Peritonitis, “acute abdomen”, Septic shock

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Anatomy and Physiology

Peritoneum tissue:
- a typical connective tissue;
- covered by polygonal mesothelium;
- has very good plastic peculiarities;
- has a very good blood supply.
Anatomy and Physiology

All organs are divided into 3 groups:

1) Intraperitoneal
2) Mesoperitoneal
3) Extraperitoneal
Anatomy and Physiology

a thin, double layer of serous membrane in the abdominal cavity

**Parietal Peritoneum**
- lines the internal surface of the abdominopelvic wall.
- derived from *somatic mesoderm* in the embryo.
- receives the same somatic nerve supply as the region of the abdominal wall that it lines.
- pain from the parietal peritoneum is **well localised** and it is sensitive to pressure, pain, laceration and temperature.

**Visceral Peritoneum**
- cover the majority of the abdominal viscera.
- derived from *splanchnic mesoderm* in the embryo.
- has the same nerve supply as the viscera it invests. Unlike the parietal peritoneum, pain from the visceral peritoneum is **poorly localised** and is only sensitive to stretch and chemical irritation.
- Pain from the visceral peritoneum is referred to areas of skin (dermatomes) which are supplied by the same sensory ganglia and spinal cord segments as the nerve fibres innervating the viscera.
Anatomy and Physiology

The parietal peritoneum is innervated by the sensitive *somatic nerves*

The pain as a result of the parietal peritoneum irritation is localized (somatic pain)

The pelvic peritoneum has no somatic innervations
Anatomy and Physiology

The visceral peritoneum has vegetative (parasympathetic and sympathetic) innervations.

The pain as a result of the visceral peritoneum irritation is not localized.
Visceral pain

Surface regions to which visceral pain may be referred
Physiology of Abdominal Pain

- **Visceral pain**
  - Comes from abdominal/pelvic viscera
  - Transmitted by *visceral afferent* nerve fibres in response to stretching or excessive contraction
  - Dull in nature and vague
  - **Poorly localised**
    - Foregut → epigastrium
    - Midgut → para-umbilical
    - Hindgut → suprapubic

- **Somatic pain**
  - Comes from parietal peritoneum (which is innervated by somatic nerves)
  - Sharp in nature
  - **Well localised**
    - Made worse by movement, better by lying still

- **Referred pain**
  - Pain felt some distance away from its origin
  - Mechanism not clear
  - Most popular theory: nerves transmitting visceral and somatic pain (e.g. from viscera or parietal peritoneum) travel to specific spinal cord segment and can result in irritation of sensory nerves that supply the corresponding dermatomes
  - E.g. Gallbladder inflammation can irritate diaphragm which is innervated by C3,4,5. Dermatomes of these spinal cord segments supplies the shoulder, hence referred shoulder tip pain.
ACUTE ABDOMEN

sudden, severe abdominal pain of unclear etiology\textsuperscript{[1]} that is less than 24 hours in duration. It is in many cases a medical emergency, requiring urgent and specific diagnosis. Several causes need surgical treatment.

\textit{Walter Siegenthaler (21 March 2007). Differential diagnosis in internal medicine: from symptom to diagnosis}
Causes of Acute Abdomen

- **Intestinal**
  - Acute appendicitis, mesenteric adenitis, mekel’s diverticulitis, perforated peptic ulcer, gastroenteritis, diverticulitis, intestinal obstruction, strangulated hernia

- **Hepatobiliary**
  - Biliary colic, cholecystitis, cholangitis, pancreatitis, hepatitis

- **Vascular**
  - Ruptured AAA, acute mesenteric ischaemia, ischaemic colitis

- **Urological**
  - Renal colic, testicular torsion, acute urinary retention

- **Gynaecological**
  - Ectopic pregnancy, ovarian cyst pathology (rupture/haemorrhage into cyst/torsion), salpingitis, endometriosis, mittelschmerz (mid-cycle pain)

- **Medical (can mimic an acute abdomen)**
  - Pneumonia, MI, Diabetic Kerato Acidosis, sickle cell crisis, porphyria
PERITONITIS - Definition

Peritonitis is an inflammation of the peritoneum.
Classification

A. Acute peritonitis
B. Subacute peritonitis
C. Chronic peritonitis
Classification

1. **Primary peritonitis**
   - Caused by the spread of an infection from the blood & lymph nodes to the peritoneum. Very rare < 1%
   - Usually occurs in people who have an accumulation of fluid in their abdomens (ascites).
   - The fluid that accumulates creates a good environment for the growth of bacteria.

