Evaluation of Prognostic Scoring System in Perforation Peritonitis – Comparitive Study between APACHE II and Manheim's Peritonitis Index Systems

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Abstract:
Introduction : *Hollow viscus perforation is a common abdominal emergency and is still a dreaded condition with high mortality. Perforation of any part of the intestine is life threatening, which is most commonly managed by general surgeons.*
Materials and Methods : *This study was conducted in The Department of General Surgery of the Sri Venkata Sai Medical College& Hospital. Fifty cases of acute bacterial peritonitis secondary to gastro intestinal tract perforations were encountered during the study period of three years from 01.08.2017 to 31.10.2020.*
Results : *Upper Gastro-intestinal perforations, namely duodenal ulcer perforations constituted the most common perforation in our study. They accounted for 52 % of the total cases, with duodenal ulcer constituting 36 % (18 cases) and gastric ulcer forming the rest 16 % (8 cases). 10 cases of appendicular perforation were included in the study (20%).*
Discussion : *Temperatures of patients presenting with perforation peritonitis were recorded. Rectal temperature measurements are ideal, but for practical reasons, axillary temperatures were recorded and used in the study. Rectal temperatures are found to be 0.5 – 0.7 o C higher than the recorded axillary readings. Mean Temperature in our study was found to be 38.6 o C with a range between 37 o C- 41 o C. Higher temperatures were observed with appendicular and ileal perforations, especially when there was a delay of more than 3 days before presentation to the hospital. Mean temperature for ileal perforations was 39.1 o C and for appendicular perforations was 38.9 o C. Subnormal temperatures were found in two cases who presented with features of shock.*
Conclusion :
• APACHE II score is the current gold standard for assessing the severity of acute perforation peritonitis.
• The mortality rate in our study of 50 patients was found to be 18%
• An APACHE II score of 15 and above predicted mortality in our study population with a positive predictive value of100%.
• The overall accuracy of this score was found to be100%
• APACHE II score is more physiological in emergency settings compared to Manheim's score.
Keywords: *Perforation,Peritonitis,APACHE,Manheim's*

I. Introduction

Hollow viscus perforation is a common abdominal emergency and is still a dreaded condition with high mortality.[1] Perforation of any part of the intestine is life threatening, which is most commonly managed by general surgeons.[2] The vast majority of perforations are duodenal and gastric in origin, precipitated by alcohol and drugs.[3] Malignancy and traumatic perforations are on the rise.[4] Evaluation and management of gastro-intestinal perforations provide one of the most challenging experiences for a surgeon.[5] Ever since the "Hippocratic facies" was identified and attributed to peritonitis, there has been a continuous and remarkable change in the diagnosis and management.[6] It is indeed true to mention here that *"Only the changes are permanent in the field of medicine".*[7] Surgeons must continually reassess the standard of treatment and be receptive to new ideas. The present thesis focuses on the prediction of mortality with APACHE II AND Manheim's Peritonitis Index in cases of perforation peritonitis and to identify the better among the two.[8] To

predict the prognosis and survival of a patient is indeed difficult as different patient respond differently and hence the emphasis and need for development of an objective score.[9]

II. Materials and Methods

This study was conducted in The Department of General Surgery of the Sri Venkata Sai Medical College& Hospital. Fifty cases of acute bacterial peritonitis secondary to gastro intestinal tract perforations were encountered during the study period of three years from 01.08.2017 to 31.10.2020. Nature of the study was prospective study and cases were included into the study by application of following criteria.[10]

Inclusion criteria :
1. Peritonitis secondary to hollow viscus perforation.
2. Age group between 15 to 75yrs.
3. Both males and females were included in the study.

Exclusion criteria :
1. Spontaneous bacterial peritonitis.
2. Post-operative peritonitis due to anastomotic leak, etc.
3. Pancreatitis induced peritonitis.
4. Ruptured liver abscess induced peritonitis, Age group less than 15yrs
5. Select sealed perforations managed conservatively.

