Physiological, anatomical features of the digestive system in children. Peptic ulcer disease

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The main functions of the digestive system

1. To process and absorb nutrients
2. The excretory function
3. Detoxification
4. Maintain fluid and electrolyte balance
5. The mechanical function

Six Major Digestive Processes

1. INGESTION
2. PROPULSION
3. MECHANICAL DIGESTION
4. CHEMICAL DIGESTION
5. ABSORPTION (of nutrients)
6. DEFECATION (of wastes)

Digestive system

- **The digestive tract**
  - a long muscular tube with many sections and areas
  - begins with the mouth and ends with the anus
- **Accessory parts**
  - organs that are not in the digestive tract but helps in the digestion

Morphological peculiarities of all parts of digestive system in infants

1. The mucous membrane is thin, soft, dry and easy damage
2. The submucosal layer is well vascularized
3. The submucosal layer consist of loose connective tissue
4. Underdevelopment (immaturity) of muscular and elastic tissue

Physiological peculiarities of digestive system in infant

1. The secretory function of digestive system is impaired

2. Digestive system produces only small amounts of digestive juice

3. Digestion is worse – the food has to be adequate for the child's age

Peculiarities of oral cavity in infant

- It is relatively small
- Maxillar alveolar apophysis are short and immature
- Soft palate is located horizontally, and hard palate is broad and flat
- Mucosa is fine, dry and well vascularised
- The sucking fat in the cheeks fill the mouth and help to maintain negative pressure
- The tongue is relatively thick and large
- Teeth are absent
- On medium line there are epithelial nodules Bon

The salivary glands

- The salivary glands are formed at birth, but are not functional (secretion of saliva is low).

- Insufficient saliva in the first months of life is explained by incomplete development of the CNS and by reduced size of the salivary glands.

- Salivation begins to increase with teething because excitation of the trigeminal nerve (the fifth pair) or by excitation of pain receptors.

- Parotid gland is missing at birth but develops intensively from the age of 3-4 months

Parotid gland

Parotid duct

Parotid gland

Sublingual ducts

Sublingual gland

Submandibular duct

Submandibular gland
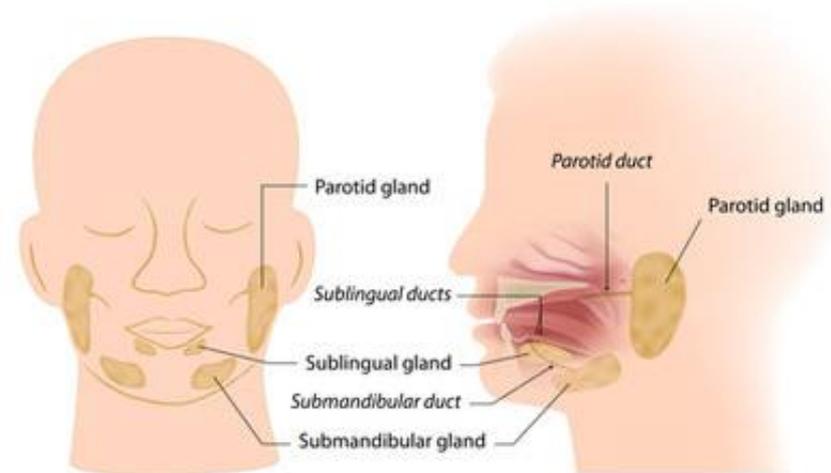
Peculiarities of pharynx in infants

- Pharynx in the newborn is larger and located lower than in adults, the oral part is on the same level as oral cavity

- Has a length of 40 mm which is 1/3 of the adult size.

- The lymphoid tissue of Waldeyer's ring is located at the gateway of adult pharyngx. In children this ring is missing (is missing the most important component of the ring – palatine tonsils).

- Eustachian tube (communicate with the middle ear) is situated in a horizontal position, is shorter and the lumen is wider.

- The baby can breath and swallow the food at once
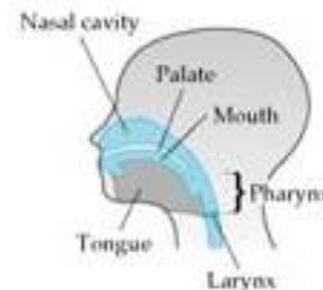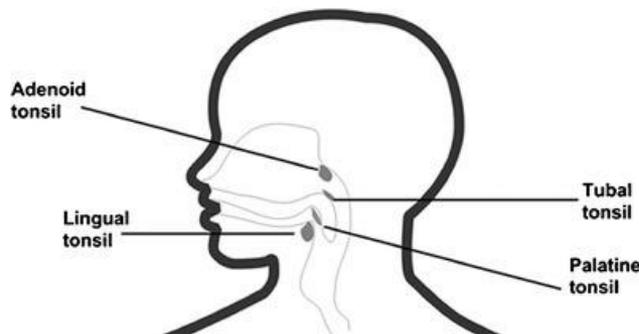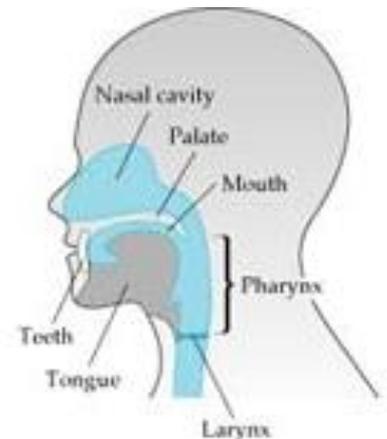
Peculiarities of the esophagus in infants

- Is well developed, has the shape of two funnels enlarged upper and lower, which facilitates leaking milk
- Average length of the esophagus in newborn is 10-16 cm
- It is relatively narrow
- The entrance into the esophagus is:
  in newborn – between the III-IV cervical vertebra
  2 years of live – IV-V cervical vertebra
  12 years of live – VI-VII cervical vertebra
- The localization of lower esophagus sphincter is the same in children of different age groups (X-XI thoracic vertebra)
- Ratio between the length of the esophagus and the length of the body is the same in children of different age groups (1:5)
- Bischoff's formula: length of esophagus = 1/5 of the body length

Peculiarities of the stomach in infants

- The stomach lying horizontally, is cylindrical until approximately 2 year of age

- In horizontally lying of baby the gastric fundus is lower as the antral part of the stomach – gastroesophageal reflux is frequent

- Cardial sphincter has a poor development of mucous membrane and muscular lining.

