

Original Research Article

Correlation between Raised Intra-Abdominal Pressure and Its Outcome in Patients Undergoing Emergency Laparotomy**Dr. Brahmacharimayum Rosylinda Devi¹, Dr. Yumnam Priyabarta Singh², Dr. Ch. Anilkumar Singh³, Dr. Angela B. Marak⁴, Dr. Ch. Arunkumar Singh⁵**¹Senior Resident, Department of General Surgery, Regional Institute of Medical Sciences, (RIMS), Imphal, Manipur, India.²Associate Professor Department of Radiodiagnosis, Regional Institute of Medical Sciences, (RIMS), Imphal, Manipur, India.³Senior Resident, Department of General Surgery, Regional Institute of Medical Sciences, (RIMS), Imphal, Manipur, India.⁴Assistant Professor, Department of General Surgery, Regional Institute of Medical Sciences, (RIMS), Imphal, Manipur, India.⁵Professor, Department of General Surgery, Regional Institute of Medical Sciences, (RIMS), Imphal, Manipur, India.**Corresponding Author**

Dr. Angela B. Marak. Assistant Professor, Department of General Surgery, Regional Institute of Medical Sciences, (RIMS), Imphal, Manipur, India.

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ABSTRACT**Background**

Raised intra-abdominal pressure is an important factor affecting the operative outcome in laparotomy. Intra-abdominal pressure greater than 12 mmHg is called IAH (Intra-Abdominal Hypertension). This study was conducted to predict early and timely intervention and hence, to improve the outcome of patients undergoing emergency laparotomies.

Aims

To assess intra-abdominal pressure as one of the predictors of outcome in patients undergoing emergency laparotomy.

Methods

104 patients who underwent emergency laparotomy in RIMS were selected and IAP was taken pre-operatively and then post-operatively at 0, 6, 24 and 72 hrs. Other hemodynamic parameters were measured to assess cardiopulmonary and renal functions.

Results

Our study found that the pre- and post-IAP were 14.3±3.4 mm Hg and 6.3±3.2 mm Hg respectively. The incidence of IAH in our study was 84.5% at the time of admission, 1.9% at 0 hour, 25.9% at 6 hours, 10.4% at 24 hours and 8.5% at 72 hours post-operatively.

Conclusions

Pre-operative intra-abdominal pressure at and above 15.5 mm Hg is a predictor of post-operative outcomes with a sensitivity of 65% and a specificity of 80%. Intra-abdominal pressure measurement can be used as an independent clinical parameter to assess the patient's

current clinical condition. Intra-abdominal pressure measurement also helps in prioritizing surgical intervention in emergencies.

Keywords: Emergency Laparotomy, Intra-Abdominal Pressure, Post-Operative Outcome, Wound Dehiscence.

INTRODUCTION

According to WSACS (World Society of Abdominal Compartment Syndrome), IAP (Intra-Abdominal Pressure) can be defined as steady state pressure concealed within the abdominal cavity. Intra-abdominal hypertension is defined as intra-abdominal pressure above 12 mm Hg. ACS (Abdominal Compartment Syndrome) is defined as a sustained increase in IAP above 20 mm Hg with or without APP (Abdominal Perfusion Pressure) <60 mmHg that is associated with a new organ dysfunction or failure.^[1,2]

Normal intra-abdominal pressure is approximately 5-7 mmHg. The presence of intra-abdominal hypertension is associated with an 11-fold increase in mortality compared with the implications of elevated IAP, which are not only restricted to intra-abdominal organs but also affect cardiac, pulmonary and neurologic functions. Subsequent studies have documented an impact on virtually every organ except the adrenal glands. Even marginally sustained IAH results in mal-perfusion and may disrupt the process of recovery.^[2]