The patient was resuscitated with fluids and electrolytes brought and maintained within the normal range.[11] Urethral catheter was inserted to monitor hourly urine output and nasogastric tube inserted to decompress the stomach. The parameters of modified APACHE II score and Manheim's Peritonitis Index were recorded at the time of admission.[12]

APACHE II scoring[13]
The following acute physiological parameters of APACHE II were included
– temperature, mean arterial pressure, heart rate, respiratory rate, serum sodium, serum potassium, creatinine, serum bicarbonate, haematocrit, white blood cell count and GCS of the patient.

The scores ranged from 0 to 4 on each side of the normal value. Zero score represents normal values, an increase to 4 indicating the extreme end of high or low abnormal values. The sum of all the individual score values were obtained which denotes the acute physiology score.

APACHE II SCORING SYSTEM

ACUTE PHYSIOLOGIC ASSESSMENT AND CHRONIC HEALTH EVALUATION (APACHE) II SCORING SYSTEM*

PHYSIOLOGIC VARIABLE†		POINT SCORE								
		+4	+3	+2	+1	0	+1	+2	+3	+4
1	Temperature, core (°C)	≥ 41°	39–40.9°	—	38.5–38.9°	36–38.4°	34–35.9°	32–33.9°	30–31.9°	≤ 29.9°
2	Mean arterial pressure (mm Hg)	≥ 160	130–159	110–129	—	70–109	—	50–69	—	≤ 49
3	Heart rate	≥ 180	140–179	110–139	—	70–109	—	55–69	40–54	≤ 39
4	Respiratory rate (nonventilated or ventilated)	≥ 50	35–49	—	25–34	12–24	10–11	6–9	—	≤ 5
5	Oxygenation:									
	a) $FiO_2 ≥ 0.5$: use A-aDO_2	≥ 500	350–499	200–349	—	< 200	—	—	—	—
	b) $FiO_2 < 0.5$: use PaO_2 (mm Hg)	—	—	—	—	> 70	61–70	—	55–60	< 55
6	Arterial pH	≥ 7.7	7.6–7.69	—	7.5–7.59	7.33–7.49	—	7.25–7.32	7.15–7.24	< 7.15
7	Serum Na (mmol/L)	≥ 180	160–179	155–159	150–154	130–149	—	120–129	111–119	≤ 110
8	Serum K (mmol/L)	≥ 7	6–6.9	—	5.5–5.9	3.5–5.4	3–3.4	2.5–2.9	—	< 2.5
9	Serum creatinine (mg/dL); double point score for **acute renal failure**	≥ 3.5	2–3.4	1.5–1.9	—	0.6–1.4	—	< 0.6	—	—
10	Hct (%)	≥ 60	—	50–59.9	46–49.9	30–45.9	—	20–29.9	—	< 20
11	WBC (in 1000s)	≥ 40	—	20–39.9	15–19.9	3–14.9	—	1–2.9	—	< 1
12	Glasgow coma score (GCS)	Score = 15 minus actual GCS								

Acute physiology score is the sum of the 12 individual variable points.

Add 0 points for age <44; 2 points, 45–54 yr; 3 points, 55–64 yr; 5 points, 65–74 yr; 6 points ≥ 75 yr.

Add chronic health status points: 2 points if elective postoperative patient with immunocompromise or history of severe organ insufficiency; 5 points for nonoperative patient or emergency postoperative patient with immunocompromise or severe organ insufficiency.‡

(13)§ Serum HCO_3 (venous–mmol/L)	≥ 52	41–51.9	—	32–40.9	22–31.9	—	18–21.9	15–17.9	< 15

*APACHE II score = acute physiology score + age points + chronic health points. Minimum score = 0; maximum score = 71. Increasing score is associated with increasing risk of hospital death.

†Choose worst value in the past 24 h.

‡Chronic health status: Organ insufficiency (eg, hepatic, cardiovascular, renal, pulmonary) or immunocompromised state must have preceded current admission.

§Optional variable; use only if no ABGs.

A-a DO_2 = Alveolar–arterial oxygen gradient; FiO_2 = fractional inspired O_2.

