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Intra-Abdominal Hypertension Syndrome in Patients with Acute Abdominal Pathology

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ABSTRACT
Intra-abdominal hypertension syndrome (IAH) is a critical complication in patients with acute abdominal pathology, significantly affecting prognosis and mortality rates. This study retrospectively analyzed 916 cases of emergency surgical conditions and abdominal trauma treated at the Republican Scientific Center for Emergency Medical Care, Uzbekistan (2021-2024). The incidence of increased intra-abdominal pressure (IAP) was observed in 35.9% of patients, with the condition more prevalent among males, elderly patients, and individuals with elevated BMI. Clinical severity, assessed using APACHE II and SOFA scales, was significantly higher in the IAH group, correlating with adverse outcomes such as multiple organ dysfunction and increased mortality. The findings highlight the necessity of early diagnosis, monitoring, and intensive management of IAH to mitigate complications and improve outcomes. Key predictive factors include BMI, gender, age, and comorbidities, with specific hemodynamic and respiratory parameters indicating the severity of IAH.

Keywords: Intra-abdominal hypertension (IAH), acute abdominal pathology, intra-abdominal pressure (IAP), emergency surgery, APACHE II, SOFA, BMI, hemodynamic parameters, multiple organ dysfunction, mortality.

INTRODUCTION

In recent years, much attention has been paid to the problem of intra-abdominal hypertension. (ВБГ) [2,3]. Together with other indicators of the human body's condition, this parameter can be used for a comprehensive analysis of various pathologies [5,6]. In clinical practice, there are a large number of examples of the development of IAH in patients with a wide variety of pathologies [1,6]. Increased intra-abdominal pressure (IAP) is recorded in 31-46% of surgical patients during their stay in the intensive care unit [4,8].

VBG is understood as an increase in pressure in the closed space of the abdominal organs of more than 12 mm Hg [7,9]. According to the literature, VBG leads to disruption of blood circulation, respiratory function, gastrointestinal tract and kidneys [10]. IAH is an independent predictor of mortality in intensive care unit patients [5,7].

In patients with acute abdominal pathology, IAH is a serious complication that can significantly worsen the prognosis and increase the risk of mortality. Timely diagnosis and treatment of IAH play an important role in preventing the development of complications and improving treatment outcomes.

The aim of this studyis to analyze the incidence of IAH in patients with emergency surgical diseases and injuries.

The aim of this study is to analyze the incidence of IAP in patients with emergency surgical diseases and abdominal trauma, as well as to characterize the impact of increased intra-abdominal pressure on the condition of patients and treatment outcomes.

Research material.A retrospective study of the medical records of 916 patients with emergency surgical diseases and abdominal injuries who were treated at the Republican Scientific Center for Emergency Medical Care of the Ministry of Health of the Republic of Uzbekistan in the period from 2021 to 2024 was conducted.

The research methods included:Clinical method, questionnaire survey, biochemical blood tests, instrumental methods: blood pressure monitoring, ECG monitoring, echocardiographic examination, ultrasound of abdominal organs, measurement of intra-abdominal pressure with a Faley catheter according to the S.E. Bradley and G.P. Bradley method, X-ray examination of the chest and abdominal organs, statistical processing of the results.

Research results

The study revealed that 35.9% (329 patients) out of 916 had a complication in the preoperative period - increased intra-abdominal pressure (IAP), 64.1% (587 patients) were patients with normal IAP (Fig. 1). The

distribution of 329 patients with emergency surgical diseases and abdominal injuries by degrees of intra-abdominal hypertension (IAH) is shown in Figure 2. Of the 329 patients, 121 (36.8%) had degree I IAH, 105 (31.9%) had degree II IAH; 72 (21.9%) had degree III IAH, and 31 (9.7%) had degree IV. I and II degrees of IAH were more common among patients with IAH.

