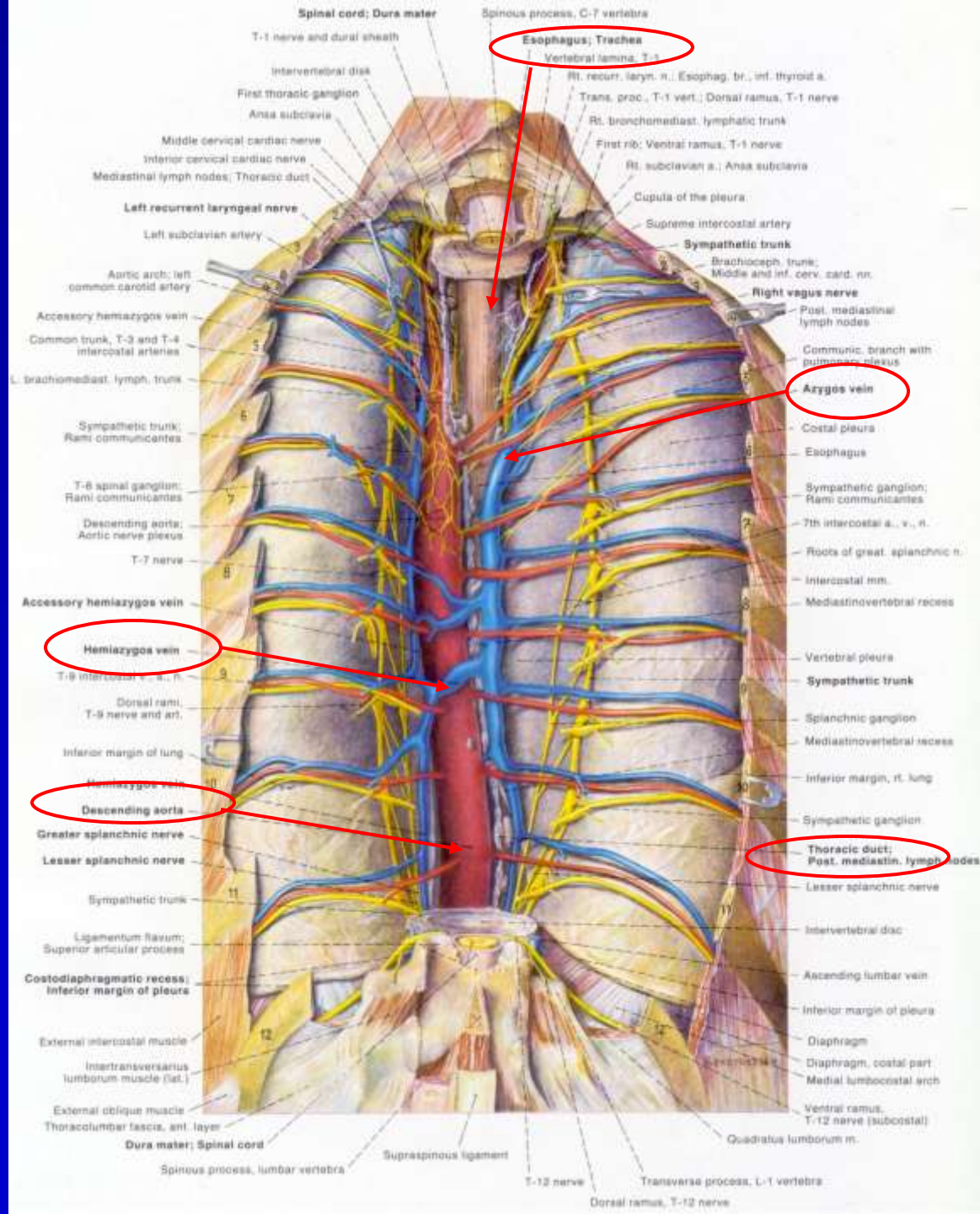
Technique of TEE Examination

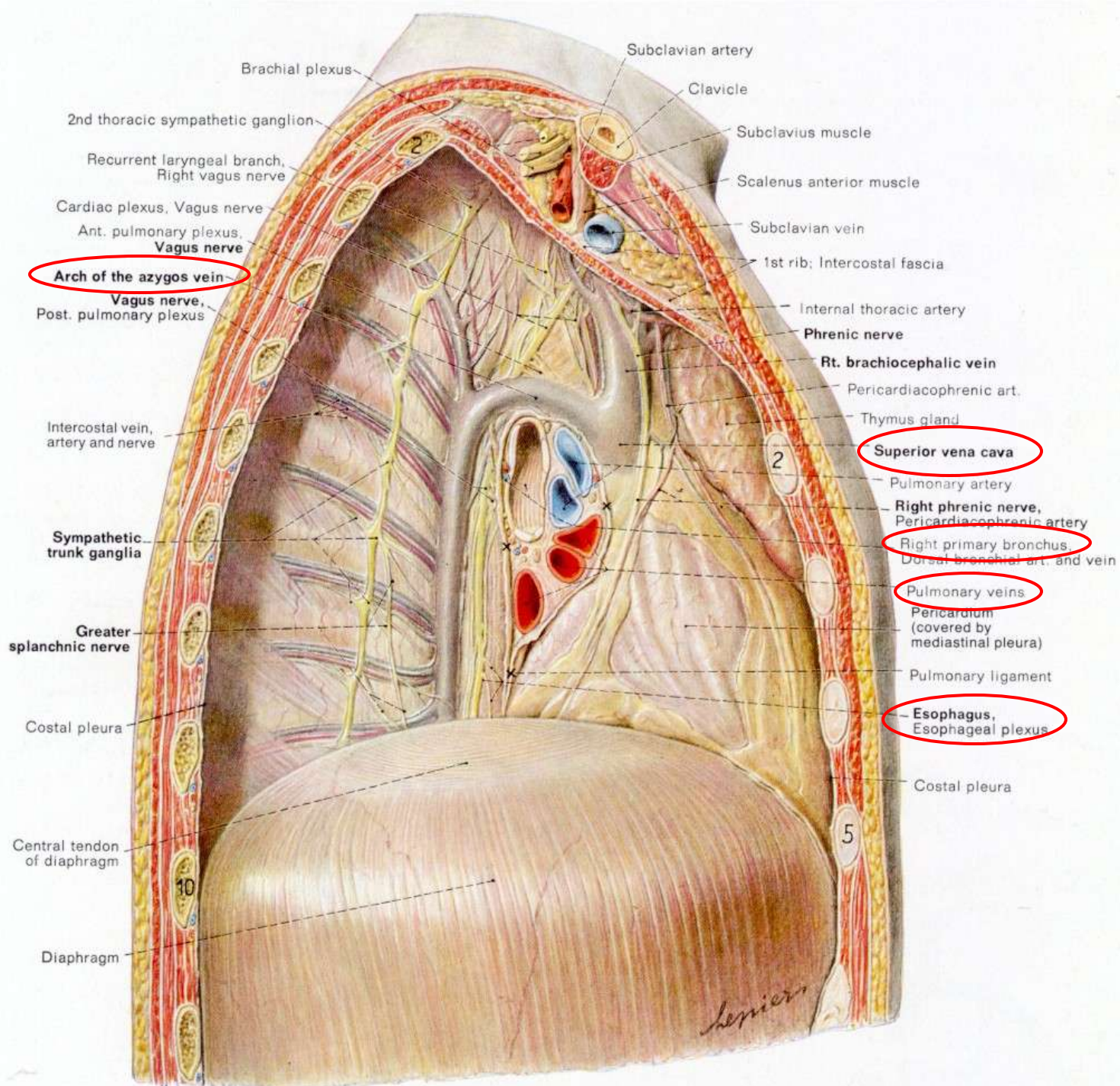
- Patient left lateral decubitus position
- Neck gently flexed; a bite guard should always be used except in edentulous patients*
- Index or index and middle fingers of nondominant hand advanced to base of tongue
- Probe advanced with dominant hand and passed beneath the index finger and guided using gentle downward pressure toward the mouth of the esophagus (manually depressing the back of the tongue provides more room, allowing the TEE probe to assume a less acute angle*)
- Anticipate transient gagging

