PROGNOSTIC RELEVANCE AND PREDICTIVE POWER OF INTRA-ABDOMINAL HYPERTENSION AND SERUM PROCALCITONIN LEVELS IN CRITICALLY ILL SURGICAL PATIENT

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ABSTRACT

Objective: The objective of the study is to determine the clinical value of procalcitonin (PCT) levels and in recognizing surgical complications, morbidity and mortality in a heterogeneous group of general surgical patient population admitted in casualty ward and intensive care unit (ICU).

Methods: A prospective, observational study was conducted on 100 patients by purposive sampling for blood and ascites in the peritoneal cavity, bowel distension and edema, high-volume resuscitation and massive transfusion, damage control surgery in traumatic patients, excessive tension after abdominal closure, post-operative ileus, circumferential abdominal eschar in burn patients, and hemodilution with severe sepsis were enrolled within 24 h of admission to the ICU or casualty ward in the Department of General Surgery, J.L.N. Medical College and Hospital, Ajmer, from August 2021 to December 2022.

Results: The mean age of the overall patient population for the study is 52.29 years and it ranges between 16 years and 84 years. 79% of the patients presented with intra-abdominal hypertension (IAH), and mean serum PCT level in the IAH group is 4.47 ± 7.49 which is higher than that in the non-IAH group ($p<0.05$). The mean serum PCT levels among the group having peritonitis as the cause of sepsis is 5.69 ng/mL and having pneumonitis as the cause of sepsis is 6.74 ng/mL ($p=0.033$).

Conclusion: Serum PCT, a new serum biomarker for infection and inflammation, that has been found to be more sensitive and specific for the same, is also an indicator for patient mortality and morbidity, and also correlates with patient's length of hospital stay can be said to have an important role in prediction of critically ill surgical patient's outcome.

Keywords: Serum procalcitonin, Critically ill, Serum biomarker.

INTRODUCTION

The pressure inside the abdomen at any 1 time is determined by the flexibility of its walls and the nature of its contents [1,2]. Intra-abdominal pressure (IAP) ranges from sub-atmospheric to 0 mmHg in normal conditions. Chronic IAP elevations may be associated with certain physiological conditions such as morbid obesity and pregnancy [2]. In critically ill patients, normal IAP is around 5-7 mmHg. 3,4 intra-abdominal hypertension (IAH) is defined as the sustained IAP above 12 mmHg. Any condition that causes intra-abdominal hemorrhage puts a patient at risk for ACS. This includes abdominal trauma, aortic aneurysm rupture, retroperitoneal hemorrhage, elective abdominal surgery, pregnancy complications, and hepatic transplantation. Other intra-peritoneal fluid collections, in addition to blood, may contribute to the development of ACS. Edema of the bowel and retro-peritoneum, abdominal packing, ileus, ascites, massive volume resuscitation for shock, and improper abdominal fascia closure all increase the risk of IAH and ACS. Despite the abundance of information, IAH remains mysteriously underdiagnosed. As a result, we should work to raise awareness and reduce morbidity and mortality by identifying the problem early on [3,4].

Procalcitonin (PCT) is a relatively new biomarker used to predict systemic inflammatory response, infection, and antibiotic treatment during sepsis. In post-operative patients with severe sepsis, increased PCT concentrations were found to be an independent predictor of survival. It has also been demonstrated that, when compared to C-reactive protein, a PCT measurement is a superior marker for distinguishing sepsis and infection from other non-infections systemic inflammatory response. Because PCT is an indirect indicator of infection, it is thought that it could be used as a marker of clinical deterioration in critically ill patients [5]. PCT may also aid in decision-making for additional interventions and the detection of surgical complications.

Aim

The aim of the study is to determine the clinical value of PCT levels and in recognizing surgical complications, morbidity and mortality in a heterogeneous group of general surgical patient population admitted in casualty ward and Intensive care unit (ICU).