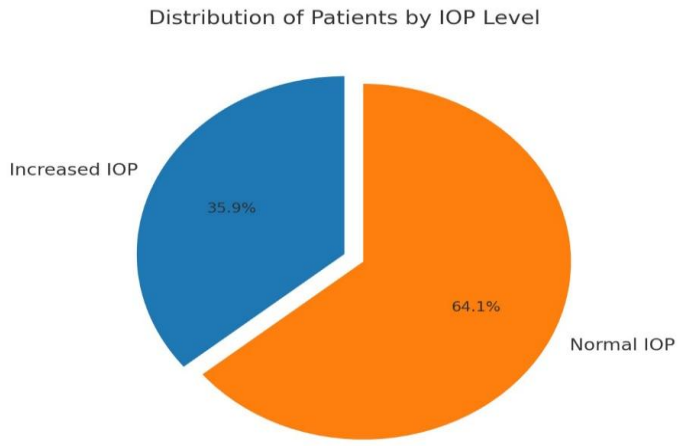


Figure 4. Frequency of IVD dependency on BMI.

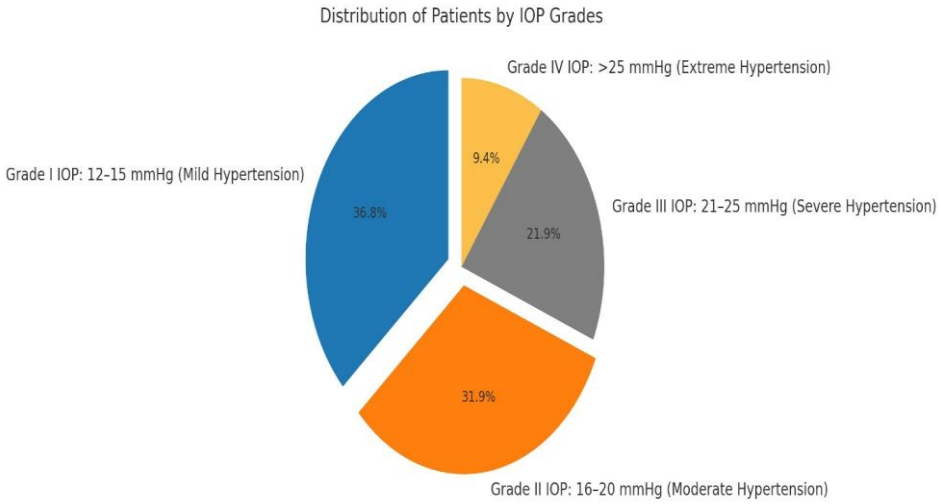
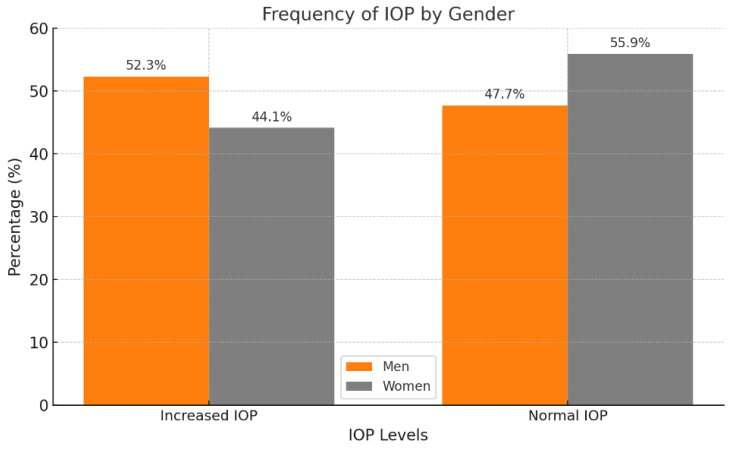


Figure 2. Distribution of 329 patients with IAH by degree.

Among patients with increased IAP, males predominated (52.3%), elderly and senile people (31.3%) and 29.8%, respectively. In the category of patients with normal IAP, young and middle-aged people predominated (33.0%) and 29.6%, respectively, and females (55.9%) (Fig. 3).



