

PERFORATION OF VISCUS (NON TRAUMATIC)



*Carver General Hospital, Washington, Visiting Day, Civil War Period.*

*“No conflict in history”, a journalist wrote, “was as much a woman’s war as the Civil War”. North and South, women looked for ways to help. In the North citizens formed the Sanitary Commission and the Christian Commission to organize private relief and check the spread of disease in the army. The disease rate was cut in half. Sanitary Commissioners prowled the camps, demanding they be cleaned up, reforming hospital*

*conditions insisting on better food, making sure blankets, shoes, medicines and packages from home were distributed fairly.*

*Prominent men ran the Sanitary Commission. New York lawyer George Templeton Strong was its treasurer. But hundreds of thousands of women in 7,000 local chapters all over the North did the work - sewing, knitting, baking, wrapping bandages, raising funds, organizing rallies.*

*“If this war developed some of the most brutal, bestial, and devilish qualities lurking in the human race, it has also shown us how much of the angel there is in the best men and women”*

*(Mary Livermore)*

*Mary Livermore, a Chicago minister’s wife, organized Midwestern volunteers into 3,000 chapters and when the army was threatened with scurvy, sent so much food south that one reporter said, “A line of vegetables connected Chicago and Vicksburg”.*

*Clara Barton, who stood barely 5 feet tall, distributed supplies by mule train, ministered to the wounded from Cedar Mountain to Antietam, and tirelessly lobbied Washington for better care for the men. In a letter home, Katherine Wormsley, a nurse on a hospital ship, decried the confusion and chaos on board, but she ended “Goodbye . This is life”.*

*George Templeton Strong’s wife, Ellie went south to serve on a hospital ship too.*

*“Ellie’s tact, sense, good nature, and energy conquered the USA Surgeon in Charge at once and coerced all his official dignity into hearty grateful cooperation in the care of his cargo of 500 cases, mostly bad ones. I have never given her credit for tithe of the enterprise, pluck, discretion, and force of character, she has shown. God bless her”.*

*(George Templeton Strong)*

*‘We had no “Sanitary Commission” in the South. We were too poor. We had no line of rich and populous cities closely connected by rail. With us every house was a hospital”*

*(Southern Nurse)*

*Southern women worked as nurses too, despite criticism that it was unladylike for them to care for ruffians. Sallie Tompkins of Richmond and a staff of only 6 nursed 1,333 wounded men in her private hospital and kept all but 73 of them alive, a record unmatched by any other Civil War Hospital, North or South.*

*Mary Ann Bickerdyke, a Quaker widow and Sanitary Commission agent, traveled with the Union army through four years and 19 battles, assisting at amputations, brewing barrels of coffee, rounding up cattle and chickens and eggs to feed the grateful men, who called her “Mother Bickerdyke”. By the end of the war General Sherman said simply - “She ranks me!”*

*“At night, my ward became like the dim caverns of the catacombs, where, instead of the dead in their final rest, there were wasted figures burning with fever and raving from the agony of splintered bones, tossing restlessly from side to side with every ill, it seemed,*

*which human flesh was heir to. From the rafters, the flickering oil lamp swung mournfully, casting a ghastly light”.*

*(Private Alexander Hunter, 17th Virginia).*

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*When the war began, there were only a handful of army hospitals in the North. When it ended, the Union was running more than 350, the Confederacy, 154. There were 16 hospitals in Washington alone. When these proved insufficient, men were cared for in the Patent Office, even in the House and Senate Chambers.*

*Hospitals were giant warehouses for the dying. The biggest and best, North or South, was Chimborazo at Richmond, with 8,000 beds, 5 soup kitchens, icehouses, dairy cattle, a herd of goats, a bakery that turned out 10,000 loaves of bread a day, and a 400 keg brewery.*

*“Aroused and angry, I’d thought to beat the alarm, and urge relentless war. But soon my fingers failed me, my face drooped and I resigned myself to sit by the wounded and soothe them ...or silently watch the dead”*

*(Walt Whitman)*

*Walt Whitman was too old for the ranks, not qualified to be an officer, not enthusiastic about firing a gun or drawing a sword on another man. But when his younger brother was wounded at Antietam, Whitman went to find him in the hospital. He was appalled by what he saw. He moved to Washington to help with the wounded, giving out small gifts, changing dressings, and reciting his poetry.*

*“The doctors tell me I supply the patients with a medicine which all their drugs and bottles and powders are helpless to yield. It has saved more than one life, so I go around. Some of my boys die. Some get well.*

