Pathophysiology of the GI Tract
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Gastro-intestinal problems
- The clinical spectrum of gastro-intestinal problems ranges from minor infections with acute vomiting and diarrhoea, to functional dyspeptic symptoms and vague undiagnosed abdominal pains through specific conditions such as peptic ulcers and chronic intestinal inflammatory disorders, to life threatening acute abdominal emergencies and cancers.

Patient consulting rates:
- One-quarter of consultations are due to GI problems.
- The most common consultations were for the less specific conditions such as presumed acute gastrointestinal infections, undiagnosed abdominal pain, dyspeptic symptoms, functional disorders of the stomach, and uncertain irritable bowel syndrome.
- Life threatening conditions such as cancer and acute abdominal emergencies are relatively small.
- The nurse must accept that two-thirds are these vague conditions of indefinite nature that have to be managed nevertheless.

A & P
The Digestive System
Consists of two main groups of organs:
1. Those of the alimentary canal:
   - Mouth,
   - Pharynx,
   - Oesophagus,
   - Stomach,
   - Small intestine,
   - Large intestine, including the anus.

2. Those of the accessory organs:
   - Teeth,
   - Tongue,
   - Salivary glands,
   - Liver,
   - Gall bladder,
   - Pancrease.

Figure 24.1 The Components of the Digestive System
The alimentary canal is a continuous, coiled, hollow muscular tube (9 metres “or 30 feet” long) that is opened to the external environment at both ends.

It digests foods and absorbs the digested materials into the blood.

Overview of functions

- **Ingestion**: (food intake).
- **Propulsion**: Movement of food through the tract.
- **Mechanical digestion**: Breaking the food down into smaller fragments.
- **Chemical digestion**: Food breakdown by enzymatic action.
- **Absorption**: Transport of products of digestion through the intestinal mucosa into the blood.
- **Defecation**: 

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**Figure 24.27 Digestive Secretion and Absorption of Water**

**Figure 24.4 Peristalsis**

**Figure 24.11 The Swallowing Process**

**Our own food breakdown factory!**
Pathophysiology of GI tract:

1. Expulsion from G.I. Tract
2. Gastrointestinal inflammation
3. Ulceration
4. G.I. Bleeding
5. Obstruction
6. Malabsorption
7. G.I. Tumours

1. Expulsion from G.I. Tract

- Vomiting
- Diarrhoea
- Constipation

2. Gastrointestinal inflammation

- i) Oesophagitis
- ii) Inflammation of the stomach and the intestine (gastritis, enteritis, gastroenteritis, colitis)
  - Various irritants of biological or chemical origin can provoke fairly mild inflammations of short duration which will trigger vomiting and diarrhoea.
  - Damage: minimal.
  - Healing: rapid.
- iii) Appendicitis
- iv) Peritonitis
  - Caused most commonly by perforation of an inflamed abdominal organ, often the appendix. It may also result from abdominal wounds, bleeding from GI Tract, or perforation of the colon’s wall by an invading tumour.
  - Peritonitis often produces the syndrome of acute pain onset, fever, and vomiting that is called acute abdomen.

3. Diverticulitis

- Diverticular Disease: Pouch formation, often multiple.
- Diverticula are present in 10% of the population; 95% of them in the sigmoid colon, mainly asymptomatic, and called Diverticulosis.
- Prevalence increases with age; 50% of patients over 60 have diverticulae.
- v) Diverticulitis

- Abscess
- Stricture
- Perforation
- Fistulae
- Haemorrhage

Signs and Symptoms

- If complications happen:
- Diverticulitis: Sometimes, faecal matter becomes impacted in them producing irritation and bacterial infection called Diverticulitis.
Investigations

- Barium Enema
- Colonoscopy
- CT – best way to show abscesses

vi) Inflammatory bowel disease.

- Non-specific inflammatory bowel diseases are those for which there is no identifiable aetiological agent.
- Two major forms:
  - Ulcerative colitis “UC”
  - Crohn’s disease.
- There is overlap between these two conditions in their clinical features, histological features and radiological features.