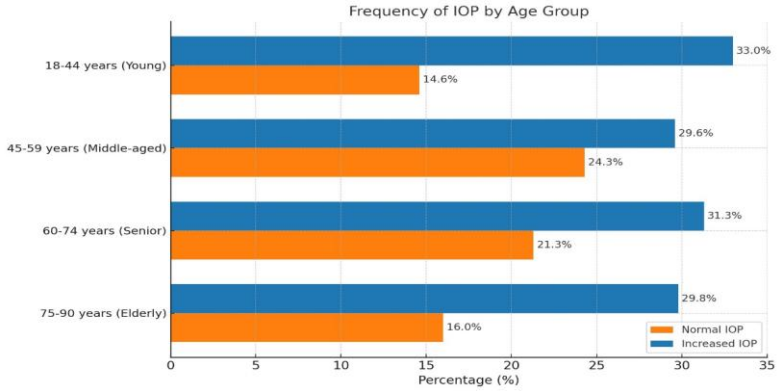


Figure 3. Frequency of VBG depending on gender and age.

The frequency of IAH depending on gender shows that men more often suffer from increased IAH, while women more often have normal IAH. The frequency of IAH depending on age shows that elderly and senile patients are most susceptible to IAH.

The incidence of IAH depending on BMI indicates that patients with BMI ≥ 30 are more susceptible to elevated IAH compared to patients with normal BMI (Fig. 3.4). Intra-abdominal hypertension develops more often in patients with increased body weight (overweight in 42.9%, obesity in 27.3%) (Fig. 3) and the presence of comorbid diseases, such as cardiovascular diseases (60.2%) and diabetes mellitus (25.8%). Late seeking of medical care was observed in 60.5% of patients with increased IAP, which is significantly higher than in patients with normal IAP (33,5 %).

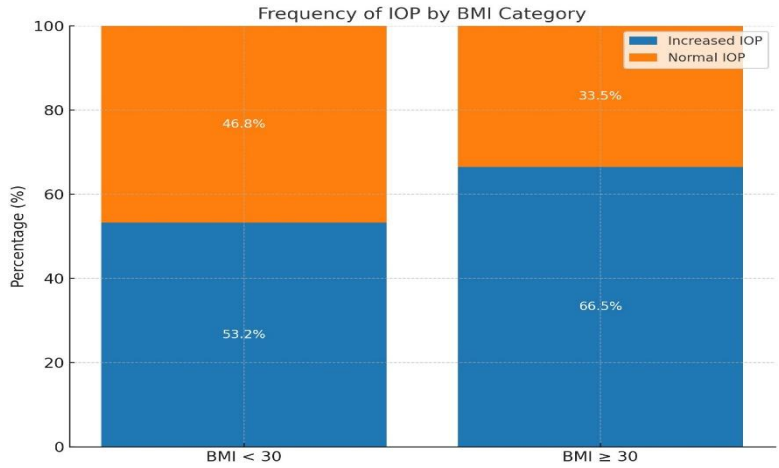


Figure 4. Frequency of IBD depending on BMI.

The analysis showed that patients with perforated ulcer, intestinal obstruction and acute pancreatitis more often had increased IAP compared to other nosological groups. This is due to the severity of inflammatory processes, deterioration of circulation and increase in intra-abdominal pressure as a result of pathological changes in these conditions (Table 1).

Mortality among patients with increased IAP is significantly higher compared to patients with normal IAP, both among men and women. Mortality among men was 18.3% (with increased IAP) versus 8.5% (with normal IAP), among women - 15.7% versus 6.3% (Table 2).

Table 1. Nosological groups of patients with normal and increased IAP

Nosological group	**Patients, n=587 normal IAP)**		**Patients, n=329 (increased IAP)**		**M ± σ for normal IBD**	**M ± σ for increased IAP**
	абс	%	абс%			
Acuteappendicitis	230	39,2	50	15,2	39.2 ± 3.5	15.2 ± 2.1
Acutepancreatitis	120	20,4	60	18,2	20.4 ± 3.2	18.2 ± 2.3
Acutecholecystitis	90	15,3	40	12,2	15.3 ± 2.8	12.1 ± 1.9
Perforatedgastriculcer	65	11,1	80	24,3	11.1 ± 1.9	24.3 ± 2.6
Intestinalobstruction	52	8,9	75	22,8	8.9 ± 1.4	22.8 ± 2.3
Traumaofabdominalorgans	30	5,1	24	7,3	5.1 ± 1.1	7.3 ± 1.2

