Risk Factors of Increasing Intra-Abdominal Pressure and Compartment Syndrome and Their Management in Post Emergency Laparotomies' Patients

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Article Info

ISSN (online): 2582-8940
Volume: 07
Issue: 03
Received: 25-05-2026
Accepted: 22-06-2026
Published: 21-07-2026
Page No: 115-120

Abstract
Background: Because of its association with high rates of illness and death, elevated intra-abdominal pressure (IAP) is a frequent occurrence in the critically sick. Since intra-vesical pressure (IVP) is easy to measure, it should be monitored in all patients who are thought to be at risk for serious increases in IAP.
Aim of study: To monitor IAP for the diagnosis and assess the risk factors for IAH and Abdominal compartment syndrome (ACS) and early treatment in post emergency laparotomy patients to prevent further organs damage.
Methods: A prospective study conducted in the surgical unit during a period of three years from the 1st of October 2022 to the 1st of November 2025. It included 142 adult patients with post emergency laparotomy done for them who were admitted to the surgical department including traumatic and non-traumatic cases. We measured the IVP for measuring IAP.
Result: In our study, postoperative IAP was elevated in 60.6% of patients (32.4% of them were in stage II IAH), 87.2% of patients with elevated IAP were treated medically, 8.1% were treated surgically, while 4.7% of them died. The highest prevalence of patients with postoperative IAH was seen significantly among males, obese patients, patients with traumatic chief complain, those who were hemodynamically unstable before operation, and patients with prolonged duration of surgery.
Conclusion: In this study, more than half of the patients developed postoperative IAH, with a small but clinically significant proportion progressing to ACS, highlighting the substantial burden of this potentially preventable complication. Most risk factors for IAH and ACS are prolonged duration of surgery, preoperative unstable hemodynamics, male gender, penetrating trauma, and obesity, so we should do serial IAP measurement in any patients who demonstrate risk factor for IAH and ACS to avoid their development with their subsequent lethal complications.

DOI: https://doi.org/10.54660/IJMBHR.2026.7.3.115-120

Keywords: Intra-abdominal hypertension, Abdominal compartment syndrome, surgery, risk factor

Introduction

A rise in the internal pressure of the abdominal cavity, as measured in relation to the resistance of the abdominal wall and the respiratory phase, is known as increased intra-abdominal pressure (IAP) [1]. It is being acknowledged as an important physiological component, or the sixth vital sign, in severely sick patients, following temperature, respiration rate, blood pressure, heart rate, and oxygen saturation [2]. Patients with severe sepsis or an acute abdomen often have an IAP of 20-30 mmHg, which

is significantly higher than the normal range of 5-7 mmHg in the critically sick [3]. When the IAP remains abnormally high for an extended period of time (more than 12 mmHg), this condition is known as intra-abdominal hypertension (IAH) [4]. The abdominal compartment syndrome (ACS) is characterized by a persistent rise in IAP more than 25 mmHg (in conjunction with or in absence of an abdominal perfusion pressure less than 60 mmHg) linked to the development of new organ dysfunction or failure [5]. IAH and ACS postoperatively and in other intensive-care situations are important causes of morbidity and mortality, The absolute number of deaths due to ACS is unknown, but it has been shown that after endovascular aortic aneurysm surgery, approximately 12% of the patients were diagnosed with ACS [6]. An increase in IAP because of illness and the subsequent consequences of this pressure on different organ systems is fundamental to the pathophysiology of IAH and ACS. When IAP rises, the abdomen expands, which presses on the diaphragm and compresses the thoracic cavity. This causes reduced intra-thoracic volume, decreased compliance of the chest wall, increased intra-pleural pressure, and collapse of the alveoli. As a result, there is a mismatch between ventilation and perfusion, hypoxia, hypercarbia, and respiratory acidosis [7]. The treatment of IAH and ACS must prioritize prevention. Although ACS has multiple causes (45 percent), the most common ones include fluid overload with intra-abdominal infection, intestinal obstruction, and bleeding. Less fluid delivery and the avoidance of tissue edema would be the outcomes of diagnosing and treating intra-abdominal sepsis earlier [8]. The precise management of IAH remains somewhat clouded. For those Patients treated firstly with conservative treatment, Aggressive non-operative intensive care support is critical to prevent the complications of ACS [9]. The delayed presentation, severe trauma, and lack of critical care resources in Iraqi post-emergency laparotomy patients greatly raise the risk of ACS and IAP. These illnesses cause avoidable deaths and illnesses because they are frequently misdiagnosed and poorly treated. Improving early identification, treatment, and patient outcomes in Iraqi hospitals can be achieved by studying their risk factors and existing management in order to produce context-appropriate guidelines. The aim of this study is to monitor IAP for the diagnosis and assess the risk factors for IAH and ACS and early treatment in post emergency laparotomy patients to prevent further organs damage.