Technique of TEE Examination - 2

- With tip of probe at esophageal inlet (about 17 cm), patient is requested to swallow
- Once the patient begins to swallow, the probe should be advanced firmly but without force
- If resistance is encountered the probe should be readjusted or redirected centrally
- Rapid initial advancement to the carina or to more than 25 cm from incisors is essential (GE junction is usually at about 40 cm*)
- Rate of failure of probe introduction is 1.5-1.9%
- With difficult intubation a laryngoscope may be used to assist in passing the endoscope
- In intubated patients (i.e. OR or ICU) supine intubation is no problem, shift ET tube to one side; typically esophageal catheters are removed to prevent kinking or knotting or intertwining, or obscuring vision

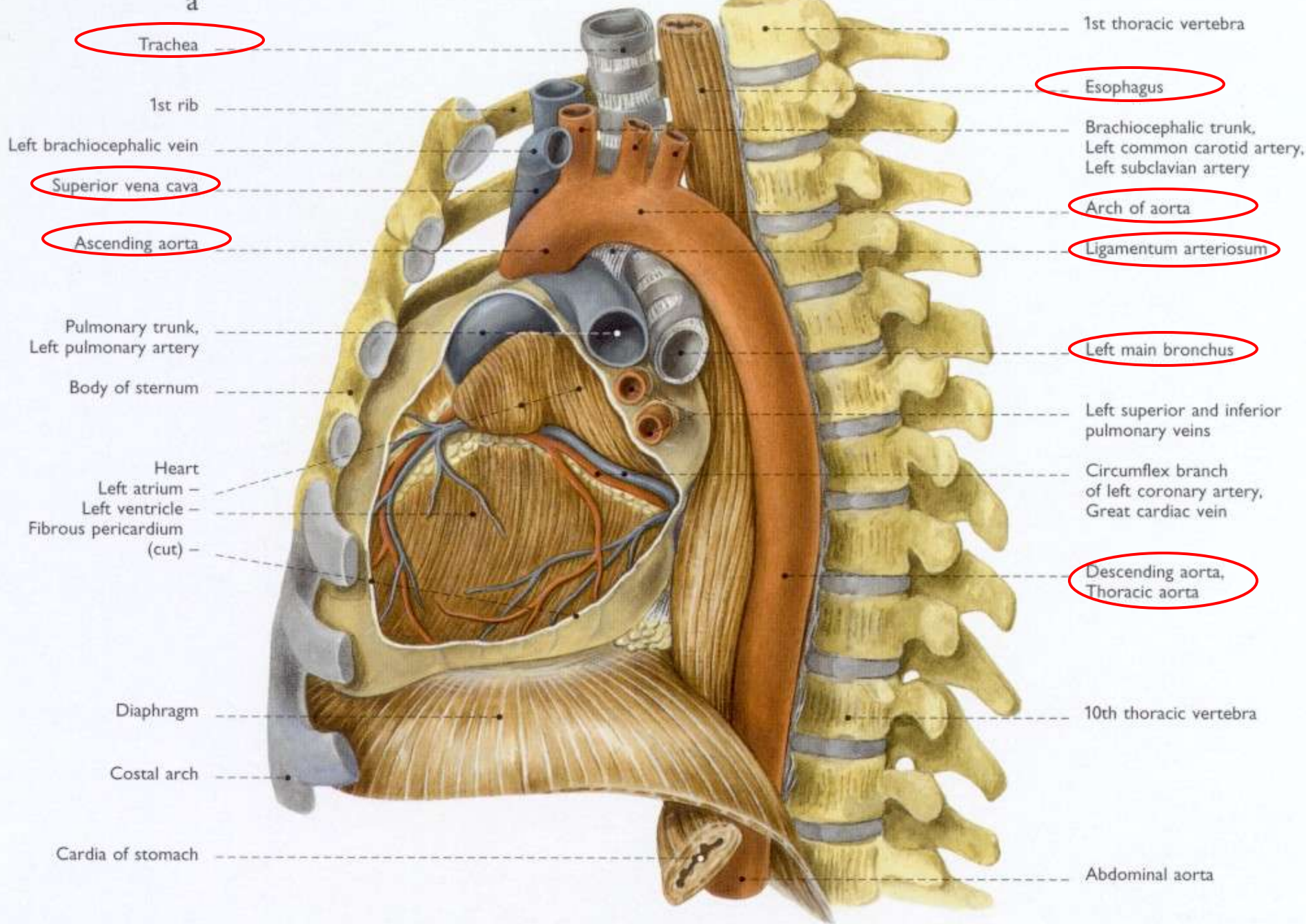
Veins





Clemente CD.
 Anatomy
 3rd Ed, 1987, fig
 184.