Small Intestine

The Structure of the Digestive Tract

Structure of the Villi in the Small Intestine

Structures Involved in Absorption of Nutrients

- Absorptive cells
- Blood capillaries
- Lacteals (specialized lymphatic capillaries)
Aetiopathogenesis

- Familial: 6–10% of patients affected have one or more relatives with the disease. 10-14 time risk with CD, and 8 times with UC.
- Genetics
- Diet
- Smoking
- Infective agents
- Immunopathogenesis

- Ulcerative colitis “UC” is always confined to the large bowel.
- Crohn’s disease (CD) affects the whole of the GI tract, from the mouth to the anus, although it has a tendency to affect the terminal ileum and ascending colon.
- UC usually begins distally affecting the rectum as proctitis and then spreads proximally to affect the whole of the large bowel.

- Crohn’s disease typically affects segments of the GI tract with areas of diseased bowel separated by intervening areas of macroscopically (grossly) normal bowel.
- The most common area to be affected is the terminal ileum and caecum. The next most common area is the colon. Isolated jejunal and ileal Crohn’s disease also occurs.

- The essential difference between UC and Crohn’s disease is the extent of the inflammation. The inflammation of UC is confined to the mucosa, whereas in Crohn’s disease it is transmural and is associated with fissuring, ulcers and granulomas.
Extra-intestinal manifestations of inflammatory bowel disease:
- These include:
  - eye disorders
  - joint disorders
  - skin lesion
  - aphthous mouth ulcers
  - finger clubbing
  - sclerosing cholangitis etc...

UC can be classified clinically into:
- 1. Mucous colitis
- 2. Relapsing colitis
- 3. Toxic dilatation
- Suspect UC whenever bloody diarrhoea lasts more than 7 days.

Symptoms:
- UC:
  - Blood and mucus passed per rectum with a formed stool suggests that disease is limited to the rectum; if accompanied by diarrhoea suspect more extensive disease.
  - Other features: Fever, aphthous ulcers, abdominal pain, weight lost, faecal urgency with incontinence.
  - General features include: malaise, lethargy, and anorexia
  - The disease can be mild, moderate or severe, and in most patients runs a course of remissions and exacerbations.
  - 10% have persistent chronic symptoms.

Clinical features of Crohn’s disease:
- Fever, diarrhoea, Cramping abdominal pain, weight loss, and slowing of growth in children. Rectal involvement and rectal bleeding is less common than in UC, fever and abdominal pain more so.
- Constitutional symptoms of malaise, lethargy, anorexia, nausea, vomiting and low grade fever.
- In 15% of these patients there are no GI symptoms.
- Anal and perianal lesions are characteristic.
- Differentiating UC from Crohn’s is possible in 80% of patients.

3. Ulceration
- Peptic ulcer: A breach in the mucosa of the oesophagus, stomach, duodenum or jejunum, which extends into the submucosa or deeper layers.
- This is in contrast to gastric erosion which is confined to mucosa.

- Peptic ulcers may arise throughout the oesophagus, stomach, and small intestine (i.e., those sites subjected to the action of the acid and pepsin of the gastric juice.
- They are also much less likely to occur in the jejunum or the ileum, most (98%) arising in the stomach and duodenum.
- They typically arise singly; only 20% of cases involve multiple sites.
- The gastric ulcers were thought to be the result of some compromise in mucosal defence mechanisms.
Main types of peptic ulcer:
- Acute (stress) ulcer
- Chronic ulcer

Outline of A & P of Stomach
- Is a J-shaped, pouch-like organ.
- About 25-30 cm long.
- It has a capacity of about 1 litre or more.
- Its inner lining is marked by thick folds (rugae).
- It receives food from the oesophagus, mixes it with gastric juice, initiates the digestion of proteins, carries on limited absorption, and moves food into the small intestine.