2. **Secondary peritonitis**
   - Caused by the entry of bacteria or enzymes into the peritoneum from the gastrointestinal or biliary tract.
   - Can be caused due to an ulcer perforation (stomach wall or intestine), rupture of the appendix or a ruptured diverticulum.
   - Can occur due to burst or injury to an internal organ which bleeds into the internal cavity.
Classification

- **Infective** – bacteria cause peritonitis e.g. due to gangrene or perforation of a viscus (appendicitis/diverticulitis/perforated ulcer). This is the most common cause of peritonitis.

- **Non-infective** – leakage of certain sterile body fluids into the peritoneum can cause peritonitis.
  - Gastric juice (peptic ulcer)
  - Bile (liver biopsy, post-cholecystectomy)
  - Urine (pelvic trauma)
  - Pancreatic juice (pancreatitis)
  - Blood (endometriosis, ruptured ovarian cyst, abdominal trauma)
  - Chemicals

Note: although sterile at first these fluids often become infected within 24-48 hrs of leakage from the affected organ resulting in a bacterial peritonitis.
Classification

1. Serous peritonitis
2. Fibrinous peritonitis
3. Fibrinopurulent peritonitis
4. Purulent peritonitis
5. Hemorrhagic peritonitis
6. Putrid peritonitis
Clinical Classification

I. Local peritonitis
   a) encapsulated (abscess)
   b) non-encapsulated

II. General (diffuse) peritonitis
Clinical Classification

Stages of Peritonitis

1. Initial (reactive) stage (up to 24 hours)
2. Toxic stage (24-72 hours)
3. Terminal stage (after 72 hours)
Clinical features

- Abdominal pain
- Tenderness to palpation
- Increased abdominal wall rigidity
- Anorexia and nausea
- Vomiting
- Fever
- Tachycardia
Clinical features of Peritonitis

- **Pain**
  - Constant and severe (site will give clue as to cause, or maybe generalised)
  - Worse on movement (hence shallow breathing in those with generalised peritonitis to keep the abdomen still)
  - Eased by lying still
    - If localised peritonitis – peritonism is in a single area of the abdomen
    - If generalised peritonitis – peritonism is all over abdomen with board like rigidity

- **Signs of ileus (generalised peritonitis > localised peritonitis)**
  - Distention
  - Vomiting
  - Tympanic abdomen with reduced bowel sounds

- **Signs of systemic shock**
  - Tachycardia, tachypnoea, hypotension, low urine output
  - More prominent with generalised than localised peritonitis
Acute Abdomen: The Examination

- Liver (hepatitis)
- Gall bladder (gallstones)
- Stomach (peptic ulcer, gastritis)
- Transverse colon (cancer)
- Pancreas (pancreatitis)
- Heart (MI)
- Spleen (rupture)
- Pancreas (pancreatitis)
- Stomach (peptic ulcer)
- Splenic flexure colon (cancer)
- Lung (pneumonia)

- Ascending colon (cancer)
- Kidney (stone, hydronephrosis, UTI)
- Appendix (Appendicitis)
- Caecum (tumour, volvulus, closed loop obstruction)
- Terminal ileum (crohns, mekels)
- Ovaries/fallopian tube (ectopic, cyst, PID)
- Ureter (renal colic)

- Descending colon (cancer)
- Kidney (stone, hydronephrosis, UTI)
- Sigmoid colon (diverticulitis, colitis, cancer)
- Ovaries/fallopian tube (ectopic, cyst, PID)
- Ureter (renal colic)

