

ABDOMINAL COMPARTMENT SYNDROME

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INTRODUCTION

Compartment : a confined body space, which in this context is the abdominal cavity.

This cavity forms a compartment & the pressure inside can be influenced by volume of fluids, blood vessels such as aorta & IVC , and organs within the compartment.



Intra abdominal pressure :the steady-state pressure within the abdominal cavity, a space enclosed by the spine, pelvis, diaphragm, and abdominal wall.

IAP **increases** with inspiration (diaphragmatic contraction) and **decreases** with expiration (diaphragmatic relaxation).

DEFENITIONS

Intra abdominal pressure : the steady-state pressure within the abdominal cavity, a space enclosed by the spine, pelvis, diaphragm, and abdominal wall.

It is **normally** subatmospheric to 0 mmHg. The upper limit of IAP is generally accepted to be 12 mmHg by the WSACS

Intra abdominal hypertension (IAH): a sustained or recurrent elevation of IAP to ≥ 12 mm Hg.

According to rush ; > 15 mmhg

According to schwartz ; > 20 mmhg

Abdominal compartment syndrome: a sustained IAP > 20 mm Hg that is **associated** with organ dysfunction

According to schwartz ; > 25 to 30

Grade	Intra-abdominal pressure, mm Hg
I	12-15
II	16-20
III	21-25
IV	≥ 25

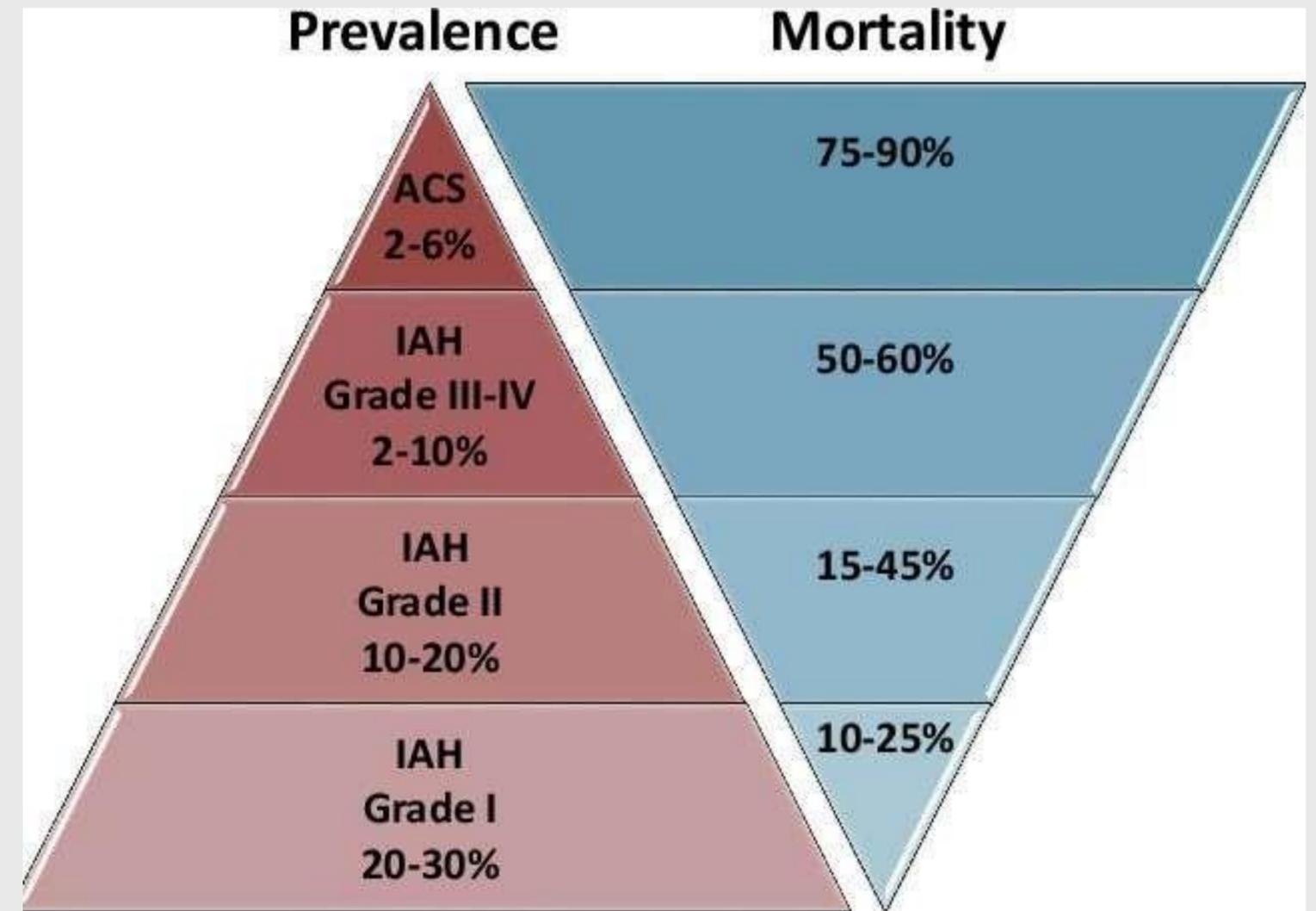
Based on information from the World Society of the Abdominal Compartment Syndrome

	Normal	Intra abdominal Hypertension	Abdominal Compartment syndrome
Intra Abdominal Pressure (mmhg)	Subatmospheric to 0	>12 Grade I :12 - 15 Grade II :16 - 20 Grade III :21 - 25 Grade IV: >25	>20
Organ Dysfunction	No	No	Yes

Sequence of events following increase in intra abdominal pressure is as follows; increase in intra abdominal pressure leads to compression of organs and blood vessels, which impairs blood flow, so perfusion decreases , followed by ischemia , and organ failure.

EPIDEMIOLOGY

- In patients with known risk factors, intra-abdominal hypertension can be found in approximately 25% of ICU admissions with almost 3% having ACS.
- Mortality rate is high, ranging from 25% to 75%, due to the presence of multi-organ failure and severe underlying injuries.



CLASSIFICATION

According to etiologies :

PRIMARY

- associated with abdominopelvic injury or disease (e.g., abdominal trauma or surgery, acute pancreatitis)
- intervention (surgical or radiologic) of the primary condition is often needed.

SECONDARY

- associated with conditions that are not due to a primary abdominopelvic pathology (e.g., third spacing caused by sepsis and/or aggressive fluid resuscitation)
- Are due to tense ascites or oedema of an otherwise normal bowel.

RECURRENT

- reoccurrence after treatment of primary or secondary abdominal compartment syndrome

ETIOLOGIES

REDUCED ABDOMINAL WALL COMPLIANCE ...→ The elasticity of the abdominal wall and diaphragm

- Abdominal or pelvic trauma
- Abdominal surgery
- Major burns
- Prone positioning
- Mechanical ventilation
- Morbid Obesity



Burn patient



Morbidly obese patient



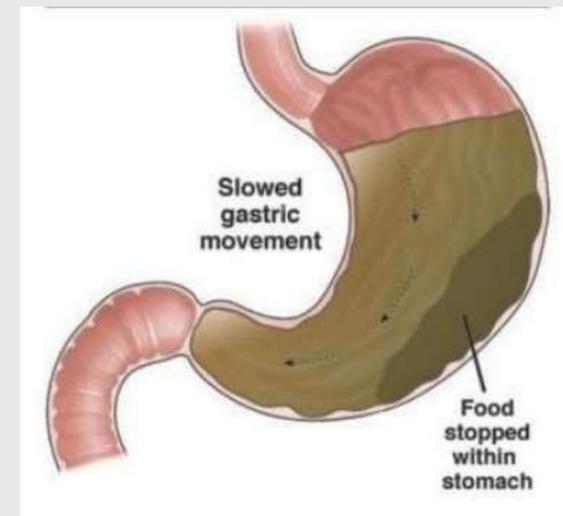
Patient on mechanical ventilator

ETIOLOGIES

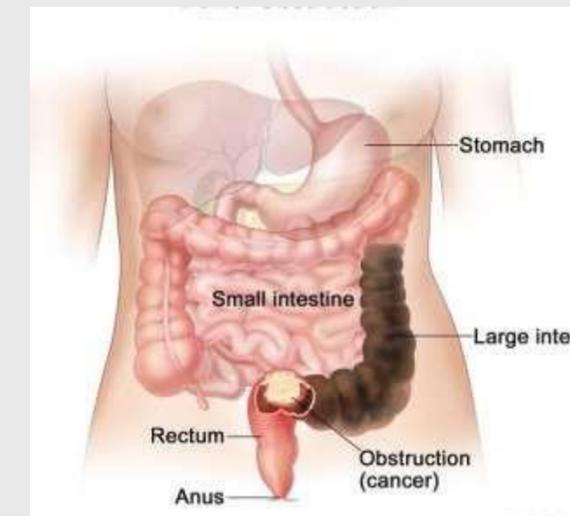
INCREASED LUMINAL CONTENTS

Any process that **decreases** or **impairs** the normal transit of bowel contents (paralytic, mechanical, or pseudo-obstructive ileus) can produce **accumulation of luminal contents** leading to **bowel distension** and an **increase in IAP**.

