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ORIGINAL ARTICLES

Serum Procalcitonin Levels as Predictors of Clinical Outcomes in Patients with Secondary Peritonitis

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Abstract

Introduction: Secondary peritonitis remains a formidable challenge in emergency general surgery, with significant morbidity and mortality. Despite advances in surgical technique, postoperative complications—particularly surgical site infections (SSIs) and respiratory failure—remain common.

This study examines the prognostic utility of serum procalcitonin (PCT) and C-reactive protein (CRP) as biochemical markers for risk stratification and prediction of clinical outcomes in patients with secondary peritonitis.

Materials and Methods: A prospective observational study was conducted from February 2023 to April 2024, including 95 patients diagnosed with secondary perforation peritonitis. Serum PCT and CRP concentrations were measured at admission and 48–72 hours postoperatively. Patients were followed for 30 days. The primary clinical endpoints were ICU admission, mechanical ventilation, prolonged hospital stay, SSI, and 30-day mortality.

Results: The study cohort had an overall mortality rate of 13.7%. Statistical analysis showed that admission PCT levels > 1.28 ng/mL were a highly significant predictor of non-survival. Furthermore, a postoperative PCT threshold of >0.5 ng/mL at 48 hours was strongly correlated with the subsequent development of SSIs. Although elevated CRP levels were associated with adverse clinical trajectories, PCT demonstrated superior discriminative power for specific outcomes.

Conclusion: Serum PCT and CRP are robust predictors of mortality and morbidity in secondary peritonitis. Specifically, a PCT level > 1.28 ng/mL at admission provides critical prognostic information about survival, whereas postoperative PCT levels > 0.5 ng/mL facilitate early identification of SSI risk. These findings suggest that incorporating serial biomarker monitoring into clinical workflows can enhance risk-based decision-making. Larger multicenter trials are warranted to validate these thresholds.

Keywords: peritonitis, sepsis, emergency laparotomy, bowel perforation

Introduction

Secondary peritonitis, caused by perforation or trauma to abdominal hollow viscus organs, is a life-threatening condition requiring immediate surgical intervention. It is characterized by severe abdominal pain, tenderness, guarding, rigidity, occasionally fever, nausea, vomiting, and systemic inflammation [1]. Postoperative complications, such as surgical site infections (SSIs), pneumonia, and septicemia, contribute to high morbidity and mortality rates. Several risk factors contribute to SSIs, including malnutrition, metabolic diseases like diabetes, immunosuppression, and inadequate surgical techniques. Secondary peritonitis is the most commonly encountered type of peritonitis and requires immediate surgical intervention [2]. The overall morbidity in these cases is significantly high, often exceeding 50%, with a need for prolonged hospitalization, ICU care, and prolonged antibiotic therapy [3].

Sepsis, often leading to multi-organ failure, remains a leading cause of mortality in surgical ICUs, with mortality rates from perforation peritonitis ranging from 10% to

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30% [4]. The primary contributor to death in these patients is septicemia, which can lead to multi-organ dysfunction syndrome (MODS) [3]. Various scoring systems and markers, such as WBC counts, CRP, and PCT, have been used to predict outcomes in these patients [5].

PCT, a precursor of the hormone calcitonin, is primarily produced in the thyroid gland but is also released in response to bacterial infections, serving as an acute-phase reactant. It has become an established marker of sepsis, especially in the ICU and neonatal patients. However, its role in predicting outcomes in secondary peritonitis remains underexplored [6]. This study aimed to evaluate the predictive value of serum PCT and CRP levels in patients with secondary peritonitis.

Material and Methods:

Study Design*:* This was a prospective observational study conducted from February 2023 to April 2024 at a tertiary care hospital in North India.

Inclusion and exclusion criteria*:* Patients with a clinically or radiologically confirmed diagnosis of secondary peritonitis, aged >18 years, were admitted to the center. Patients who were operated outside our hospital and later referred to our hospital, patients with other causes of elevated procalcitonin levels (e.g., chronic renal disease, neuroendocrine tumors, heat stroke), and patients with other causes of peritonitis (e.g., spontaneous bacterial peritonitis, tertiary peritonitis) were excluded from the study.

Data collection*:* The Institutional Ethics Committee of Government Medical College and Hospital, Chandigarh, approved the study under GMCH/IEC/834/2022/196 on November 29, 2022.

A total of 95 patients were included in the study after obtaining informed consent. Serum PCT and CRP levels were measured at admission and 48-72 hours postoperatively. Lactate levels were assessed at admission. Resuscitation, as well as preoperative and postoperative care, adhered to the established protocol for secondary peritonitis, and relevant data were collected using a study pro forma.

Patients were followed up throughout their hospital stay and for up to 30 days after discharge. Incidence of SSIs, ICU admission, mechanical ventilation, prolonged hospital stays (>7 days), and mortality were assessed.