- The cardia is fixed on the left to the Th_X vertebra.

- Pyloric part is developed well, is on the median line at the level of the Th_{XII} vertebra

- The fundus of the stomach is under the left dome of diaphragm

- The weight of the stomach in newborn is 6-7 g, in 1 year – 18-21 g

The anatomical capacity of the stomach, ml (cm³)

Child age	Stomach volume
Newborn	30-35
4th days	40-45
10th day	80 (is increased by 11 times)
14th days	90
In next months the anatomical capacity of the stomach increase for 25 cm³	
1 year	250-300
2 years	500
3 years	400-600
4 years	700
7 years	900
8 years	1000
10-12 years, adults	1300-1500

Glandular epithelium

Glandular epithelium contains **3 types of glands:**

- ***Cardial glands*** secrete mucus
- ***Fundic glands*** with 4 cell types
  - *Mucous neck cells* secrete mucus and bicarbonates
  - *Parietal cells* – secrete hydrochloric acid, water, electrolytes.
  - *Chief cells* – secrete pepsinogen and gastric lipase
  - *Enterocromaffinlike cells* – secrete histamine
- ***Piloric glands*** – exocrine cells
  - *D cells* – glucagon, somatostatin, D1 vasoactiv polypeptide.
  - *G cells* – motilin, histamine, kallikrein
- Gastric secretion in newborn is 1 ml/kg/h, 1-2 years is – 2-3 ml/kg/h
- The protheolytic function of the gastric juice is 1/3 less than in adults and gastric acidity is 2-3 times lower than in adults
  - Infant gastric pH ranges from 4.5-3.8, at the age of 7-10 years is – 2-2.5

Peculiarities of the bowels in infant

- The length is relatively longer then in adult
- The bowel is more mobile in infant
- Increasing of the intestine length is slower than the growth of body length

Stomach
Duodenum
Duodenojejunal flexure
Jejunum
Ascending colon
Mesentery
Ileocecal junction
Cecum
Appendix
Ileum
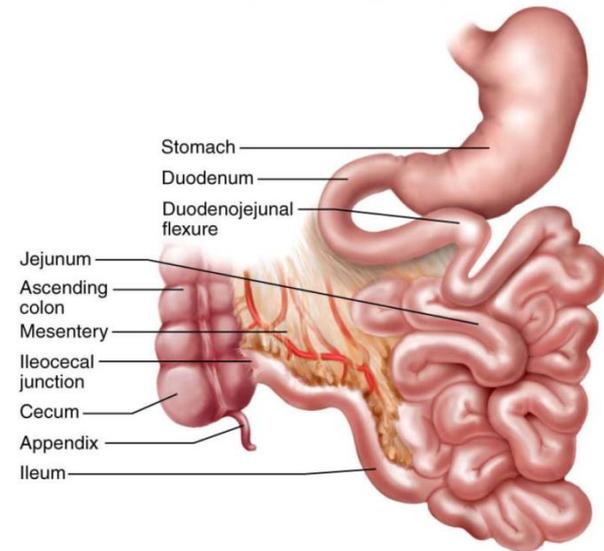
Ratio of bowel length to body length

Age	Ratio
newborn	8.3:1
1 year	6.6:1
16 years	7.6 :1
adult	5.4:1

Peculiarities of the small intestine in infants

- The small intestine is a specialized tubular structure with the stomach proximally and the colon distally
- The small bowel increases 20 times in length with aging, from 200 cm in the newborn to almost 6 m in the adult
- Small intestine has three segments:
  - Duodenum – upper part, connected to the stomach
    - is located at the I lumbar vertebra, at the age of 12 years is found in the III and IV lumbar vertebrae
    - where the digestive juices from the pancreas and the liver combine with chyme making it thin and watery
    - at the age of 7 years begins to develop adipose tissue that fix duodenum
  - Jejunum – occupies the left upper portion of the abdomen
  - Ileum – is positioned in the right abdomen and upper part of the pelvis
- The length of small intestine mesentery is relatively longer

Peculiarities of the intestinal wall

- Intestinal mucosa is very thin and well vascularized and villi are developed
- Intestinal submucosa is smooth and hydrophilic
- The mucosa is very permeable to many toxic substances, including undigested proteins that are potent allergens
- The mucosa and submucosa adheres poorly to the muscle layer, so often there is danger of detachment and intussusception
- The intestinal glands are bigger then in adult
- Lymphoid cells are in all regions of the small intestine
- At the age of 5-7 years mucosa becomes identical to that of the adult

Small Intestine

- **Digested nutrients are absorbed through intestinal walls**
- **Chemical digestion must be completed in the small intestine through enzymatic activity**
- Intestinal mucosa secretes several enzymes that acts on the food, but very few
- Absorbed materials cross the mucosa into the blood then other parts of the body for storage or further chemical change

Peculiarities of the large intestine in infants

- The large intestine is not completely developed
- Intestine length is approximately equal to body length (in any age)
- The mucosa is smooth, does not contain villi, but contains glands Lieber (larger than in adults)
- Lymph follicles are more numerous, but they do not form Peyer's patches. These patches appear at 2-3 years, so local protection is weak
- Haustrumes appear after 6 month of life
- Muscle tissue is poorly developed so the propulsion capacity is insufficient, this is the major cause of constipation and common inflammation in the intestine
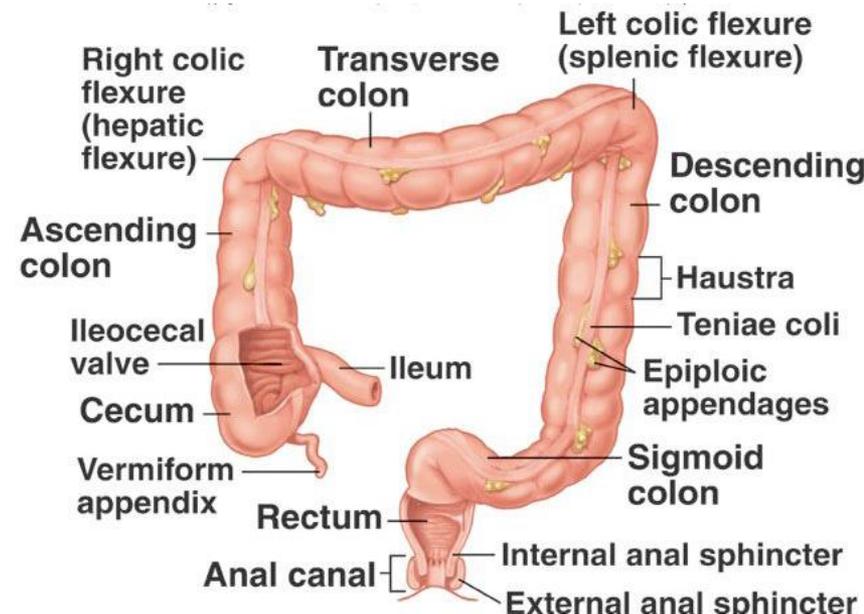
Peculiarities of the sigmoid colon in infants