Liver: Documented portal hypertension and biopsy proven cirrhosis and/ or prior episodes of hepatic failure, encephalopathy or coma.
CVS: Class IV New York Heart Associationailment
RS: chronic restrictive, obstructive or vascular disease resulting in severe exercise restriction, chronic hypoxia, hypercapnoea, severepolycythemia,
RENAL: patient on chronicdialysis
IMMUNOCOMPROMISED: the patient has received therapy that suppresses resistance to infection. E.g.: immune suppression, chemotherapy, radiation, long term or recent steroids, or has a disease that is sufficiently advanced to suppress to infection. E.g.: leukaemia, lymphoma, AIDS.
Organ insufficiency or immune-compromised state must have been evident prior to hospital admission and conform to following criteria:

Manheim's peritonitis index includes

MANNHEIM PERITONITIS INDEX

RISK FACTOR	WEIGHTING IF PRESENT
AGE>50 years	5
Female sex	5
Organ failure	7
Malignancy	4
Origin of sepsis not colonic	4
Diffuse generalised peritonitis	6
Preoperative duration of peritonitis >24h	4
Intra peritoneal Exudates	
Clear	0
Cloudy, purulent	6
Faecal	12

Organ failure criteria

Creatinine level>177 micro mol per litre

Urea level >167 mmol per litre

Oliguria <20 ml per hour

PaO2<50 mm of hg

PaCO2>50mm of hg

Shock: systolic blood pressure<90mm of hg, MAP<60mm of hg

Intestinal obstruction only if profound with paralytic ileus>24h, complete mechanical

After adequate resuscitation and assessment, patients underwent exploratory laparotomy. At surgery, the pathology was identified and treated accordingly. Thorough and copious irrigation of the cavity was given and insertion of drains was decided on case to case basis. Abdomen was closed with non-absorbable suture material in a continuous fashion. All patients received appropriate broad spectrum antibiotics for a minimum period of 5 to 7days.

Analysis
Demographic, clinical, preoperative, and/or post operative complications on each patient were entered into a standard proforma. Each patient's postoperative outcome/ mortality was compared to determine the significance of illness on postoperative complications and mortality.[14]

III. Results
TABLE 1: PERCENTAGE OF CASES

TOTAL NUMBER OF CASES				
	MALE	FEMALE	TOTAL	
GASTRIC	7	1	8	16%
DUODENAL	16	2	18	36%
JEJUNAL	2	0	2	4%
ILEAL	5	1	6	12%
APPENDICULAR	6	4	10	20%
COLONIC	3	2	5	10%
GALL BLADDER	0	1	1	2%
	39	11	50	

Upper Gastro-intestinal perforations, namely duodenal ulcer perforations constituted the most common perforation in our study. They accounted for 52 % of the total cases, with duodenal ulcer constituting 36 % (18 cases) and gastric ulcer forming the rest 16 % (8 cases). 10 cases of appendicular perforation were included in the study (20%).