The high IAP during ACS may lead to cardiovascular failure or dysfunction in consequence of diminished venous return, which is defined by the need for vasopressors. Respiratory failure may also happen which is defined as a ratio of partial pressure arterial oxygen to a fraction of inspired oxygen <200 with the need for respiratory support in the form of mechanical ventilation. Moreover, elevated IAP can also lead to acute renal failure, splanchnic hypo-perfusion, gut ischemia and even affect the brain causing increased intracranial pressure.^[3,4]

Given the broad range of potential etiological factors and the significant associated morbidity and mortality of IAH/ACS, monitoring IAP in high-risk patients from the time of admission may influence the outcome. With the above aspects and background, the current study was conducted to predict for early and timely intervention and hence, to improve the outcome of patients undergoing emergency laparotomies.

OBJECTIVE

To assess intra-abdominal pressure as one of the predictors of outcome in patients undergoing emergency laparotomy.

MATERIALS AND METHODS

A prospective observational study was conducted at the Department of Surgery, Regional Institute of Medical Sciences, Imphal, Manipur. The study was carried out for 2 years, from December 2020 to November 2022. All the patients who had attended the Department of Surgery, RIMS, Imphal during the study period, fulfilled the inclusion criteria with features of an acute abdomen and underwent an emergency laparotomy were included in the study.

Patients with penetrating abdominal trauma, bladder disorders, pelvic fractures, urethral obstruction, pregnant women and intra-abdominal tumors were excluded. The consecutive sampling method was used to select the patient for this study.

Study Procedure

A detailed history was taken, and a thorough clinical examination was carried out. Laboratory investigations like a complete hemogram, liver function test, kidney function test, serum

electrolytes, serum urea and creatinine, ECG, x-ray of the of the erect abdomen, and supine position were included in routine examinations, while abdominal ultrasound was done only in indicated cases. Histopathological examination of any tissue removed was done.

Pre-operative management included keeping the patient nil per orally, nasogastric aspiration, correction of fluid and electrolyte imbalances, and administering antibiotics and analgesics. Blood transfusions were done if necessary.

IAP was taken preoperatively and then postoperatively at 0, 6, 24, and 72 hrs. If IAP remained below 12 mmHg, measurement was discontinued after 24 hours.

Parameters noted: In addition to the routine parameters like pulse rate, respiratory rate, blood pressure, oxygen saturation, temperature and urine output, other important parameters that were noted include intra-abdominal pressure, duration of surgery, intra-operative findings, duration of hospital stay, morbidity (wound dehiscence) and mortality.

According to the level of IAP, IAH is graded as follows:^[5]

Grade 1: IAP 12-15 mmHg, Grade 2: IAP 16-20 mmHg, Grade 3: IAP 21-25 mmHg, Grade 4: IAP >25 mmHg

The abdominal pressure was directly measured by measuring the urinary bladder with a Foley's catheter. The patient was catheterized under strict precautions with a 16-Fr Foley's catheter. The bladder was drained and then filled with 25 ml of sterile saline through the Foley's catheter. The tubing of the collecting bag was clamped. The catheter was connected to a CVP manometer. The symphysis pubis is the zero reference, and pressure was measured in centimeters of water at the end of expiration. A conversion factor of 0.7 is multiplied to convert the pressure in cm of water to a millimeter of Hg.

Ethical approval for this study was obtained from the Research Ethics Board, RIMS (Regional Institute of Medical Sciences), Imphal, Manipur.

Statistical Analysis

The data collected above was analysed using descriptive and inferential statistics. The collected data were tabulated and data analysis was done using SPSS software version 21.0.

RESULTS

The study was conducted among 104 patients (18 years of age and older) undergoing emergency laparotomies. The mean (\pm SD) age was 43.1 (\pm 14.5) years, with a minimum age of 18 years and a maximum age of 74 years.