- Is longer and is mobile
- Increasing in size during the life
- In children younger 5 years is upper then in schoolchildren (in schoolchildren is in the pelvic cavity)

Peculiarities of the rectum in infants

- The localization is under the entrance into the small pelvis in preschoolchildren
- In schoolchildren the rectum is in the small pelvis
- Is longer and is mobile
- In newborn is absent ampulla

Accessory structures of digestive system
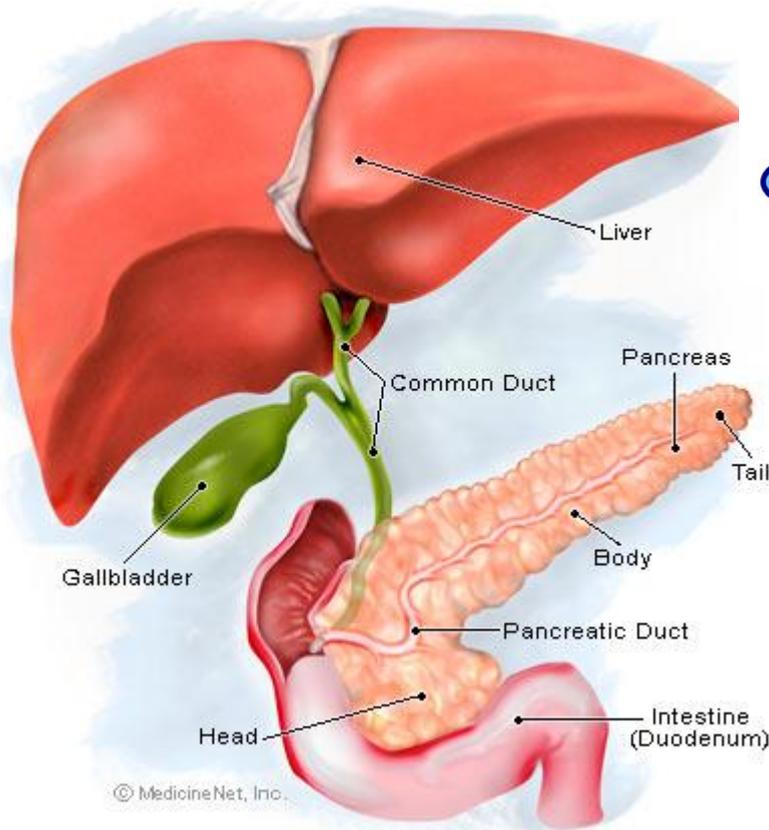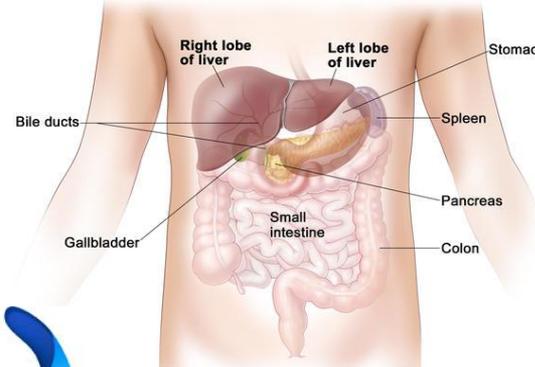
- **LIVER**

- **GALL BLADDER**

- **PANCREAS**

Peculiarities of the liver in infants

- Before the birth the liver is the largest organ of the body, occupying ½ of the whole abdomen
- It is in the upper quadrant of the abdomen and one part of the left and epigastrium
- The left lobes before the birth up to 1 year of life is very massive
  - may be below the costal margin of 2-4 cm
  - can be palpated below the right costal margin until the age of 7 years
- Large size of the liver is explained by the importance of liver function – *hematopoietic organ*
- Hematopoietic function in the newborn is imperfect so there is a volume compensation from the liver
- Liver capsule is very thin
- In the capsule and parenchyma are present elastic and collagen fibers

Peculiarities of the gallbladder in infants

- Gallbladder has a cylindrical shape in newborns, is smaller in relation to the liver and is fully protected by it

- The gallbladders bottom is covered with peritoneum

- Duct length is greater (5-18 mm) in comparison with adults

- Bile content is richer in water and low in cholesterol and bile pigments

Spiral part of cystic duct

Right hepatic duct
Left hepatic duct
Common hepatic duct

Neck of gallbladder

Infundibulum (Hartmann's pouch) of gallbladder

Body (corpus) of gallbladder

Smooth part of cystic duct

Common bile duct

Fundus of gallbladder

Descending (2nd) part of duodenum

Gland openings

Pancreatic duct

Major duodenal papilla (of Vater)