## FIG 1: DISTRIBUTION OF CASES OBSERVED IN OUR STUDY
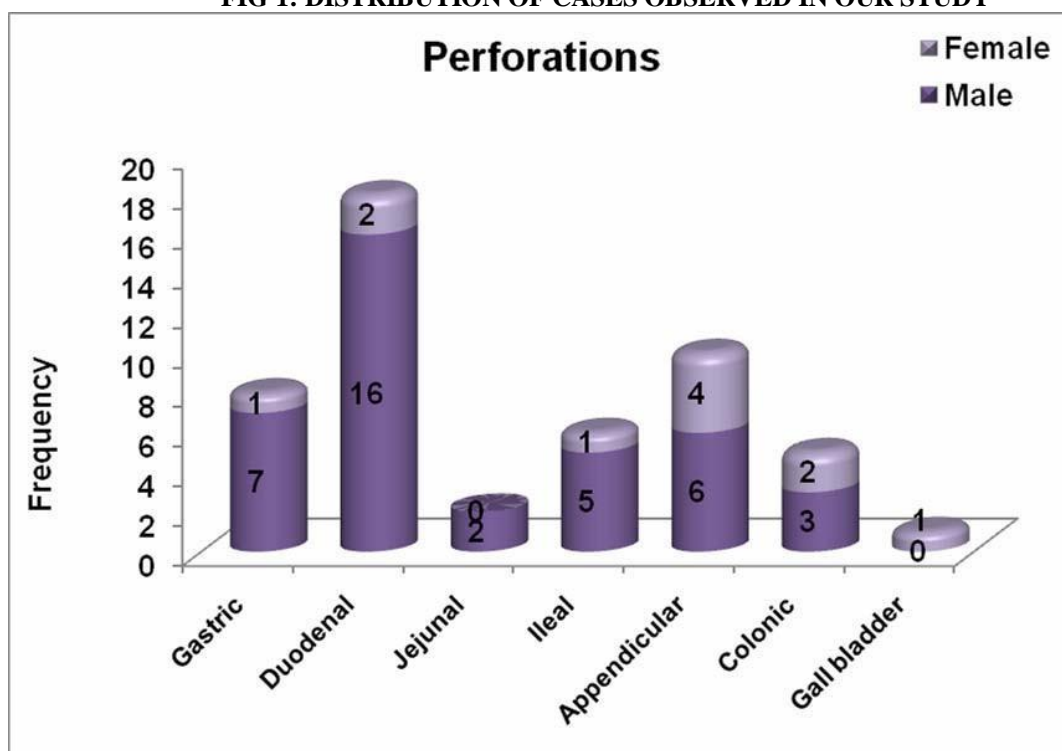
Duodenal perforation was the most common perforation among the male patients (16/39 patients) and most of them had a binge of alcohol within a day or two of presentation. Among females, appendicular perforations were identified commonly (4/11 patients).

TABLE 2: AGE DISTRIBUTION

AGE DISTRIBUTION						
	15-25	26-35	36-45	46-55	56-65	66-75
MALE	6	5	7	15	4	1
FEMALE	2	1	4	3	1	1
TOTAL	8	6	11	18	5	2

FIG. 2: AGE DISTRIBUTION IN OUR STUDY
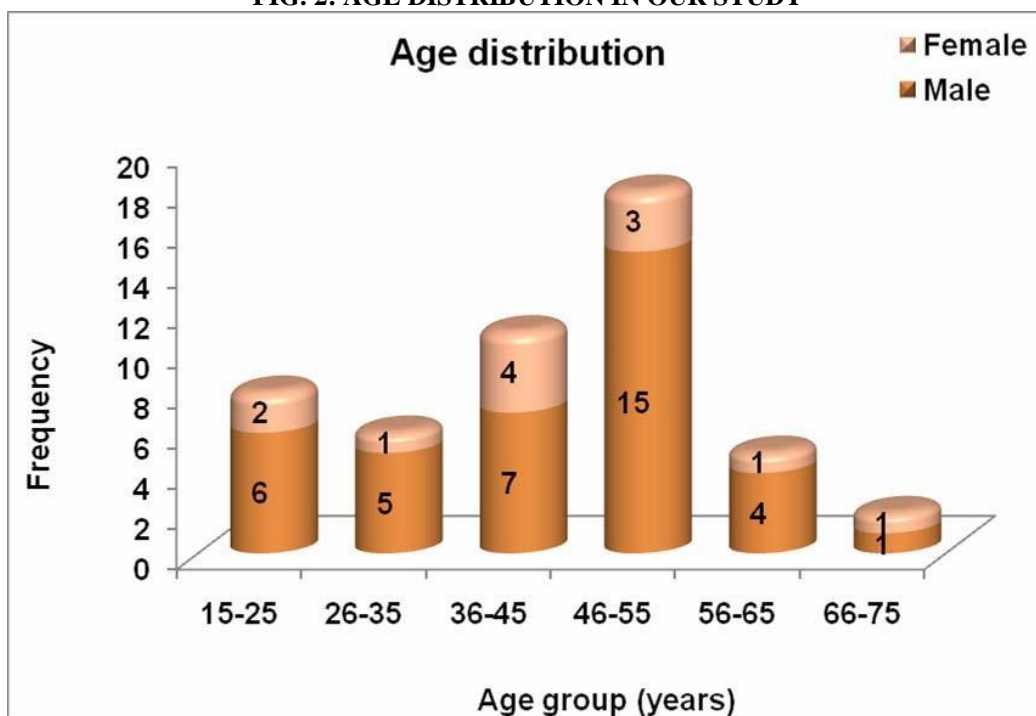
The patients included in this study had a mean age of 42.7 years with a range between 20–68years.The male: female ratio was 3.1:1 with 38 male patients and 12 female patients. The mean age of males was 42.6 years (20-68 years) and females was 42.9 years (21-68years).[15]

