



TABLE 1. Basic principles of EUS

EUS

Organ	Normal appearance	Pathology				
Esophagus	Normal wall layers	Esophageal cancer staging Subepithelial lesions				
Stomach	Normal wall layers	Gastric cancer staging Subepithelial lesions				
Duodenum	Normal wall layers	Subepithelial lesions, polyps				
Ampulla	Normal appearance	Ampullary polyps/masses				
Pancreas	Normal parenchyma	Parenchymal changes Solid masses Cystic lesions				
Biliary tree (intrahepatic, extrahepatic, cystic duct)	Normal ducts Normal appearance	Ductal changes				
		Presence of stones, sludge				
		Dilation				
		Strictures				
		Wall thickening				
Gallbladder	Normal appearance	Masses				
		Foreign bodies (stents)				
		Stones, sludge, wall thickening				
		Pericholecystic fluid				
Anorectum	Normal wall layers Internal and external anal sphincters	Polyps/masses				
		Rectal cancer staging				
		Sphincter abnormalities				
		Fluid collections Subepithelial lesions				
Other structures	Mediastinum	Lymph nodes	Posterior	Celiac	Perirectal	
			Inferior	Perigastric	Left iliac	
			Aortopulmonary window	Gastrohepatic ligament		
	Vascular structures	Aorta Pulmonary artery Azygous vein		Portahepatis		
				Peripancreatic		
				Aorta	Aorta	Iliac arteries and veins
				Celiac artery		
				SMA		
				Splenic artery		
				Gastroduodenal artery		
				Portal vein		
				SMV		
				Splenic vein		
				IVC		
				Hepatic veins		
Non-GI organs	Heart (left atrium) Lungs Trachea Bronchi		Liver	Urinary bladder		
			Spleen	Prostate, seminal vesicles, urethra		
			Kidneys	Uterus, vagina		
			Left adrenal gland			

SMA, Superior mesenteric artery; SMV, superior mesenteric vein; IVC

Section 100

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1. $\mathbf{Y} = \mathbf{X}\boldsymbol{\beta} + \boldsymbol{\epsilon}$, where \mathbf{Y} is the vector of observed values, \mathbf{X} is the design matrix, $\boldsymbol{\beta}$ is the vector of parameters to be estimated, and $\boldsymbol{\epsilon}$ is the vector of error terms.

2. The error terms $\boldsymbol{\epsilon}$ are assumed to be independent and normally distributed with mean zero and constant variance σ^2 .

3. The least squares method minimizes the sum of squared residuals, which is equivalent to minimizing the squared norm of the error vector:

$$\min_{\boldsymbol{\beta}} \|\mathbf{Y} - \mathbf{X}\boldsymbol{\beta}\|^2$$

4. The normal equations are derived by setting the derivative of the squared norm to zero:

$$\mathbf{X}^T(\mathbf{Y} - \mathbf{X}\boldsymbol{\beta}) = \mathbf{0}$$

5. This leads to the normal equations:

$$\mathbf{X}^T\mathbf{X}\boldsymbol{\beta} = \mathbf{X}^T\mathbf{Y}$$

6. If $\mathbf{X}^T\mathbf{X}$ is invertible, the least squares estimate of $\boldsymbol{\beta}$ is:

$$\hat{\boldsymbol{\beta}} = (\mathbf{X}^T\mathbf{X})^{-1}\mathbf{X}^T\mathbf{Y}$$

7. The fitted values $\hat{\mathbf{Y}}$ are then calculated as:

$$\hat{\mathbf{Y}} = \mathbf{X}\hat{\boldsymbol{\beta}}$$

8. The residuals \mathbf{e} are the difference between the observed values and the fitted values:

$$\mathbf{e} = \mathbf{Y} - \hat{\mathbf{Y}}$$

9. The variance-covariance matrix of the least squares estimates is:

$$\text{Cov}(\hat{\boldsymbol{\beta}}) = \sigma^2(\mathbf{X}^T\mathbf{X})^{-1}$$

10. The total variance of the response variable \mathbf{Y} is decomposed into the variance of the fitted values and the variance of the residuals:

$$\text{Cov}(\mathbf{Y}) = \text{Cov}(\hat{\mathbf{Y}}) + \text{Cov}(\mathbf{e})$$

11. The variance of the fitted values is:

$$\text{Cov}(\hat{\mathbf{Y}}) = \mathbf{X}(\mathbf{X}^T\mathbf{X})^{-1}\mathbf{X}^T$$

12. The variance of the residuals is:

$$\text{Cov}(\mathbf{e}) = \sigma^2(\mathbf{I} - \mathbf{X}(\mathbf{X}^T\mathbf{X})^{-1}\mathbf{X}^T)$$

13. The total variance of \mathbf{Y} is:

$$\text{Cov}(\mathbf{Y}) = \sigma^2\mathbf{I}$$

14. The variance of the residuals is:

$$\text{Cov}(\mathbf{e}) = \sigma^2\mathbf{I} - \text{Cov}(\hat{\mathbf{Y}})$$

15. The variance of the fitted values is:

$$\text{Cov}(\hat{\mathbf{Y}}) = \mathbf{X}(\mathbf{X}^T\mathbf{X})^{-1}\mathbf{X}^T$$

16. The variance of the residuals is:

$$\text{Cov}(\mathbf{e}) = \sigma^2(\mathbf{I} - \mathbf{X}(\mathbf{X}^T\mathbf{X})^{-1}\mathbf{X}^T)$$

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