Patients and Methods

Study Design and Setting

A prospective study conducted in the surgical unit of Baghdad Teaching Hospital / Medical City / Baghdad, Iraq during the period of three years from 1st of October 2022 to the 1st of October 2025.

Study Patients

The study included 142 adult patients with post emergency laparotomy done for them who were admitted to the surgical department including traumatic and non-traumatic cases. They arranged in groups according to the most risk factors for development of IAP and ACS.

Data Collection Tools

All patients were evaluated thoroughly by taking history and clinical examinations. Regarding history, the data collected were age and gender, BMI, duration of surgery, hemodynamic status of patients, and type of trauma. Investigation included (B. urea, S. creatine, Coagulopathy (PT, PTT, INR) and Blood gas analysis) done for all patients for assessment and detection of organ failure.

IAP measurement

IAP was measured indirectly by using intravesical method which is the most popular method used.

- First, A Foley catheter of the correct size was placed, in case one wasn't already there.
- After the bladder is emptied, a 25-50 ml injection of sterile saline is administered into the bladder using the catheter's aspiration port.
- At the end of the urine drainage bag's sterile tubing, close the cross-clamps.
- By measuring the height of the water column in the manometer, the pressure in cm H_2O is recorded when a handheld manometer is linked to the Foley catheter. By dividing it by 1.36, it can be expressed in millimeters of mercury.
- Pressure is zeroed at the iliac crest in the midaxillary line while the patient is in a supine position and at the conclusion of expiration for the test. The bladder detrusor muscle relaxes 30-60 seconds after saline is injected, and the pressure is then measured. A falsely high result could be the consequence of muscular contraction, which is not allowed.
- Base line measurement of IAP with 12-hour interval done for each patient and serial measurement at 6-hour interval for patients with IAP more than 20 mmHg.
- We followed the World Society on Abdominal Compartment Syndrome (WSACS), in its latest definition of IAH and ACS, who had graded IAH into four stages, with stage IV as equivalent to ACS. Table 1 summarizes the WSACS classification of IAH:

Table 1: WSACS classification of IAH

Stages	Definition
Normal	IAP <12 mmHg
Stage I	IAP 12-15 mmHg
Stage II	IAP 16-20 mmHg
Stage III	IAP 21-25 mmHg
Stage IV (ACS)	IAP >25 mmHg

Management

- Patients in stage 1 and 2 were treated conservatively by removing all constrictive dressing, N/G tube, rectal enema, pain killer and avoiding massive I.V. fluid (crystalloid) administration; instead, use of colloid fluid, using of loop diuretics (furosemide) and use of anti-emitting drugs, and colonic decompression.
- Patients in stage 3 were treated firstly by conservative treatment, then if no response and IAP increased, surgical treatment is indicated as urgent decompression was performed if two readings confirmed the elevation of IAP > 25 mmHg.
- Those ACS on initial measurement or during follow up urgently underwent decompressive laparotomy, this was done with temporary closure of abdominal method. There are multiple methods for temporary closure, one of them, Bogota bag was used in this study (Figure 1). This procedure involves cutting open an intravenous fluid bag—or, more often, a urinary bag—and then

suturing it to the skin or fascia using a continuous thick nylon stitch. Next, betadine-soaked laparotomy packs are placed on top of the bag. These packs are replaced every day in the operating room or intensive care unit (ICU) using two drains; one drains excess fluid and the other instills normal saline. On rare occasions, when symptoms of infection are detected, the bag is replaced.