TABLE 3: PERCENTAGE OF NON-SURVIVORS IN VARIOUS PERFORATIONS

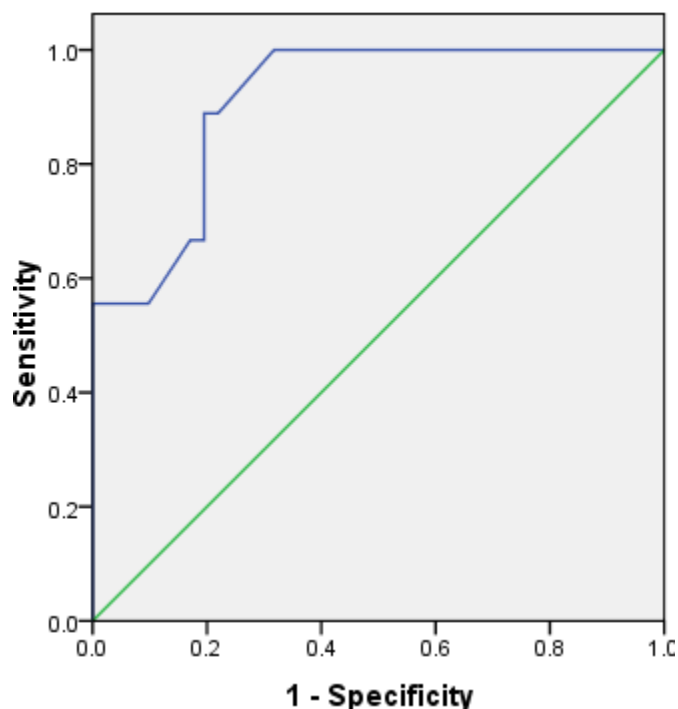| NON SURVIVORS				
	MALE	FEMALE	TOTAL	
GASTRIC	1	1	2	25%
DUODENAL	2	0	2	11.10%
JEJUNAL	1	0	1	50%
ILEAL	0	0	0	0
APPENDICULAR	1	0	1	10%
COLONIC	2	1	3	60%
GALL BLADDER	0	0	0	0

Majority of cases were diffuse generalized peritonitis. 11 cases of localized peritonitis (22 %) were encountered and most of them were appendicular (7/11 cases) in origin. Few early cases of duodenal perforation were also limited in nature.

TABLE 4: MORTALITY RATES IN VARIOUS PERFORATIONS ACCORDING TO MANHEIMM'S SCORE GROUPS

SCORE	≤ 15			15 - 25			≥ 26		
	n	NS	%	N	NS	%	n	NS	%
GASTRIC	4	0	0	1	0	0	3	2	66.7
DUODENAL	11	0	0	5	1	20	2	1	50
JEJUNAL	1	0	0	0	0	0	1	1	100
ILEAL	1	0	0	5	0	0	0	0	0
APPENDICULAR	6	0	0	3	1	33.3	1	0	0
COLONIC	1	0	0	0	0	0	4	3	75
GALL BLADDER	0	0	0	1	0	0	0	0	0

The mortality rates among patients who had score of less than 15 are found to be zero. Only two deaths were observed with a score between 15-25 group and mortality rose to high levels among patients with higher values. 7 deaths were recorded out of the 11 patients who had a score of more than 25. To find the appropriate cut off point above which the mortality can be predicted requires the construction of an ROC curve.[16]

FIG. 3: ROC CURVE ANALYSIS TO FIND THE BEST CUT-OFF POINT FOR MANHEIM'S SCORE TO PREDICT MORTALITY

The ROC curve analysis predicted that the MANHEIM'S score of 22 or more will predict the non-survival status.