Regulation of gastric activity
- **Cephalic phase**: prepares the stomach to receive food. Triggered by the sight, smell, taste, or thought of food.
- **Gastric phase**: begins with the arrival of food in the stomach.
- **Intestinal phase**: begins when chyme starts to enter the small intestine, mainly inhibitory.
The lining epithelium of the stomach mucosa is a simple columnar epithelium composed entirely of goblet cells (which produce protective mucus).

**Other cells in the stomach are:**
1. Mucus neck cells: mucus
2. Parietal cells: HCl & Intrinsic factor
3. Chief cells: Pepsinogen (the inactive form of pepsin).
4. Enteroendocrine cells: Gastrin, somatostatin, histamine, etc

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**The Secretions of Hydrochloric Acid**

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**Aetiology**

- *Helicobacter pylori* – N.B. - Its location is relevant
  - an acid-resistant, Gram-negative bacillus;
  - Approx in 90% of DUs; and in 70% of GUs
  - may be linked with gastric carcinoma
May also c/o – anorexia, vomiting may be relieved or aggravated by food dull or burning

**Epigastric pain:**
- Alcohol, Spicy food, Stress.
- Genetic factors
- The effect of NSAIDS
- Helicobacter pylori antral gastritis
- Non-steroidal anti-inflammatory drugs
- Rare causes
  - Crohn's disease
  - Hypergastrinaemia
  - Idiopathic
  - Gastrinoma
  - Hyperparathyroidism

**Clinical Features**
- May be little clinical indication.
- Epigastric pain:
  - dull or burning
  - episodic: often wakes patient at night
  - may be relieved or aggravated by food
- May also c/o – anorexia, vomiting

**Complications**
- Bleeding
- Perforation
- Malignancy (GU)
Oesophagus

- Is a muscular, collapsible tube, about 25 cm (10 inches) long and about 2 cm in diameter.
- It carries solid food and liquids to the stomach.
- Lined with a stratified squamous epithelium that resists abrasion, hot or cold temperatures, and chemicals.
- Regions of muscle in the superior and inferior ends make up the upper and the lower oesophageal sphincters.
- The lower oesophageal sphincter (LOS) is normally contracted to prevent the backflow of materials from the stomach into oesophagus.

Symptoms & Signs of oesophageal disorders

**Symptoms:**
- Dysphagia
- Substernal discomfort/heartburn
- Acid regurgitation
- Painful swallowing

**Signs:**
- Very few signs.
- May be weight loss as a consequence of dysphagia.

Investigations

- Upper GI barium series
- Intra-oesophagus pH monitoring
- Radio-nuclear scintigraphy
- Oesophagoscopy
- Biopsy
- Oesophageal manometry

Hiatus Hernia (HH)

- Anatomical abnormality with part of the stomach in the chest, usually asymptomatic
- Herniation of part of the stomach into the chest
- Sliding HH
- Para-oesophageal or rolling hernia

Hiatal Hernia and Reflux

LES - pressure often low
Gastric pouch - intra-thoracic reservoir
Diaphragm - no esophageal pinch
Para-esophageal or rolling hernia
- When a small part of the fundus of the stomach rolls up through the hernia alongside the oesophagus.
- The sphincter remains below the diaphragm and remains competent. Occasionally a rolling para-oesophageal hernia will produce severe pain and require surgical treatment for gastric volvulus or strangulation.

Gastro-Oesophageal Reflux Disease (GORD)
- **Definition:**
  - Where there are symptoms or mucosal damage (or both) brought about by exposure of the distal oesophagus to refluxed gastric acid.
  - (Reflux: effortless return of gastric contents into oesophagus).

Important Reasons to Diagnose and Treat GORD
- Negative impact on health-related quality of life
- Risk factor for oesophageal adenocarcinoma

Documenting Reflux:
- Barium swallow X-ray is a reliable way of assessing the potential severity of reflux. It will also show the presence of a hiatus hernia.