- Regions of the abdominal cavity

- Uterus (fibroid, cancer)
- Bladder (UTI, stone)
- Sigmoid colon (diverticulitis)
- Bowel (obstruction/ischaemia)
- Aorta (leaking AAA)
Physical Exam for the Patient with Abdominal Pain

- Need complete set of vital signs
- Look in nose and mouth for sites of bleeding (swallowed blood may mimic an intraluminal bleed)
- Look at skin for stigmata of liver disease or signs of coagulopathy
- Careful chest & lung exam (basilar pneumonias can present as abd. pain)
- Palpate and observe the back
- Genital and rectal exam (& stool guiac) should usually be routine
Exam of the Abdomen in the Patient with Abdominal Pain

Inspection - look for:

- Scars from prior surgeries
- Distension
- Localized swelling or mass
- Eccymoses or erythema
- Visible peristalsis

Palpation & percussion

Auscultation with stethoscope

- Listen for bowel sounds & bruits
Interpretation of Bowel Sounds
(Associated, but not Definite, Diagnoses)

- High pitched or "tinkling": bowel obstruction
- Continuous & hyperactive: acute gastroenteritis
- Absent: ileus or peritonitis (need to listen for at least one minute)
- Audible without stethoscope: "borborygmi"
Acute Abdomen: Investigations

- **Simple Investigations:**
  - Blood tests
  - Urine test
  - Pregnancy test (all women of child bearing age with lower abdominal pain)
  - AXR/E-CXR
  - ECG

- **More complex investigations:**
  - USS
  - Contrast studies
  - Endoscopy (OGD/colonoscopy/ERCP)
  - CT
  - MRI
Blood tests

- Type and Cross (the most important if patient has shock)
- Complete blood count (CBC)
- Urine or serum pregnancy test (HCG)
- Serum amylase, lipase
- Liver function tests (bilirubin, SGOT, SGPT, alk. phos.)
- Electrolytes, glucose, creatinine, blood urea nitrogen (BUN)
- Serum alcohol, serum or urine drug screen
- Serum medication levels (such as digoxin)
- Clotting studies (platelet count, protime, PTT, fibrinogen)
- Cardiac enzymes (if coronary ischemia suspected)
- Blood culture (if sepsis or bacteremia suspected)
- Nonemergent tumor markers (CEA, AFP)
WBC typically elevated (+/- "left-shifted") in any cause of: peritonitis & in bowel infarction & in spleen & liver bleeding

However often NOT elevated appropriately in:
- the elderly
- immunocompromised patients
- patients on chronic corticosteroid Rx
Interpretation of Lab Studies for Abdominal Pain

- **Hematocrit** may be normal in early stages of even severe hemorrhage
- **BUN to creatinine ratio** of > 20 to 1 may indicate upper gastrointestinal (GI) bleed with digestion of blood in upper GI tract
- Degree of elevation of **amylase or lipase** does not always correlate with severity of pancreatitis or of pancreatic injury
- **Amylase** may also be chronically elevated in patients with renal dysfunction
Plain Radiographs for Abdominal Pain

the 3 view "Acute Abdomen Series " is best :

1/ upright Chest X-ray,

2/ upright plate of the abdomen

3/ flat plate of the abdomen

• Chest X-ray best shows small amounts of free air

• Upright abd. film best shows bowel air-fluid levels
  (indicating bowel obstruction or ileus if multiple)

• Look also for abnormal calcifications
Chest X-ray
Abdominal X-ray
Abdominal X-ray
Diagnostic Ultrasound for Abdominal Pain

US – the test of choice for:

- Unstable patient in shock & suspected intraabdominal bleed, fluid
- Gallstones (cholecystitis)
- Ectopic pregnancy
- Other complications of pregnancy (placenta previa, abruptio, etc.)
- Renal or ureteral stones in the pregnant patient
US - gallstone
US - fluid
US – renal gallstones

pyelocalyceal system
Disadvantages of Diagnostic Ultrasound

- Visualization may be limited by bowel gas or obesity
- Good interpretation requires experience
- Not good at showing retroperitoneal conditions
- May not directly visualize solid organ lacerations
Immediate Life-Threatening Causes of Abdominal Pain

These must be recognized from the primary survey:

- Ruptured abdominal aortic aneurism (AAA)
- Rupture of the spleen or liver
- Ruptured ectopic pregnancy
- Bowel infarction
- Perforated viscus
- Acute myocardial infarction (MI)
Urgent surgery should not be delayed for time consuming tests when an indication for surgery is clear.

The following three categories of general surgical problems will require emergency surgery:

- Generalised peritonitis on examination (regardless of cause – except acute pancreatitis, hence all patients get amylase)
- Perforation (air under diaphragm on E-CXR)
- Irreducible and tender hernia (risk of strangulation)
Treatment

- Antibiotic therapy
- Correction of existing serum electrolytes disturbances
- Correction of coagulation abnormalities
- Surgery
Resuscitation of Generalised Peritonitis

- ABC
- Oxygen
- Fluid resuscitation (large bore cannule, bloods, IVF, catheter)
- IV antibiotics (wide spectrum)
- Analgesia
- Surgery (with or without preceeding CT depending on availability and stability of patients)
Surgery

- To eliminate the source of contamination
- To reduce the bacterial contamination
- To prevent further complications and sepsis
SEPSIS: TIME = MORTALITY
Definitions

- Systemic Inflammatory Response Syndrome (SIRS)
- Sepsis
- Severe Sepsis
- Septic Shock
SIRS: Systemic Inflammatory Response Syndrome

SIRS: A clinical response arising from a nonspecific insult manifested by ≥2 of the following:

- Temperature
  ≥38°C or ≤36°C
- HR ≥90 beats/min
- Respirations ≥20/min
- WBC count ≥12,000/mL or ≤4,000/mL or >10% immature neutrophils

Infection: A microbial phenomenon characterized by an inflammatory response to the presence of microorganisms or the invasion of normally sterile host tissue by those organisms.

Sepsis: More Than Just Inflammation

- Sepsis:
  - Known or suspected infection
  - SIRS criteria

Severe Sepsis:  
Acute Organ Dysfunction

Severe Sepsis = 
Sepsis with signs of **acute** organ dysfunction in any of the following systems:

- Cardiovascular (septic shock)
- Renal
- Respiratory
- Hepatic
- Hemostasis (bleeding diathesis)
- CNS
- Unexplained metabolic acidosis

Severe Sepsis: The Final Common Pathway

**Endothelial Dysfunction and Microvascular Thrombosis**

**Hypoperfusion/Ischemia**

**Acute Organ Dysfunction (Severe Sepsis)**

**Death**
SEVERE SEPSIS
PATHOPHYSIOLOGY

Microvascular dysfunction → Hypoperfusion/hypoxia → Organ dysfunction
↑ Inflammation
↑ Coagulation
↓ Fibrinolysis
Microvascular thrombosis
Endothelial dysfunction
Global tissue hypoxia
Direct tissue damage
‘SIRS’

2 or more of the following:

- Temp $>38^\circ$C or $<36^\circ$C
- HR $>90$ beats/min
- RR $>20$ breaths/min or PaCO2 <4.5kPa
- WBC $>12,000$ or $<4000$ cells/mm³, or $>10\%$ immature (band) forms
‘Sepsis’

- **Sepsis:**
  - Known or suspected infection, plus
  - ≥2 SIRS Criteria.