TABLE 5: SENSITIVITY AND SPECIFICITY OF MANHEIM'S INDEX

		MORTALITY		Total
		Yes	No	
MANHEIM'S SCORE	≥22	8	8	16
	<22	1	33	34
Total		9	41	50

| Parameter	Estimate	Lower - Upper 95% CIs
Sensitivity	88.89%	56.50, 98.01
Specificity	80.49%	65.99, 89.77
Positive Predictive Value	50.00%	28.00, 72.00
Negative Predictive Value	97.06%	85.08, 99.48
Diagnostic Accuracy	82.00%	69.20, 90.23

ROC curve analysis predicted the AUC (Area Under the Curve) to be 0.972 for a Manheim's score of 22. Of the total 9 mortality observed in this study, 8 cases had a score of 22 and above. Only one case with a score of less than 22 expired during the study. This gives the score a sensitivity of 88.89%(56.5) and a specificity of 80.49%(65.99-89.77).The overall diagnostic accuracy of this score is 82 % in our study.

TABLE 6: MORTALITY RATES IN VARIOUS PERFORATIONS ACCORDING TO APACHE II SCORE GROUPS

	≤ 5			6 to 15			≥ 16		
	N	NS	%	N	NS	%	n	NS	%
GASTRIC	4	0	0	3	0	0	2	2	100
DUODENAL	12	0	0	3	0	0	2	2	100
JEJUNAL	1	0	0	0	0	0	1	1	100
ILEAL	1	0	0	4	0	0	0	0	0
APPENDICULAR	9	0	0	0	0	0	1	1	100
COLONIC	1	0	0	3	1	33.3	2	2	100
GALL BLADDER	0	0	0	1	0	0	0	0	0
TOTAL	28	0		14	1		8	8	0

The mortality was found to rise as the score rises. Below a score of 5, no deaths were observed. There was only one death among the group with scores between 6 and 15. The expired case had a value of 15. The last group had 8 patients and all 8 expired. The mortality rate was 2.3% below the score of 15 and rose proportionately beyond it. The timing of death was varied in different cases, but most cases expired on the second post-operative day.

FIG. 4: ROC CURVE ANALYSIS TO FIND THE BEST CUT-OFF POINT FOR APACHE II SCORE TO PREDICT MORTALITY
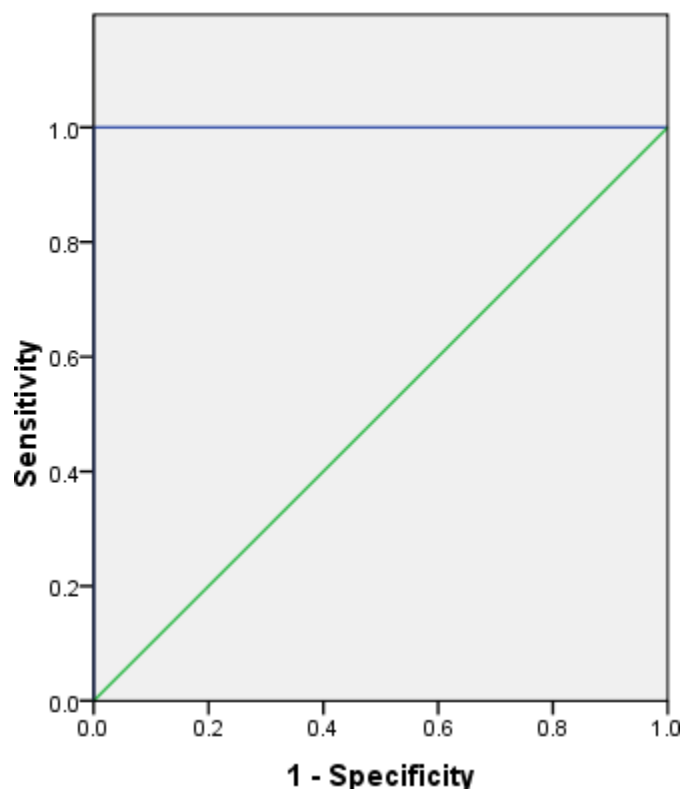
The ROC curve analysis predicted that the APACHE II score of 15 or more will predict the non-survival status.