*(Walt Whitman)*

*“No woman under 30 years need apply to serve in government hospitals. All nurses are required to be very plain looking women. Their dresses must be brown or black, with no bows, no curls, no jewelry, and no hoop skirts”.*

*(Dorothea Dix)*

*Early in the war, Dorothea Dix volunteered her services to the Union. The 59 year old crusader for the mentally ill was put in charge of all women nurses employed by the armies. Tireless, and so autocratic one woman called her “Dragon Dix”. She bared any applicant she thought interested in romantic adventure, even nuns were sometimes turned down. By the end of the war though, the only question she asked potential recruits was “When can you start?”. Under her strict guidance, care for the sick and wounded was vastly improved. Despite the bitter criticism and petty rivalry of male colleagues, she stayed at her post for all four years - the entire war - without pay.*

*“Armory Square Hospital: I am learning not to let myself feel as much as I did at first, yet I can never get used to it”*

*(Harriet Foote Hawley)*

*“They would see that the doctor gave them up and would ask me about it. I would tell them the truth. I told one man that and he asked “How long?” I said not over 20 minutes. He did not show any fear. They never do. He put his hand up, so, and closed his eyes with his own fingers, and stretched himself out, and crossed his arms over his breast. “Now, fix me”, he said. I pinned the toes of his stockings together. That was the way we laid corpses out and he died in a few minutes. His face looked as pleasant, as if he was asleep. And many is the time the boys would fix themselves that way before they died”.*  
(Walt Whitman)

*“Lorenzo Strong, Company A, 9th United States Cavalry. Shot by a shell last Sunday. Right leg amputated on the field. Took a turn for the worse. I stayed and saw all. The doctor comes and gives him a little chloroform. One of the nurses constantly fans him, for it is fearfully hot. He asks to be raised up, and they put him in a half sitting posture. He called for “Mark” repeatedly, half deliriously, all day. Life ebbs, runs now with the speed of a millrace, his eyes turned back. A crowd including two or three doctors, several students, and many soldiers, has silently gathered. The struggle goes on and dwindles a little more and a little more, and then welcome oblivion, painless death. A pause. The crowd drops away....*

*June 17 1864: “Dearest mother, this place seems to have got the better of me. I think I shall come home for a short time”*  
(Walt Whitman)

