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Intra-abdominal hypertension and abdominal compartment syndrome in critical medical patients: Incidence, prognosis and association with renal dysfunction

Mohamad Mostafa Habli, Sirine Omar Ahmad, Sabine Youssef Karam, Houssam Nassib Rabah, Najat Issa Joubran-Fares

ABSTRACT

Aims: The objective of this study was to measure the intra-abdominal pressure (IAP) in critically ill medical patients in order to determine the incidence and prognosis of intra-abdominal hypertension (IAH) in patients with two or more risk factors for IAH. The incidence of acute kidney injury (AKI) in high group patients was also recorded and evaluated. Methods: This is a prospective study that was conducted at Makassed General Hospital in Beirut. Daily screening of categorized risk factors (CRF) for IAH was performed. In patients with risk factors for IAH, intra-abdominal pressure (IAP) was measured daily during ICU stay. IAH was not measured in the low risk group (less than two categorized risk factors). Data included severity scores (APACHE II, APACHE III and SOFA),demographics, incidence and staging of acute kidney injury (AKI), cumulative fluid balance, mechanical ventilation, BMI< 30, length of stay (LOS), and mortality. Results: Eighty-eight patients admitted to ICU during four-month duration, were screened for two CRF for IAH. Only 66 patients (67.16%) were found to have ≥2 CRF and thus were included in the study. Out of 66 patients, 41 (62.12%) were found to have IAH. Patients with IAH (41 out of total number of patients 66 with CRF) had higher incidence of AKI (24 patients = 58.5%). The study showed that patients with IAH had higher incidence of AKI, higher severity scores APACHE II, APACHE III, SOFA, and higher mortality rate.IAH was found to be independent risk factor for mortality. High SOFA score was also independent risk factor for mortality. Conclusion: ICU patients are more likely to have more than two categorized risk factors for IAH on admission. Intra-abdominal hypertension was common in critical ill-medical patients who have ≥2 CRF and was associated with high incidence of acute kidney injury, significant mortality and morbidity. Our study highlights the importance of screening and early detection of IAH, as early detection and management may improve outcomes.

Keywords: Abdominal compartment syndrome, Acute kidney injury (AKI), Intra-abdominal hypertension, Intra-abdominal pressure

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INTRODUCTION

Intra-abdominal hypertension (IAH) and abdominal compartment syndrome (ACS) have been increasingly recognized in the critically ill as causes of significant morbidity and mortality. Over the last decades, IAH has been shown to be an important predictor of adverse outcomes in critical patients. The variety of previous definitions has led to confusion and difficulty in comparing one study to another [1]. The prevalence of IAH has recently been estimated between 32% and 65% in both medical and surgical intensive care units [2, 3].

Abdominal compartment syndrome refers to organ dysfunction caused by intra-abdominal hypertension. When intra-abdominal pressure rises, perfusion of internal organs is declined leading to tissue hypoxia. If undetected or untreated, multi-organ failure occurs and patient mortality may ensue [4].

It may be under-recognized because it primarily affects patients who are already severely ill and whose organ failure may be incorrectly contributed to progression of the underlying disease.

Since treatment can improve organ dysfunction, it is important to detect early in the appropriate clinical situation.

In 1947, Bradley and Bradley published a study of the effects of elevated IAP on kidneys in humans [5]. Since that time, many studies have been conducted to evaluate the renal manifestations of IAH/ACS, mainly in surgical patients. Critically, ill medical patients have been also the field of study in the last two decades. However, physicians in many countries are still not aware of this condition.

The world society of abdominal compartment syndrome (WSACS) has published a consensus statement including definitions and recommendations for the screening and management of IAH and ACS [6]. According to the WSACS, ACS is defined as sustained intra-abdominal pressure (IAP) of >20 mmHg with the presence of an attributable organ dysfunction. It is very important to differentiate between ACS from its predecessor, intra-abdominal hypertension. In the absence of any underlying disease, the average intra-abdominal pressure ranges from 5 to 7 mmHg with a normal upper limit of 12 mmHg. Thus, IAH is defined as sustained IAP greater than 12 mmHg.