Patients with abdominal injuries, acute pancreatitis and perforated gastric ulcer demonstrate the highest mortality among all nosological groups, especially with increased IAP (Table 2).
The highest mortality is observed in elderly patients with both normal and increased IAP. In elderly patients with increased IAP, mortality is 20.5%, which is almost twice as high as the rates for patients with normal IAP (10.8%) (Table 2).
Analysis of laboratory test results did not reveal any significant differences in the level of total protein, creatinine, urea, total bilirubin, electrolytes and blood glucose. Thus, it was established that these "traditional" laboratory parameters are not significant in the complex of differential diagnostics of the degree of IAH and are primarily indicators reflecting the degree of metabolic disorders.

Table 2. Mortality in patients with normal and elevated IAP by gender, age and nosological groups, stage I of the study.

Gender	Letalnostprinormalom VBD (M ± s,%)	p<	Letalnostprivyshennom VBD (M ± s, %)
Gender			
Men	8.5 ± 1.2	0,001	18.3 ± 2.5
Women	6.3 ± 1.1	0,05	15.7 ± 2.3
Agecategory:			
Young age (up to 40 years)	3.2 ± 0.9	0,001	8.5 ± 1.3
Middle age (40-60 years)	6.7 ± 1.2	0,001	12.9 ± 2.1
Old age (60-75 years)	10.8 ± 2.0	0,001	20.5 ± 2.7
Old age (>75 years)	14.5 ± 2.2	0,001	27.3 ± 3.1
Nosologicalgroup:			
Acuteappendicitis	1.5 ± 0.5	0,001	5.8 ± 1.0
Acutepancreatitis	10.2 ± 2.1	0,001	19.3 ± 2.4
Acutecholecystitis	7.1 ± 1.8	0,001	14.9 ± 2.3
Perforatedgastriculcer	12.5 ± 2.2	0,001	25.7 ± 3.0
Intestinalobstruction	9.8 ± 1.9	0,001	20.8 ± 2.7
Traumaofabdominalorgans	15.0 ± 2.5	0,001	27.2 ± 3.2

The heart rate (HR) in the group with increased IAP (95.0 ± 10.5) was significantly higher than in the group with normal IAP (78.5 ± 8.2). Blood pressure (BP) - systolic pressure was higher in patients with IAP+ (140.5 ± 15.3) than in IAP- (125.4 ± 12.6). Diastolic pressure was also increased in the group with IAP+ (90.8 ± 10.2). The mean arterial pressure in patients with increased IAP (106.2 ± 12.1) was significantly higher. Cardiac output (CO) was reduced in the group with increased IAP (4.5 ± 0.5) compared to normal IAP (5.0 ± 0.4) (Table 3).

Table 3. Hemodynamic parameters depending on the presence of IAH

Hemodynamic parameters	Increased IAP, n=329	p-value	Normal IBP, n=587
Heart rate (bpm)	95,0 ± 10,5	<0,001	78,5 ± 8,2
Systolicbloodpressure (mmHg)	140,5 ± 15,3	<0,001	125,4 ± 12,6
Diastolicbloodpressure (mmHg)	90,8 ± 10,2	<0,001	80,7 ± 8,5
Meanarterialpressure (mmHg)	106,2 ± 12,1	<0,001	95,3 ± 10,0
Cardiacoutput (L/min)	4,5 ± 0,5	<0,001	5,0 ± 0,4

In the group with increased IAP, the frequency of PH is higher (25.8%), which may be associated with an increase in intra-abdominal pressure affecting the diaphragm and pulmonary circulation. In the group with normal IAP, the frequency of PH is significantly lower (7.7%), which reflects a lower load on the cardiopulmonary system (Fig. 5).
Table 4 shows the diastolic overload indices. It was found that the EDV in patients with increased IAP was significantly increased, indicating left ventricular overload, the increased EDP in the IAP+ group reflects the overfilling pressure in the left ventricle, the E/A ratio:
In the group with increased IAP, the ratio is higher, which may indicate impaired diastolic function of the heart; an increase in the filling fraction in patients with IAP+ is also associated with diastolic overload.

