Chapter 44
Approach to Raised Intra-abdominal Pressure in the ICU

44.1 Introduction

Abdominal compartment syndrome (ACS) is a critical condition characterized by increased intra-abdominal pressure (IAP), leading to potential organ dysfunction and high mortality if not managed appropriately. It is essential to distinguish between intra-abdominal hypertension (IAH) and ACS: IAH refers to a sustained or repeated pathological elevation of IAP $\geq$ 12 mm Hg, while ACS involves a sustained IAP > 20 mm Hg with associated new organ dysfunction or failure. The concept of abdominal perfusion pressure (APP), defined as mean arterial pressure (MAP) minus IAP, serves as a crucial marker of abdominal organ perfusion. Maintaining adequate APP is vital to ensure sufficient blood flow to the abdominal organs [1, 2] [Ref: Algorithm 44.1].

44.2 Epidemiology

IAH is a relatively common condition in the intensive care unit (ICU), affecting up to 25% of ICU patients, with a smaller subset progressing to ACS. This condition often goes underdiagnosed, which underscores the importance of regular monitoring and maintaining a high index of suspicion, especially in at-risk patients. Without timely intervention, the mortality rate for untreated ACS can reach up to 40% due to the progression to multiorgan failure.

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44.3 Pathophysiology

The pathophysiological mechanisms of ACS include increased IAP, which impairs venous return, elevates intrathoracic pressure, and compromises diaphragmatic movement. This results in decreased cardiac output, reduced renal perfusion, and impaired respiratory mechanics, leading to potential organ dysfunction. Understanding these mechanisms helps ICU staff appreciate the systemic impact of elevated IAP and underscores the urgency of timely management to prevent irreversible organ damage [3].

44.4 Measurement of IAP

Measurement of IAP is crucial for early diagnosis and management of IAH and ACS. The bladder-based method remains the gold standard for IAP measurement, involving measurement of pressure via the bladder with a Foley catheter. Measurements should be taken at end-expiration and with a standardized technique to avoid erroneous readings. The transducer must be zeroed at the mid-axillary line, ensuring that abdominal muscle contractions are minimized during the measurement. Alternative measurement techniques, such as gastric or rectal pressure monitoring, can be considered for specific clinical scenarios. IAP should be monitored regularly in patients with risk factors like sepsis, trauma, or recent abdominal surgeries.

44.5 IAH and Its Grading

IAH is classified into four grades based on IAP measurements:

- Grade I: IAP 12–15 mm Hg.
- Grade II: IAP 16–20 mm Hg.
- Grade III: IAP 21–25 mm Hg.
- Grade IV: IAP > 25 mm Hg.

This grading helps tailor management strategies according to the severity of IAP. For instance, Grade I may only require close monitoring, while higher grades might necessitate more aggressive interventions.

44.6 Management of Elevated IAP (> 12 mm Hg)

44.6.1 Conservative Measures

- Fluid Management: Optimizing fluid balance is critical, as excessive fluid can exacerbate IAH by increasing intra-abdominal volume. Strategies to achieve a negative fluid balance can help prevent further IAP elevation.

- Patient Positioning: Adjusting the patient's position to a semi-recumbent position can reduce IAP by improving venous return.
- Sedation and Neuromuscular Blockade: These can be employed to decrease abdominal wall muscle tone, which can help lower IAP when conservative measures alone are insufficient.
- Minimally Invasive Techniques: Consider percutaneous catheter drainage in cases where intraluminal or extraluminal fluid needs to be reduced without resorting to surgery.

44.6.2 Decision-Making for Surgical Intervention (Decompressive Laparotomy)

44.6.2.1 Indications

A decompressive laparotomy is indicated for patients with IAP > 20 mm Hg who exhibit signs of ongoing organ dysfunction that are unresponsive to conservative measures, such as optimizing fluid balance, adjusting patient positioning, and using pharmacological interventions like neuromuscular blockade. Indications include persistent hypotension despite adequate fluid resuscitation, oliguria or anuria indicating renal compromise, worsening respiratory parameters due to decreased lung compliance, and increasing lactate levels suggesting tissue hypoperfusion. The goal of decompressive laparotomy is to rapidly relieve intra-abdominal pressure, allowing improved perfusion to vital organs such as the kidneys, liver, and intestines, and to prevent further progression to multiorgan failure [4].