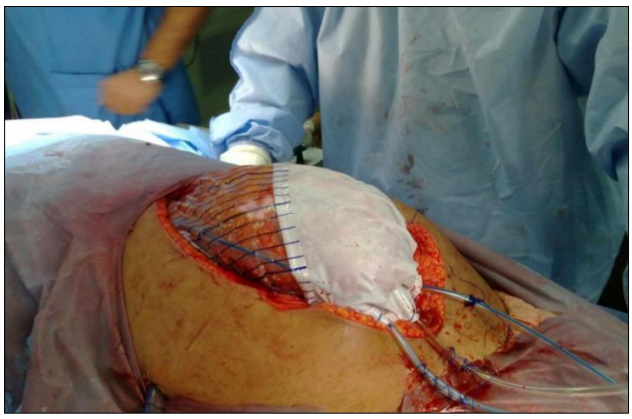

Fig 1: Bogota bag

Ethical Considerations

For an ethically sound research project like this one, it's important to follow the guidelines provided by the Declaration of Helsinki. We got the green light from the ethics committee at Al-Yarmouk Teaching Hospital. A sign informed permission was obtained from each patient after they were apprised of the study's aims and methods. The use of identifying coding and the storage of data in a password-protected environment ensured data security.

Statistical Analysis

The data was analyzed using the Statistical Package for Social Sciences (SPSS), version 28, which is freely available. Standard deviation, range (lowest to highest), percentage, mean, and frequency were the basic metrics used to display the data. The ANOVA test (Two tailed) was used to evaluate the significance of difference between various means (quantitative data). When appropriate, we used the Chi-square test with Yate's correction or the Fisher exact test to determine the statistical significance of percentage differences (qualitative data). When the p-value was less than 0.05, statistical significance was assumed.

Results

This study included 142 patients, the mean age was 46.72 ± 8.7 years (range: 17 – 56 years), with 72 (50.7%) females. This study showed that 42.3% of them were obese, 60.6% complained from non-traumatic events, 64.1% were hemodynamically stable before operation. Postoperative IAP was elevated in 60.6% of patients (32.4% of them were in stage II IAH). Re-exploration was done for 10% of them (Table 2).

Table 2: Patients' Characteristics (n= 142)'

Patients' Characteristics	No. (n= 142)	Percentage (%)
Age (Year)		
< 20	7	4.9
20 – 39	54	38.0
≥ 40	81	57.1
Gender		
Male	70	49.3
Female	72	50.7
BMI Level		
Underweight	27	19.0
Normal	55	38.7
Overweight / Obese	60	42.3
Chief complain		
Traumatic	56	39.4
Non-traumatic	86	60.6
Preoperative hemodynamic stability		
Stable	91	64.1
Unstable	51	35.9
Postoperative IAP (mmHg)		
Normal (< 12)	56	39.4
Stage I IAH (12 – 14)	20	14.1
Stage II IAH (15 – 19)	46	32.4
Stage III IAH (20 – 24)	12	8.5
ACS (≥ 25)	8	5.6
Re-exploration		
Yes	10	7.0
No	132	93.0

As shown in figure 2, 87.2% of patients with elevated IAP were treated medically, 8.1% were treated surgically, while 4.7% of them died.