METHODS

This prospective, observational study was conducted on 100 patients by purposive sampling for blood and ascites in the peritoneal cavity, bowel distension and edema, high-volume resuscitation and massive transfusion, damage control surgery in traumatic patients, excessive tension after abdominal closure, post-operative ileus, circumferential abdominal eschar in burn patients, and hemodilution with severe sepsis were enrolled within 24 h of admission to the ICU or casualty ward in the Department of General Surgery, J.L.N. Medical College and Hospital, Ajmer, from August 2021 to December 2022. Study protocol was approved by the Ethics Committee (Order No. 1968/Acad-III/MCA/2021; Dated September 27, 2021) of the college. For pregnant females, Foley's catheterization was not possible, and therapeutic open abdomen patients were excluded from the study. IAP was measured for every patient pre- and postoperatively at 0, 6, 12, 24, and 48 h. Serum PCT values were measured on 2nd day of admission of all of the above patients. The PCT assay is a sandwich chemiluminescence immunoassay.

Measurement of IAP

The abdominal pressure was indirectly determined by measuring urinary bladder pressure by a 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 saline manometer. The anterior superior iliac spine was taken the zero reference and the pressure was measured in centimeters of water at the end of expiration. A conversion factor of 1.36 was used to convert pressure into mmHg.

Statistical analysis

Analysis of data was done using IVMSPSS software for Windows (the Statistical Package for the Social Sciences, version 23.0). Categorical variables were summarized in frequency and percentages. Continuous variables were summarized using descriptive statistics such as mean and standard deviation. Statistical tests such as Independent samples t-test, Chi-square test, and Pearson test for correlation were applied. Our resulting $p < 0.05$ led to rejection of null hypothesis and yielded statistically significant results.

The investigation was started after receiving ethical approval from the institute. Written informed consent was obtained from all the study subjects.

RESULTS

The mean age of the overall patient population for the study is 52.29 years and it ranges between 16 years and 84 years. Majority of the patients are in the age range of 40–64. 79% of the patients are male and the rest 21% are female (Table 1).

79% of the patients presented with IAH and the rest 21% did not. Majority (38%) of the patients had Perforation as the Indication for Admission followed by Saio (34%). Trauma patients constituted 22% (Table 2).

The mean IAP at 0 h after admission was 16.43 mmHg for the overall patient population and it gradually decreased across the progressing time points and finally at 48 h, the mean IAP was 12.70 mmHg (Table 3).

At 0 h, majority of the patients fall in Grade 2 IAP. At 6 h, majority again fall in Grade 2 IAP. At 12 h, majority fall in both Grades 1 and 2 of IAP. At 24 h and 48 h, majority of the patients fall in Grade 1 of IAP (Fig. 1).

Table 1: Sociodemographic status of study subjects

Sociodemographic variables	Frequencies	%
Age groups		
16–28 years	8	8.0
28–40 years	16	16.0
40–52 years	23	23.0
52–64 years	29	29.0
64–76 years	18	18.0
76–88 years	6	6.0
Sex		
Male	79	79.0
Female	21	21.0

Table 2: IAH and indication for admission

At admission	Frequency	Percentage
IAH in the patients		
Yes	79	79.0
No	21	21.0
Indication for admission		
Burn	1	1.0
Ascites	3	3.0
BTA	22	22.0
Gut Gangrene	2	2.0
Perforation	38	38.0
Saio	34	34.0

57% of the patients in study group had peritonitis as the cause of sepsis. 19 % of the patients had pneumonitis. 68% of the patients underwent laparotomy (surgical management) while 32% were conservatively managed (Table 4).

The mean duration of IAH was 2.11 days. Regarding hospital, number of days spent in ICU, and duration of ventilator dependency, the mean values were 10.43 days, 2.58 days, and 0.85 days, respectively. 9% of the patients had death as their final prognosis (Table 5).

The mean serum PCT level in the IAH group is 4.47±7.49 which is higher than that in the non-IAH group ($p < 0.05$). The mean serum PCT levels among the group having peritonitis as the cause of sepsis is 5.69 ng/mL versus those not having peritonitis as the cause of sepsis is 0.88 ng/mL ($p < 0.05$). The mean serum PCT levels among the group having pneumonitis as the cause of sepsis is 6.74 ng/mL versus those not having pneumonitis as the cause of sepsis is 2.94 ng/mL ($p = 0.033$) (Table 6).