Following this consensus, the goal of this study was to determine the incidence and prognosis of IAH in higher risk critically ill medical patients.

MATERIALS AND METHODS

The study was conducted in ICU at Makassed General Hospital in Beirut. The study included an informed consent from the patients on admission (or their family if necessary) to participate and publish the results. All medical patients admitted to the ICU during a four-month period and expected to stay >24 h were prospectively enrolled. Exclusion criteria were ICU stay less than 24 h, age <18 years, pregnancy, contraindication for intravesical pressure measurement (pelvic fracture, gross hematuria, or neurogenic bladder), and bladder surgery.

Demographic data

Gender, body mass index (BMI) expressed as kg/m^2 [7], age, cumulative fluid balance, length of ICU and hospital stay, incidence of acute kidney injury (AKI), and hospital mortality were considered in collecting the patient's data.

Organ dysfunction

On admission, APACHE II (Acute Physiology and Chronic Health Evaluation II), APACHE III (Acute Physiology and Chronic Health Evaluation III)and SOFA (Sequential Organ Failure Assessment) scores were recorded [8, 9].

Risk factors for IAH

Patients were screened for categorized risk factors (CRF) of IAH on admission based on four categories from the WSACS algorithm (Table 1). Patients who present any risk factor (RF) of at least two different categories, on admission or during the ICU stay, were considered to have a high risk of developing IAH, and IAP was measured daily. IAP was not measured in the low risk group as our study aim to evaluate the incidence of IAH/ACS in the high risk group. IAP is classified into 3 grades according to the staging criteria by WSACS (I, 12-15; II, 16-20; III, 21-25; IV, ≥25 mmHg) [1].

Intra-abdominal pressure measurement

Intra-abdominal pressure was measured intravesically using a Foley catheter according to the revised closed system repeated measurements technique description of Malbrain and Sugrue [10–12].

Measurements of IAP were recorded every 24 h in patients with ≥2 CRF until resolution of IAH, death, or discharge from the ICU.

IAP measurements according to WSACS [1, 4]:

1. Expressed in mmHg (1 mmHg = 1.36 cm H_2O)
2. Measured at end-expiration
3. Performed in the supine position
4. Zeroed at the iliac crest in the mid-axillary line
5. Performed with an instillation volume of no greater than 50 ml of saline

6. Measured 30-60 seconds after instillation to allow for bladder detrusor muscle relaxation
7. Measured in the absence of active abdominal muscle

AKI definition and staging

Acute kidney injury was defined according to the latest KDIGO definition 2012 [13]:

- Increase in SCr by ≥ 0.3 mg/dl within 48 hours; or
- Increase in SCr to ≥ 1.5 times baseline, which is known or presumed to have occurred within the prior 7 days; or
- Urine volume < 0.5 ml/kg/h for 6 hours.

The severity of AKI was based on the definition of KDIGO 2012 [13] and classified into three stages according to increment of creatinine and/or drop in urine output (Table 2).

RESULTS

General results of the study cohort

During the study period, 88 patients were admitted to the ICU. All of the patients had ICU stay >24 hours, no one had had contraindications for intravesical pressure measurement or bladder surgery, 1 patient was <18. All patients who were admitted to ICU were screened for categorized risk factors of intra-abdominal hypertension. Not all patients admitted to ICU were included for IAP measurements. Only high risk patients with two or more than two categorized risk factors were included. Algorithm of general results of the study cohort is shown in Figure 1. Twenty-one patients had <2 CRF on admission and during all the ICU stay, so IAP was not followed-up. The remaining 66 patients, the high risk group, presented with ≥ 2 CRF on admission, so IAP was measured daily.