*Ken Burn’s “The Civil War”, 1990*

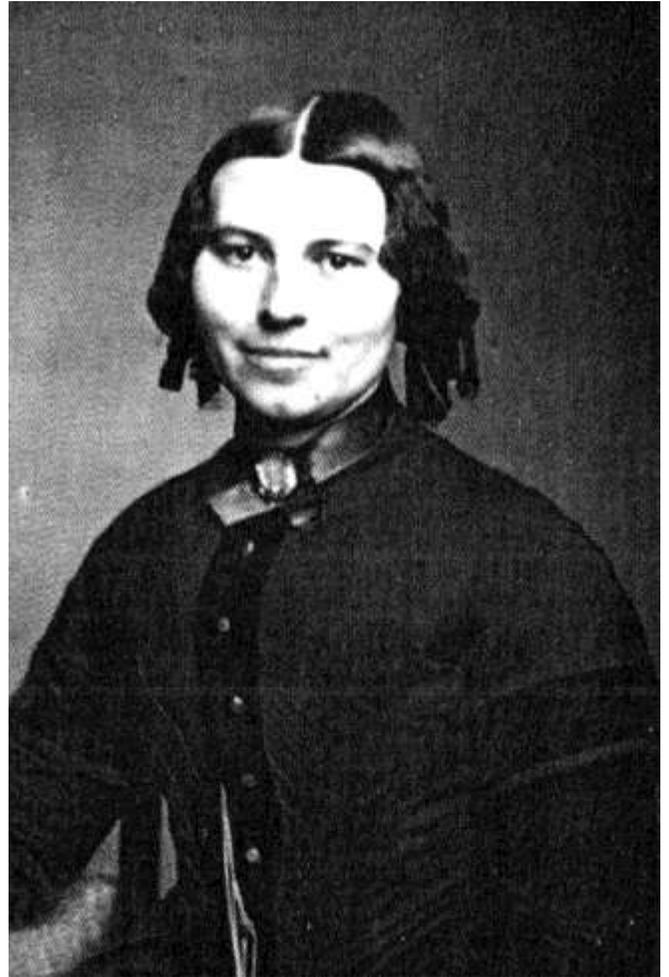
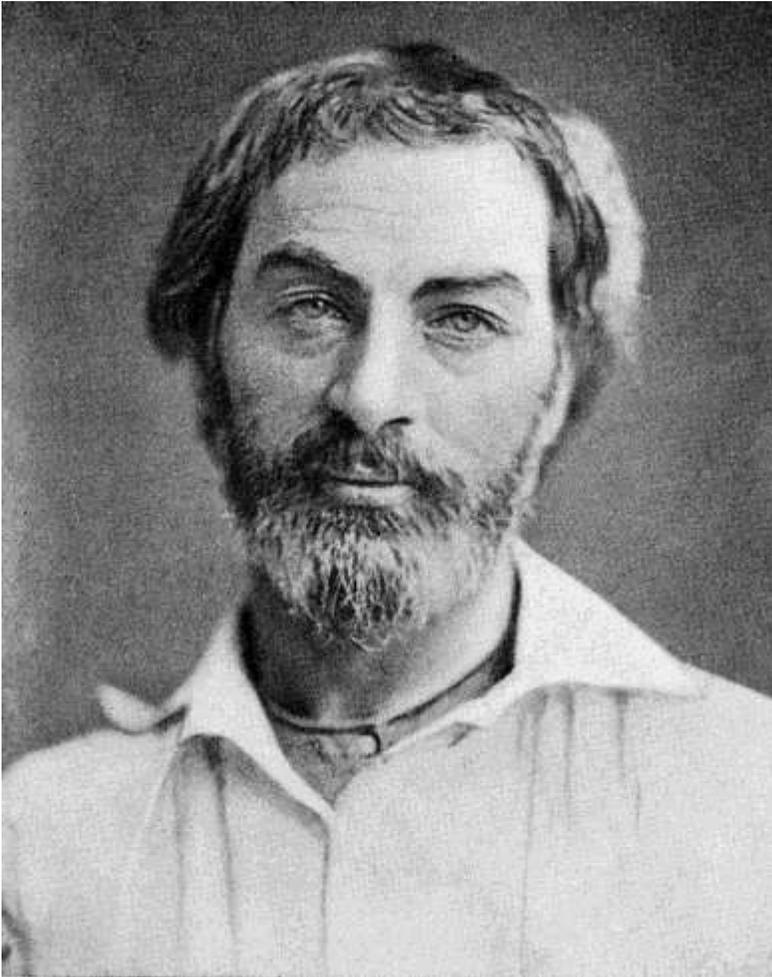
*The most important innovation of the whole war was the rifled musket, along with a French refinement - a new bullet, an inch long lead slug that expanded into the barrel’s rifled grooves and spun as it left the muzzle. The Minié ball could kill at half a mile and was accurate at 250 yards - five times as far as any other one man weapon. The age of the bayonet charge had ended, though most officers did not yet know it when the war began, and some has still not learned it when the war was over. It was brutal stuff. The reason for the high casualties is really quite simple - the weapons were way ahead of the tactics. The rifle itself, it threw a 0.53 caliber soft lead bullet at low muzzle velocity, and when it hit - the reason there were so many amputations - if you got hit here, (indicates upper arm) it didn’t clip your bone the way the modern steel-jacketed bullet does. You didn’t have any bone from here to here. They had no choice but to take the arm off, and you’ll see pictures of the dead on the battlefields with their clothes in disarray as if someone had been going through - rifling - their bodies. That was the men themselves tearing their clothes up to see where the wound was, and they knew perfectly well if they were gut shot, they’d die.*

*(Shelby Foote, Civil War Historian)*

*To be severely wounded during the time of the American Civil War, a time of extremely rudimentary anesthesia, primitive surgical techniques, and a time before antibiotics, meant a 15-20% chance of dying. One of most feared wounds was the “gut shot” - with a perforated viscus, eventual death was virtually inevitable. There are descriptions of wounded men, who upon being hit were often unaware of exactly where they had been hit*

*- their first impulse - following surprise at still being alive - was to tear open their shirts and look for a gut wound. If found, then they knew they had not long to make peace with their God.*

*Today a perforated viscus, is far more often the result of a non-traumatic pathology - although still a serious life-threatening condition, with timely fluid resuscitation, intravenous antibiotics, and modern anesthetic and surgical techniques, the chances of survival are infinitely better than those of the time of the Civil War.*



*“.....this place seems to have got the better of me. I think I shall come home for a short time...”*

*“...Armory Square Hospital: I am learning not to let myself feel as much as I did at first, yet I can never get used to it....”*

*Civil War nurses, Walt Whitman and Clara Barton*

## PERFORATION OF VISCUS (NON TRAUMATIC)

### Introduction

**Perforation** of a **hollow abdominal viscus** represents a **surgical emergency**.

The commonest causes are upper GIT, (i.e **stomach** and **duodenal**) perforations.