TABLE 7: SENSITIVITY AND SPECIFICITY OF APACHE II INDEX

		MORTALITY		Total
		Yes	No	
APACHE II SCORE	≥15	9	0	9
	< 15	0	41	41
Total		9	41	50

Parameter	Estimate	Lower - Upper 95% CIs
Sensitivity	100%	70.08, 100.00
Specificity	100%	91.43, 100.00
Positive Predictive Value	100%	70.08, 100.00
Negative Predictive Value	100%	91.43, 100.00
Diagnostic Accuracy	100%	92.86, 100.00

Of the total 9 deaths observed in this study, all cases had a score of 15 and above. Hence an APACHE II score of 15 predicts mortality with a sensitivity of 100 % and a specificity of 100 %. The overall diagnostic accuracy of mortality with this score is found to be 100 %. An ROC curve plotted for a score of 15 gives an area under curve to be 1.0.[17]

Scoring	Mean ± SD	p-value
MANNHEIM SCORING	18.7200±8.46129	
APACHE II SCORING	7.5200± 5.97355	*P<0.0001

*p<0.0001 is statistically significant

• APACHE II score is the current gold standard for assessing the severity of acute perforation peritonitis.
• The mortality rate in our study of 50 patients was found to be 18%
• An APACHE II score of 15 and above predicted mortality in our study population with a positive predictive value of100%.
• The overall accuracy of this score was found to be100%
• APACHE II score is more physiological in emergency settings compared to Manheim's score.
• Compared to the MPI score, APACHE II score could be used serially to monitor the patient in the immediate post-operative period.
• Patient treatment can be optimized by appropriate intensive supportive care when it is determined to be needed.
• APACHE II score can triage the patients with the treatment directed to the most effective patient.
• Scoring patients into groups based on risk could help future clinical research by comparing therapeutic interventions in similar patients. Of the two scoring systems evaluated, the APACHE II seems to be better suited to achieve these goals.

IV.   Discussion

Temperatures of patients presenting with perforation peritonitis were recorded. Rectal temperature measurements are ideal, but for practical reasons, axillary temperatures were recorded and used in the study. Rectal temperatures are found to be 0.5 – 0.7 o C higher than the recorded axillary readings. Mean Temperature in our study was found to be 38.6 o C with a range between 37 o C- 41 o C. Higher temperatures were observed with appendicular and ileal perforations, especially when there was a delay of more than 3 days before presentation to the hospital. Mean temperature for ileal perforations was 39.1 o C and for appendicular perforations was 38.9 o C. Subnormal temperatures were found in two cases who presented with features of shock.

Mean arterial pressures (MAP) were calculated by systolic and diastolic blood pressure measurements using a sphygmomanometer. It is computed using the formula "Diastolic pressure + 1/3(Pulse pressure)". Pulse pressure is the difference between systolic and diastolic blood pressures. The MAP ranges in our study is

between *65- 155 mm Hg,* with a *mean value of 98.5 mm Hg.*[18] Low values were observed with a case of shock consequent to stab injury to the abdomen (65 mm Hg) and with another case of colonic malignant perforation with septic shock (68 mm Hg) of the total 50 cases, 7 patients had malignancy. A gastric malignancy presented as perforation in a 64 years old male patient. He was treated with subtotal gastrectomy and gastro jejunostomy. Biopsy report turned out to be moderately differentiated adenocarcinoma and the resected margins were free from tumour invasion. Two of the resected 7 nodes showed metastatic deposits. Patient was followed up with chemotherapy using 5 FU based regimens.[19]

One case of incidentally diagnosed well differentiated hepatocellular carcinoma in a duodenal ulcer perforation was encountered. Post operatively it was treated with chemotherapy as the patient was not amenable to liver resection.

Two cases of colonic perforations with malignancy were encountered. Due to hemodynamic instability, one case was treated with diversion colostomy alone and the other with Hartmann's procedure. Both the patients were in fulminant sepsis and needed post-operative ventilator and hemodynamic support. These patients had a downhill course and expired on second and third post-operative days.