In the high risk group, 41 (62.1%) developed IAH. Of this group, 16 (39%) patients developed Grade 1 IAH, 23 (56.1%) patients had Grade 2 and only two patients developed Grade 3 IAH. The main diagnosis on admission is given in Table 3 with predominance of pulmonary diseases and septic shock.

General characteristics of the study cohort

Table 4 shows the general characteristics of participants. Different variables were studied including age, sex, IAH severity (Grade 1, 2 and 3), AKI or ESRD, critical care severity scores (APACHE II, APACHE III, SOFA score), BMI>30, CFB, mechanical ventilation, length of stay and mortality rate.

Incidence of AKI in pts with different grades of IAH

Patients with IAH (41 out of total number of patients 66 with CRF) had higher incidence of AKI (24 patients; 58.5%). Of the total AKI patients in this group, 15 patients (62.5%) were diagnosed with AKI (AKI on top of chronic kidney disease) upon presentation and nine patients (37.5%) develop AKI during hospitalization. Figure 2 shows the distribution of renal impairment in the form of AKI in patients with IAH. Higher incidence of AKI was among patients with IAH Grade 2 (55.2%), Grade 1 (37.90%) and Grade 3 (6.09%).

Mortality rates in patients with different grades of IAH

Mortality rate with significantly higher in patients with IAH Grade 2 (62.50%), 29.20% in patients with IAH Grade 1 and 8.30% with Grade 3 (Figure 3).

Comparative analysis between IAH versus no IAH in patients with ≥ 2 CRF

In Table 5, we compared patients who developed IAH with ≥2 CRF (n=41) with those who did not (n=25). Severity scores among patients with IAH were higher with statistical significance (p-value for SOFA score 0.002, for APACHE II p-value < 0.0001, for APACHE III p-value <0.0001). Mortality rate was also higher in patients with IAH (p-value <0.0001). Decline in kidney function in the form of AKI, or AKI on top of chronic was also noted to be higher in patients with IAH with significant p-value =0.008. Other variables like BMI>30, LOS, positive cumulative fluid balance were studied among both groups but showed no statistical significance.

Comparative analysis between survivors and non survivors

Non-survivors had higher incidence of renal impairment in the form of AKI, and AKI on top of chronic with statistical significance. Non-survivors had higher critical care severity scores with significant p-value as given in Table 6. Patients with Grade 2 IAH had higher mortality rate comparing to other grades.

Multivariate analysis: predictive and prognostic models

Predictive model for IAH development in the high risk group (66 patients with ≥2 CRF)

APACHE II on admission (odds ratio (OR) 0.832, 95% confidence interval (CI), 0.722–0.958), mortality occurrence (OR, 4.777; 95% (CI), 1.099–20.763) were independent predictors of IAH development. Mechanical ventilation as one out of 2 CRF was not shown to be statistically significant for IAH (Table 7).

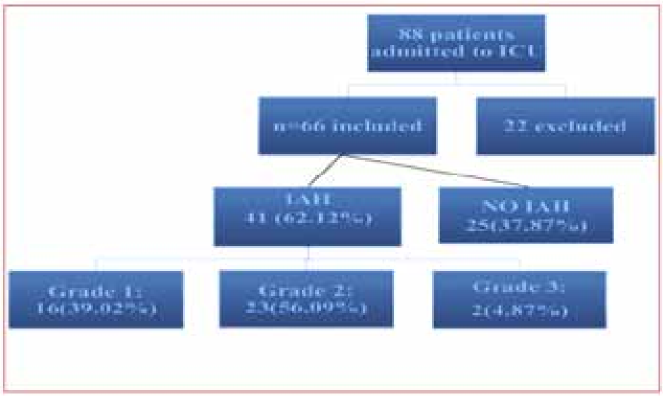

Figure 1: Algorithm and general results of the study cohort.