Ampulla (of Vater)
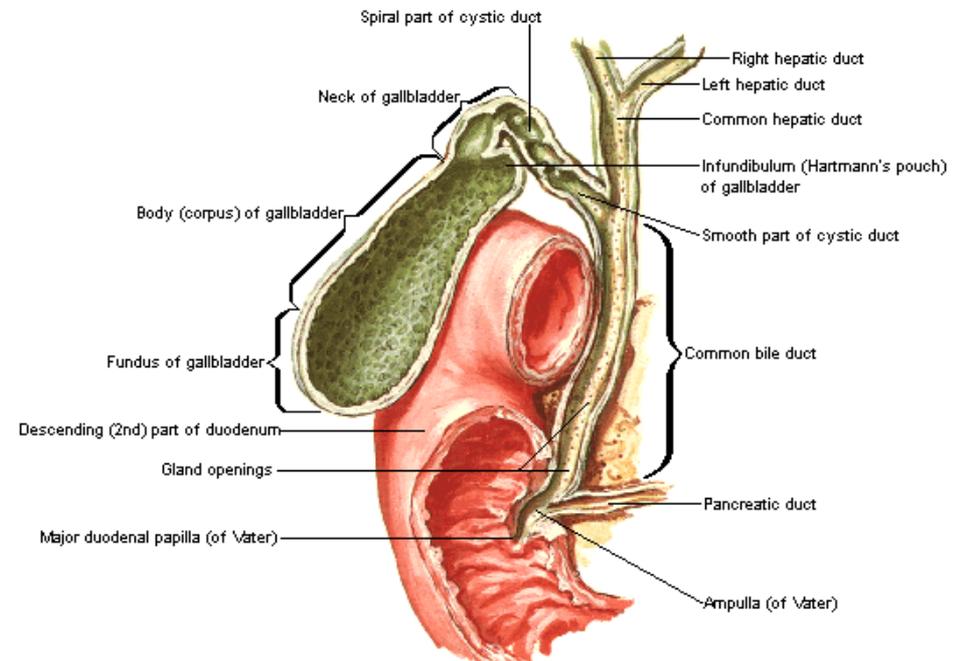
Liver functions

- Bile production
- Synthesis of the majority of serum proteins (albumin, α-globulin, β-globulin, prothrombin, fibrinogen, proconvertin, proaccelerin)
- Stores vitamins A,D,E,K
- Stores sugar and glycogen
- Carbohydrate metabolism
- Detoxification
- Hematopoietic function

Liver ——

—— Spleen
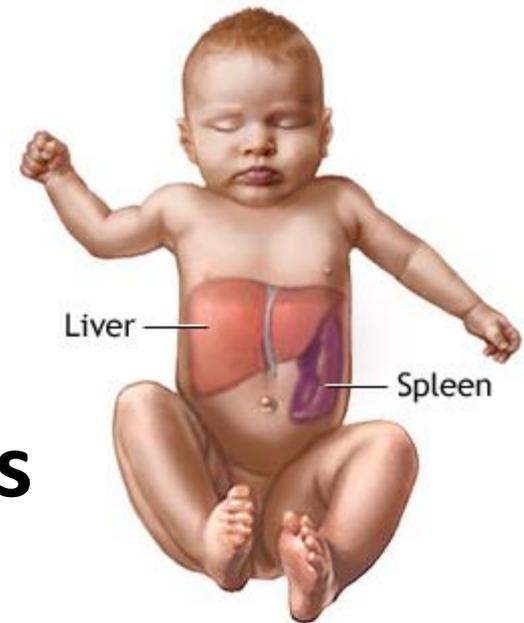
Gallbladder functions

- Stores bile in between meals
- Secretes bile to the duodenum through the bile duct during mealtime
  - Bile contains bile salts, pigments, cholesterol and phospholipids
  - Bile is an emulsifier **NOT** an enzyme
  - Emulsifier – dissolves fat into the watery contents of the intestine

Peculiarities of the pancreas in infants

- Pancreas contains exocrine (97%) and endocrine (3%) cells
- **Exocrine function** – the secretion of enzymes
  - proteolytic (trypsin, kimotrypsin, elastase)
  - glycolytic (α-amylase, β-lactase, maltase)
  - lipolytic (lipase, phospholipase A and B)

- **Endocrine function** is expressed through the secretion of hormones (insulin, glucagon, somatostatin, lipocain)

Gallbladder:
Neck
Body
Head

Hepatic ducts

Common hepatic duct

Cystic duct

Bile duct

Accessory pancreatic duct

Pancreatic duct

Duodenum

Pancreas:
Tail
Body
Head

Minor duodenal papilla

Duodenojejunal flexure

Hepatopancreatic sphincter

Major duodenal papilla

Circular folds

Jejunum
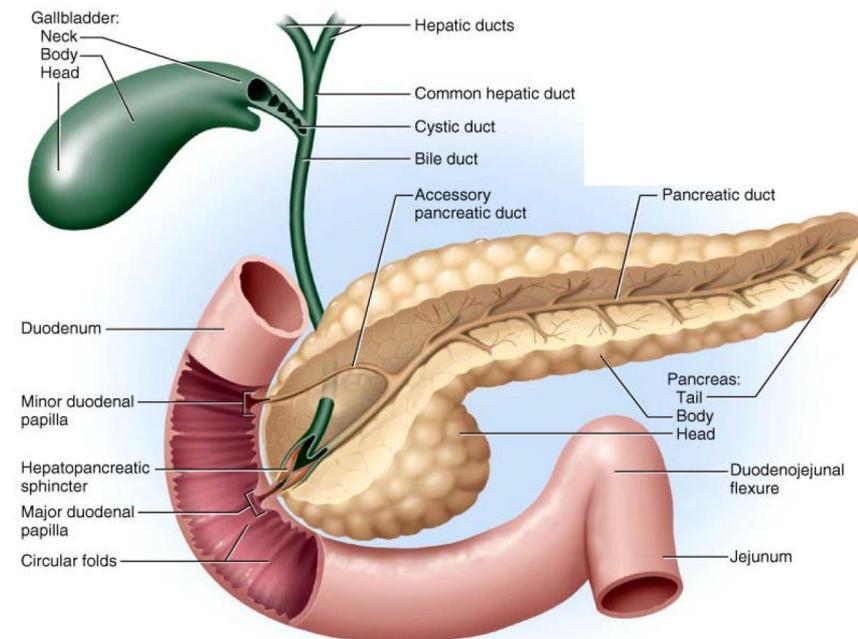
The most common complaints of digestive disorders

- Dispeptic disturbances
- Appetite (poor, excessive, moderate)
- Heartburn (gastro-esophageal reflux)
- Nausea and Vomiting
- Abdominal pain
- Diarrhea and Constipation
- Bloating, Hiccups and Excessive gas
- Ingesting a nonfood item or poison
- Anal Fissures, odd color or blood in stools

Gastro-esophageal reflux

- The term **gastro-esophageal reflux** (GER) implies a functional or physiologic process in a healthy infant with no underlying systemic abnormalities

- GER is a common condition involving regurgitation, or "spitting up" which is the passive return of gastric contents retrograde into the esophagus

- The prevalence of GER peaks between 1-4 months of age, and usually resolves by 6 to 12 months of age

- Regurgitation has been reported in 40-65% of healthy infants, but decreases to 1% by one year of age.