44.6.2.2 Risks

While decompressive laparotomy can be lifesaving, it carries several potential risks that must be carefully weighed before proceeding:

- Wound Complications: The open abdomen can lead to difficulties in wound healing, including delayed closure and a higher risk of wound infections. Wound management is critical to prevent infection and sepsis, which can further complicate patient outcomes.
- Entero-atmospheric Fistulas: These abnormal connections between the intestines and the open wound can develop when bowel loops are exposed and become adherent to the wound edges. They are difficult to manage and can lead to significant fluid and electrolyte imbalances, increasing patient morbidity.
- Need for Abdominal Wall Reconstruction: Patients who undergo decompressive laparotomy may eventually require reconstructive surgery to close the abdominal wall, especially if delayed primary closure is not possible. This can include complex procedures such as skin grafting or the use of biological or synthetic mesh. These secondary procedures add to the overall burden of care and can extend the patient's ICU and hospital stay.

The decision to proceed with decompressive laparotomy should involve multidisciplinary input, including critical care specialists, surgeons, and possibly a wound care team, to ensure that the benefits of intervention outweigh the risks.

44.7 Open Abdomen Management

Open abdomen management is a crucial aspect of care following a decompressive laparotomy. This technique involves intentionally leaving the abdominal cavity open using temporary abdominal closure (TAC) techniques. The open abdomen approach allows for:

- Relief of Continued Swelling: After decompressive laparotomy, ongoing edema and inflammation can maintain elevated intra-abdominal pressures. TAC allows for continued decompression and access for subsequent surgical interventions if needed.
- Planned Reexplorations: It facilitates planned re-exploratory surgeries, where the surgical team can reenter the abdomen to address bleeding, infection, or other complications without having to reopen a fully closed abdomen.
- Techniques for Temporary Closure: Common methods include negative pressure wound therapy (NPWT) with vacuum-assisted closure devices, which help remove excess fluid, reduce edema, and promote granulation tissue formation. Other options include using absorbable meshes or silastic sheets to protect the exposed organs while maintaining some degree of coverage.

Early fascial closure is a key objective once the patient's condition stabilizes and IAP is under control. This involves closing the abdominal wall within 7–10 days to minimize complications associated with a prolonged open abdomen, such as the development of a frozen abdomen, where adhesions make future closure difficult. Achieving early closure can reduce the risk of further infections and improve long-term outcomes, including the likelihood of successful abdominal wall reconstruction [5].

44.8 Post-decompression Care

44.8.1 Fluid Resuscitation

Following decompressive laparotomy, careful management of fluid therapy is essential to prevent reperfusion injury. Reperfusion injury can occur when blood flow is suddenly restored to previously ischemic tissues, leading to oxidative stress and inflammation. Therefore, fluid resuscitation should be gradual and carefully titrated, focusing on maintaining adequate perfusion without causing a sudden rise in fluid volume that could increase IAP again. The use of balanced crystalloids and close monitoring of fluid status, such as through daily weight measurements and central venous pressure (CVP) monitoring, can help guide appropriate resuscitation.

44.8.2 Complication Management

The postoperative phase also requires vigilant monitoring for complications to ensure optimal patient recovery:

- Bleeding and Coagulopathy: Patients who have undergone decompressive laparotomy may be at risk for bleeding due to surgical trauma and possible coagulopathy. Coagulopathy should be addressed promptly with blood products like platelets or fresh frozen plasma, guided by regular coagulation profiles.
- Infections: The open abdomen presents a significant risk for abdominal and wound infections, which can progress to sepsis if not controlled. Prophylactic antibiotics and strict aseptic techniques during dressing changes are critical components of infection prevention. Early signs of infection, such as fever or purulent wound drainage, should prompt immediate intervention.
- Nutritional Support: Due to high catabolic demands and protein losses from the open abdomen, early enteral nutrition is recommended as soon as it is feasible to support healing and immune function.