DISCUSSION

In the study, it was observed that the mean age of patients included is 52.29 years and it ranges between 16 years and 84 years. Majority of the patients are in the age range of 40–64 years. Kim *et al.*, [5] found that the mean (±Standard deviation [SD]) age for their study population was 60.5±16.2 years.

Regarding sex distribution, it was found that majority, that is, 79% of the patients were males and the rest 21% were females. Kuteesa *et al.* [6] found that for the adult population, the percentage of males were 80.7%.

Table 3: IAP values (in mm. of Hg) at different time intervals

Intra-abdominal pressure in mmHg	Mean	SD	Min	Max
0 h	16.43	3.84	10	26
6 h	15.44	3.64	8	22
12 h	14.60	3.41	9	22
24 h	13.69	3.43	8	21
48 h	12.70	3.35	7	21

Table 4: Cause of sepsis and pattern of pneumonitis

Complications	Frequency	Percentage
Cause of sepsis		
Peritonitis	57	57.0
Non-peritonitis	43	43.0
Pneumonitis		
Pneumonitis	19	19.0
Not pneumonitis	81	81.0

Table 5: Duration of IAH among study subjects

Variables	Mean	SD	Min	Max
Duration of IAH	2.11	1.66	0	8.0
Time spent in ICU (days)	2.58	2.221	0	9
Hospital stay (days)	10.430	3.6522	2.0	23.0
Ventilator stay (days)	0.85	1.38	0	8

Table 6: Procalcitonin levels among study subjects

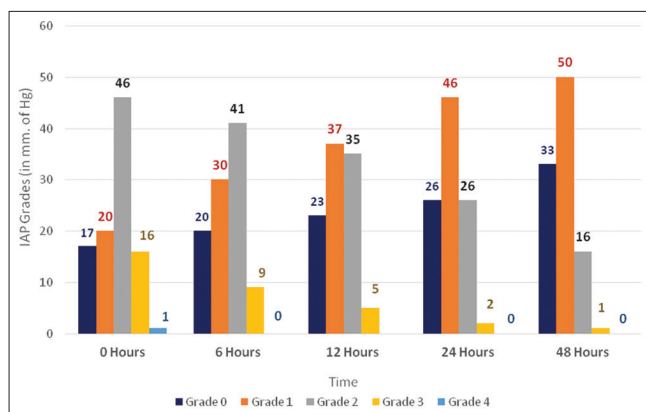| Serum Procalcitonin (ng/mL)	Mean±SD	p-value
IAH (79)	4.47±7.49	<0.05
Non-IAH (21)	0.43±1.08	
Peritonitis (57)	5.69±8.31	<0.05
No peritonitis (43)	0.88±2.36	
Pneumonitis (18)	6.74±11.93	0.033
Non-pneumonitis (82)	2.94±5.01	

Fig. 1: Intra-abdominal pressure grades at different times

In the present study, out of all the 100 patients, 79% presented with IAH and the rest 21% had normal IAPs. Reintam Blaser *et al.* [7] found that 240 of 491 patients (48.9%) developed IAH during the observation period.

Out of 100 patients, 38% of the patients presented with perforation peritonitis followed by Saio (34%) due to various causes. 22% of our patients came with blunt trauma of the abdomen. Studies conducted showed a similar distribution of trauma patients [7,8]. In our study, patients with ascites (3%), burn (1%), and gut gangrene (2%) constituted a small percentage.

The mean value of IAP at 0 h was 16.43 mmHg and it gradually decreased with increasing time. At 6 h, it was 15.44; at 12 h, it was 14.60; at 24 h, it was 13.69, and finally, at 48 h, the mean IAP was 12.70 mmHg. Kuteesa *et al.* [6] found that the mean IAP before and after emergency laparotomy was 15.4 (SD±3.6) mmHg and 14.21 (SD±5.0) mmHg, respectively. These findings can be explained by the fact that since a majority of our study patients had perforation peritonitis and intestinal obstruction, both medical and surgical management that included decompression of the abdomen by drainage of large quantities of abdominal fluids and gases led to decreased pressure values post-interventions.