Nausea

Nausea is the unpleasant feeling of repulsion towards certain foods, accompanied by imminent desire to vomit

Causes:

- *Digestive:* appendicitis, biliary, intestinal obstruction, pancreatitis, peptic ulcer disease, pyloric stenosis
- *Neurological:* brain tumors, meningitis
- *Metabolic and endocrine:* diabetes, Addison's disease
- Renal: chronic renal failure
- Other: febrile illness, pregnancy, seasickness, drugs

Vomiting

- **Vomiting** is a reflex act which represents the evacuation of the stomach contents (food or fluid) through the mouth, following the simultaneous contraction of the stomach, diaphragm, abdominal muscles, contraction of the pylorus and opening of the cardia

- The act of vomiting takes place in three successive stages
  - nausea and autonomic phenomena associated with it
  - muscle contractions (effort vomiting)
  - expulsion of gastrointestinal content (vomiting itself)

- Types of vomiting
  - acute vomiting
  - chronic vomiting

Acute vomiting

- begins suddenly in full health;

- untreated, can cause severe disorders of internal homeostasis (acidosis, dehydration, etc.)

Types of acute vomiting

- **Primary vomiting (occasional)** – transient, self-limited and without major clinical consequences; more common in infants caused by nutritional technical mistakes (overeating), qualitative changes in the diet; use of age-inappropriate foods; in infants that are sucking greedily

- **Secondary vomiting** – are the result of GIT diseases or other organs which may send impulses to the vomiting center associated with acute vomiting production;

There are two major groups of *causes: medical* and *surgical*

Acute diarrhea in children

- Acute diarrhea is defined as the abrupt onset of 3 or more unusually loose stools in a 24 hour period and lasts no longer than 14 days;

- Persistent diarrhea is defined as an episode that lasts longer than 14 days.

- However, it is the consistency of the stools rather than the number that is most important
  - frequent passing of formed stools is not diarrhea.
  - babies fed only breast-milk often pass loose, "pasty" stools; this also is not diarrhea.

Clinical types of diarrheal diseases

- *acute watery diarrhea* (including cholera), which lasts several hours or days: the main danger is dehydration; weight loss also occurs if feeding is not continued;

- *acute bloody diarrhea*, which is also called dysentery: the main dangers are damage of the intestinal mucosa, sepsis and malnutrition; other complications, including dehydration, may also occur;

- *persistent diarrhea*, which lasts 14 days or longer: the main danger is malnutrition and serious non-intestinal infection; dehydration may also occur;

- *diarrhea with severe malnutrition* (marasmus or kwashiorkor): the main dangers are severe systemic infection, dehydration, heart failure, vitamin and mineral deficiency.

Constipation

- For practical clinical purposes, **constipation** is generally defined as infrequent defecation, painful defecation, or both. In most cases, parents are worried that their child's stools are too large, too hard, not frequent enough, and/or painful to pass.

- The North American Society of Gastroenterology, Hepatology, and Nutrition (NASPGHAN) defines **constipation** as *"a delay or difficulty in defecation, present for 2 weeks or more, and sufficient to cause significant distress to the patient."*

- The Paris Consensus on Childhood Constipation Terminology (PACCT) defines **constipation** as *"a period of 8 weeks with at least 2 of the following symptoms: defecation frequency less than 3 times per week, fecal incontinence frequency greater than once per week, passage of large stools that clog the toilet, palpable abdominal or rectal fecal mass, stool withholding behavior, or painful defecation."*

Health History Assessment

- **Appetite:** Assess any changes in appetite, food intolerances, and the presence of nausea and/or vomiting.

- **Pain:** include specific questions about when the pain occurs – before meals, after meals, in the middle of the night, and any food associations. Specifically ask about heartburn and problems with a sore mouth, tongue, or throat.

- **Teeth/Gums:** Ask about problems with bleeding gums, dental caries

- **Throat:** Ask about any hoarseness or voice changes that might indicate the presence of a tumor, any difficulty swallowing, and the presence or absence of tonsils.

- **Lower GI:** Assess for problems with eructation, flatulence, the color, frequency, and amount of stools.

- Assess previous GI disease history such as cholecystitis, inflammatory bowel disease

Mouth and throat inspection

- *Angular cheilitis* (angular stomatitis or perleche)

- *Aphthous ulcers* are small, superficial, painful ulcers with a white or yellow base and a narrow halo of hyperemia

- *Retention cysts of* the mucous glands of the lips and buccal mucosa appear as round, translucent swellings, elevated from the surface with a characteristic white or bluish appearance

The breath

- The commonest sources of offensive breath are: carious teeth, infection or ulceration of the gum, stomatitis, retention and decomposition of secretion in the follicles of enlarged tonsils are.

- Characteristic odorous may be recognized:
  - in ketosis, the breath smells of acetone;
  - in uraemia, there is a fishy or ammoniacal odour;
  - in hepatic failure, the odour is described as 'mousy';
  - in suppurative conditions of the lung the breath may have a putrid smell;
  - in bronchiectasis the odour has been compared to that of apple blossom with a hint of stale faeces.

Examination of abdomen

- Inspection:
  - Shape.
  - Visible swellings, hernias.
  - Umbilicus, veins.
  - Visible peristalsis.

- Percussion:
  - Fluid wave, shifting dullness.
  - Liver, spleen.

- Palpation:
  - Masses.
  - Areas of tenderness, rebound, guarding.
  - Liver, spleen: <3 years may palpate up to 2 cm below costal margin.
  - Kidneys, bladder.

- Auscultation:
  - Bowel sounds.