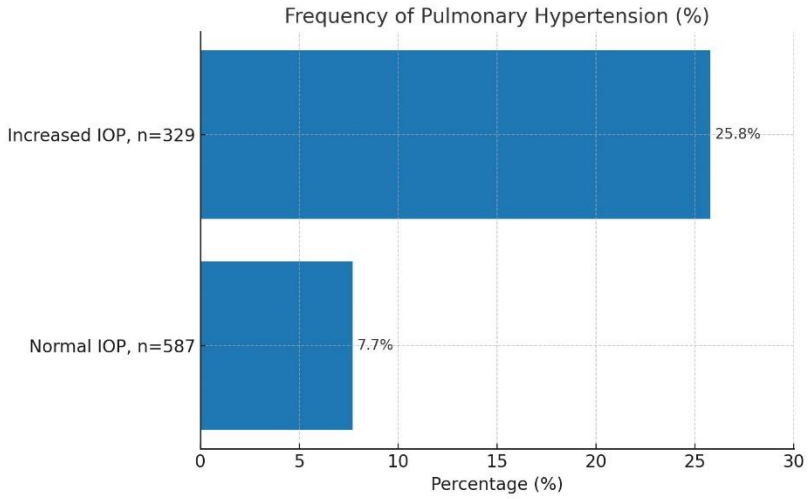


Figure 5. Frequency of pulmonary hypertension (PH) in groups

Table 4. Diastolic overload indicators depending on the presence of IAH

	Indicator	Increased IAP, n=329	p-value	Normal IBP, n=587
	End diastolic volume (EDV, ml)	150,2 ± 20,5	<0,001	130,8 ± 18,3
	End diastolic pressure (EDP, mmHg)	18,5 ± 3,2	<0,001	14,2 ± 2,8
	E/A ratio	1,5 ± 0,2	<0,001	1,1 ± 0,1
	Leftventricularfillingfraction (%)	75,3 ± 5,1	<0,001	65,4 ± 4,8

Note: E/A (early filling rate to atrial filling rate) ratio.

The severity of the condition of patients in the intensive care unit was assessed using the APACHE II and SOFA scales. The APACHE II (Acute Physiology And Chronic Health Evaluation II) scale is a scale designed to assess the severity of the condition of patients in the intensive care unit. It is used to predict the risk of death and the severity of the disease based on physiological, laboratory, and clinical data.
The SOFA (Sequential Organ Failure Assessment) score is a sequential organ failure assessment scale designed to monitor and predict outcomes in critically ill patients. The scale helps determine the degree of dysfunction of six major body system.

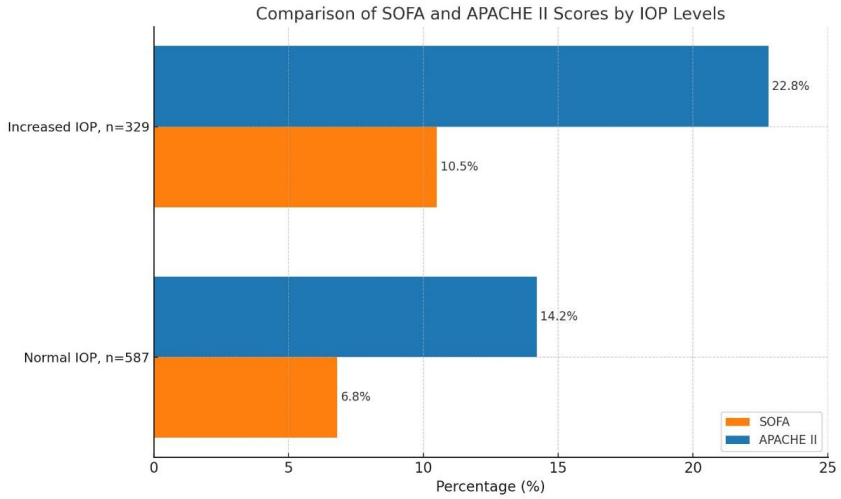


Figure 6. Assessment of the severity of patients' condition, APACHE II and SOFA scales.