- Gastroparesis
- Mechanical bowel obstruction
- Paralytic ileus



Gastroparesis



Mechanical bowel obstruction

ETIOLOGIES

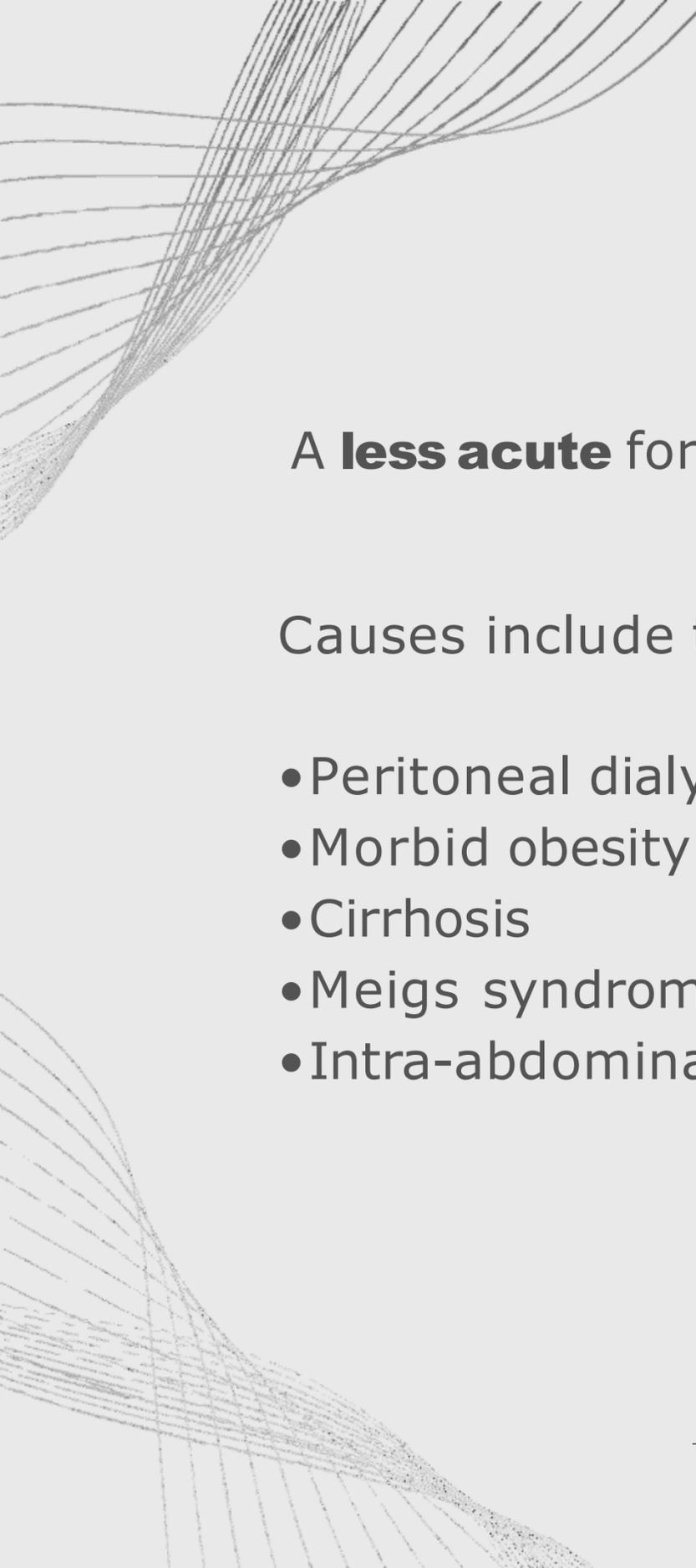
INCREASED ABDOMINAL CONTENTS

- Acute pancreatitis
- Intraabdominal tumor or abscess
- Massive ascites
- Hemoperitoneum
- Pneumoperitoneum
- Peritoneal dialysis

ETIOLOGIES

VISCERAL EDEMA

- Massive volume resuscitation (**>3L within a 24-hour period**) is the **most common cause of ACS**, usually with a significant crystalloid component (in postoperative patients, treatment of hypovolemic shock, severe burns)
- Massive blood transfusion protocols (**>10units in 24 hours**)
- Sepsis



CHRONIC ABDOMINAL COMPARTMENT SYNDROME

A **less acute** form of ACS occurring with **gradual increases in intra-abdominal pressure.**

Causes include the following:

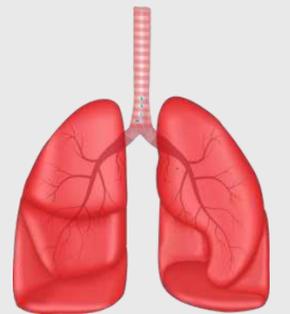
- Peritoneal dialysis
- Morbid obesity
- Cirrhosis
- Meigs syndrome (Ascites, pleural effusion, benign ovarian tumor)
- Intra-abdominal mass

CONSEQUENCES

EFFECTS ON ORGANS

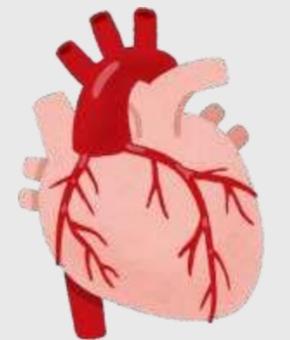
1. RESPIRATORY SYSTEM

Due to elevation of the diaphragm, the space around the lungs decrease, which leads to limited expansion . As a result, O₂ will decrease as a compensatory mechanism, leading to tachypnea due to hypoventilation



2. CARDIOVASCULAR SYSTEM

Impaired cardiac function due to elevated diaphragm
Decrease heart expansion which decreases diastole and cardiac output
Reduced venous return due to compression on IVC , blood return will decrease

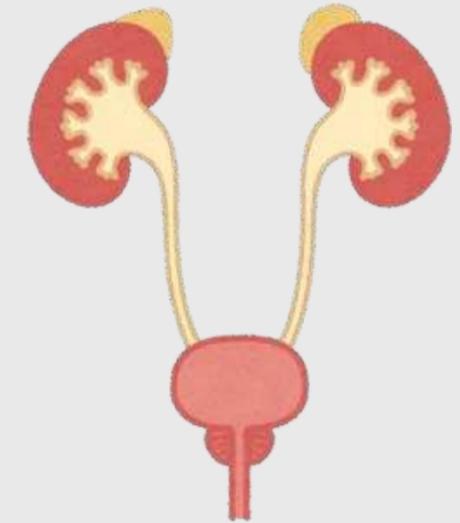


CONSEQUENCES

EFFECTS ON ORGANS

3. RENAL SYSTEM

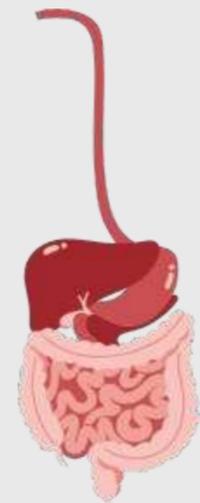
- Renal vein compression increases venous resistance
- Renal artery VC
- **oliguria** develops at intra abdominal pressure of approximately **15mmhg**
- **Anuria** develops at intra abdominal pressure of approximately **30 mmhg**