	Factor	Number of Patients	Percentage (%)
Age	18-20	3	2.9
	21-30	27	26.0
	31-40	23	22.1
	41-50	19	18.3
	51-60	21	20.2
	61-70	7	6.7
	71-80	4	3.8
	Total	104	100.0
Gender	Male	74	71.2
	Female	30	28.8

Table 1: Demographic Distribution

Out of the 104 patients, only 9 (8.7%) had a history of blunt trauma to the abdomen and the majority of 95 (91.3%) patients had a non-traumatic aetiology of acute abdomen.

Pain in the abdomen was the most common presenting symptom. It was present in all patients, followed by abdominal distension (71.1%), constipation (66.3%), vomiting (24.1%), shock (18.3%), and fever (6.7%).

On clinical examination, abdominal tenderness was the most common finding and was present in all the patients. Other findings were distension of the abdomen (80%), diminished or absent bowel sounds (60%), tachycardia (87.4%), two patients with hypotension, tachypnoea (85.5%), and reduced O₂ saturation (51.8%).

The diagnosis was based mainly on clinical features: a plain x-ray abdomen in erect posture. Pneumoperitoneum was present in 83% of the cases and multiple air fluid levels and a dilated bowel shadow were present in 4.7% of the cases. Ultrasound was done for all cases of blunt abdominal trauma.

Variables	Non-Trauma/ Trauma		P-Value
	Non-Trauma	Trauma	
Pulse Rate (beats/mm)	106.1±6.2	112.4±9.1	0.02*
SBP (mm Hg)	94.2±12.3	94.5±12.7	0.89
DBP (mm Hg)	60.2±11.2	58.7±13.1	0.72
Respiratory Rate (times/min)	24.3±2.9	26.7±2.8	0.05
Axillary Temperature (F)	98.7±0.8	96.6±0.5	0.01*
SPO ₂ (%)	89.7±3.9	84.1±4.2	0.001*
Pre-Op IAP	14.1±2.2	15.9±3.4	0.04*
Haemoglobin (g/dl)	11.4±2.1	9.2±1.2	0.01*
TLC	9179.7±3867.6	12130±3571.1	0.06
Serum Urea (mg/dl)	42.1±8.7	37.7±3.3	0.09
Serum Creatinine (mg/dl)	1.2±0.5	1.3±0.4	0.06
Sodium (mEq/L)	135.4±5.1	133.5±3.7	0.18
Potassium (mEq/L)	3.7±0.7	3.9±0.4	0.3

Table 2. Comparison of Vital Parameters According to Non-Trauma or Trauma Patients Studied (N = 104)

Among the 104 patients, majority of them had cardio-vascular dysfunction (35.6%), followed by renal system dysfunction (34.6%) and respiratory system dysfunction (25.9%).

Pre-Op IAP (mmHg)	Gender		Total (N = 104)
	Female (N = 30)	Male (N = 74)	
<12 (Normal)	5	11	16 (15.3%)
12-15 (Grade I IAH)	19	33	52 (50.0%)
16-20 (Grade II IAH)	6	26	32 (30.7%)
21-25 (Grade III IAH)	0	4	4 (3.8%)
>25 (Grade IV IAH-ACS)	0	0	0
Total	30	74	104

Table 3. Pre-Operative IAP (Intra-Abdominal Pressure) Level Showing of IAH (Intra-Abdominal Hypertension) of Patients (N = 104)

In this study, 84.5% of the patients presented with elevated intra-abdominal pressure. The majority of them, 50%, were in grade I IAH, followed by grade II IAH (30.7%), and only 15.3% had normal IAP.

A total of 104 patients underwent emergency exploratory laparotomy. The majority of the patients had duodenal ulcer perforation; Graham's omental patch repair was done (40.3%);

and ileal and jejunal perforation, depending on the viability of bowel primary closure or resection, and anastomosis were done. Six patients underwent appendicectomy, colostomy was done in 2.8% of the cases; one patient underwent ileostomy; and one patient underwent cholecystectomy for gall bladder neck perforation.