a



Trachea

1st rib

Left brachiocephalic vein

Superior vena cava

Ascending aorta

Pulmonary trunk,
Left pulmonary artery

Body of sternum

Heart
Left atrium -
Left ventricle -
Fibrous pericardium
(cut) -

Diaphragm

Costal arch

Cardia of stomach

1st thoracic vertebra

Esophagus

Brachiocephalic trunk,
Left common carotid artery,
Left subclavian artery

Arch of aorta

Ligamentum arteriosum

Left main bronchus

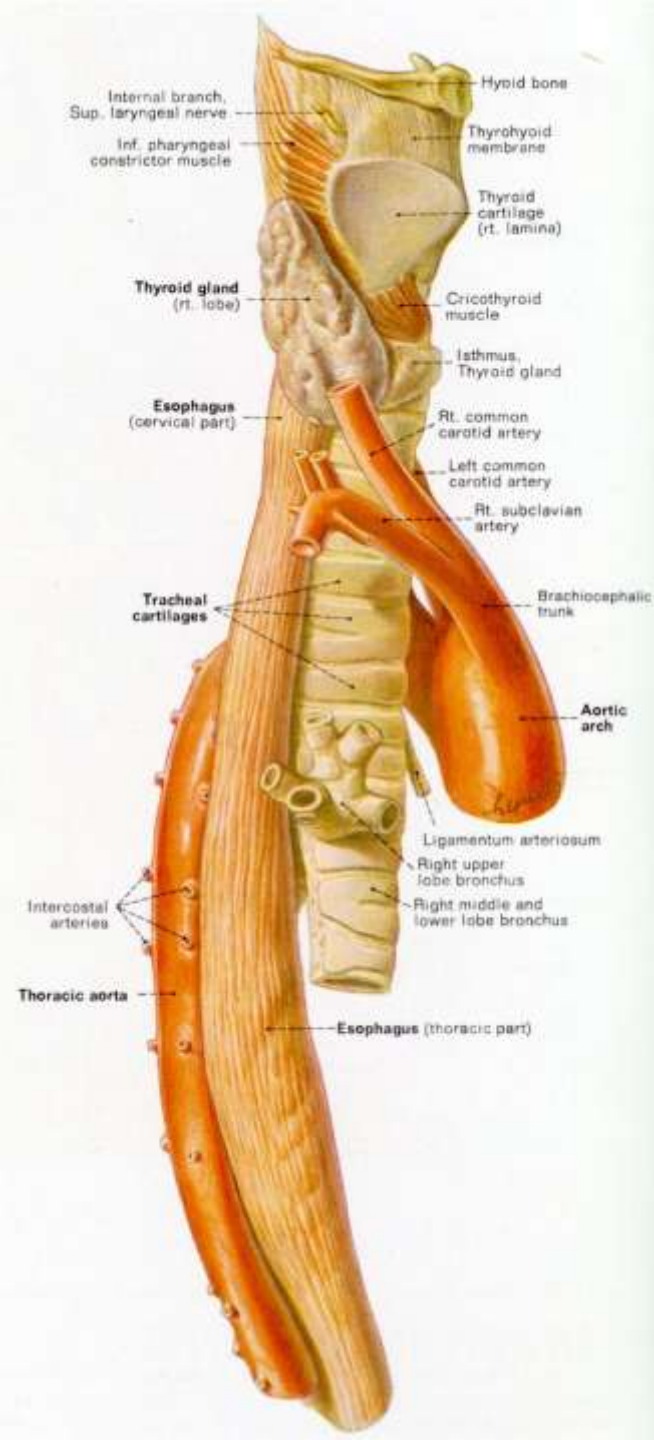
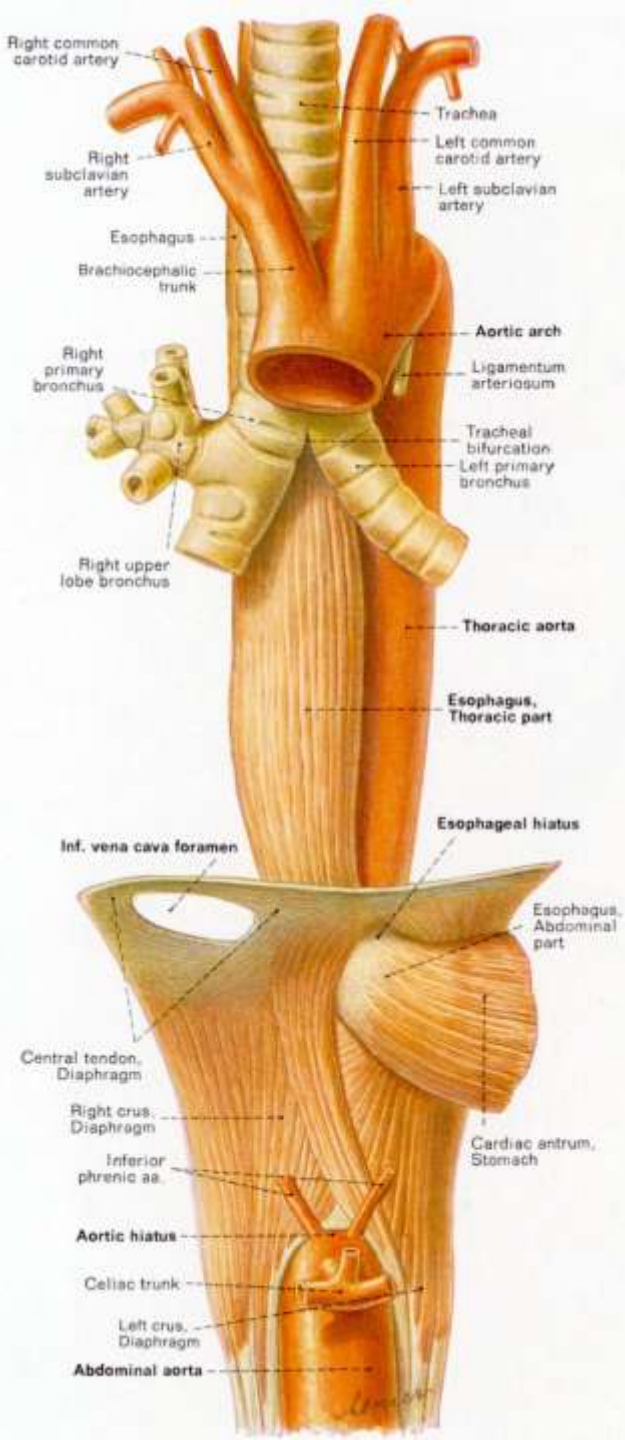
Left superior and inferior
pulmonary veins