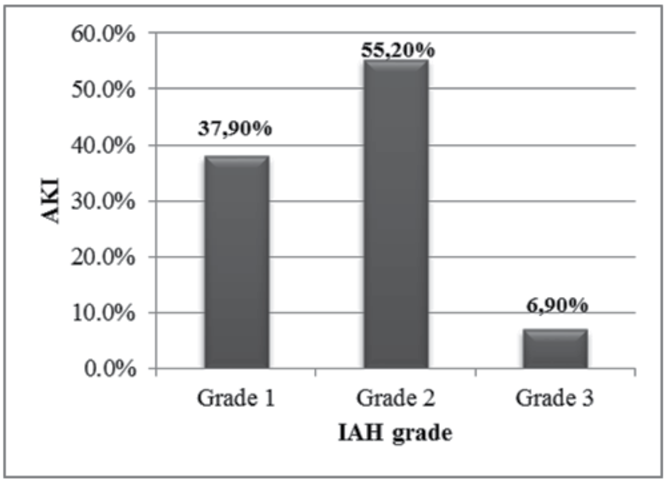

Figure 2: incidence of AKI in patients with IAH according to grades.

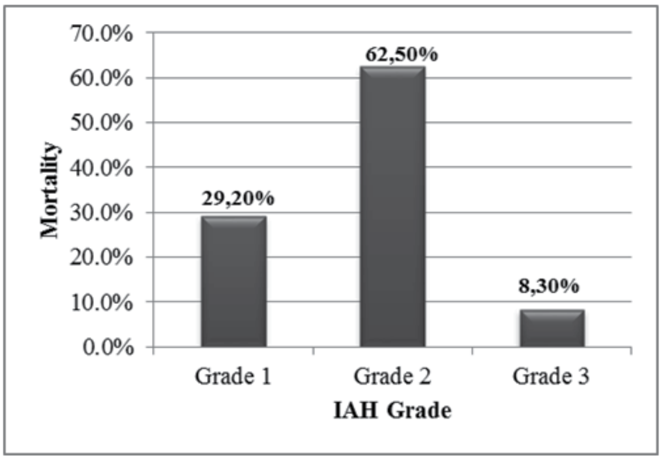

Figure 3: Mortality rate in different grades of IAH.

Predictive model of mortality in the high risk group

IAH development was independent predictor of mortality (OR, 5.382; 95% CI, 1.218–23.781). SOFA score was also shown to be independent predictor for mortality (OR, 0.613; 95% CI, 0.450–0.835).

DISCUSSION

In our prospective epidemiologic study, we performed assessment of IAH in critically ill medical patients, according to the updated consensus definitions and clinical practice guidelines from the WSACS 2013 (screening, IAP measurement, definitions, and classification recommendations).

In our study, we found several significant findings:

a) Significant number of patients with ≥2 CRF developed IAH on admission or during hospitalization stay,
b) IAH at intensive care admission or during hospitalization stay was independent risk factor for mortality,
c) Decline in renal function (AKI) was more common in patients with IAH, mainly IAH Grade 2, and mortality rate among this group was higher,
d) Critical care severity scores (SOFA, APACHE II, APACHE III) were higher in patients with IAH,
e) Mortality rate was significantly higher in patients with higher critical care severity scores,
f) Other variables like sex, age, LOS, and BMI>30 were not shown to be statistically significant in patients with IAH.

The results of our study support the importance of screening for risk factors of IAH as recommended by the WSACS, as early detection and management of IAH may improve outcomes in this high risk group of patients.

Incidence of IAH in high risk group (≥ 2 CRF)

The incidence of IAH in the high risk group was high [41 (62.1%)]. High incidence of IAH had also been reported in literature [11, 14–17]. Other studies done on mixed population (surgical and medical) [14, 15], and recent study done on critically ill medical patients [18] showed also high incidence of IAH in high risk group (≥2 CRF).

In contrast to other studies, screening for CRF was done on admission and upon occurrence of any risk factors or any new organ failure. In addition to the previously mentioned, our study assessed exclusively critically ill medical patients according the latest recommendations and clinical practice guidelines by WSACS [6].