4. GASTROINTESTINAL SYSTEM

Intestinal mucosal perfusion is decreased at intra abdominal pressure of approximately **20 mmHg**

- Celiac artery and superior mesenteric artery blood flow are decreased at intra abdominal pressure of approximately **40 mmHg**



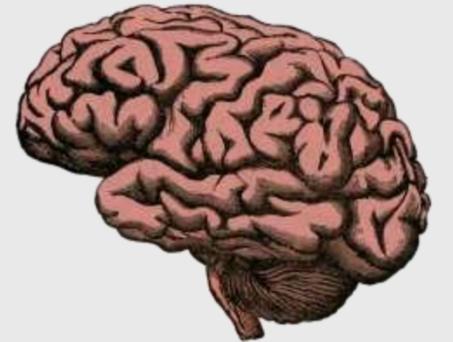
CONSEQUENCES

EFFECTS ON ORGANS

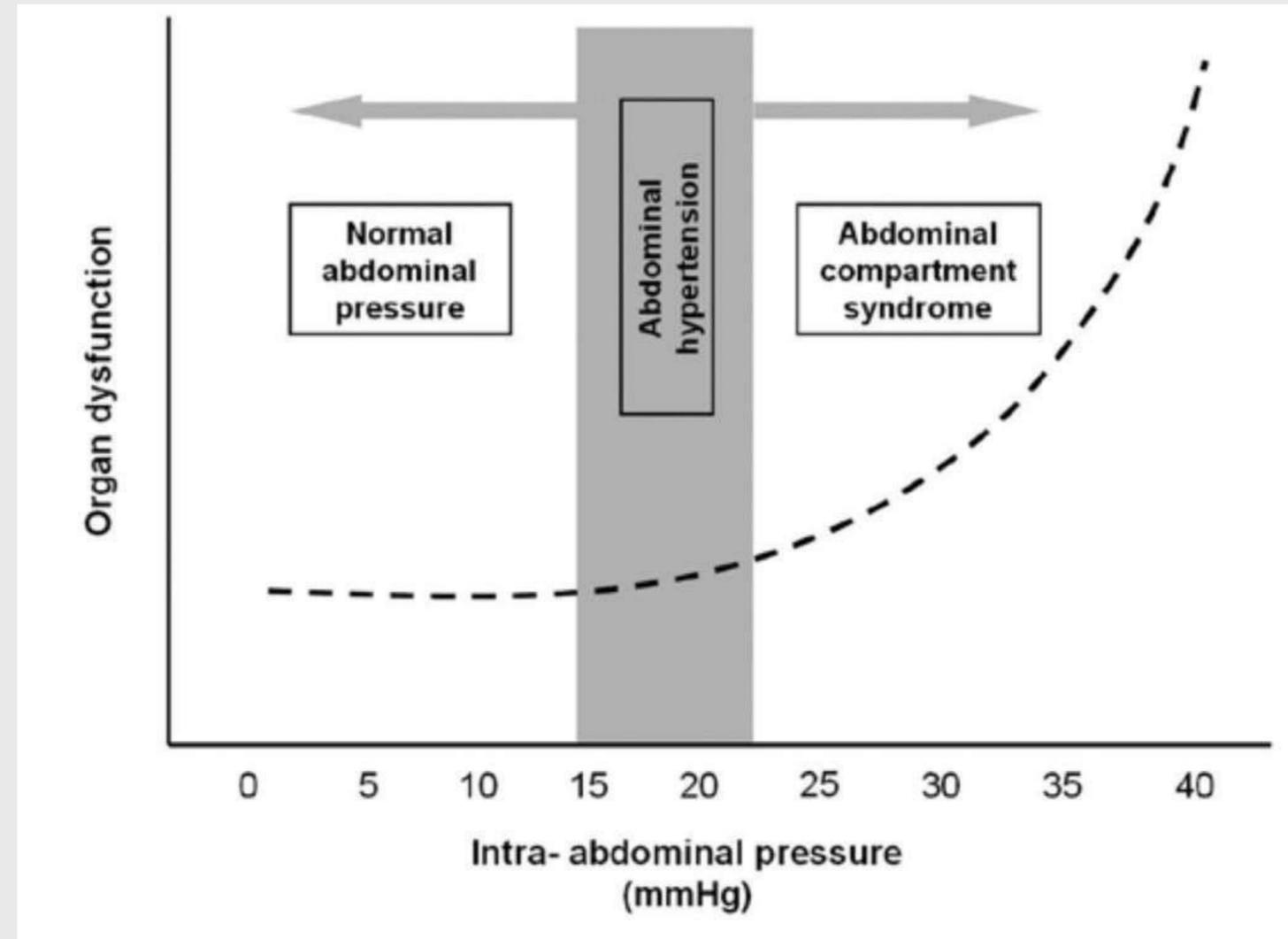


5. CENTRAL NERVOUS SYSTEM

- Intracranial pressure transiently increases during elevation of intra abdominal pressure leads to altered mental status and encephalopathy
- Critical decrease in cerebral perfusion and progressive cerebral ischemia



CORRELATION BETWEEN IAP & ORGAN DYSFUNCTION



CLINICAL PRESENTATION

SYMPTOMS

Malaise

Weakness

Light
headedness

Dyspnea &
SOB

Abdominal
pain



this is an early warning
sign of rising intra
abdominal pressure

SYMPTOMS

1. MALAISE

Generalized sense of discomfort, fatigue, or unease, early systemic symptoms signaling the onset of intra-abdominal hypertension (IAH) and potential progression to ACS.

2. WEAKNESS

As IAP rises, it compresses abdominal vessels, reducing venous return and cardiac output.

This leads to decreased oxygen delivery, metabolic acidosis, and tissue hypoxia, which manifest as generalized weakness and fatigue

SYMPTOMS

3. LIGHT HEADEDNESS

Light-headedness reflects **reduced cerebral perfusion**, often due to impaired cardiac output and venous return caused by elevated IAP.

- As IAP rises **above 20 mmHg**, it compresses abdominal vessels and elevates the diaphragm, reducing venous return to the heart.
- This leads to **hypotension, tachycardia**, and ultimately **decreased cerebral blood flow**, which manifests as light-headedness or dizziness.

4. DYSPNEA & SOB

As IAP increases, the diaphragm is pushed upward, reducing thoracic volume and impairing lung expansion.

This leads to extrinsic compression of the lungs, decreased chest wall compliance, and reduced spontaneous tidal volumes.

The result is a sensation of breathlessness—dyspnea and observable shortness of breath (SOB)

SYMPTOMS

5. ABDOMINAL BLOATING / ABDOMINAL PAIN

These symptoms arise due to **distension of the abdominal cavity**, often from fluid accumulation, bowel edema, or impaired motility (e.g. ileus).

- Bloating suggests **mechanical expansion** from fluid, gas, or fecal accumulation, while pain indicates **tissue ischemia, stretching of visceral structures, or inflammatory processes**

REMEMBER:

These are **early red flags** of rising intra-abdominal pressure.

Early recognition and intervention are essential to prevent irreversible organ damage.

SIGNS

PROGRESSIVE OLIGURIA

Oliguria refers to reduced urine output, typically <0.5 mL/kg/hr.