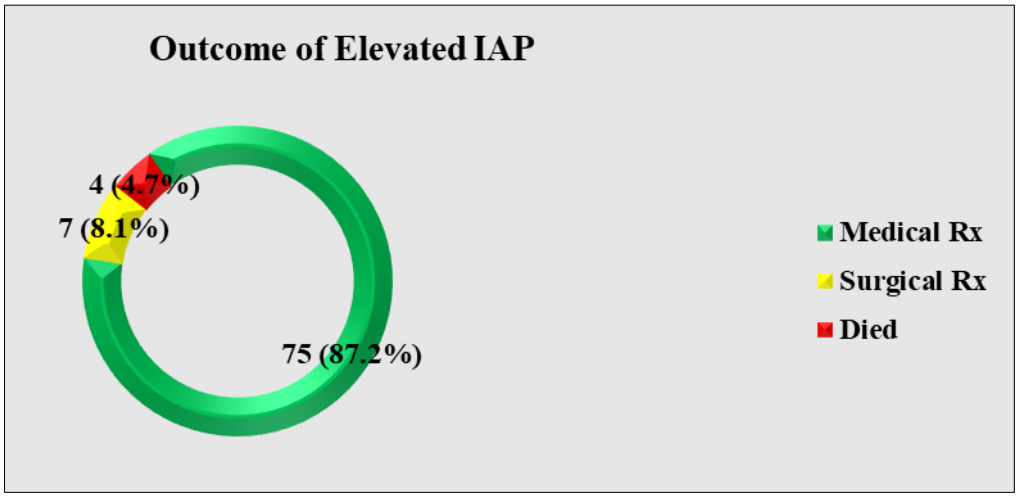

Fig 2: Outcome of patients with elevated IAP

We noticed that the highest prevalence of patients with postoperative IAH was seen significantly among males (80%, P= 0.001), obese patients (68.3%, P= 0.001), patients with traumatic chief complain (75%, P= 0.001), and those who were hemodynamically unstable before operation (82.4%, P= 0.001). The increase in IAP is directly proportional to the duration of surgery, so mean time for surgery in patients with normal IAP was significantly lower than that in those with IAH and ACS as shown in table (3).

Table 3: Association between postoperative IAP level and patients' characteristics

Variable	Postoperative IAP Level			Total (%) n= 184	P -Value
	Normal (%) n= 56	IAH (%) n= 78	ASC (%) n= 8		
Age Group (Year)					
< 20	4 (57.1)	3 (42.9)	0 (0)	7 (4.9)	0.181
20 – 39	27 (50.0)	24 (44.4)	3 (5.6)	54 (38.0)	
≥ 40	25 (30.9)	51 (63.0)	5 (6.2)	81 (57.1)	
Gender					
Male	7 (10.0)	56 (80.0)	7 (10.0)	70 (49.3)	0.001
Female	49 (68.1)	22 (30.6)	1 (1.4)	72 (50.7)	
BMI Level					
Underweight	21 (77.8)	6 (22.2)	0 (0)	27 (19.0)	0.001
Normal	20 (36.4)	31 (56.4)	4 (7.3)	55 (38.7)	
Overweight / Obese	15 (25.0)	41 (68.3)	4 (6.7)	60 (42.3)	
Chief complain					
Traumatic	9 (16.1)	42 (75.0)	5 (8.9)	56 (39.4)	0.001
Non-traumatic	47 (54.7)	36 (41.9)	3 (3.5)	86 (60.6)	
Preoperative hemodynamic stability					
Stable	53 (58.2)	36 (39.6)	2 (2.2)	91 (64.1)	0.001
Unstable	3 (5.9)	42 (82.4)	6 (11.8)	51 (35.9)	
Duration of surgery (Hrs.)					
Mean ± SD	1.6 ± 0.5	2.4 ± 0.6	3.4 ± 0.6	-	0.001