Incidence of renal dysfunction in patients with IAH

The study came out with some interesting findings. Higher incidence of AKI was among patients with IAH (24 patients = 58.5%). Upon presentation 15 patients (62.5%) were considered to have AKI or AKI on top of chronic kidney disease, whereas nine patients (37.5%) develop AKI during hospitalization. Furthermore,

Table 1: Categorized risk factors for intra-abdominal hypertension

***Diminished abdominal wall* compliance**
• Mechanical ventilation
• Abdominal surgery with primary fascial or tight closure
• Major trauma
• Major burns
• Prone positioning
• Head of bed > 30 degrees
• Body mass index ≥ 30 kg/m² or morbid obesity
Increased intra-luminal contents
• Gastroparesis (gastric dilation or gastric residual > 500 mL).
• Ileus, paralytic or mechanical (abdominal distention or absence of bowel sounds)
• Colonic pseudo-obstruction
Increased abdominal contents
• Hemoperitoneum or pneumoperitoneum
• Ascites secondary to liver dysfunction
• Ascites secondary to liver dysfunction
• Other intra-abdominal injuries (peritonitis, abscess)
Capillary leak syndrome or fluid resuscitation
• Acidosis (arterial pH < 7.2)
• Hypotension (systolic blood pressure < 90 mmHg or mean arterial pressure < 70 mmHg or a systolic blood pressure decrease > 40 mmHg or
> 2 standard deviation below normal for age in the absence of other causes of hypotension)
• Hypothermia (core temperature < 33°C).
• Multiple transfusions (> 10 units of blood)
• Coagulopathy (platelets < 55,000/mm³ or prothrombin time < 15 s or partial thromboplastin time > 2 times normal or international standardized ratio > 1.5)
• Massive fluid resuscitation (> 5 L of colloid or crystalloid)
• Acute pancreatitis
• Oliguria (urine output < 500 mL).
• Sepsis (American-European Consensus Conference definitions)
• Major trauma
• Major burns
• Damage control laparotomy

Table 2: Staging of AKI according to KDIGO 2012

Stage	Serum creatinine	Urine output
1	1.5–1.9 times baseline OR ≥0.3 mg/dl (≥26.5 mmol/l) increase	<0.5 ml/kg/h for 6–12 hours
2	2.0–2.9 times baseline	<0.5 ml/kg/h for ≥12 hours
3	3.0 times baseline OR Increase in serum creatinine to ≥4.0 mg/dl (≥353.6 mmol/l) OR Initiation of renal replacement therapy OR, In patients <18 years, decrease in eGFR to <35 ml/min per 1.73 m²	<0.3 ml/kg/h for ≥24 hours OR Anuria for ≥12 hours

Table 3: Main diagnosis of the patients included in the study upon admission

Characteristics	Frequency (%)
Cardiac arrest	5 (7.57%)
Pancreatitis (acute)	3 (4.54%)
Liver cirrhosis with ascitis	3 (4.54%)
Acute liver failure	2 (3.03%)
Septic shock	20 (30.30%)
Acute respiratory failure (COPD, exacerbation, pneumonia)	23 (34.84%)
Poly-trauma	3 (4.54%)
Neurological disease (ICB, Ischemic CVA)	7 (10.60%)

Table 4: General characteristics of the study cohort

Characteristics	Data (n=66)
Age	67.62 (21.26)
Gender	
Male	33 (50.0%)
Female	33 (50.0%)
Intra-abdominal Hypertension	41 (62.1%)
Grade 1	16 (39.0%)
Grade 2	23 (56.1%)
Grade 3	2 (4.9%)
Acute Kidney Injury	
Yes	30 (45.5%)
No	29 (43.9%)
End Stage Renal Disease	7 (10.6%)
Mortality	26 (40.0%)
Mechanical Ventilation and many risk factors	47 (71.2%)
MV (1 of 2 Categorized Risk Factors)	15 (22.7%)
BMI greater than 30	25 (37.9%)
Positive Cumulative Fluid Balance	27 (40.9%)
LOS (days)	15.73 (12.68)
APACHE II	21.42 (5.89)
APACHE III	71.92 (17.72)
SOFA	9.55 (2.74)