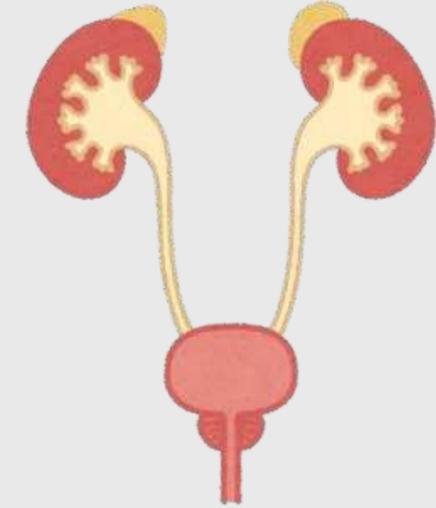
Elevated IAP causes:

- Renal vein compression, increasing venous resistance
- Renal artery vasoconstriction, reducing arterial inflow

These changes lead to decreased glomerular filtration, resulting in oliguria. It's a **direct** marker of organ dysfunction

HYPOTENSION, TACHYCARDIA

occur as a result of oliguria



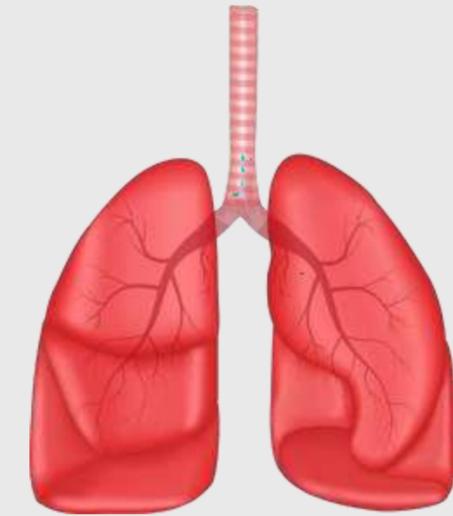
Oliguria develops at an intra-abdominal pressure of approximately 15 mmHg, **Anuria** usually develops at an intra-abdominal pressure of approximately 30 mmHg.

SIGNS

INCREASED VENTILATORY REQUIREMENTS

Elevated IAP causes the diaphragm to **shift upward**, *reducing* thoracic volume

As a result, patients require greater ventilatory support to maintain adequate oxygenation and ventilation

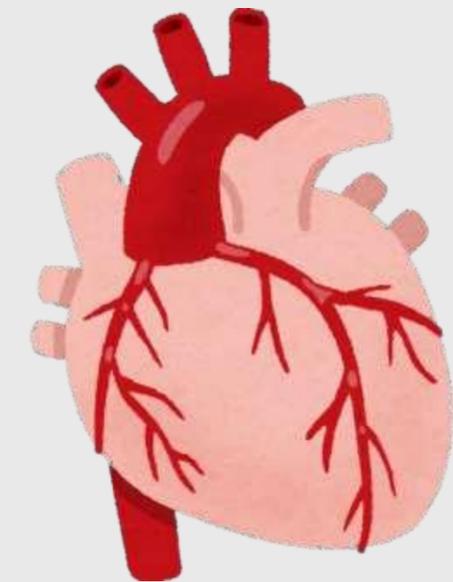


ELEVATED JUGULAR VENOUS PRESSURE, JUGULAR VENOUS DISTENTION & PERIPHERAL EDEMA

As IAP increases, it compresses the inferior vena cava and other major abdominal veins.

This leads to:

- **Reduced venous return to the heart**
- **Impaired cardiac preload**
- **Elevated central venous pressure**



SIGNS

ABDOMINAL TENDERNESS

Abdominal tenderness **may be localized or diffuse pain** that is elicited on palpation—clinically recognized as tenderness.

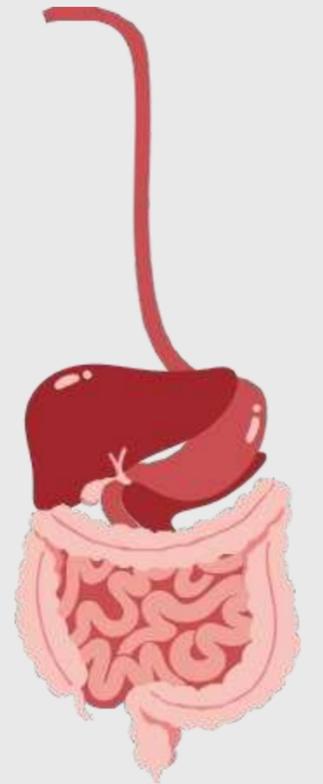
HYPOPERFUSION

(INCLUDING COOL SKIN, RESTLESSNESS OR LACTIC ACIDOSIS)

As IAP rises above 20 mmHg, it compresses major vessels (e.g., inferior vena cava), reducing venous return and cardiac output.

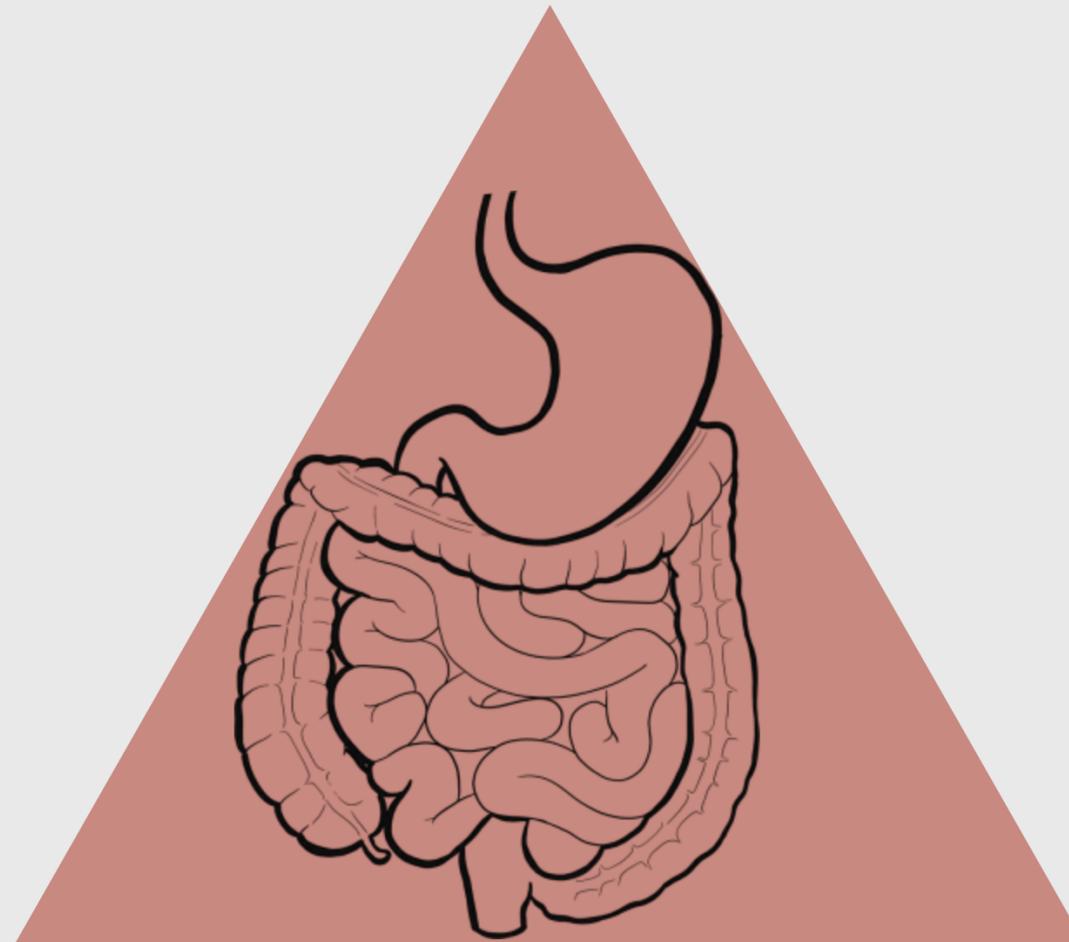
This leads to decreased perfusion pressure across vital organs, including the kidneys, liver, intestines, and brain.

so the liver's ability to clear lactate is also impaired at IAP as low as 10 mmHg and lead to lactic acidosis



ACS TRIAD

**INCREASED PEAK
AIRWAY PRESSURE**



OLIGURIA

**ABDOMINAL
DISTENTION**

DIAGNOSIS

- Definitive diagnosis of ACS requires measurement of the intra abdominal pressure.
- Measurement of intra-abdominal pressure:
intra-abdominal pressure can be measured **indirectly** using intragastric, intracolonic, intravesical (bladder), or inferior vena cava catheters. (> **12mmhg**)
- Measurement of bladder (**intravesical**) pressure is the **standard method** to screen for intra-abdominal hypertension (IAH) and ACS (> **25 mmHg**)