Areas of the anterior abdominal wall
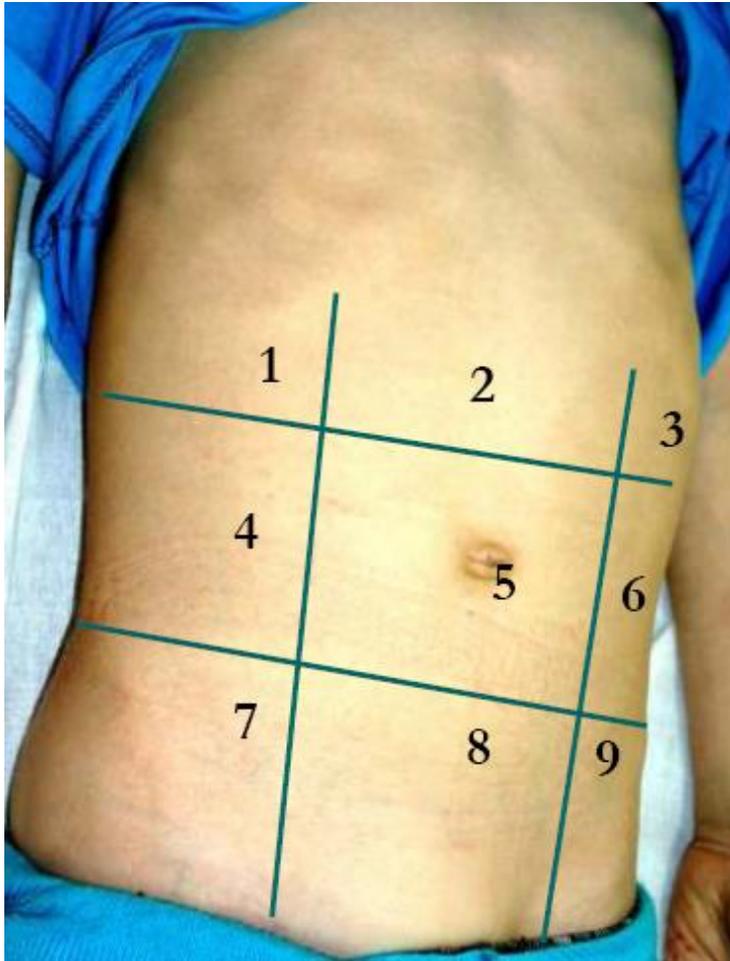
- The **abdominal cavity** is the portion of the trunk from directly beneath the diaphragm and thoracic cavity to the region of the pelvic cavity.

Abdominal cavity is divided into 9 quadrants.

- vertical lines from the mid-clavicular area to the mid-inguinal point
- two horizontal lines through the subcostal margins and the anterior iliac crests

Areas of the anterior abdominal wall
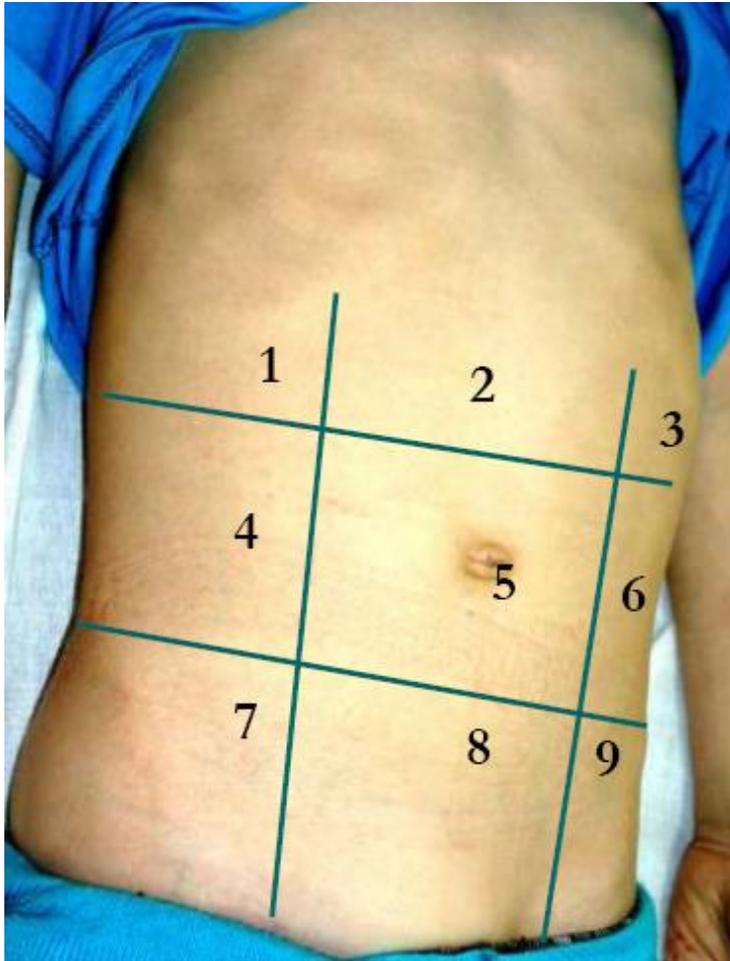
Abdomen can be divided 9 regions

- Epigastric area
  1. Right hypocondrium
  2. Epigastrium
  3. Left hypocondrium

- Midepigastrium area
  4. Right lumbar
  5. Umbilical
  6. Left lumbar

- Hypogastric area
  7. Right inguinal
  8. Hypogastric
  9. Left inguinal

Abdomen inspection

- *Contour* – quite cylindric, prominent in the erect position (physiologic lordosis), flat in supine position
- *Size* and *tone* of the abdomen give indication of general nutritional status and muscular development
  - obese children – large, prominent, flabby abdomen
  - undernutrition – a concave abdomen
  - protruding abdomen – may indicate pathologic states such as abdominal distention, ascites, tumors, or organomegaly.
- *Skin* covering the abdomen – scars, ecchymotic areas, excessive hair distribution, or distended veins
- *Movement* of the abdomen - *peristaltic waves* may be visible through the abdominal wall
- A doctor may observe *pulsation* of the descending *aorta* in the epigastric region (midline and below the xiphoid).

Abdomen auscultation

- The most important sound to listen for is *peristalsis,* or *bowel sounds,* which sound like short metallic clicks and gurgles.

- Loud grumbling noises, known as *borborygmi,* are the familiar "stomach growls" usually denoting hunger.

- A sound may be heard every 10 to 30 seconds and its frequency per minute should be recorded (for example, 5 bowel sounds/minute).

- Absent bowel sounds or hyperperistalsis is recorded and reported, since either usually denotes abdominal disorder.

- Normally the pulsation of the aorta is heard in the epigastrium.

Abdomen percussion

- Liver – dullness on the right side at the lower costal margin

- Tympany is typically heard over the stomach on the left side and usually in the rest of the abdomen.