The diagnosis is usually made on CT scan, however on occasions it may not be made until laparotomy or laparoscopy.

**Immediate fluid resuscitation** and commencement of **antibiotics** should occur, as soon as the diagnosis is suspected.

The **surgical unit** should be notified urgently once the diagnosis has been made.

The following refers to GIT perforations **at, and distal, to the level of the stomach**.

### Anatomy

Whether or not GIT perforation leads to free fluid and diffuse peritonitis or is contained, resulting in an abscess or fistula formation, can depend upon the exact location along the gastrointestinal tract as well as the patient's ability to mount an inflammatory response to the specific pathologic process.

**Retroperitoneal** perforations for example are more likely to be **contained** locally.

The GIT is arranged thus:

- The stomach is intraperitoneal.
- The duodenum is retroperitoneal in its second and third portion
- The ileum and jejunum are intraperitoneal.
- The ascending and descending colon are retroperitoneal, while the transverse colon, which extends from the hepatic flexure to the splenic flexure, is intraperitoneal.
- The sigmoid colon is intraperitoneal and continues from the descending colon, ending where the teniae converge to form the rectum.
- The anterior upper two-thirds of the rectum are located intraperitoneally and the remainder is extraperitoneal.

### Pathophysiology

#### Causes:

Causes of non-traumatic perforation of a hollow abdominal viscus include:

*Commonest:*

1. The commonest cause by far is duodenal ulcer.

*Less commonly:*

2. Gastric ulcer.
3. Perforation due to infection:
  - Diverticulitis / appendicitis / cholecystitis
4. Bowel obstruction:
  - With bowel obstruction, perforation occurs proximal to the obstruction as pressure builds up within the bowel, exceeding intestinal perfusion pressure, and leading to ischemia and subsequently necrosis.

When perforation is proximal to a colon obstruction, it usually occurs in the cecum in the presence of a competent ileocecal valve.
  - Hernias or intestinal volvulus obstructions can lead to perforation either related to bowel wall ischemia from strangulation, or pressure necrosis.
5. Ischemic gut
6. Malignancy:
  - Neoplasms can perforate by direct penetration and necrosis, or by producing obstruction.
  - Perforations related to tumor can also occur spontaneously, following chemotherapy, or as a result of radiation treatments when the tumor involves the wall of a hollow viscus organ
7. Severe colitis (of any cause)
  - Inflammatory bowel disease: Crohn's disease has a propensity to perforate slowly, leading to formation of entero-enteric or enterocutaneous fistula formation.
  - Toxic megacolon
  - Infectious disease of the GIT:

- ♥ Typhoid or tuberculosis, (usually perforation occurs in the small intestine)
- ♥ Cytomegalovirus, particularly in the immunocompromised

*Uncommonly:*

8. Gallstone ileus
  - Causes perforation by direct pressure or otherwise indirectly by obstruction resulting in a proximal perforation
9. Connective tissue diseases
10. Intussusception (usually seen in young children)

*Complications:*

Complications of GIT perforation include:

1. Chemical peritonitis
2. Bacterial peritonitis
3. Bleeding
4. Shock
  - Hypovolemic
  - Septic
5. Tension pneumoperitoneum (occasionally):

As free gas accumulates within the peritoneal cavity, it can:

- Compress intra-abdominal veins leading to reduced venous return to the heart, and hence reduced CO
- Lead to respiratory compromise by impairing diaphragmatic function

6. *Chronic complications:*

- Local phlegmon or abscess formation
- Local fistula formation:

- ♥ Fistulas are most commonly related to inflammatory bowel diseases such as Crohn disease

## Clinical assessment

### Important points of history:

#### 1. Pain:

- **Onset:**

Pain that is of **acute onset** and **severe** is characteristic of **perforation of the stomach or duodenum due to peptic ulceration**

The patient with a free perforation is often able to state with precision the exact time of the onset of the perforation.

A more indolent onset of pain may be seen with perforations that are secondary to abscesses or intestinal fistulae formation.

- **Shoulder tip pain:**

Perforation of **upper abdominal organs** can **irritate the diaphragm**, leading to pain radiating to the **shoulder**.