APACHE II: Patients with increased IAP (22.8 ± 3.5) have higher values than patients with normal IAP (14.2 ± 2.8). This indicates a more severe general condition in the IAP+ group. SOFA: Patients with IAP+ (10.5 ± 2.2) also have higher values, indicating a greater severity of organ dysfunction compared to the group with normal IAP (6.8 ± 1.9).

Both indices (APACHE II and SOFA) show statistically significant differences between the groups ($p < 0.001$), which reflects the severity of the condition of patients with increased IAP.

The central venous pressure (CVP) values also vary depending on whether intra-abdominal pressure (IAP) is elevated or normal. With elevated IAP, the average CVP value is 14.5 mmHg, which is significantly higher than normal. This is due to the increased intra-abdominal pressure, which affects venous return and central venous pressure. With normal IAP, the average CVP value is 9.8 mmHg, which is within normal values (usually 5–10 mmHg (p.7)

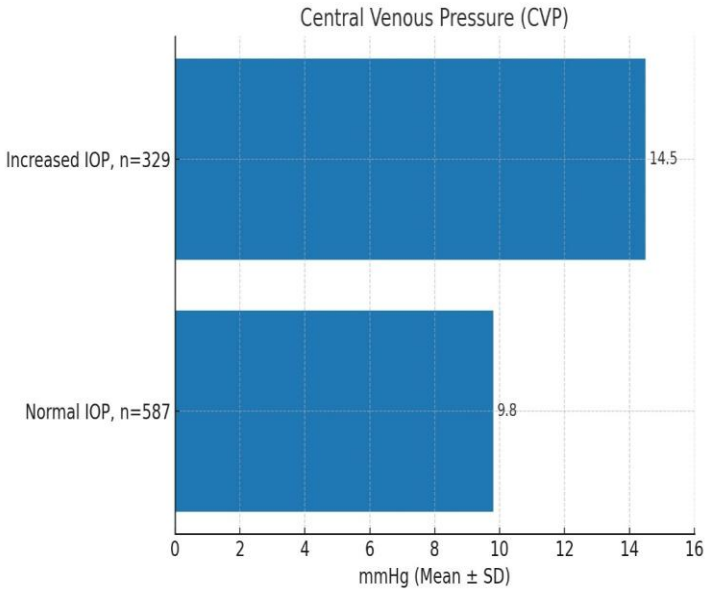


Figure 7. Central venous pressure (CVP) indicators in groups.

Increased CVP in the group with increased IAP is associated with the influence of intra-abdominal hypertension, which can lead to an increase in intrathoracic pressure and a decrease in venous return. The statistically significant difference between the groups ($p < 0.001$) confirms the relationship between the level of IAP and CVP.

The analysis of biochemical blood parameters in the groups with elevated and normal intra-abdominal pressure (IAP) is shown in Table 5. The analysis of laboratory test results did not reveal any significant differences in the level of total protein, creatinine, urea, total bilirubin, electrolytes and blood glucose.

Thus, it was established that these "traditional" laboratory indicators are not significant in the complex of differential diagnostics of the degree of IAH and are primarily indicators reflecting the degree of metabolic disorders.

Table 5. Basic biochemical blood parameters in groups

Indicator	Increased IAP, n=329	p-value	Normal IBP, n=587
Total protein (g/l)	61,2 ± 6,5	<0,001	65,8 ± 5,2
Creatinine (μmol/l)	102,5 ± 18,3	<0,001	95,2 ± 15,1
Urea (mmol/l)	5,9 ± 2,1	<0,001	5,7 ± 1,4
Total bilirubin (μmol/L)	15,3 ± 7,8	<0,001	15,4 ± 5,6
Sodium (mmol/L)	136,5 ± 4,2	<0,001	140,2 ± 3,8
Potassium (mmol/l)	4,9 ± 0,6	<0,001	4,2 ± 0,5
Glucose (mmol/l)	5,8 ± 1,2	<0,001	5,6 ± 0,9

The patients underwent diagnostic radiography of the chest and abdominal organs. The results of the study are shown in Figure 8. Thus, patients with increased IAP more often have pathological changes in both the chest and abdominal cavity, which is associated with intra-abdominal hypertension and its effect on neighboring organs. The main changes include a high position of the diaphragm, atelectasis, stretching of intestinal loops and signs of ascites (Fig. 8).