- Lack of tympany may occur normally when the stomach is full after a meal, but in other situations it may denote the presence of fluid or solid masses.

Abdomen palpation

- Palpation is used to establish normal topographic relations between the abdominal organs; or to detect any possible pathology

- In *superficial palpation* a doctor lightly places the hand against the skin and feels each quadrant, noting any areas of tenderness, muscle tone, and superficial lesions.

- *Deep palpation* is used for palpating organs and large blood vessels and for detecting masses and tenderness that were not discovered during superficial palpation. If the child complains of abdominal pain, that area of the abdomen is palpated *last.*

Special methods of investigation

- Laboratory tests
- Gastroscopy
- Duodenal intubation
- Esophageal intubation
- Colonoscopy
- Scanning of the liver
- Laparoscopy
- Esophagoscopy

Laboratory tests

- **Complete blood count (CBC)**
- **Albumin level** – low levels of albumin (chronic liver disorders)
- **Bilirubin level** – elevated levels may indicate an obstruction of bile flow or a defect in the processing of bile by the liver
- **Electrolyte tests** – children who have lost large amounts of fluid due to vomiting or diarrhea often lose large amounts of the electrolytes
- **Fecal fat test** – in malabsorption elevated amounts of fat in the stool.
- **Fecal occult blood test**
- **Hydrogen breath test** – diagnose several digestive problems, including carbohydrate intolerance, bacterial overgrowth of the small intestine, rapid transit of food through the small intestine

Imaging tests

- **Ultrasound** – create images of blood vessels, tissues, and organs.

- **Upper GI series** – examine the organs of the upper part of the digestive system: the esophagus, stomach, and duodenum

- **Lower GI series (barium enema)** – a procedure that examines the rectum, the large intestine, and the lower part of the small intestine

- **CT and MRI** – shows detailed images of any part of the body, including the bones, muscles, fat, and organs

Endoscopic procedures

- **Colonoscopy** is a procedure that allows to view the entire length of the large intestine, and can often help identify abnormal growths, inflamed tissue, ulcers, and bleeding.

- **Endoscopic retrograde cholangiopancreatography (ERCP)** is a procedure that allows to diagnose and treat problems in the liver, gallbladder, bile ducts, and pancreas.

- **Esophagogastroduodenoscopy (upper endoscopy)** is a procedure that allows to look at the inside of the esophagus, stomach, and duodenum

Peptic Ulcer Disease

Peptic ulcer disease

- The lesion of peptic ulcer disease (PUD) is a disruption in the mucosal layer of the stomach or duodenum

- An ulcer is distinguished from an erosion by its penetration through the muscular mucosa or the muscular coating of the gastric or duodenal wall

Peptic Ulcer Disease

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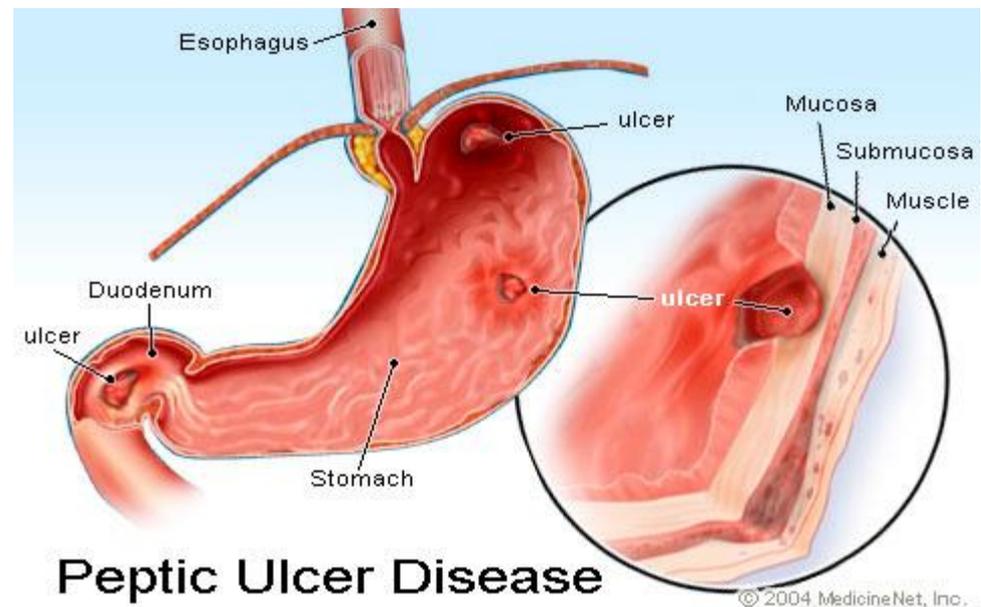
Pathophysiology

- PUD results from the **imbalance** between defensive factors that protect the mucosa and offensive factors that disrupt this important barrier

- Some mucosal **protective factors** include
  - water-insoluble mucous gel layer
  - local production of bicarbonate
  - regulation of gastric acid secretion
  - adequate mucosal blood flow

- **Aggressive factors** include
  - the acid-pepsin environment
  - infection with *Helicobacter pylori*
  - mucosal ischemia

Causes

- Primary peptic ulcers are still relatively uncommon in children

- It is seen more often in adolescents than in childrenâ

- Secondary ulcers are seen in head trauma, severe burns, and in use of corticosteroids and nonsteroidal anti-inflammatory drugs (NSAIDs)

- The highest mortality rates are found in young infants with secondary stress ulcers, who may present acutely with life-threatening GI hemorrhage or intestinal perforation

Clinical History

- Review of past illnesses and chronic medical conditions
- Family history of ulcer disease, including known *H pylori* infection, or conditions affecting the GI tract (e.g., Crohn disease)
- Character, location, frequency, duration, severity, and exacerbating (especially meals in children) and alleviating factors of abdominal pain
- Vomiting and description of gastric material
- Bowel habits and description of stool (eg, profuse diarrhea seen in Zollinger-Ellison syndrome [ZES])
- Medications, especially NSAIDs and corticosteroids
- Prior diagnostic testing and specific GI therapies
- Appetite, diet, and weight changes
- Family and social stressors
- Alcohol ingestion and smoking habits

Abdominal pain is the most common symptom of childhood PUD

- The pain is usually dull and vague.
- Food intake often causes the pain; this is the opposite of the adult pattern.
- The pain may be poorly localized or localized to the periumbilical or epigastric areas.
- In preschool-aged children, the pain is typically periumbilical and worsens after eating.
- After 6 years of age, the child's description of pain may be similar such in adults.
- The classic pain of PUD (pain that awakens the child, worsens with food, and is relieved by fasting) is described infrequently, but it helps in distinguishing GI pathology from psychogenic pathology when present.
- Frequent exacerbations and remissions of pain extend over weeks to months.