Table 5: General characteristics of patients and comparison between IAH versus non-IAH

Characteristics	Intra-abdominal Hypertension	Non Intra-abdominal Hypertension	p-value
Age	71.10 (20.338)	61.92 (21.922)	0.089
Gender			
Male	21 (51.2%)	12 (48%)	
Female	20 (48.8%)	13 (52%)	0.800
Acute Kidney Injury			
Yes	24 (58.5%)	6 (24%)	
No	12 (29.3%)	17 (68%)	
End Stage Renal Disease	5 (12.2%)	2 (8%)	0.008
Mortality			
Yes	23 (57.5%)	3 (12%)	
No	17 (42.5%)	22 (88%)	<0.0001
Mechanical Ventilation			
Yes	31 (75.6%)	16 (64%)	
No	10 (24.4%)	9 (36%)	0.312
MV (1 of 2 Categorized Risk Factors)	15 (22.7%)		
Yes	6 (14.6%)	9 (36%)	
No	35 (85.4%)	16 (64%)	0.045
BMI greater than 30			
Yes	18 (43.9%)	7 (28%)	
No	23 (56.1%)	18 (72%)	0.196
Positive Cumulative Fluid Balance			
Yes	19 (46.3%)	8 (32%)	
No	22 (53.7%)	17 (68%)	0.250
LOS (days)	15.42 (10.877)	16.20 (15.242)	0.814
APACHE II	23.56 (5.758)	17.92 (4.271)	<0.0001
APACHE III	78.34 (16.173)	61.40 (15.133)	<0.0001
SOFA	10.34 (2.661)	8.24 (2.368)	0.002

Table 6: General characteristics of patients with IAH and comparison survivors versus non-survivors

Characteristics	Survivors	Non-survivors	p-value
Age	65 (20.696)	71.42 (22.322)	0.239
Gender			
Male	18 (46.2%)	14 (53.8%)	
Female	21 (53.8%)	12 (46.2%)	0.543
Intra-abdominal Hypertension			
Yes	17 (43.6%)	23 (88.5%)	
No	22 (56.4%)	3 (11.5%)	<0.0001
Acute Kidney Injury			
Yes	15 (38.5%)	14 (53.8%)	
No	22 (56.4%)	7 (26.9%)	
End Stage Renal Disease	2 (5.1%)	5 (19.2%)	0.034
Mechanical ventilation			
Yes	24 (61.5%)	22 (84.6%)	
No	15 (38.5%)	4 (15.4%)	0.045
MV (1 of 2 Categorized Risk Factors)	15 (22.7%)		
Yes	11 (28.2%)	4 (15.4%)	
No	28 (71.8%)	22 (84.6%)	0.687
BMI greater than 30			
Yes	13 (33.3%)	12 (46.2%)	
No	26 (66.7%)	14 (53.8%)	0.298
Cumulative Fluid Balance			
Yes	14 (35.9%)	13 (50%)	
No	25 (64.1%)	13 (50%)	0.258
LOS (days)	14.77 (10.922)	17.29 (15.230)	0.448
APACHE II	19.41 (5.471)	24.27 (5.408)	0.001
APACHE III	66.67 (19.200)	79.19 (12.162)	0.004
SOFA	8.33 (2.568)	11.23 (1.925)	<0.0001

Table 7: Logistic regression model for predictors of development of IAH in the high risk group

Characteristics	Odds Ratio	95% Confidence Interval	p-value
IAH			
Mortality	4.777	1.099–20.763	0.037
APACHE II	0.832	0.722–0.958	0.011
Mortality			
IAH	5.382	1.218–23.781	0.026
SOFA	0.613	0.450–0.835	0.002