The mean duration of IAH in our total study population was 2.11 days. This mean duration in our non-survivor group is 3.77±1.92 days and in the survivor group are 1.94±1.55 days. Gupta *et al.* [8] found in their study that the mean duration of IAH in the survivor group is 2.85 days and that in the non-survivor group is 8.38 days.

57% of the patients in our study had peritonitis as the cause of sepsis and the rest 43% fell in the non-peritonitis group. 19% of our study patients developed pneumonitis. A similar observation was made in the study conducted by Prasad *et al.* [9] which showed 59% patients with peritonitis and 18% with pneumonitis.

68% patients of our study patients underwent laparotomy, i.e., surgical intervention for management, 65 (82.3%) of which fell in the IAH category, and 3 (14.3%) in the non-IAH group. In the study by Smit *et al.*, 91% of the patients underwent surgical management [9].

Regarding hospital stay and number of days spent in ICU, the mean values were 10.43 days and 2.58 days, respectively, for the overall study population. Reintam Blaser *et al.* [7] found that the mean number of days spent in ICU were 5 days and that for hospital stay were 17 days.

39% of the patients in our study had to be mechanically ventilated whereas, in study by Smit *et al.* [9], 59.4% patients were mechanically ventilated at the time of admission and this data were 64.6% in Reintam Blaser *et al.* [7] study. The mean number of days that the patients were

vasopressor dependent was 1.39 days. Enteral feed was resumed after a mean of 6.23-day post-admission.

9% of the patients in the study had death as their final outcome. The study conducted by Reintam Blaser *et al.* [7] showed a 18.7% mortality and that by Kim *et al.* [5] showed 16% mortality.

In this study, the mean serum PCT levels among the group having peritonitis as the cause of sepsis is 5.69 ng/mL versus those not having peritonitis as the cause of sepsis is 0.88 ng/mL and this difference is statistically significant (Independent samples T-test).

Also, the mean serum PCT levels among the group having pneumonitis are 6.74 ng/mL versus those not having pneumonitis are 2.94 ng/mL and this difference is statistically significant. (Independent samples T-test). Abu Elyazed and El Sayed Zakiin in their study found the diagnostic accuracy of PCT for diagnosing post-operative hospital-acquired pneumonia on day 2 with mean level 1.52 ng/mL [10]. Peritonitis and pneumonitis were the major causes of sepsis in our study population. Thus, PCT levels in these patients were compared with their counterparts that show that serum PCT can be used as a marker for predicting sepsis in critically ill patients.

Jensen *et al.* found that the median increase in PCT differed between patients with sepsis, 8.4 ng/mL (SE 18.9 ng/mL, range 0.029–635.8 ng/mL) and patients without sepsis, 3.7 ng/mL (SE 2.6 ng/mL, range 0.0–189.4 ng/mL, p=0.04, Mann–Whitney U-test) thus resonating to our findings [11].

The mean serum PCT levels in the IAH group are statistically significantly higher than that in the non-IAH group (Independent samples t-test). As our study population constituted critically ill surgical patients, a correlation was found between the values of our two variables which have been independently used as markers for the study group.

CONCLUSION

IAH is associated with declining functions of not only intra-abdominal organs but also of other distant vital organ systems over time, thus worsening the vital parameters and hence the clinical outcome of surgical patients. This requires management by both medical and surgical interventions to restore normal physiology. Hence, IAP measurement in surgical setups is an important question in prompt patient management that can help to decrease morbidity, mortality, length of hospital, and ICU stay brought about as a result of this increased entity.

Serum PCT, a new serum biomarker for infection and inflammation, that has been found to be more sensitive and specific for the same, is also an indicator for patient mortality and morbidity and also correlates with patient's length of hospital stay. Having several other advantages, this marker can be said to have an important role in the prediction of critically ill surgical patient's outcome.

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