Gastro-oesophageal reflux: Reflux of gastric contents which can occur normally with no symptoms.
- **GORD** - patient with reflux who has persistent symptoms.
- **Reflux oesophagitis** – inflammation of the lower oesophagus produced by persistent episodes of reflux. Patients may be asymptomatic.
The Lower Oesophagus Sphincter (LOS)
- Main barrier to reflux
- Normally contracted, so pressure raised
- Relaxes on swallowing
- Also, transient relaxations at other times.

Aetiology of GORD
- In reflux: –
- LOS pressure is too low
- Or
- Excessive number of transient relaxations

Pathogenesis of GORD:
- The following mechanisms have been implicated:
- Transient LOS relaxations.
- Low resting LOS tone which fails to increase when the patient is lying flat, as occurs normally.
- The LOS tone fails to increase when intra-abdominal is increased by tight clothing or pregnancy.
- There is increased oesophageal mucosal sensitivity to acid
- There is reduced oesophageal clearance of acid. The reduced acid clearance is exacerbated with a HH.
- Delayed gastric emptying occurs, which may increase the chance of reflux
- Prolonged episodes of gastro-oesophageal reflux which occur at night and post-prandially
Potential Oral and Laryngopharyngeal Signs Associated with GORD

- Edema and hyperemia of larynx
- Vocal cord erythema, polyps, granulomas, ulcers
- Hyperemia and lymphoid hyperplasia of posterior pharynx
- Interarytenoid changes
- Dental erosion
- Subglottic stenosis
- Laryngeal cancer

Clinical Features of GORD
- Heartburn
- Oesophagus pain
- Regurgitation into mouth
- Cough

Barium Swallow
- Useful first diagnostic test for patients with dysphagia
  - Stricture (location, length)
  - Mass (location, length)
  - Hiatal hernia (size, type)
- Limitations
  - Detailed mucosal exam for erosive esophagitis, Barrett's esophagus

Endoscopy
- Indications for endoscopy
  - Alarm symptoms
  - Empiric therapy failure
  - Preoperative evaluation
  - Detection of Barrett’s esophagus

Ambulatory 24 hr. pH Monitoring
- Physiologic study
- Quantify reflux in proximal/distal oesophagus
  - % time pH < 4
  - DeMeester score
- Symptom correlation
Ambulatory 24 hr. pH Monitoring

<table>
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<tr>
<th></th>
<th>Normal</th>
<th>GERD</th>
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<tbody>
<tr>
<td>pH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time of Day (hours)</td>
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Microbial Populations in the Digestive Tract of Normal Humans

<table>
<thead>
<tr>
<th>Location</th>
<th>Viable bacteria per gram</th>
<th>pH</th>
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<tbody>
<tr>
<td>Stomach</td>
<td>0 - $10^3$</td>
<td>3.0</td>
</tr>
<tr>
<td>Jejunum</td>
<td>0 - $10^4$</td>
<td>6.0-7.0</td>
</tr>
<tr>
<td>Ileum</td>
<td>$10^1$ - $10^4$</td>
<td>7.5</td>
</tr>
<tr>
<td>Colon</td>
<td>$10^{10}$ - $10^{12}$</td>
<td>6.8-7.3</td>
</tr>
</tbody>
</table>

Oesophageal Manometry

- Limited role in GORD
  - Assess LES pressure, location and relaxation
  - Assist placement of 24 hr. pH catheter
  - Assess peristalsis
  - Prior to antireflux surgery

Wireless, Catheter-Free Oesophageal pH Monitoring

Potential Advantages
- Improved patient comfort and acceptance
- Continued normal work, activities and diet study
- Longer reporting periods possible (48 hours)
- Maintain constant probe position relative to SCJ

Peptic Stricture

Barium Swallow

Endoscopy

TTS Balloon Dilation of a Peptic Stricture
Barrett’s Esophagus

- Presence of intestinal metaplastic columnar epithelium which has replaced squamous epithelium as a consequence of acid reflux.