Two cases of rectal malignancy, one at the extra peritoneal site and the other in intra peritoneal location. The former had posterior fixity and was not respectable, and hence a diversion loop transverse colostomy was done. The patient was started with chemotherapy.[20] The second case had a cancer at the recto-sigmoid junction with hugely dilated proximal descending colon with a contained perforation in it. The patient underwent primary Hartmann's procedure with adjuvant chemotherapy and a colo-rectal anastomosis in a secondary sitting with a covering loop colostomy which was closed under local anesthesia. Both the patients are on regular follow up.

Another case of jejunal Gastro Intestinal tumour perforation was seen. The malignancy had invaded adjacent loops of ileum, and hence an *en bloc* resection was done. The patient deteriorated with sepsis and succumbed on second post-operative day.

The mortality rate in our study is found to be 18%. Various trials have estimated the mortality rate to be between 10-60% and the average mortality is 19.5% which is close to the value noted with our study. The mortality rates are influenced by disease specific as well as patient related factors. In a prospective study was conducted by *Carlos* over a period of 10 years 1994-2004 (n=267), overall mortality was 20% and mean hospital stay was 20 days.[21]

In our study, a Manheim's score of 22 was found to predict mortality which was statistically significant. This is in accordance with previous studies where a score of 21 was found to predict mortality. In a study by *Billing et al*, mortality rate in patients with a score of less than 21 was found to be 2.3% and above this score a mortality rate of 60-80% was observed. The mortality rate was found to rise proportionately beyond this score.[22]

Demmel et al evaluated the usage of MPI in acute peritonitis (n=438). Analysis revealed the MPI to have a sensitivity of 87% and a specificity of 77% for a score of 26. In our study, the cut off score of 22 had a sensitivity of 89% and a specificity of 80%.[23]

An APACHE II score of 15 was found to predict mortality with significant difference between the two groups. Below this score, the mortality rate was 2.3% and above this value, the mortality rate to 90-100%. This is in accordance to *Schein et al* where the APACHE II score was found to predict mortality very well between a score of 11-20.61

Kulkarni et al evaluated the APACHE II score among patients with perforation peritonitis. A score between 11 and 20 was found to predict mortality with greater accuracy than a score of less than 10 or more than 20. Our study is in accordance with this study, as the best cut off score was found to be 15 with a diagnostic accuracy and positive predictive value of 98% and 100% respectively.[24]

The comparison as to which score is the best is varied among different studies. *Bosscha et al* evaluated the various scoring systems in a study sample of 50 patients. A multivariate analysis revealed both APACHE II and MPI to predict the outcome independently.[25]*Malik et al* also arrived at similar conclusions but favoured APACHE II score as it better identified the physiological reserve of the patient understudy.[26]

Ohmann et al found that the APACHE II score was better a predictor of mortality than MPI score. It was also useful to decide on the treatment formulations and repetitive monitoring in ICU setup.[27,28]

In our present study, both scoring systems are useful to predict mortality beyond their respective cut off scores. Though the Manheim's peritonitis index is accurate and easy to apply, it does not consider the underlying physiological derangements in the patient. An MPI also required intra operative details without which the score cannot be computed. Hence an APACHE II score, which is more physiological, is useful for risk stratification in acute settings. Despite its relative demerits of being cumbersome to calculate and not including the etiology of the underlying process, it is widely being followed for prediction of mortality and outcome.

V.   Conclusion

• APACHE II score is the current gold standard for assessing the severity of acute perforation peritonitis.

• The mortality rate in our study of 50 patients was found to be 18%

• An APACHE II score of 15 and above predicted mortality in our study population with a positive predictive value of100%.

• The overall accuracy of this score was found to be100%

• APACHE II score is more physiological in emergency settings compared to Manheim's score.

• Compared to the MPI score, APACHE II score could be used serially to monitor the patient in the immediate post-operative period.

• Patient treatment can be optimized by appropriate intensive supportive care when it is determined to be needed.

• APACHE II score can triage the patients with the treatment directed to the most effective patient.

• Scoring patients into groups based on risk could help future clinical research by comparing therapeutic interventions in similar patients. Of the two scoring systems evaluated, the APACHE II seems to be better suited to achieve these goals.

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