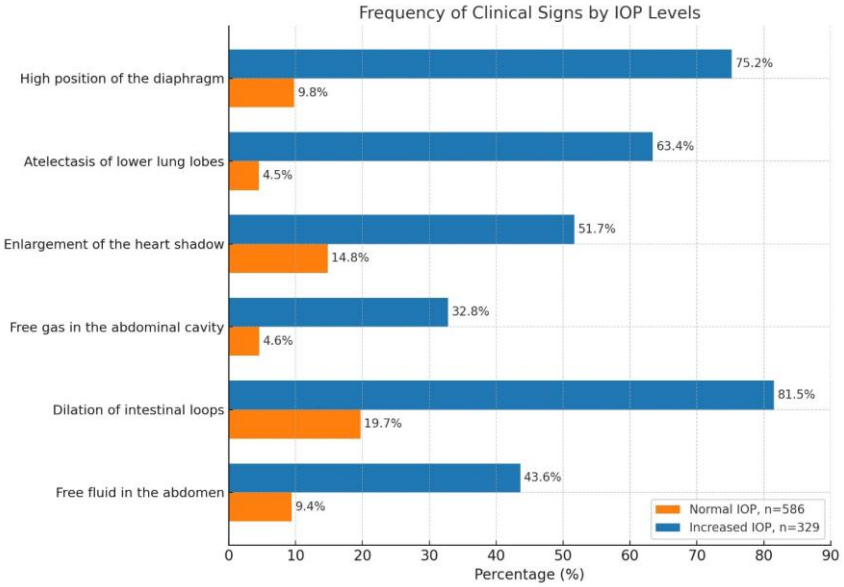


Figure 8. Characteristics of radiological studies

A single-factor correlation analysis was performed to compare the relationship between IABG and the following parameters:

APACHE II and SOFA: Strong positive correlation, which is expected since both scales assess the severity of the patient's condition. BMI (Body Mass Index): Positive correlation with IAG, indicating the influence of obesity on the development of intra-abdominal hypertension. Weak or no correlation with cardiac output and HR. CVP (Central Venous Pressure): Moderate positive correlation with IAG. Strong association with pulmonary hypertension, reflecting the influence of elevated venous pressure. E/A Ratio: Moderate association with IAG and cardiac output. Negative correlation with HR, which may be due to compensatory mechanisms. HR (Heart Rate): Positive correlation with APACHE II and SOFA, reflecting the severity of the patient's condition. Moderate positive association with IAG.Cardiac output: Negative correlation with APACHE II and SOFA, which may indicate a decrease in the pumping function of the heart in severe conditions. Pulmonary hypertension: Strong positive correlation with CVP and IAH, which is consistent with clinical observations.

Thus, high correlation between APACHE II, SOFA and HR confirms the severity of the condition in IAH. BMI and CVP have a significant impact on the presence of IAH and the development of pulmonary hypertension. Cardiac output is inversely proportional to the severity of the condition according to the scales.

CONCLUSIONS

Positive predictors: BMI, SOFA, CVP and the presence of pulmonary hypertension are significant factors increasing the likelihood of developing IAH. Negative predictors: APACHE II, E/A ratio, HR and cardiac output have an inverse effect, reducing the likelihood of IAH. Significance levels (p-value < 0.05) confirm the statistical significance of most predictors, with the exception of some borderline values. Increased BMI, age, comorbidity and male gender are key clinical risk factors for IAH. E/A ratio and decreased cardiac output reflect deterioration of diastolic function of the heart against the background of IAH.

Thus, intra-abdominal hypertension syndrome is a serious complication in patients with acute abdominal pathology, requiring timely recognition and intensive treatment. Increased IAP can lead to the development of multiple organ failure and significantly worsen the prognosis in such patients. Early detection and comprehensive treatment of IAP, including monitoring of intra-abdominal pressure and correction of hemodynamic disorders, are key factors in improving treatment outcomes and reducing the risk of complications.

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