Circumflex branch
of left coronary artery,
Great cardiac vein

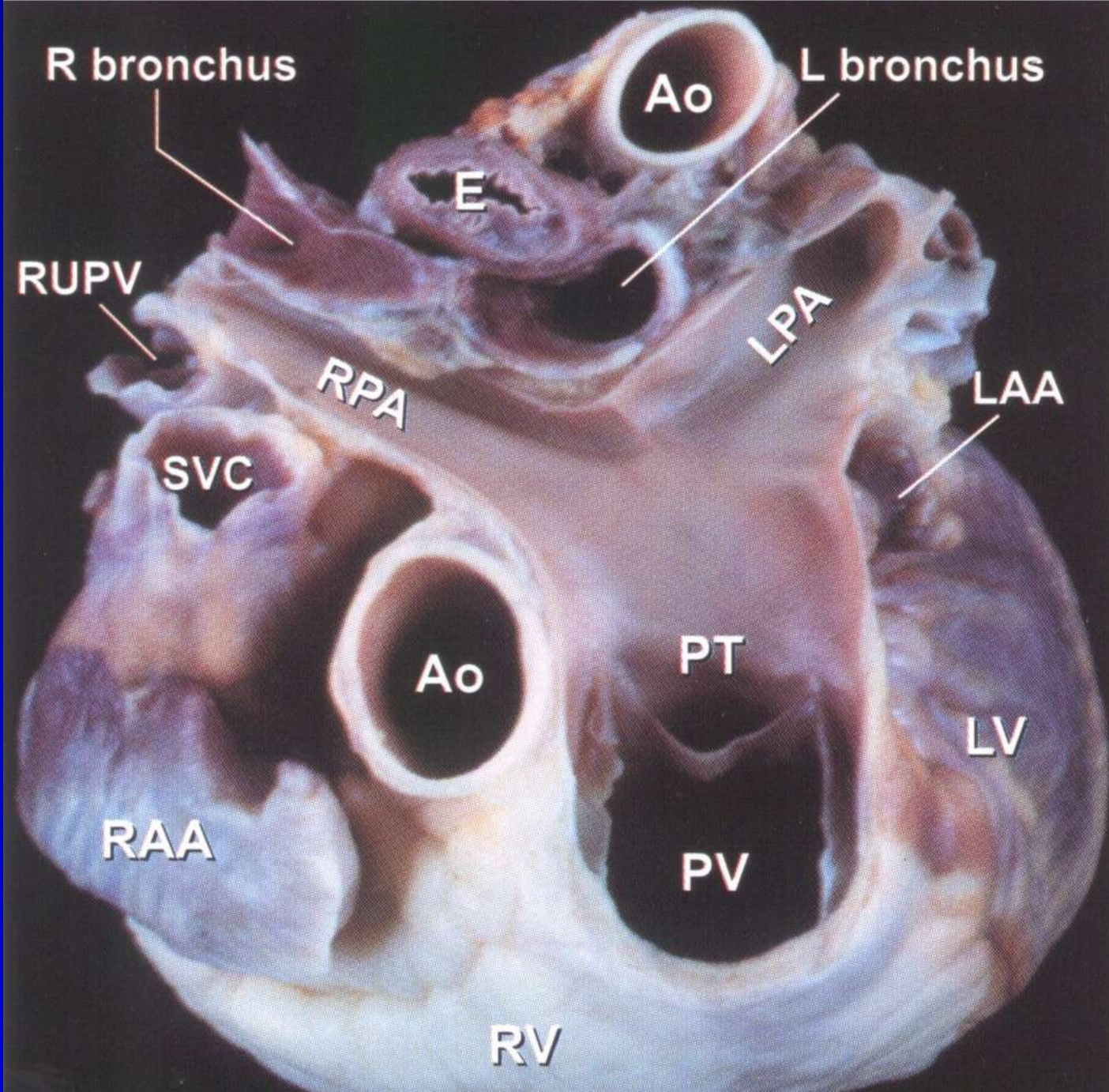
Descending aorta,
Thoracic aorta

10th thoracic vertebra

Abdominal aorta



Clemente CD. Anatomy
 3rd Ed, 1987, fig 216, 7.