Clinical picture

- Vomiting in infants may be associated with slow growth
- GI tract bleeding (melena, hematemesis) may be another presentation in children
  - In infants and particularly neonates, serious underlying illness and stress ulceration most commonly manifest as acute perforation or hemorrhage.
  - GI bleeding may lead to iron-deficiency anemia, and patients may present with vague complaints of fatigue, headache, dyspnea, or malaise.
- For children with ulcer perforation, the symptoms are consistent with peritonitis and abrupt in onset

Physical examination

- Observation of the **general appearance** of the child
- Evaluation of **vital signs**
- Assessment of perfusion with attention to mental status, heart rate, pulses, and capillary refill
- Assessment of **hydration status** with attention to moisture of the mucous membranes and skin turgor
- Observation of any pallor of the skin and conjunctivae
- Thorough chest examination
- Careful inspection, auscultation, and palpation of the abdomen, with notation of any liver or spleen enlargement
- Rectal examination and stool testing

Differential diagnosis

- Appendicitis
- Cholecystitis
- Cholelithiasis
- Crohn Disease
- Esophagitis
- Gastroenteritis

Laboratory tests

- Measurement of the **prothrombin time** and the **activated partial thromboplastin time**
  - These values are used to identify coagulopathy in patients with sepsis, multiple injuries, or massive GI bleeding
- Determination of **electrolyte**, **creatinine** levels
  - These levels aid in assessing patients with volume depletion or those who require fluid resuscitation
- **Arterial blood gas analysis**
  - to assess the degree of acidosis in a patient with systemic illness, respiratory failure, or severe hypovolemia
- **WBC** count and differential
  - to detect peripheral eosinophilia in children with eosinophilic gastritis
- Examine on the **stool** to confirm GI bleeding

Imaging Studies

- Abdominal and/or chest **radiography** assist in the diagnosis of perforation.

- **Upper-GI series** (barium swallow)
  - An upper-GI series helps in detecting PUD in approximately 70% of children who are examined
  - The sensitivity is higher for duodenal ulcers than for gastric ulcers.

  - Radiologic findings of duodenal ulcers include filling defects or deformities of the duodenal bulb.
  - A fibrinous clot in the ulcer may lead to false-negative findings
  - Rates of false-positive findings on barium studies are especially high, up to 30-40%, in pediatric patients
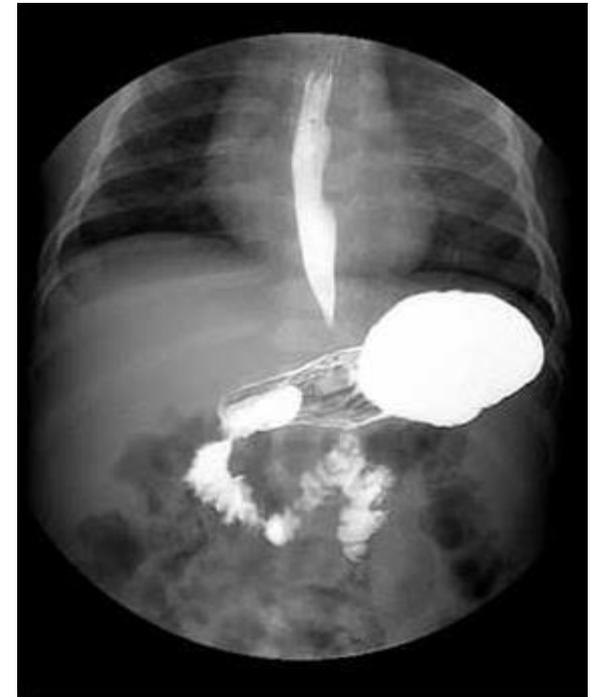
Esophagogastroduodenoscopy

- Is the procedure of choice for detecting PUD in children

- EGD allows for direct visualization of the mucosa; for localization of the source of bleeding; and for the diagnosis of *H.pylori* infection by analyzing biopsy specimens, performing cultures or detecting urease activity

- **Therapeutic endoscopy** for acute bleeding (coagulation of a bleeding ulcer with a heater probe or injection with vasoconstricting agents)
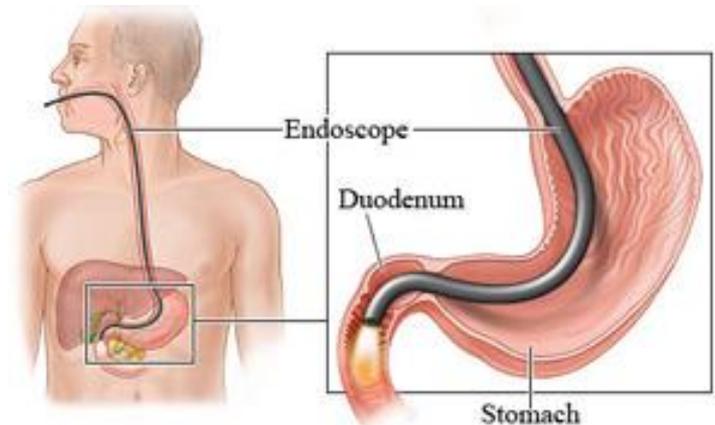
Treatment

- First-line eradication regimens
  - **triple therapy** with a PPI + amoxicillin + imidazole; or PPI + amoxicillin + clarithromycin; or bismuth salts + amoxicillin + imidazole; or sequential therapy
  - the duration of triple therapy is 7-14 days
- Second-line or salvage therapy
  - Quadruple therapy is with PPI + metronidazole + amoxicillin + bismuth
  - the duration of triple therapy is 14 days

Prognosis

- Mortality rates are low in older children with primary ulceration and *H pylori* infection

- Mortality rates remain highest in neonates, as well as infants and children with systemic illness or injury, who present with acute bleeding or perforation