- **Severe Sepsis:**
  - Sepsis plus >1 organ dysfunction.
  - MODS.
  - Septic Shock.
The presence of altered organ function in an acutely ill patient such that homeostasis cannot be maintained without intervention
‘Severe Sepsis’

Sepsis associated with hypotension, hypoperfusion and/or organ-dysfunction
Organ Failure

• CVS
• RS
• Renal
• Hepatic
• CNS
• Haematological
Organ Dysfunction

- Lungs ➢ Adult Respiratory Distress Syndrome
- Kidneys ➢ Acute Tubular Necrosis
- CVS ➢ Shock
- CNS ➢ Metabolic encephalopathy
- PNS ➢ Critical Illness Polyneuropathy
- Coagulation ➢ Disseminated Intravascular Coagulopathy
- GI ➢ Gastroparesis and ileus
- Liver ➢ Cholestasis
- Endocrine ➢ Adrenal insufficiency
- Skeletal Muscle ➢ Rhabdomyolysis

Specific therapy exists
‘Septic Shock’

Sepsis induced with hypotension despite adequate resuscitation along with the presence of perfusion abnormalities which may include, but are not limited to lactic acidosis, oliguria, or an acute alteration in mental status.
Prognostic effects of organ dysfunction in severe sepsis

- Proportion (%) of admissions to ICU with severe sepsis in the first 24 hours in ICU with (N) organ dysfunctions
- Hospital mortality (%)

Prevalence of hospital mortality associated with severe sepsis

Proportion (%) of admissions to ICU with severe sepsis in the first 24 hours
Hospital mortality (%)
Mortality Increases in Septic Shock Patients

- **Incidence**
  - Sepsis: 400,000
  - Severe Sepsis: 300,000

- **Mortality**
  - 53-63%
  - 20-53%
  - 7-17%

Approximately 200,000 patients including 70,000 Medicare patients have septic shock annually.

Balk, R.A. Crit Care Clin 2000;337:52
Death Spiral of Shock

Myocardial dysfunction
- Release of vasodilators (i.e. nitric oxide)
- Systemic inflammation

Tissue hypoperfusion

Vasoplegia
- 3rd space fluid extravasation

Shock
Clinical Signs of Sepsis

- Fever.
- Leukocytosis.
- Tachypnea.
- Tachycardia.
- Reduced Vascular Tone.
- Organ Dysfunction.
How do we manage sepsis and septic shock?

1) Investigate and treat sepsis
   - Try and find and treat source
   - Early blood cultures
   - Start antibiotics asap ideally within 1 hour and after cultures taken (upset test)

2) Assess extent of end organ hypoperfusion and improve oxygen delivery (early goal directed therapy)
Question: Why do Septic Patients Die?

Answer: Organ Failure
Response - diagnosis

- **Physiology**
  - Heart rate
  - Respiration
  - Fever
  - Blood pressure
  - Cardiac output
  - WBC
  - Hyperglycemia

- **Markers of Inflammation**
  - TNF
  - IL-1
  - IL-6
  - Procalcitonin
  - PAF
Markers of perfusion

- Clinical signs
  - Warm skin, conscious level, u/o

- Haemodynamic variables
  - CVP

- Bloods

- Serum Lactate (increased production (anaerobic glycolysis) or reduced metabolism (hepatic, renal))
  - ScvO2
Therapeutic Strategies in Sepsis

Optimize Organ Perfusion

Pressors may be necessary.

- Compensated Septic Shock:
  - Phenylephrine
  - Norepinephrine
  - Dopamine
  - Vasopressin

- Uncompensated Septic Shock:
  - Epinephrine
  - Dobutamine + Phenylephrine / Norepinephrine
Therapeutic Strategies in Sepsis

Control Infection Source

- Drainage
  - Surgical
  - Radiologically-guided
- Culture-directed antimicrobial therapy
- Support of reticuloendothelial system
  - Enteral / parenteral nutritional support
  - Minimize immunosuppressive therapies
Therapeutic Strategies in Sepsis

Support Dysfunctional Organ Systems

- Renal replacement therapies (CVVHD, HD).
- Cardiovascular support (pressors, inotropes).
- Mechanical ventilation.
- Transfusion for hematologic dysfunction.
- Minimize exposure to hepatotoxic and nephrotoxic therapies.