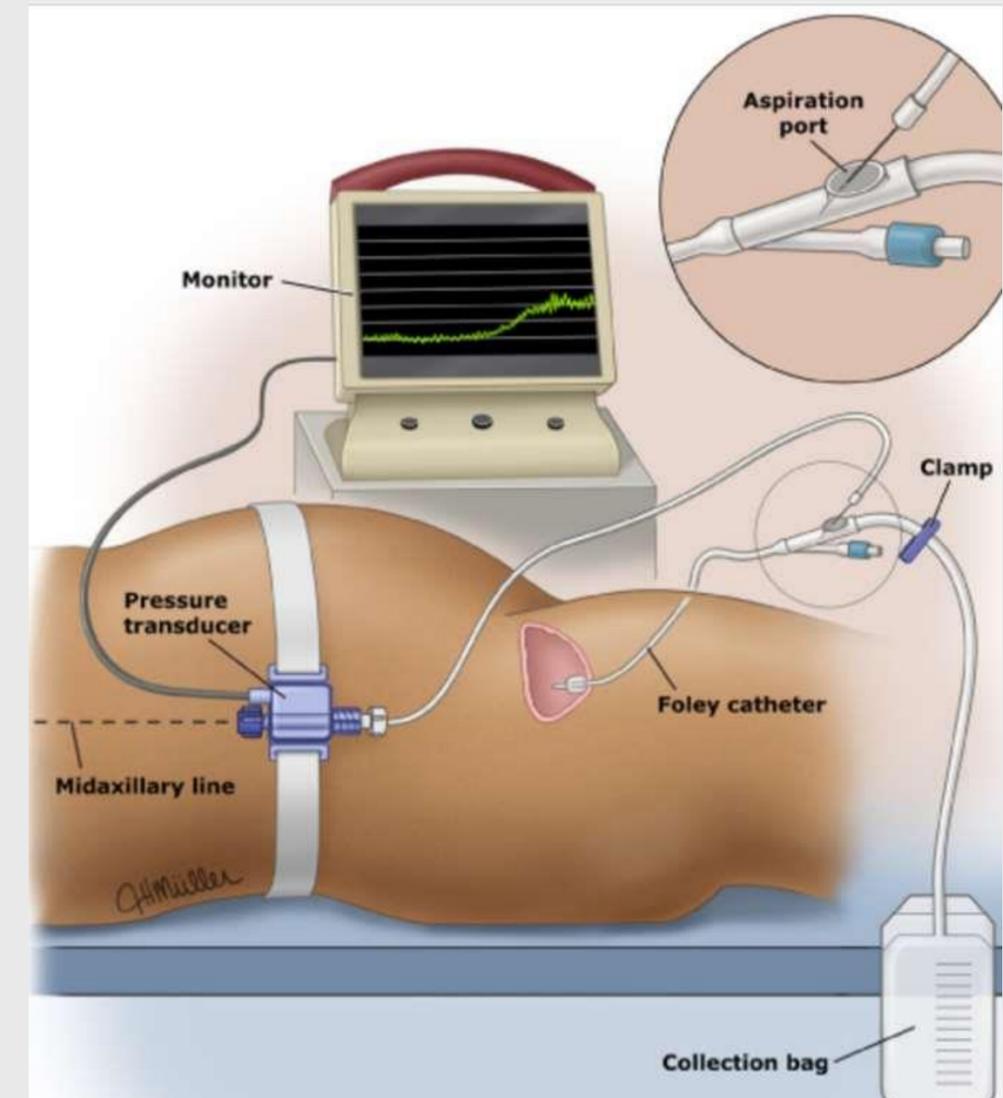
DIAGNOSIS

INTRAVESICAL MEASUREMENT :

1. Insert a thin, flexible tube (catheter) into the tube that transports urine out of your body (urethra).
2. Advance the catheter to your bladder.
3. Attach the catheter to a bag of fluid.
4. Use a syringe to inject the fluid into your bladder.
5. Measure the pressure.



IAP should be expressed in mmHg and measured at end-expiration in the complete supine flat position after ensuring that abdominal muscle contractions are absent and with the transducer zeroed at the level of the midaxillary line.



DIAGNOSIS

Blood tests: Blood tests can measure certain chemicals and gasses in your body. For example, a creatinine clearance test (A decreasing creatinine clearance (or increasing serum creatinine and decreasing urine output) can measure your kidney function.



Imaging tests: Imaging tests can provide pictures of the inside of your abdomen. For example, a CT scan or abdominal ultrasound.

Oxygen saturation: This test uses a simple clamp on the outside of your finger to see whether your body is getting enough oxygen. It provides **critical insight into organ perfusion and oxygen delivery**

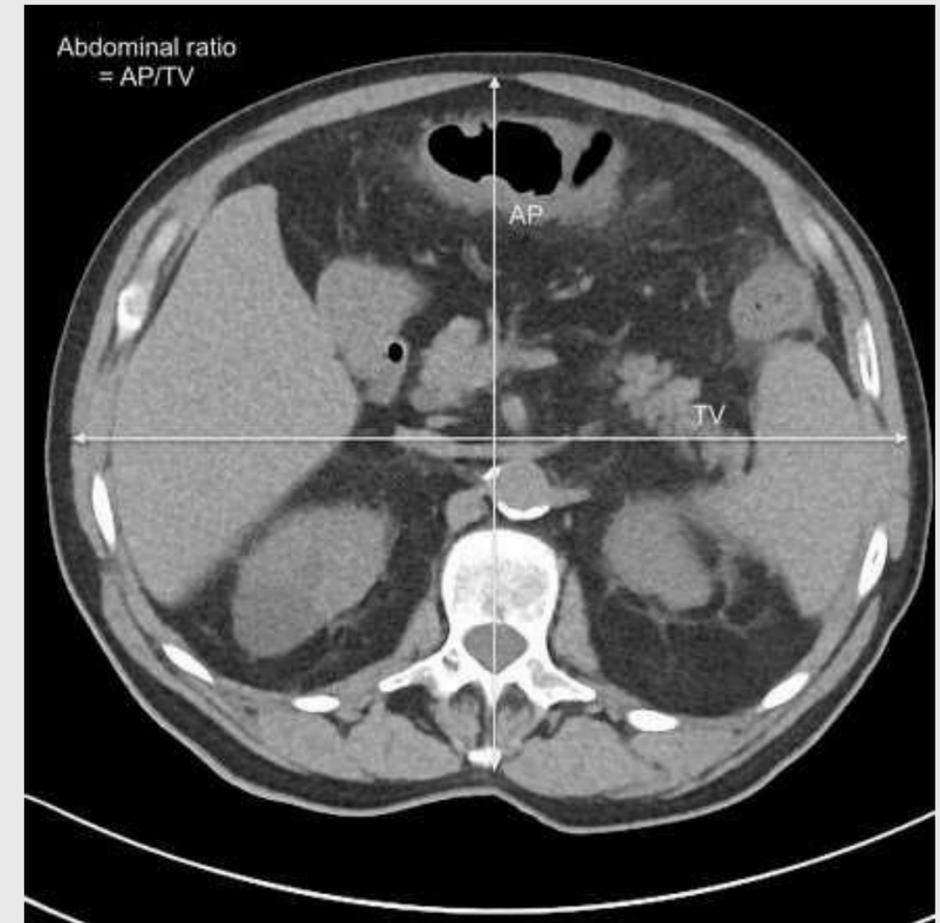


IMAGE FINDING

A **chest radiograph** may show decreased lung volumes, atelectasis, or elevated hemidiaphragms.