Barrett’s oesophagus

- This is thought to occur from long-standing reflux.
- It consists of columnar epithelium with intestinal metaplasia extending upwards into the lower oesophagus replacing normal squamous epithelium.
- Seen in 20% of patients undergoing endoscopy for gastro-oesophageal reflux disease.

Barrett’s oesophagus is pre-malignant for adenocarcinoma.

- An indocarwine spray down the endoscope can detect intestinal metaplasia and possibly dysplasia.
- Dysplasia is patchy and biopsies from all 4 quadrants (every 2 cm) of the Barrett’s segment must be performed.

GORD: Complications

- Barret’s oesophagus
- An indocarwine spray down the endoscope can detect intestinal metaplasia and possibly dysplasia.
- Dysplasia is patchy and biopsies from all 4 quadrants (every 2 cm) of the Barrett’s segment must be performed.
Achalasia

- A disease characterized by aperistalsis in the body of the oesophagus and failure of relaxation of the lower oesophagus sphincter on initiation of swallowing.

Achalasia: Diagnosis

Aetiology & Pathology

- Unknown (idiopathic).
- A similar clinical picture is seen in Chagas’ Disease (American trypanosomiasis).
- Degenerative lesions are found in the vagus as well as a decrease in ganglionic cells in the nerves of the oesophageal wall.

4. G.I. Bleeding

- Haematemesis (vomiting of blood), is typically associated with gastric or oesophageal bleeding.
- Melena: Dark tar-like colour stool due to blood lost directly into the small intestine or reaching it from gastric lesion. Bleeding peptic ulcers are the most common cause of such blood loss.
- Bleeding from colon’s wall usually appears bright red in the stool.
- Long-term bleeding of smaller quantities of blood may not be detected in the stool. The presence of a low-grade anaemia may be evidence of the slow bleeding and confirmation by detecting occult blood.

Cholelithiasis (Gallstones)

- The Gall bladder:
- The gall bladder rests in a recess on the inferior surface of the right liver lobe.
- Bile leaves the liver through several bile ducts that fuse to form large hepatic duct, which will fuse with the cystic duct (draining the gall bladder) to form the common bile duct.
The gall bladder is a thin-walled, green muscular sac. APPROXIMATELY 10 CM LONG.

It stores bile that is not immediately needed for digestion and concentrates it by absorbing some of its water and ions.

**Cholelithiasis (Gallstones)**

- **Aetiology:**
  - Uncertain, but…….
  - - metabolic?
  - - bile stasis?
  - - infective component?

**Clinical Features**

1. **80% of patients with gallstones are asymptomatic**
2. **Inflammatory:**
   - - acute cholecystitis
   - - acute pancreatitis
   - - cholangitis
3. **Motility:**
   - Biliary colic
   - Obstructive jaundice
   - Cholangitis
4. **Other problems:**
   - Mucocele, empyema, fistula formation

**Vomiting (Emesis)**

- The forceful, sudden expulsion from the mouth of the gastric, and possibly duodenal, contents.
- Often preceded by:- nausea; anorexia
- Nausea - ↑ Salivary flow; ↑ Sympathetic activity.

**The Anatomy of the Liver**

**The Gall Bladder**

**Figure 24.19b, c**

**Figure 14.6**

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Mechanism

- Epiglottis closes off larynx;
- Soft palate rises to close off nasopharynx;
- Pyloric sphincter relaxes (→ duodenal contents enter stomach);
- Diaphragm, abdominal muscles & pyloric sphincter contract strongly;
- Lower oesophageal sphincter relaxes

Diarrhoea:

- World-wide, diarrheal diseases are second only to cardiovascular diseases as a cause of death. In the UK, diarrhoea is the most common illness after the common cold, and account for about 10% of all visits to GPs, and incur substantial time lost from school and work.
- Many diarrheal illnesses are acute, mild to moderate in severity, of brief duration and self-limiting. In such cases, individuals do not seek the advice of a nurse or doctor and usually deal with the illness themselves using over-the-counter remedies, by modifying their diet, or by doing nothing.
- Medical help is usually sought when diarrhoea is more severe, lasts for more than a few days, is accompanied by fever or rectal bleeding.
- There are many diagnostic tests, many of which are costly, time-consuming and invasive. It is therefore essential to have a systematic approach such that an accurate diagnosis can be reached without subjecting the patient to too many unnecessary investigations.