- **Back pain:**

If a perforation is confined to the **retroperitoneum** or **lesser sac** (e.g. duodenal perforation), the presentation may be far more subtle. Retroperitoneal perforations often lead to back pain.

#### 2. Past history:

In particular check for a past history of

- Peptic ulcer disease
- Diverticulitis
- GIT malignancy

#### 3. Medications:

*In particular:*

- Steroids
- NSAIDs

- Immunosuppressive agents (or condition)s - these may suppress “classical” clinical findings.

Important points of examination:

1. Vital signs:

- Tachycardia.
- Fever, is a late and ominous sign, indicating the onset of infective peritonitis.

Note that initially the temperature may be normal, as the inflammatory process is predominantly chemical rather than bacterial in nature.

Fever will develop as bacterial infection progresses.

- Tachypnea, an often overlooked sign of underlying pathology
- Hypotension is also a late and ominous sign, indicating the onset of shock due to sepsis or bleeding.

2. In the early stages of perforation the patient may appear pale and anxious

3. Features of “peritonism”:

Severe pain will lead to the avoidance of any movement due to peritoneal inflammation. .

There may be:

- Voluntary or involuntary guarding on palpation.
- **“Board-like” abdominal rigidity, is a classical finding.**
- Rebound tenderness
- Patients may also splint the abdomen during respiration thus impairing ventilation.

4. Bowel sounds:

- Bowel sounds may absent due to paralytic ileus.

5. Peritonitis:

After several hours a diffuse peritonitis develops with:

- Abdominal distention
- Ileus
- Significant fluid losses into the GIT.
- Septic shock

*Differential Diagnosis includes:*

These include:

1. Cholecystitis.
2. Pancreatitis.
3. Bowel Obstruction.
4. Volvulus.
5. Renal Colic.
6. Aortic pathology:
  - Aortic dissection
  - Ruptured/ leaking abdominal aortic aneurysm

Pneumoperitoneum, identified typically on CT scanning, that is **not** associated with abdominal discomfort or other symptoms, may be a benign finding, with causes including

1. Postsurgical free air that enters the abdominal cavity during laparotomy or laparoscopy. This typically resolves within a week.

**Increasing** amounts of intra-abdominal air during a period of postoperative observation however is concerning. A finding of increasing free intra-abdominal air suggests perforation until proven otherwise

2. Abdominal paracentesis
3. Peritoneal dialysis
4. Vaginal instrumentation
5. Placement of a percutaneous gastrostomy tube (or PEG tube)

## Investigations

### Blood tests:

1. FBE
2. CRP
3. U&Es/ Glucose
4. LFTs
5. Lipase
6. VBGs/ lactate
7. Blood group and save or cross match, as clinically indicated.

### ECG

As for any unwell patient.

AF may raise suspicion for the possibly of ischemic gut.

Myocardial ischemia can also mimic an upper abdominal surgical condition, and so should always be considered in the differential diagnosis.

### Plain Radiology:

#### CXR:

To look for the presence of free gas under the diaphragm.

Note that the absence however of this sign does not necessarily rule out a perforation.

#### AXR:

Erect and supine views are routinely done.

AXR is an insensitive investigation for the detection of free gas within the abdominal cavity. A number of radiological signs may be noted however, if the amount of free gas is large.

These signs can include:

1. Rigler's sign, (gas outlines both the inner and **outer** surfaces of the intestine).
2. Subphrenic gas (ie "gas under the diaphragm") on an erect film.

*Variations on this include:*

- Air over the liver (right lateral decubitus)
  - Air over the spleen (left lateral decubitus),
3. Ligamentous delineations:
- Falciform ligament sign.
  - Ligamentum teres sign.
4. Psoas sign (air in the retroperitoneal space outlining the line of the psoas muscle).
5. Cupola sign (an inverted cup) is an arcuate lucency over the lower thoracic spine
- The cupola sign is seen on a supine chest/abdominal radiograph in the presence of pneumoperitoneum.

It refers to non-dependent gas that rises within the abdominal cavity of the supine patient to accumulate underneath the central tendon of the diaphragm in the **midline**.

It is seen as lucency overlying the lower thoracic vertebral bodies. The superior border is well defined, but the inferior margin is not.

**See also appendix 1 below**

6. Football sign:
- A large central oval generalized lucency on supine films, (where air has gathered superiorly).

Ultrasound: <sup>4</sup>

Free air / fluid in the abdomen may be detected by ultrasound by a skilled operator.

A linear-array transducer (10-12 MHz) is considered more sensitive than a standard curvilinear abdominal transducer (2-5 MHz).