Among traumatic cases, three patients suturing for liver laceration were done; for two ileal perforation cases, primary closure with ileostomy and jejunal perforation cases underwent primary closure.

Intra-Abdominal Pressure (mmHg)	Gender		Total (N = 104)
	Female (N = 30)	Male (N = 74)	
IAP (0 Hours)			
<12	29	29	58 (55.7%)
12-15	0	0	0
16-20	1	1	2 (1.9%)
21-25	0	0	0
>25	0	0	0
IAP (6 Hours)			
<12	24	53	77 (74.1%)
12-15	5	15	20 (19.2%)
16-20	0	5	5 (4.8%)
21-25	1	1	2 (1.9%)
>25	0	0	0
IAP (24 Hours)			
<12	29	64	93 (89.4%)
12-15	1	5	6 (5.7%)
16-20	0	3	3 (2.9%)
21-25	0	1	1 (0.9%)
>25	0	1	1 (0.9%)
IAP (72 Hours)			
<12	29	66	95 (91.3%)
12-15	1	4	5 (4.8%)
16-20	0	2	2 (1.9%)
21-25	0	1	1 (0.9%)
>25	0	1	1 (0.9%)

Table 4. Post-Operative IAP Levels Showing Grades of Intra-Abdominal Hypertension of Patients (N = 104)