Chest computed tomography (CT):

rounded appearance of the abdominal wall (**round belly sign**), extrinsic compression of the inferior vena cava, massive abdominal distention, direct renal compression or displacement,



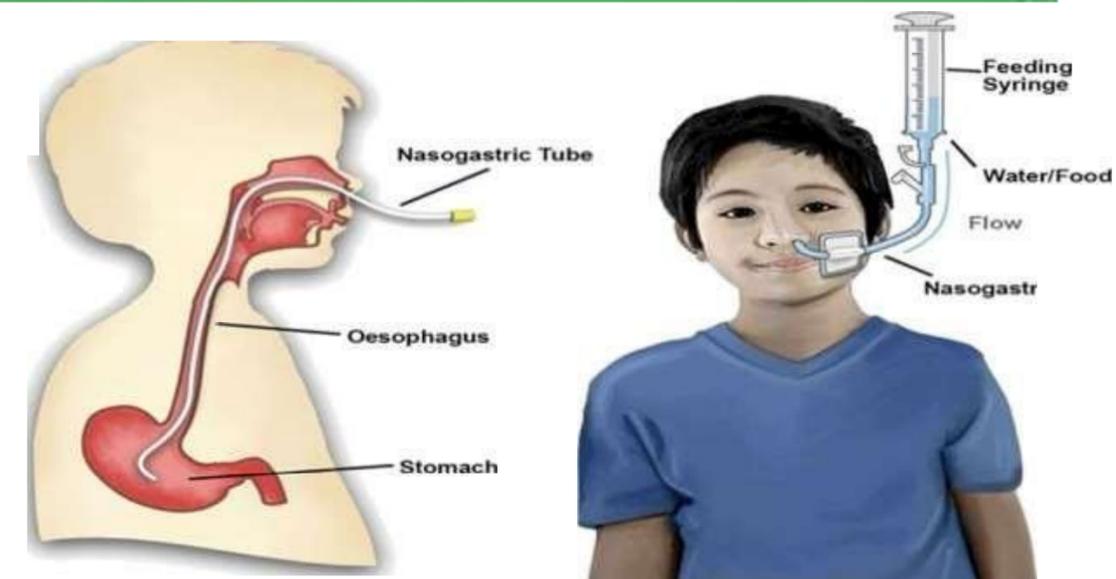
⚠ The ratio of maximal anteroposterior to transverse abdominal diameter (>0.8)

The background features a light gray gradient with abstract elements. In the top-left and bottom-right corners, there are clusters of thin, overlapping wavy lines that create a sense of motion and depth. Additionally, there are solid gray geometric shapes: a large triangle in the top-right corner and another in the bottom-left corner, both pointing towards the center.

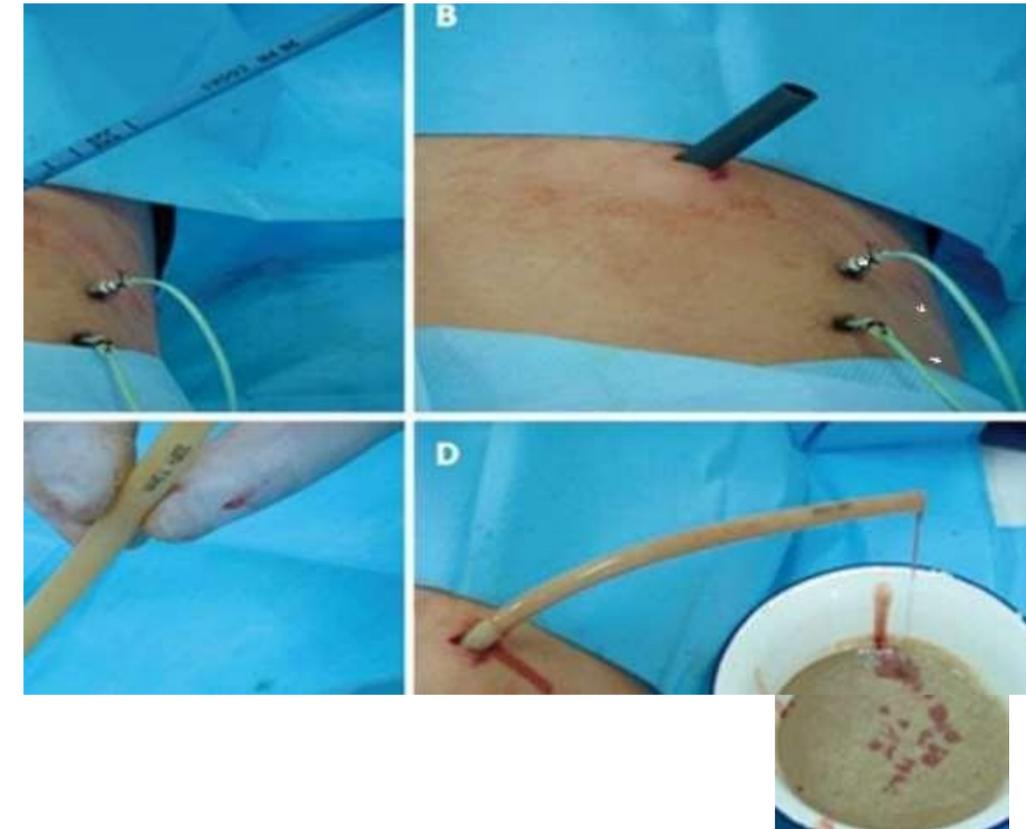
MANAGEMENT

1- CONSERVATIVE (NON-SURGICAL) MANAGEMENT

- The early use of **non-surgical** interventions may prevent the progression of IAH to ACS.
- The **neuromuscular** blocker is used for relaxation of the abdominal muscles , leading to a decrease in pressures .These patients must be put on a ventilator.
- **Gastric decompression** is done with NGtube. **Colonic decompression** is done with rectal tube. These are done to evacuate the lumen.
- The head of the patient's bed should not be raised for more than **30°**.



- **Percutaneous drainage** is a decompressive procedure used for abscesses, ascites, or any free fluid in the abdominal compartment.
- These patients are identified by bedside ultrasound
- The morbidity of a laparotomy is avoided.
- Patients with excess body fluid (hypervolemia) often have heart failure, making dialysis treatment risky and linked to high mortality. When pulmonary edema happened , respiratory support such as assisted ventilation becomes necessary to maintain adequate oxygenation.



2 SURGICAL MANAGEMENT

- It is the **primary treatment** of ACS , if conservative management does not resolve the IAH, or end-organ damage is seen.
- The treatment of ACS is to release the abdominal fascia.
- When management for ACS is considered the abdominal fascia should be left open and covered under sterile conditions with delayed fascial closure.
- After surgical laparotomy, the abdominal fascia can be temporarily closed (fascia approximation), by devices such as (vacs, meshes, and zippers).
- The fascia can be completely closed after 5-7 days, if the pressure decreased.



VACUUM-DRESSING WITH TEMPORARY MESH BEING CHANGED.

WITH DECOMPRESSION :

- With Decompressive laprotomy , there's immediately relieving the pressure :
- Compression on **IVC** relived causes increased in VR then the cardiac output and blood pressure , now we can stop vasopressors and iontopics.
- Blood flow to the viscera (gut, liver, kidneys) improves.
- Improve renal function (renal perfusion increases).
- Ventilation becomes easier since the diaphragm moves freely again.

- **If ACS not treated , this make the mortality rate 100%.**
- **Abdominal wall Closure should be attemptd every 48-72H until we can approximation the facia .**

If the abdomen cannot be closed within 5 to 7 days , large incisional hernia happen.