Discussion

This prospective study provides important evidence regarding the epidemiology, risk factors, and management of postoperative IAH and ACS among patients undergoing emergency laparotomy in Iraq. This study showed that over 50% of patients experienced IAH, and a small but statistically significant percentage (5.6%) went on to develop ACS, underscoring the heavy load of this possibly avoidable consequence. This result was similar to that obtained by Blaser AR *et al* study in 2019 (Incidence of IAH was 51%) [10] and higher in Nansubuga P *et al* study in 2020 (Incidence of IAH was 62.7%) [11]. Higher incidence of ACS was seen in Pinto GCC *et al* study in 2023 [12]. As compared to studies that depend only on clinical suspicion, our cohort's higher incidence is probably attributable to the fact that we included a high-risk population with multiple concurrent risk factors and that we prospectively used serial intravesical IAP measurements, which improve the detection of clinically significant IAH [13]. This study demonstrated that the possible associated factors that might increase the incidence of IAH and ACS were male gender, obesity, traumatic chief complain, hemodynamic unstable status before operation, and prolonged duration of surgery. The male predominance that associated with IAH and ACS is largely reflecting the higher rate of male trauma, severe pancreatitis, and shock admissions in critical. Agreement was seen in studies conducted by Mohan S *et al* study in 2023 [14] and Melo EB *et al* in 2026 when they concluded that obese patients had a

higher risk of IAH. Higher pressures in the obese could be explained by a direct mass effect of the abdominal adipose tissue on the measurement of IAP [15]. A study conducted by Smit M *et al* in 2020 when the concluded that most patients at risk of IAH or ACS were admitted to the ICU after emergency abdominal surgery [16]. Most penetrating injuries resuscitate aggressively and end with laparotomy instead of blunt trauma which is mostly treated conservatively [17]. Baseline IAP is unlikely affected by a patient's hemodynamic instability prior to surgery. However, because of the extensive fluid resuscitation, acidosis, and hypothermia that is necessary to stabilize the patient, the incidence of IAH and progression to ACS are markedly increased [18, 19]. The current study showed that prolonged surgery increases the incidence of IAH and ACS. Systemic capillary leak and severe intra-abdominal edema are caused by surgical trauma, hypothermia, and extensive fluid resuscitation, all of which are more likely to occur over longer operating times [20].

Study Limitations

- Because research only took place at one tertiary referral facility, its results might not apply to other facilities that treat different types of patients or use different clinical procedures.
- However, due to the small number of patients who developed ACS and the relatively modest sample size, the statistical power to detect less prevalent risk factors may have been diminished, even though the prospective design avoided information bias.
- There was no assessment of functional recovery, quality of life, or late surgical problems as long-term outcomes following hospital discharge.

Conclusion

This study showed that more than half of the patients developed postoperative IAH, with a small but clinically significant proportion progressing to ACS, highlighting the substantial burden of this potentially preventable complication. Most risk factors for IAH and ACS are prolonged duration of surgery, preoperative unstable hemodynamics, male gender, penetrating trauma, and obesity. Serial IAP measurements represent an important physiologic parameter that should be monitored in any patient who demonstrates risk factors for IAH / ACS to avoid their development with their subsequent lethal complications. To reduce the risk of organ dysfunction and maximize the success of surgical procedures, these results highlight the significance of early risk assessment, regular postoperative IAP monitoring, and prompt management. It's recommended that IAP should be measured in all patients who show risk factors for IAH and especially those who are in critical care units to prevent early detection of ACS and prevent its complications.

Acknowledgments

The authors thank the technicians and nursing staff for their assistance in data collection.

Funding: None.

Conflicts of Interest: None declared.

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How to Cite This Article
Rashid RA, Mohey NR, Naji BJ. Risk factors of increasing intra-abdominal pressure and compartment syndrome and their management in post emergency laparotomies' patients. Int J Med All Body Health Res. 2026;7(3):115-120. doi:10.54660/IJMBHR.2026.7.3.115-120.