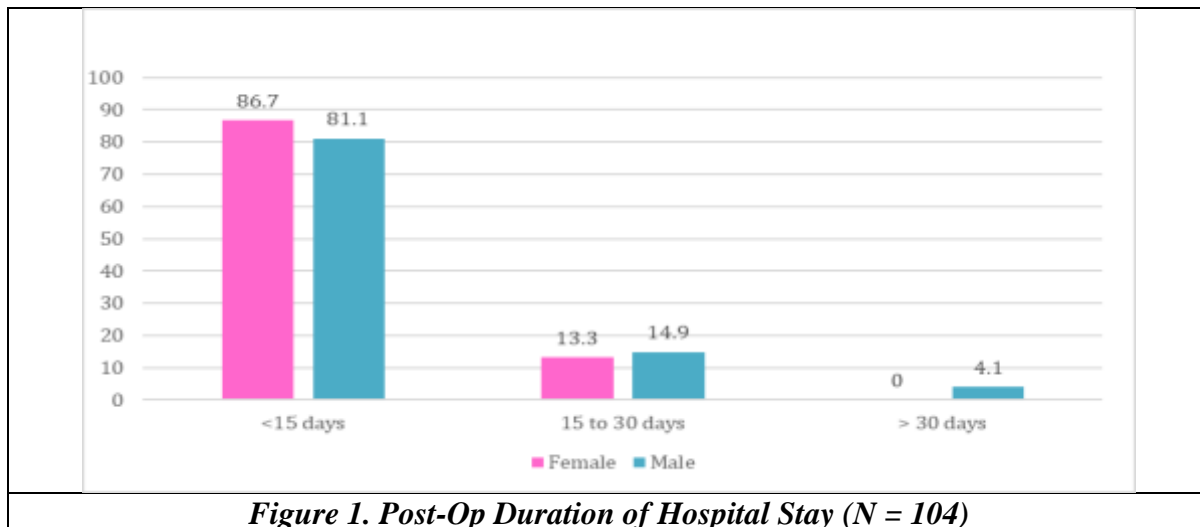


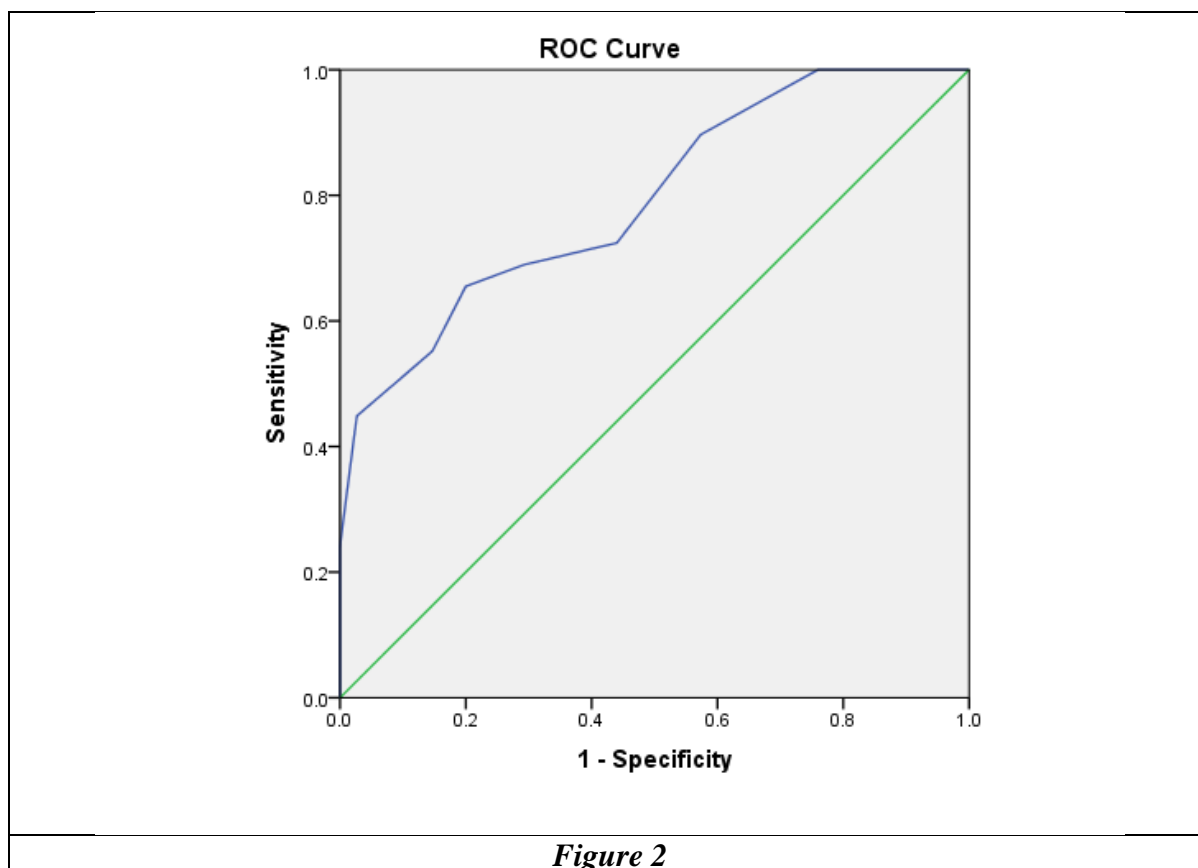
Figure 1. Post-Op Duration of Hospital Stay (N = 104)

Intra-Abdominal Pressure		Wound Dehiscence		P-Value*
		Present	Absent	
Pre-Op	Normal	0	1 (100.0)	0.581
	Elevated	6 (6.8%)	8 (93.2%)	
0 Hour	Normal	3 (3.1%)	95 (96.9%)	0.21
	Elevated	3 (50.0%)	3 (50.0%)	
6 Hours	Normal	1 (1.3%)	76 (98.7%)	0.001
	Elevated	5 (5.8%)	22 (81.5%)	
24 Hours	Normal	0	93 (100.0%)	<0.001
	Elevated	6 (54.4%)	5 (45.5%)	
72 Hours	Normal	0	95 (100.0%)	<0.001
	Elevated	6 (66.7%)	3 (33.3%)	

Table 5. Association of Intra-Abdominal Pressure with Wound Dehiscence (N = 104)