Time of decompression is very important :

If we make it as soon as possible this will reduce the mortality rate

If we delay it this make the mortality rate 70%

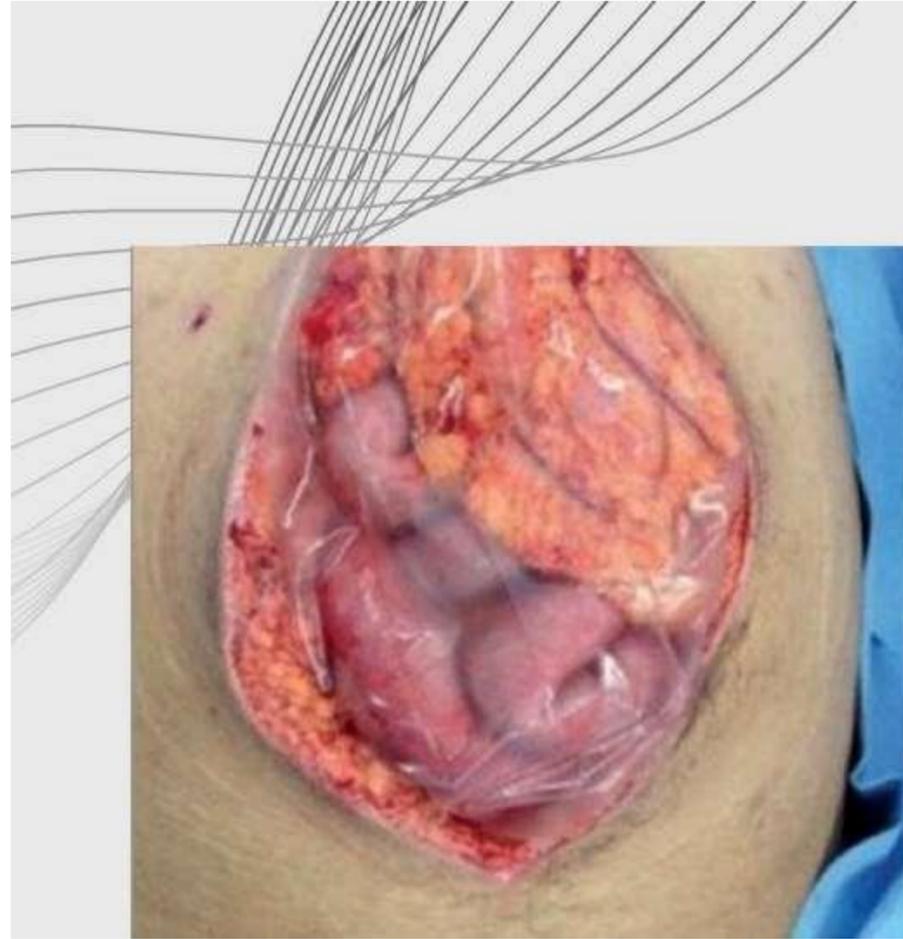
If we not make decompressive laprotomy , this make the mortality rate 100%.

The place we do the decompression is dependent on the stability of the patient , If the patient unstable we make it in the ICU (ICU bedside laprotomy).

If stable we make it in the operating room.

- Complications of decompressive laprotomy :
- 1) fluid loss.
- 2) protein loss (as peritoneal fluid rich with albumin).
- 3)Fistula formation.

Despite having open abdomen , patients can develop recurrent ACS . Therefore bladder pressure should be monitored every 4 hours.



1-temporary closure of the abdomen & covering the bowel with a fenestrated subfacial 45*60 cm sterile drape



2- Placing Jackson- Pratt drains along the fascial edge.

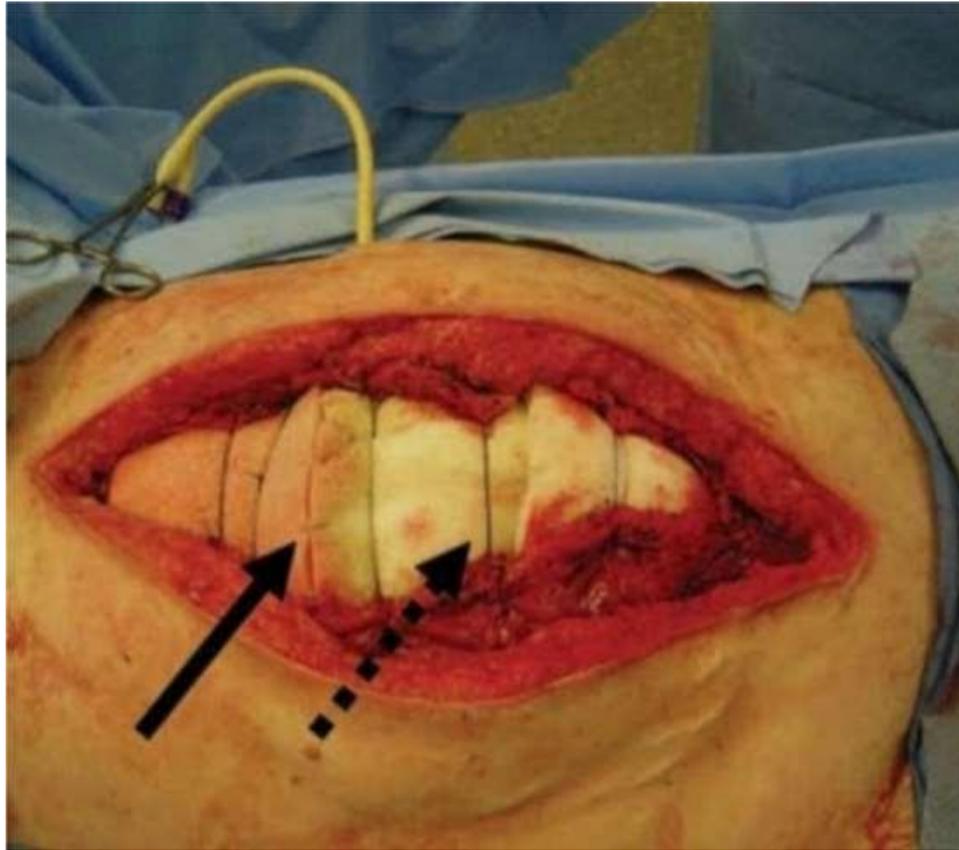


3&4 - Occluding with an ioban drape to prevent bacterial wound contamination.



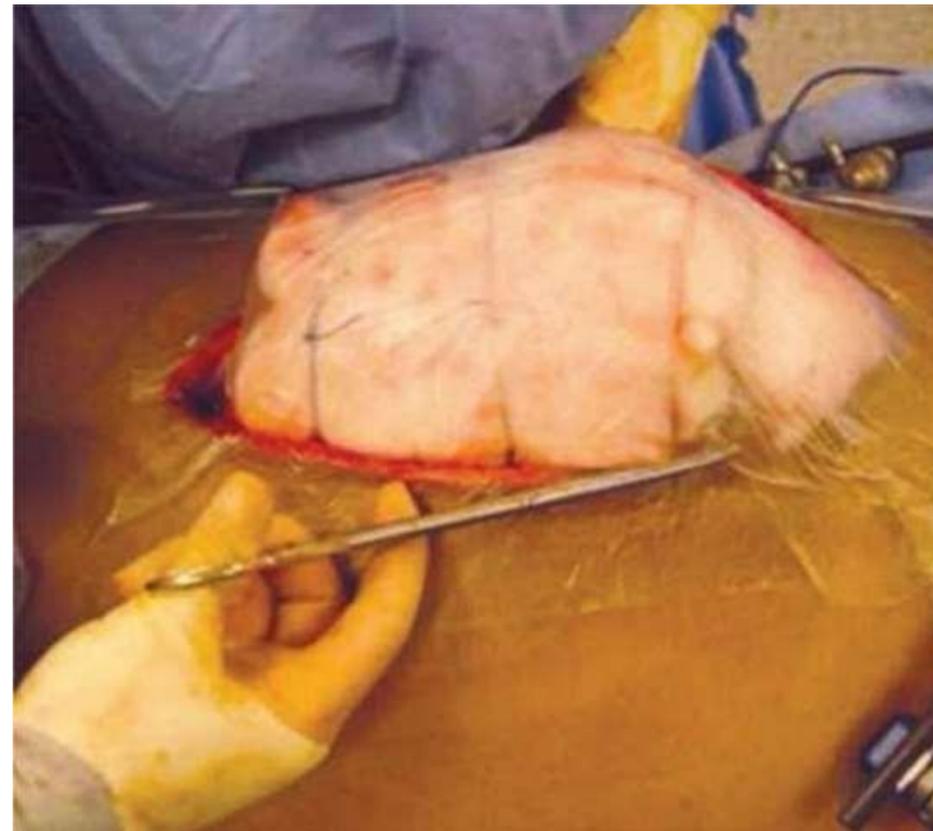
sequential closure techniques

recurrent return to operative room every 48H until closure complete



1-Multiple white sponges (solid arrow), stapled together are placed on top of the bowel underneath the interrupted fascia