IAH Intra-abdominal hypertension, APACHE II Acute physiology and chronic health evaluation, SOFA Sequential organ failure assessment

Table 8: Final 2013 WSACS consensus management statements

Recommendations
1. We recommend measuring IAP when any known risk factor for IAH/ACS is present in a critically ill or injured patient [GRADE 1C].
2. Studies should adopt the trans-bladder technique as the standard IAP measurement technique [not GRADED].
3. We recommend use of protocolized monitoring and management of IAP versus not [GRADE 1C].
4. We recommend efforts and/or protocols to avoid sustained IAH as compared to inattention to IAP among critically ill or injured patients [GRADE 1C].
5. We recommend decompressive laparotomy in cases of overt ACS compared to strategies that do not use decompressive laparotomy in critically ill adults with ACS [GRADE 1D].
6. We recommend that among ICU patients with open abdominal wounds, conscious and/or protocolized efforts be made to obtain an early or at least same-hospital-stay abdominal fascial closure [GRADE 1D].
7. We recommend that among critically ill/injured patients with open abdominal wounds, strategies utilizing negative pressure wound therapy should be used versus not [GRADE 1C].
Suggestions
1. We suggest that clinicians ensure that critically ill or injured patients receive optimal pain and anxiety relief [GRADE 2D].
2. We suggest brief trials of neuromuscular blockade as a temporizing measure in the treatment of IAH/ACS [GRADE 2D].
3. We suggest that the potential contribution of body position to elevated IAP be considered among patients with, or at risk of, IAH or ACS [GRADE 2D].
4. We suggest liberal use of enteral decompression with nasogastric or rectal tubes when the stomach or colon are dilated in the presence of IAH/ACS [GRADE 1D].
5. We suggest that neostigmine be used for the treatment of established colonic ileus not responding to other simple measures and associated with IAH [GRADE 2D].
6. We suggest using a protocol to try and avoid a positive cumulative fluid balance in the critically ill or injured patient with, or at risk of, IAH/ACS after the acute resuscitation has been completed and the inciting issues have been addressed [GRADE 2C].
7. We suggest use of an enhanced ratio of plasma/packed red blood cells for resuscitation of massive hemorrhage versus low or no. attention to plasma/packed red blood cell ratios [GRADE 2D].
8. We suggest use of PCD to remove fluid (in the setting of obvious intraperitoneal fluid) in those with IAH/ACS when this is technically possible compared to doing nothing [GRADE 2C]. We also suggest using PCD to remove fluid (in the setting of obvious intraperitoneal fluid) in those with IAH/ACS when this is technically possible compared to immediate decompressive laparotomy as this may alleviate the need for decompressive laparotomy [GRADE 2D].
9. We suggest that patients undergoing laparotomy for trauma suffering from physiologic exhaustion be treated with the prophylactic use of the open abdomen versus intraoperative abdominal fascial closure and expectant IAP management [GRADE 2D].
10. We suggest not to routinely utilize the open abdomen for patients with severe intraperitoneal contamination undergoing emergency laparotomy for intra-abdominal sepsis unless IAH is a specific concern [GRADE 2B].
11. We suggest that bioprosthetic meshes should not be routinely used in the early closure of the open abdomen compared to alternative strategies [Grade 2D].

patients who had no IAH had higher chance not to have AKI (68%). The results obtained in our study were similar to results of other studies that showed that IAH is an under-appreciated cause of acute renal failure [19] and that IAH is an independent cause of postoperative renal impairment [20]. Other articles also supported the same idea about renal dysfunction associated with IAH and ACS [21].

In addition to the significance incidence of AKI in IAH patients, it was also noticed, with statistical significance, the higher mortality rate among patients with AKI (55.6%). Low incidence of AKI and high survival rate in high risk group (56.4%) was noticed.