*Fischer exact test

In the preoperative and immediate postoperative periods, intra-abdominal pressure had no association with wound dehiscence; however, there was significant development of wound dehiscence at 6 hours ($p = 0.001$), 24 hours ($p < 0.001$), and 72 hours ($p < 0.001$). IAP elevation post-operatively at 24 hours was positively associated with the duration of hospital stay ($p < 0.001$) and also at 72 hours ($p < 0.001$). IAP elevation at pre-operative period was significantly associated with the presence of CVS dysfunction ($p = 0.02$). However, there was no association between IAP elevation and CVS dysfunction during immediate post-operative period but significant association was seen again at 24 hours ($p = 0.027$). IAP elevation was significantly associated with the presence of post-operative respiratory dysfunction at 72 hours ($p = 0.02$). IAP elevation was significantly associated with post-operative renal dysfunction at 6 hours ($p < 0.001$), 24 hours ($p = 0.003$) and 72 hours ($p = 0.01$).



Area under the curve = 0.793 (95% CI: 0.69-0.89), p-value<0.001.

Pre-operative intra-abdominal pressure above 15.5 mm Hg is a predictor of post-operative outcomes with a sensitivity of 65% and a specificity of 80%.

DISCUSSION

Acute abdomen is the most common surgical emergency. The elevation of intra-abdominal pressure can be a symptom of an acute abdominal process or can be the cause of the process. The available studies on intra-abdominal pressure and abdominal compartmental syndrome are on trauma patients or critically ill ICU patients.^[1,2] Hence, this study was conducted for the analysis of the intra-abdominal pressure in acute abdomen cases undergoing emergency laparotomy.

Demographic Distribution

In our study, the mean (\pm SD) age was 43.1 (\pm 14.5) years, with a minimum age of 18 years and a maximum age of 74 years. The majority of the patients belonged to the age group of 50 years or less, 72 (69.2%) and 32 (30.8%) were 51 years of age or older. The studies conducted by Cheatham M. L. et al.^[6] showed a mean age of 51 (\pm 19) years; Meldrum D. R. et al.^[7] showed a mean age of 39 \pm 9 years; Hong J. J. et al.^[8] showed a mean age of 42 \pm 14 years.

The majority of our patients were male (71.2%) and the M:F ratio was 2.5:1. This was found to be comparable with the study conducted by Hong J. J. et al., Khan S et al.,^[9] Meldrum D. R. et al. where male preponderance was seen.

Aetiology

Our study showed that out of the 104 patients, only 9 (8.7%) had a history of blunt trauma to the abdomen, and the majority of 95 (91.3%) patients had a non-traumatic aetiology of acute abdomen. This finding is in contrast with the study conducted in the west^[10] where the main

aetiology was found to be traumatic. Meldrum DR et al.^[7] reported 60% blunt trauma injuries and packing in 675 cases. The reasons may be due to the differences in the lifestyles of the study populations. In developed nations, road traffic accidents due to over speeding are found to be responsible for severe blunt injuries to the abdomen.

Intra-Abdominal Pressure

Our study found that the pre- and post-IAP were 14.3 ± 3.4 mm Hg and 6.3 ± 3.2 mm Hg, respectively. The study conducted by Sugrue M et al. before and after decompression was 16.6 ± 9.4 mm Hg and 10.3 ± 3.1 mm Hg, respectively. The study by Meldrum et al.^[7] reported higher IAP, where pre and post were 27 ± 2.3 mm Hg and 14 ± 4.6 mm Hg, respectively. The study by Khan S et al.^[9] showed that the pre- and post laparotomy IAPs were 18 ± 4.8 mm Hg and 6 ± 1.7 mm Hg, respectively.

The majority of the cases in our study of acute abdomen were due to perforation peritonitis, which led to elevated IAP, but the decompression and removal of gas and fluids led to a decrease in the IAP level. More than half of our patients at the time of admission had elevated IAP along with multiple organ dysfunctions; they could not be identified as cases of primary acute compartmental syndrome as the baseline data on organ system functions were not available. Sugrue M. et al. reported renal impairment in 69% of patients with IAH. Khan S. et al.^[9] reported pre-operative renal dysfunction in 49% of patients.