Sutures are placed approximately 5 cm apart



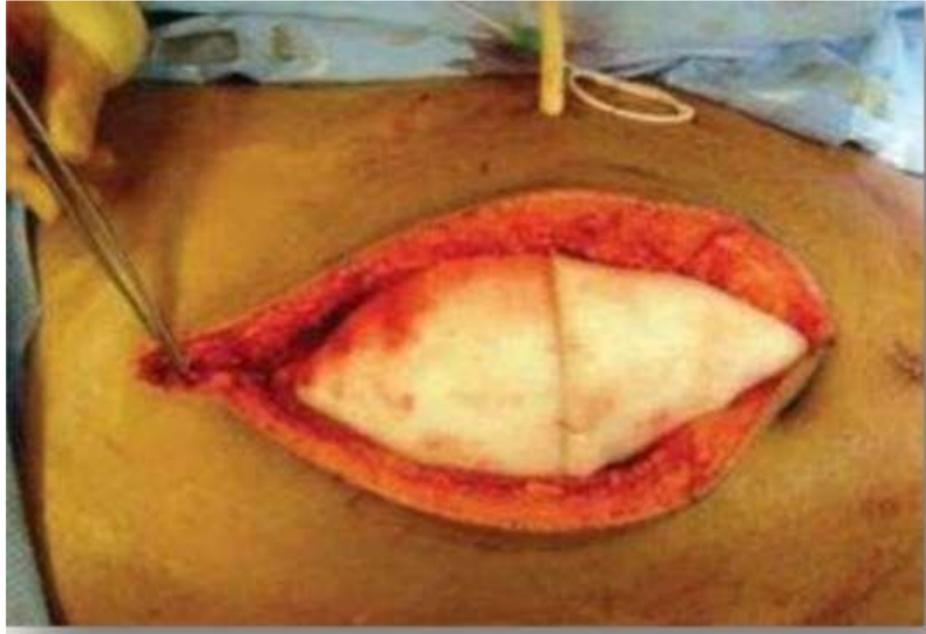
2- After the placement of the sticky clear plastic Vacuum-assisted closure (VAC) dressing over the white sponges and a

5 cm of skin, the central portion is removed by cutting along the wound edges.



3&4_ Black VAC sponges are **Placed on top of the white sponge**

And plastic protected With standard occlusive dressing and suction



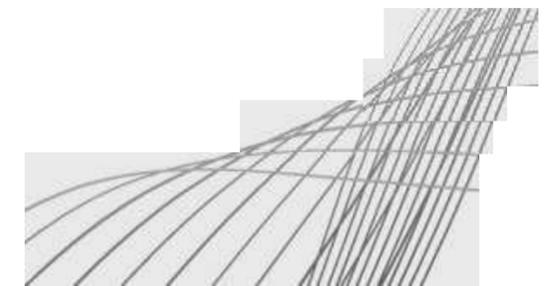
ON RETURN TO THE OR 48 HOURS later, fascial sutures are placed from both the superior and inferior directions until tension prevent further closure; skin is closed over the fascial closure with skin staples.



6—White sponges(fewer in number) are again applied, and fascial retention sutures are placed with planned return to the OR in 48 hours.

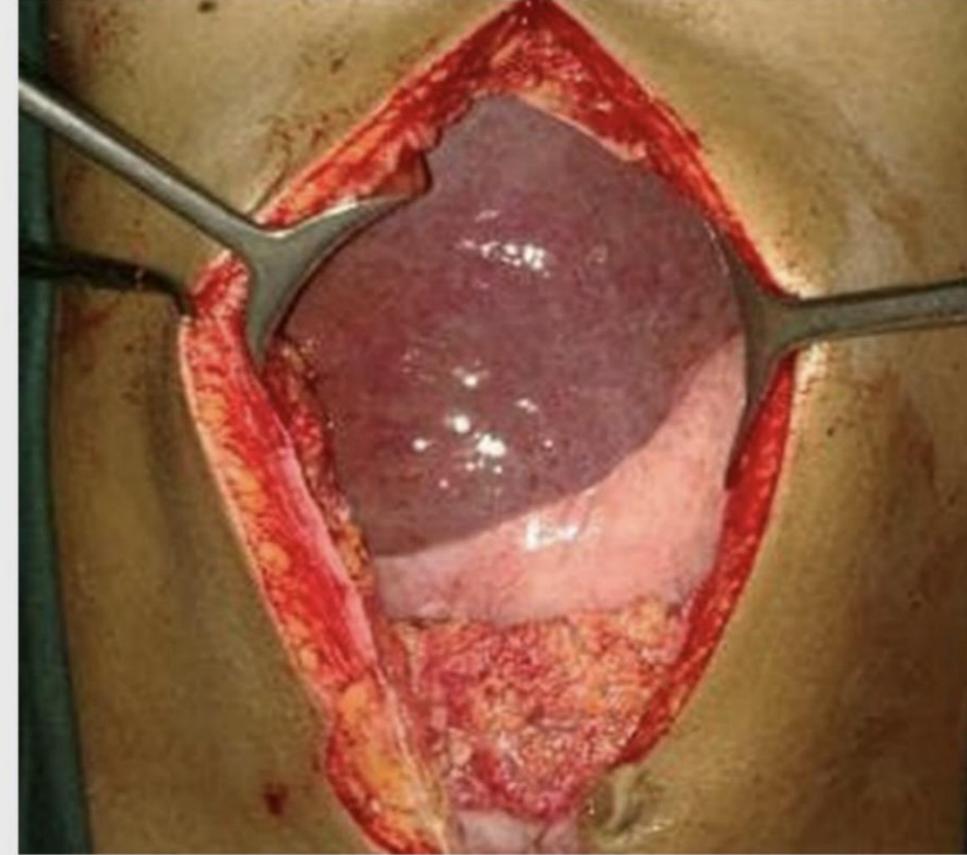
TYPES OF INCISIONS:

When determining the best procedure for surgical decompression, previous abdominal incisions (wounds) are desirable. If a patient has had a midline laparotomy, using the same incision for decompression is clearly the best. The midline laparostomy is the most common type of surgical decompression. All layers (skin, fascia, and peritoneum) are separated by a vertical midline incision that runs from the Xiphisternum to the pubis, with a few centimetres of fascia left intact at both ends to ease later closure or repair. A full-thickness laparostomy can also be performed through a transverse bilaterally expanded incision a few centimetres below the costal margins.

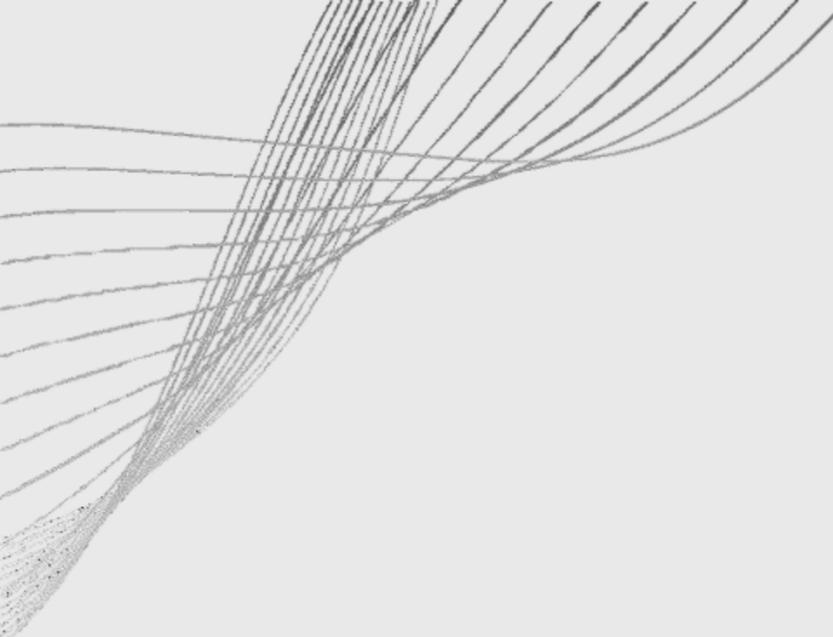




Transverse laparotomy



Midline laparotomy



Thank you