44.8.3 Ongoing Monitoring

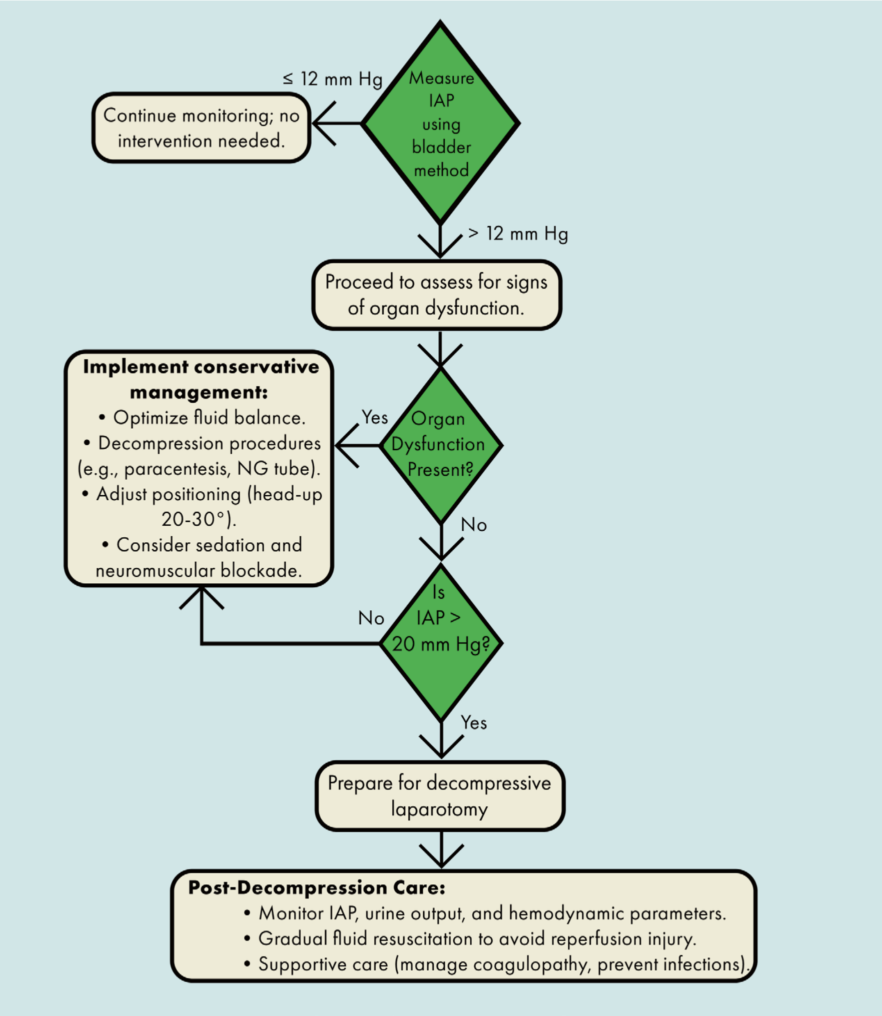
Regular IAP monitoring remains crucial even after surgical decompression to detect early signs of recurrent intra-abdominal hypertension. IAP should be measured every 4–6 hours during the initial postoperative period or whenever there are signs of hemodynamic instability. This allows for timely interventions such as adjusting fluid therapy or considering further decompressive measures if pressures rise again. Continuous assessment of organ function, including renal output, liver enzymes, and arterial blood gases, helps gauge the patient's response to decompression and guide ongoing treatment strategies.

Together, these steps aim to stabilize the patient post-laparotomy and improve the chances of recovery while mitigating the complications associated with ACS and its surgical treatment.

44.9 Conclusion

Effective management of IAH and ACS requires a systematic and patient-specific approach. Regular monitoring, timely conservative interventions, and judicious decision-making regarding surgical decompression are essential for optimizing patient outcomes. It is crucial to adapt the management strategy to the dynamic evolution of each patient's condition, integrating insights from a multidisciplinary team of critical care physicians, surgeons, and nurses. Recognizing the interplay between IAP and systemic physiology allows for a more tailored approach, improving survival rates and reducing long-term morbidity for patients with IAH and ACS.

Algorithm 44.1: Approach to raise intra-abdominal pressure in the ICU



Bibliography

1. Kirkpatrick AW, Roberts DJ, De Waele J, Jaeschke R, Malbrain ML, De Keulenaer B, et al. Intra-abdominal hypertension and the abdominal compartment syndrome: updated consensus definitions and clinical practice guidelines from the world society of the abdominal compartment syndrome. Intensive Care Med. 2013;39(7):1190–206.
2. Coccolini F, Roberts D, Ansaloni L, Ivatury R, Gamberini E, Kluger Y, et al. The open abdomen in trauma and non-trauma patients: WSES guidelines. World J Emerg Surg. 2018;13:7.
3. Jang H, Lee N, Jeong E, Park Y, Jo Y, Kim J, et al. Abdominal compartment syndrome in critically ill patients. Acute Crit Care. 2023;38(4):399–408.
4. De Laet IE, Malbrain M, De Waele JJ. A clinician's guide to management of intra-abdominal hypertension and abdominal compartment syndrome in critically ill patients. Crit Care. 2020;24(1):97.
5. Montalvo-Jave EE, Espejel-Deloiza M, Chernitzky-Camaño J, Peña-Pérez CA, Rivero-Sigarroa E, Ortega-León LH. Abdominal compartment syndrome: current concepts and management. Revista de Gastroenterología de México (English Edition). 2020;85(4):443–51.