In the postoperative period, 58 (55.7%) of the patients had their IAP at a normal level. Two patients had raised IAP during the immediate postoperative period. At 6 hours post-operatively, 25.9% of the patients had elevated IAP. Among these patients, there are various complications, like wound dehiscence and entero-cutaneous fistulas. In a study conducted by Khan S et al.^[9] there were no intra-abdominal hypertension cases in the immediate postoperative period, but at 6 hours postoperatively, six patients had IAH.

Incidence

The incidence of IAH in our study was 84.5% at the time of admission, 1.9% at 0 hours, 25.9% at 6 hours, 10.4% at 24 hours, and 8.5% at 72 hours post-operatively. A similar finding was reported in a study conducted by Khan S et al.^[9] where the incidence was 80% at the time of admission and 3.5% at 6 hours postoperatively. The incidence of IAH reported by various studies ranges from 2 to 89% and depends on the population and the values used in the operational definitions. The lower incidence in our study can be explained by the fact that lower-risk patients were included in our study, while other studies included high-risk patients.

Morbidity

In our study, the majority of the patients had a postoperative hospital stay of less than 15 days. Among 104 patients, 5.8% developed wound dehiscence, cardiovascular system dysfunction was seen in 18.2%, respiratory system dysfunction in 8.6%, and renal dysfunction in 11.5% of the cases during the postoperative period.

Our study reported that in the preoperative and immediate postoperative periods, intra-abdominal pressure had no association with wound dehiscence; however, there was significant development of wound dehiscence at 6 hours ($p = 0.001$), 24 hours (<0.001), and 72 hours ($p < 0.001$). IAP elevation postoperatively at 24 hours was positively associated with the duration of hospital stay ($p < 0.001$) and also at 72 hours ($p < 0.001$). IAP elevation at the pre-operative period was significantly associated with the presence of CVS dysfunction ($p = 0.02$). However, there was no association between IAP elevation and CVS dysfunction during the immediate postoperative period, but a significant association was seen again at 24 hours ($p = 0.027$). The findings contrasted with the studies conducted by Khan S. et al.,^[9] Burch J. M. et al.^[11] where no significant association was found between IAP at any point in time and the

occurrence of burst abdomen. The pre-op IAP or IAP at 0 hours did not correlate significantly with the duration of hospital stay, but the IAP at 6 hours post-op was found to have a negative correlation with the duration of hospital stay. This paradox is explained by the fact that elevated IAP postoperatively invariably led to death and termination of hospital stay.

Our study showed that pre-operative intra-abdominal pressure at and above 15.5 mm Hg was a predictor of post-operative outcomes with a sensitivity of 65% and a specificity of 80%. The study by Cheatham et al.^[6] found that elevated IAP alone did not have sufficient sensitivity and specificity to be useful as a predictor of mortality.

It is noteworthy to mention the challenges, surgeons are often reluctant to consider a second look (either directed by CT or otherwise) because they may feel that recurrent problems are unlikely after they have performed an operation. Similarly, although it has been shown that the use of regular IAP measurements and early detection of IAH can alert the attending surgical team of an impending abdominal catastrophe, few ICUs around the world regularly measure IAP.

Also, we know that girth measurements and clinical estimates of IAP are often inaccurate. In patients with grades three to four IAH, the treating surgical and ICU teams should make it a priority to locate the underlying problem, and provide interim hemodynamic support until the focus of bleeding, sepsis, or obstruction has been dealt with. Not all patients require surgical exploration, and often percutaneous drainage of an abscess or ascites will be all that is required.^[12-15]

CONCLUSION

Intra-abdominal pressure measurement can be used as an independent clinical parameter to assess the patients' current clinical condition. Intra-abdominal pressure measurement also helps in prioritizing surgical intervention in emergencies.

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