Recognized features include:

- Enhancement of the peritoneal stripe (peritoneal stripe sign) either alone or with associated posterior multiple reflection artifacts or dirty shadowing.
- Posterior artifactual reverberation echoes with a characteristic comet-tail appearance

### CT scan:

**CT scan is the imaging modality of choice for the diagnosis of GIT perforation.**

**Plain CT scan** is much more sensitive and specific than plain AXR for the detection of **free (i.e extra-luminal) intra-abdominal gas**.

The location of gas on abdominal CT scan can also help indicate the site and cause of the perforation.

### Laparotomy / laparoscopy:

If a diagnosis of perforation is strongly suspected but imaging remains equivocal, abdominal surgical exploration may ultimately be necessary

### Management

1. Attention to any immediate ABC issues.
  - The patient may be hypoxic due to splinting of the diaphragm. Oxygen should be given via Hudson Mask.

Establish monitoring:

- ECG
  - Pulse oximetry
  - In compromised septic patients a central line/ arterial line and urinary catheter should be considered.
2. IV Fluid resuscitation:
    - There can be significant fluid losses.
  3. Nil by mouth.
  4. Analgesia:
    - Pain is usually **significant** and in the case of perforated **peptic ulceration** acidic chemical peritonitis is usually severe.  
  
IV titrated **opioids** will be required  
  
In cases of *intractable* pain - titrated **IV ketamine** is a useful option.

5. **IV antibiotics:** <sup>1</sup>

These should be commenced *early*.

Peritonitis due to perforated viscus is usually a **polymicrobial infection** with both **aerobic** and **anaerobic** bowel flora.

Broad spectrum antibiotics should be commenced.

Options include:

- Ceftriaxone 1 gram (child 1 month or older: 50 mg/kg up to 1 gram) IV, daily

*Or*

Cefotaxime 1 gram (child: 50 mg/kg up to 1 gram) IV, 8 hourly peritonitis

*PLUS (with either of the above drugs)*

Metronidazole 500 mg (child: 12.5 mg/kg up to 500 mg) IV, 12 hourly.

- Piperacillin + tazobactam 4 + 0.5 grams (child: 100 + 12.5 mg/kg up to 4 + 0.5 grams) IV, 8 hourly
- Ticarcillin + clavulanate 3 + 0.1 grams (child: 50 + 1.7 mg/kg up to 3 + 0.1 grams) IV, 6 hourly.

A further traditionally used option is:

- Gentamicin IV

*PLUS*

Amoxy/ampicillin 2 grams (child: 50 mg/kg up to 2 grams) IV, 6 hourly

*PLUS*

Metronidazole 500 mg (child: 12.5 mg/kg up to 500 mg) IV, 12 hourly.  
peritonitis, perforated viscus

This option however, has lost favour in recent years, due to the potential toxicity and the complexity of dosing of gentamicin.

*For patients with **immediate** hypersensitivity to penicillins use:*

- Gentamicin IV

*PLUS*

Clindamycin IV or (Lincomycin IV)

**See also latest edition of Antibiotic Therapeutic Guidelines for full prescribing details, and alternative regimes.**

6. **Surgery:**

- Laparotomy and repair of the defect, as well as peritoneal washout will usually be required.

7. Conservative:

- Some patients who are not unwell or septic and who have contained perforations, may be suitable for conservative (i.e non-surgical) management

8. Palliative management:

- Elderly, unwell patients with severe co-morbidities and/ or at end of life may be treated palliatively.

Disposition:

**The Surgical Unit should be notified as soon as the diagnosis is made.**

ICU/HDU should be notified for all unwell patients.