Malouf JF et al. Ch. 3, "Functional Anatomy of the Heart" in Hurst's The Heart 11th ed. 2004

Mechanical Complications of TEE

- Esophagogastric trauma
- Dental trauma
- Minor oral trauma
- Laryngospasm
- Transient vocal-cord paralysis
- Buckling of probe in esophagus

Complications of TEE

- Anesthetic complications
 - Laryngospasm
 - Lidocaine/benzocaine toxicity - methemoglobinemia
 - Respiratory depression, hypoxia
- Physiologic complications
 - Hypertension
 - Arrhythmias
 - Extending of aortic dissection – death
 - Aspiration pneumonia (prior CVA)
 - Myocardial ischemia
- Premature termination due to patient intolerance of probe, about 0.8%

TEE Complications, Mayo Clinic Series

• Transient hypertension	0.3%	1/255
• SVT	0.3%	1/294
• Blood-tinged sputum	0.2%	1/425
• Hypoxia	0.3%	1/294
• Transient hypotension	0.3%	1/294
• NSVT	0.2%	1/478
• Laryngospasm	0.14%	1/765
• Heart failure	0.05%	1/1913
• VT	0.02%	1/3827
• Death	0.01%	1/3827
• Miscellaneous	0.8%	1/123

Esophageal Trauma from TEE

- Review of 10,000 TEE's in one institution
- 3 cases of perforation, all after difficult intubation and multiple attempts and resistance to passage
 - Age of patients: 73, 79, 84 ... 2 anticoagulated
 - Symptoms occurred 12, 4, and 22 hours after the procedure
 - Symptoms were hemoptysis and mild dyspnea, severe sore throat and subsequent dyspnea and hypoxia, and dyspnea and cough and pain swallowing
 - 2 had subcutaneous emphysema, all had elevated WBC, 2 had drop in Hct, 2 had hypoxia
 - All had surgery: 2 patients failed conservative therapy and required surgery, and the third patient had primary surgery
 - Mucosal tear in the left piriform sinus with abscess
 - Mucosal laceration of cervicoesophageal mucosa
 - Esophageal perforation of cervical esophagus
 - All survived, with prolonged hospitalization of 19-20 days

Methemoglobinemia

- Topical anesthesia with benzocaine or lidocaine may result in acute toxic methemoglobinemia
- Also can be caused by nitrates (Na nitrate is saltpetre), nitrites, and acetaminophen, and hundreds of other chemicals
- Risk may be increased in patients with G-6-PD deficiency, may be increased in patients on acetaminophen and receiving benzocaine

Otto CM. The Practice of Echocardiography, 2nd ed. 2002; P. 18.

Dougherty AH. Circulation 1995;92:268. Wong DH. Mayo Clin Proc. 1995;70:197.

Methemoglobinemia: $\text{Fe}^{++} \rightarrow \text{Fe}^{+++}$ Ferrous to ferric

- Hemoglobin is oxidized by the topical agent and is unable to carry oxygen to the tissues
- Usually normal metabolism but it is possible that cytochrome B₅ reductase, methemoglobin reductase, or diaphorase, is overwhelmed, or the hemoglobin is an abnormal M hemoglobin

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Methemoglobinemia: $\text{Fe}^{++} \rightarrow \text{Fe}^{+++}$ Ferrous to ferric

- pO_2 is normal but oxyhemoglobin level is low
- Cyanosis (total methemoglobin ~ 1.5 g/dL = 8-12%) and dyspnea
- Pulse oximeter saturation appears only mildly reduced because this technique cannot distinguish well between methemoglobin and reduced hemoglobin
 - It measures red and infrared transmission of light (660 nm and 940 nm respectively)
 - methemoglobin (equal absorption at 940 and 660)
 - oxyhemoglobin (more at 940 whereas reduced Hb is more at 660)
 - in high methemoglobin concentration the display will read about 85%
- Diagnosis by ABG with measurement of methemoglobin level at $>10\%$ (nl is 0.4-1.5%), symptoms if 30-40% and CNS depression if $>50\%$, usually fatal at $>70\%$