In conclusion, it is believed now that IAH or even small rises in IAP elevation are under-appreciated causes of AKI, and should be added to the list of causes of acute renal failure. Renal dysfunction in ACS appears to be caused by renal hypoperfusion, due to the raised renal vein pressure and partly to the low cardiac output and high renal vascular resistance [19].

Comparing critical care severity scores in patients with IAH versus non-IAH

Several organ dysfunction scores were taken using measurements obtained at the first day of admission. IAH was significantly associated with higher severity of critical care scores and incidence of organ failure. Concerning APACHE II score, patients with IAH had higher index with mean of (23.56), comparing to (17.92) in non-IAH patients. APACHE III score had similar results with higher index in the IAH group (78.34) versus non-IAH (61.40). SOFA was also taken in the first day of admission/or occurrence of IAH, and showed higher score in the IAH group (10.34) versus (8.24) in the comparison group, with statistical significance in all critical care severity score. On the other hand, illness severity scores were higher in deceased patients with IAH, comparing to the survived group. The mean values were 19.41, 66.67 and 8.33 for APACHE II, APACHE III and SOFA respectively, in the survived group comparing to higher values in the deceased group.

The study showed the higher severity scores in IAH group. As a result, it is becoming clear that IAH is independent risk factor for mortality. However, none of critical care severity indices includes IAP measurement despite all of the recommendations of WSACS.

Development of IAH has been described as an independent predictor of mortality in mixed populations [18]. In another study, IAH was a non-independent predictor of mortality, and this supported the fact that IAH was a marker of mortality in association with other clinical factors.

In our study, IAH was an independent risk factor for mortality in critically ill medical patients.

We found a high rate of resolution of IAH in our medical patients, but non-resolution was an independent predictor of mortality. Treatment of IAH was proposed by the final 2013 WSACS consensus management statements (Table 8), but still not applied in most of the ICU medical patients due to lack of awareness of IAH.

CONCLUSION

In conclusion, intra-abdominal hypertension (IAH) is a frequent finding in critically ill medical patients, and showed an independent association with mortality and deterioration in kidney function. IAH was significantly associated with more severe organ failures. Intravesical pressure technique is the gold standard method for measurement of IAP. Intra-abdominal hypertension's manifestations are difficult to detect on physical examination. At-risk patient populations should be routinely screened and monitored, and whenever diagnosis in confirmed patients should be managed early and aggressively. Our study highlights the importance of screening and early detection of IAH, as early detection and management may improve outcomes. Specific guidelines and recommendations for the management of patients with IAH/ACS have been published in 2004 and updated in 2013.

Limitations

Our study generated important findings but unfortunately, there were several limitations.First of all IAP was only measured in high risk patients with ≥2 CRF. Second, measurements of IAP was performed only once daily due to the lack of trained staff. Another limitation is that the study did not identify the significance of subgroups of risk factors in the incidence of IAH and did not analyze each RF of the four categories as predictors of IAH. Additionally, not all patients who had their IAP measured were sedated, which could have caused a falsely elevated IAP. Finally, the study had small sample size, although other international studies had similar numbers of patients.

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Author Contributions

Mohamad Mostafa Habli – Substantial contributions to conception and design, Acquisition of data, Analysis and interpretation of data, Drafting the article, Revising it critically for important intellectual content, Final approval of the version to be published
Sirine Omar Ahmad – Analysis and interpretation of data, Revising it critically for important intellectual content, Final approval of the version to be published
Sabine Youssef Karam – Analysis and interpretation of data, Revising it critically for important intellectual content, Final approval of the version to be published
Houssam Nassib Rabah – Analysis and interpretation of data, Revising it critically for important intellectual content, Final approval of the version to be published
Najat Issa Joubran-Fares – Analysis and interpretation of data, Revising it critically for important intellectual content, Final approval of the version to be published

Guarantor

The corresponding author is the guarantor of submission.

Conflict of Interest

Authors declare no conflict of interest.

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