## Appendix 1

### Plain radiography



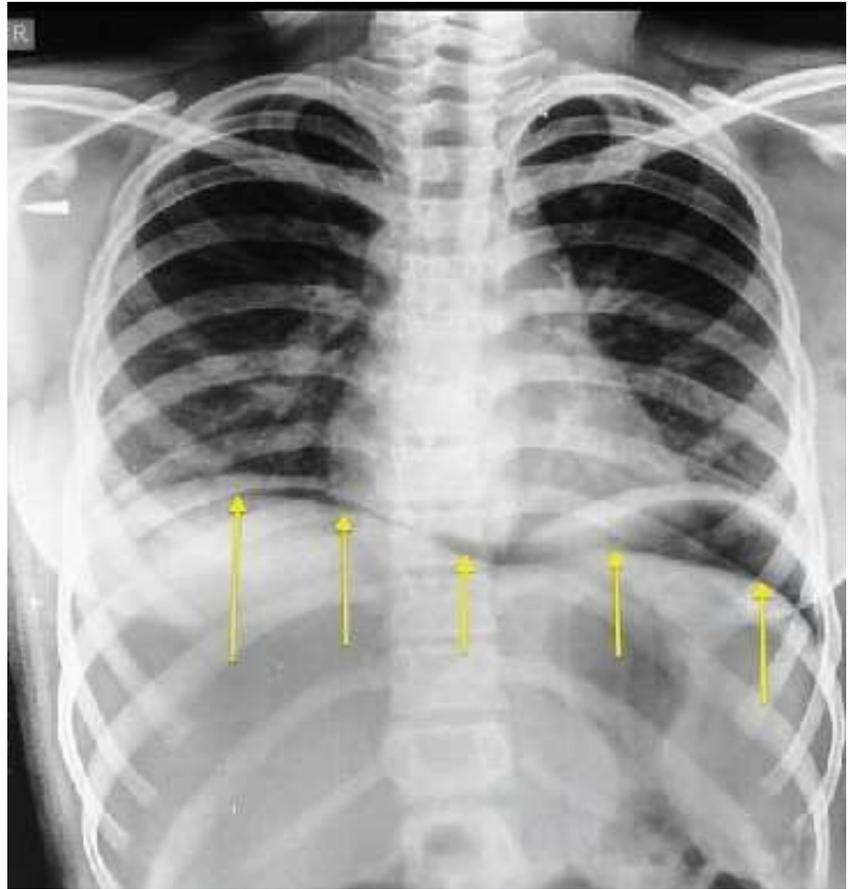
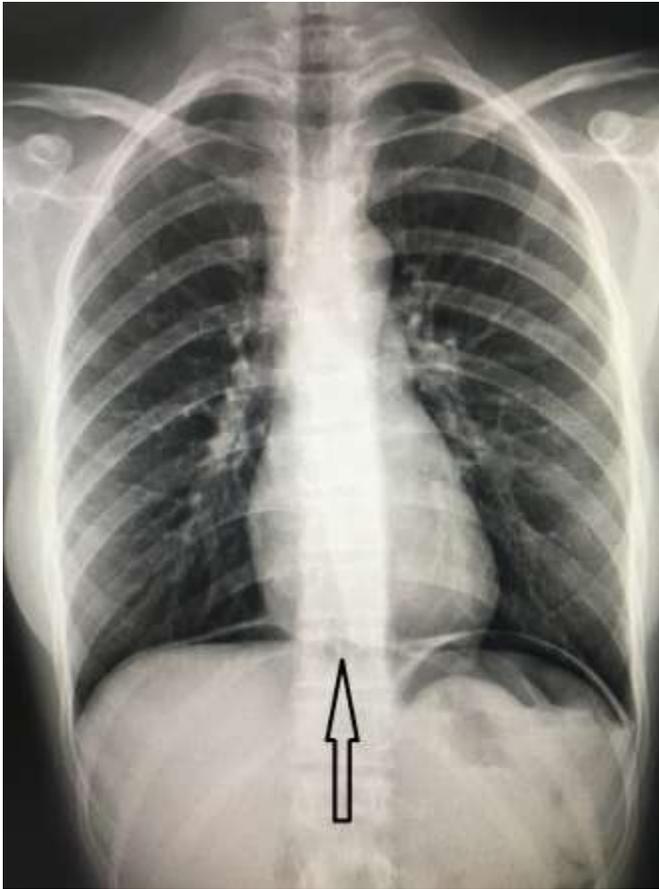
*Left: CXR showing the typical appearance of “gas under the diaphragm”, in a young male who had a perforated duodenal ulcer, (author’s photograph)*

*Right: AXR showing a number of signs of free intra-abdominal gas in a 4 year old girl.*

These include:

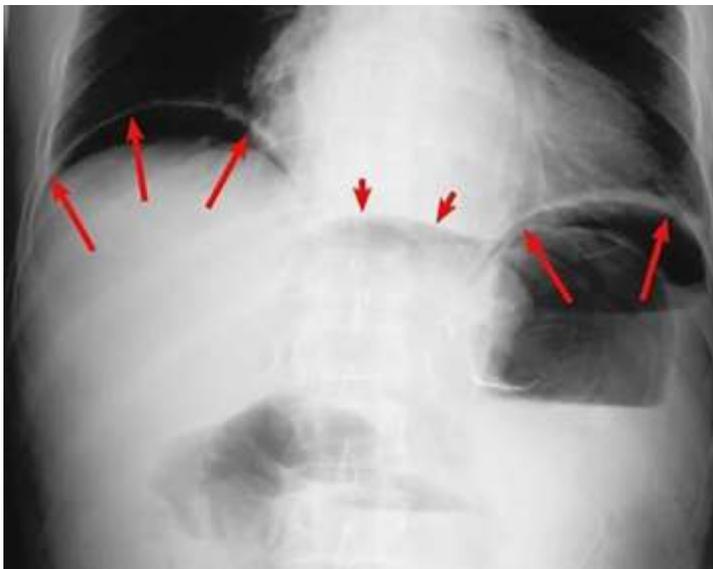
- Air accumulation in the right upper quadrant (the subphrenic area and ventral surface of the liver) (solid white arrows)
- The falciform-ligament sign, visible as a longitudinal linear density on the ventral surface of the liver (dashed white arrows)
- The ligamentum teres sign, visible as a linear density running along the inferior edge of the falciform ligament (solid black arrows);
- Rigler’s sign, the visualization of air on both sides of the bowel wall (dashed black arrows).

All these signs indicate pneumoperitoneum.



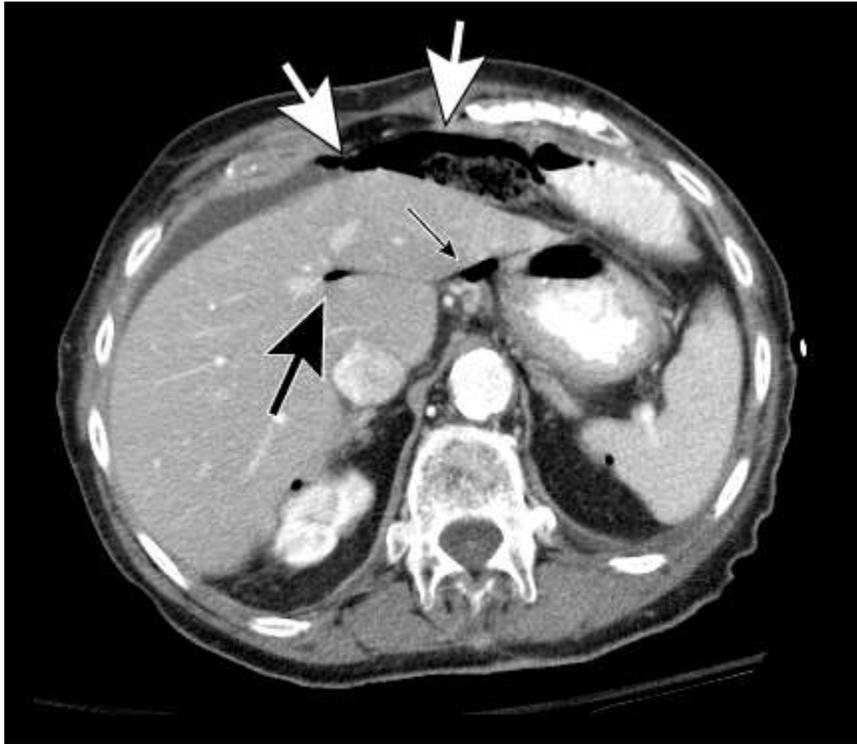
*Left: The Cupola sign (gas is seen under the **central** tendon of the diaphragm, (Case courtesy of Dr Portia D’Anverrs, Radiopaedia.org, rID: 46608)*

*Right: The cupola sign may sometimes appear as part of the “continuous diaphragm sign” - as the cupola extends to gas under the diaphragm over both the liver and stomach, (Case courtesy of Dr Aditya Shetty, Radiopaedia.org, rID: 27306).*



*Left: Another central cupola sign, flanked on either side by further evidence of free gas under the diaphragm.*

CT Scan:



*Computed tomographic scan showing free air in the anterior peritoneal space (white arrows), in the ligamentum venosum (black arrow), and in the hepatogastric ligament (small black arrow) resulting from a perforation of a duodenal peptic ulcer.*



*Confederate dead at Antietam, September 1862, (Mathew Brady)*

*...and you'll see pictures of the dead on the battlefields with their clothes in disarray as if someone had been going through - rifling - their bodies. That was the men themselves tearing their clothes up to see where the wound was, and they knew perfectly well if they were gut shot, they'd die.....*



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*“When can you start?” .....*

## References

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