Diarrhoea:

- The term “diarrhoea” means different things to different people.
- Decrease in stool consistency;
- and an increase in its fluidity.
- Increased frequency (more than 3 stools/day)
- Quantity 200-250 gm/day ??
- Acute diarrhoea is usually defined as diarrhoea that lasts for 2-3 weeks.
- Chronic diarrhoea is any diarrhoeal illness that lasts for more than 3 weeks.

Clinical approach to diarrhoea:

- There are many ways to classify diarrhoea:
- duration of diarrheal disease (acute vs chronic)
- risk group (travellers to developing countries, patients with AIDS, hospital in-patients)
- specific features of the diarrhoea (bloody vs fatty vs watery).

History:

- Determine what the patient means by diarrhoea.
- The diarrhoea should be characterised with regard to:
  - onset, duration, frequency, estimation of volume, characteristics of stool (e.g., floating, foul smell, blood, mucus, pus), relationship to meals/tasting and diurnal variation.
  - Specific enquiry should be made about faecal incontinence.
  - A careful dietary, drug and travel history should be taken.
  - The patient should be questioned about poorly absorbed carbohydrates (e.g., sorbitol).
  - A detailed social history should be taken.
  - Bloody diarrhoea and abdominal pain suggest mainly an inflammatory process
  - Bulky, greasy, foul-smelling stool is highly suggestive of steatorrhoea (fat malabsorption).
Nocturnal diarrhoea, particularly with faecal incontinence, should always prompt a search for organic disease.

The patient should be questioned about associated symptoms such as abdominal pain or cramps, flatulence, bloating, fever, weight loss and tenesmus.

The influence of psychological stress should be explored in a sensitive manner (? irritable bowel syndrome).

History of diabetes
History of radiation therapy
Previous abdominal surgery
A family history of diarrhoeal disease is uncommon. It raises the possibility of coeliac disease.

Physical examination:

- Signs of dehydration (dry mouth, decreased skin turgor, tachycardia, orthostatic hypotension).
- Tenderness of the abdomen suggest an underlying inflammatory condition.
- Abdominal mass (Crohn’s disease, diverticular disease, malignancy).
- Distension
- The presence and the quality of bowel sounds.
- Digital examination of the rectum and inspection of the perianal area allows detection of occult or gross faecal blood (infectious, inflammatory, or neoplastic).
- Enlarged lymph nodes may suggest malignancy.

Diagnosis:

- Acute diarrhoea are usually brief (< 5 days) and self-limiting, and are not associated with systemic upset.
- Causes (Table)
- Chronic diarrhoea:
- Almost all patients with chronic diarrhoea need investigation after the history and physical examination.
- Causes (Table)

Constipation:

- Defined as a bowel frequency of fewer than three per week or the need to strain more than 25% of the time during defecation.
- In Western societies, 10-20% of adults believe themselves to be constipated, and a similar proportion regularly take laxatives.
- Other symptoms that patients regard as constipation include the passage of hard stools, painful or incomplete evacuation, and even abdominal discomfort.

Successful management depends on:

- defining the patient’s symptoms
- characterising the abnormality of defecation
- excluding secondary causes
- Long standing mild constipation in younger patients can usually be managed symptomatically. Investigations to exclude an obstructive cause are required in:
- Older patients
- Patients with rectal bleeding
- Patients with symptoms of recent onset

Causes of constipation:

- In most patients, the aetiology (the cause) is unknown.
- Abnormal neurological control
- Psychological factors
- Obstruction
- Drugs
- Spinal or pelvic nerve injuries
- Other causes (depression, Parkinson’s disease, hypothyroidism)