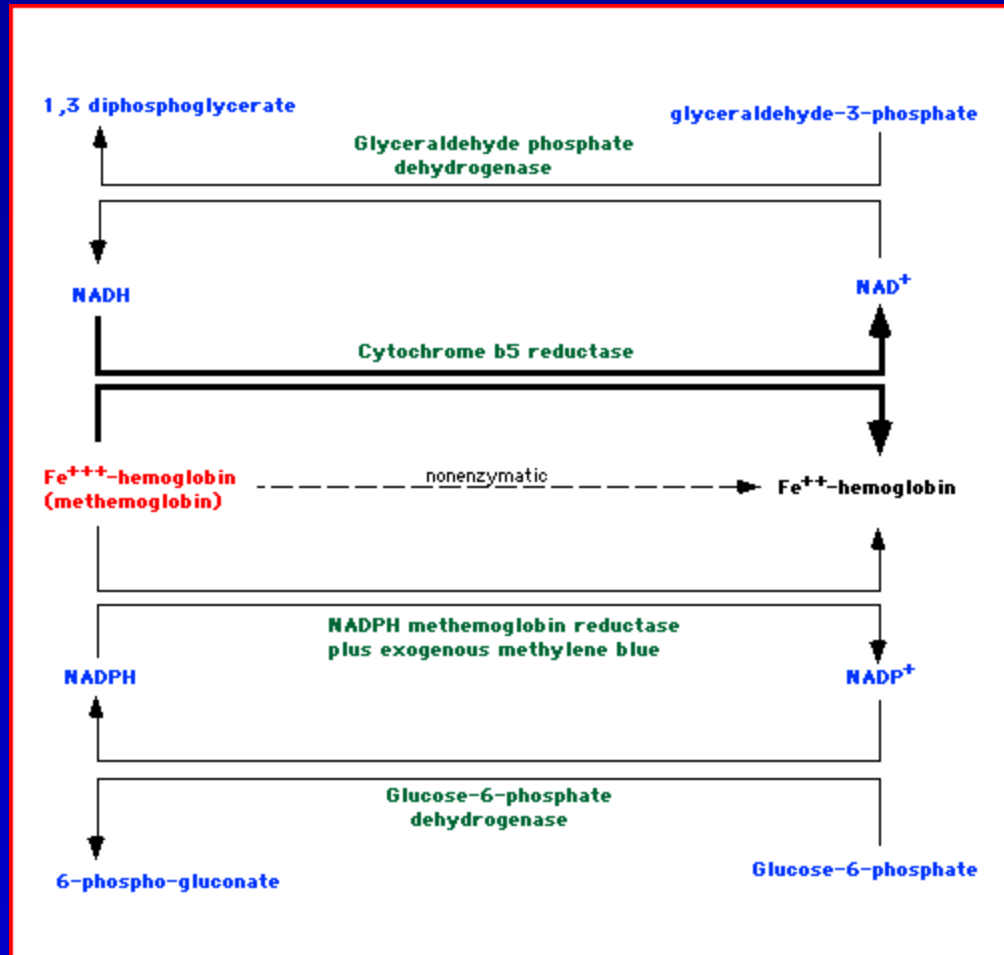
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Methemoglobinemia: $\text{Fe}^{++} \rightarrow \text{Fe}^{+++}$

- Management: Methylene blue (1-2 mg/kg) as 1% solution (1,000 mg/100 ml) over 5 minutes will result in prompt resolution of cyanosis;
- If patient has G6PD deficiency, methylene blue will not help, and ascorbic acid should be used.
 - Could prescreen African Americans, subjects of Mediterranean descent, southeast Asians
 - Also hyperbaric O₂ and/or exchange transfusion have been used

Methemoglobinemia



Metabolic pathways for reduction of methemoglobin The major pathway for methemoglobin reduction is via cytochrome b5 reductase (thick arrows). An alternative pathway, which requires an exogenous electron acceptor such as methylene blue, is via NADPH methemoglobin reductase. Only a small amount of methemoglobin is reduced via nonenzymatic pathways (dashed arrow).