Statistical Analysis*:* Data were analyzed using Statistical Package for Social Sciences (SPSS) version 21.0. Quantitative variables were expressed as mean ± standard deviation, and categorical variables as frequencies and proportions. Statistical significance was set at $p < 0.05$.

Results

Demographics: The mean age of patients was 40.6 years (range, 18-74 years); 85.3% were male, and 24.2% were older than 50 years. Abdominal pain was the most common presenting symptom, present in all 95 patients (100%), followed by nausea and vomiting in 49.5% of patients and non-passage of stool and flatus in 44.2% of patients.

The mean duration from symptom onset to hospital presentation was 4.29 days; 89.5% had a delayed hospital presentation (>24 hours), 88.4% presented with diffuse peritonitis, 58.9% were smokers, 9.5% were obese, 3.2% had a pre-existing malignancy, and 3.2% had a history of chronic corticosteroid exposure.

The most common site of perforation was the ileum (36.8%), followed by prepyloric perforation (27.4%). Other sites included duodenal (15.8%), appendicular (7.4%), gastric (4.2%), diverticular (3.2%), colonic (3.2%), caecal (3.2%), and jejunal (2.1%).

A total of 92 patients underwent midline exploratory laparotomy, while 3 patients underwent open appendectomy via a Gridiron incision for appendicular perforation. Ileostomy was the most commonly performed procedure (22.1%), followed by Cellan Jones repair with feeding jejunostomy (21.1%) and omental patch repair of gastroduodenal perforation (20%).

CRP Levels: Elevated CRP levels (>3 mg/dL) were observed in 98.9% of patients at admission and in 97.8% at 48 hours postoperatively. The mean CRP at admission was 318.28 $\pm$ 163.33 mg/L among non-survivors, compared with 276.92 $\pm$ 142.94 mg/L among survivors.

Serum procalcitonin levels were measured at admission and then 48 hours postoperatively. The mean values at admission were 5.81 $\pm$ 14.43 ng/mL, 4.09 + 11.18 ng/mL in the survivor group, and 16.69 + 25.26 ng/mL in the non-survivor group, respectively. The mean values observed at 48 hours ±post-surgery in the survivor and non-survivor groups were 2.49 + 11.97 ng/mL and 11.78 $\pm$ 25.20 ng/mL, respectively.

Lactate Levels: 88.4% of patients had lactate levels >1 mmol/L, with non-survivors having higher levels (3.18 ± 2 mmol/L) than survivors (2.31 ± 1.22 mmol/L).

Surgical site infections (SSIs): 55.8% of patients developed SSIs. PCT levels > 0.5 ng/mL at 48 hours postoperatively were associated with a higher risk of SSIs. In this study, serum PCT levels > 0.5 ng/mL at 48 hours postoperatively, CRP values > 100 mg/dL at 48 hours postoperatively, and an MPI score > 27 were significant predictors of SSIs.

Mortality: A total of 13 patients died within 30 days of surgery; the overall mortality rate was 13.7%. Of these 13 patients, 8 were aged 50 years or older, 12 were male, and 12 had a delayed hospital presentation (> 48 hours after symptom onset). 8 patients were chronic smokers, and all 13 received postoperative ICU admission and mechanical ventilatory support.

Non-survivors had significantly higher PCT levels at admission (>1.28 ng/mL) and presented to the hospital with delays (>48 hours). An MPI score >27, PCT >1.28 ng/mL at admission, and the need for mechanical ventilation were significant predictors of mortality.

This table presents the demographic and clinical characteristics of the 95 patients included in the study at hospital admission, including age, sex, risk factors, clinical symptoms, and initial laboratory findings.

Parameter	(n = 95)
Age	
<50 years	72
>50 years	23
Sex	
Male	81
Female	14
Risk Factors	
Chronic smoking	56
Obesity (BMI > 30)	3
Malignancy	3
Preoperative duration of symptoms (> 24 hours)	85
Chronic corticosteroid exposure	3
Signs and symptoms	
Pain abdomen	95
Nausea and vomiting	47
Non-passage of stool and flatus	42
Fever	35
Abdominal distention	10
Loss of appetite	5
Investigations	
Lab Investigations	
Anaemia (Hb < 10mg/dL)	45
Raised TLC counts (> 11 x 10^9/L)	52
Acidosis (pH < 7.35)	34
Alkalosis (pH > 7.45)	14
Lactate levels > 1 mmol/L	84
CRP at admission (mg/L)	
≤ 3	1
> 3	94
Procalcitonin at admission (ng/mL)	
≤ 0.5	21
> 0.5	74

Table 1: Patient characteristics and preoperative data

Summary of intraoperative findings, including the site and type of bowel perforation, the extent of peritonitis, and the surgical procedures performed.

Parameter	No. of cases	%
Site of Perforation		
Single Ileal Perforation	27	28.4
Pre-pyloric	26	27.4
Duodenal	15	15.8
Multiple Ileal Perforation	8	8.4
Appendicular Perforation	7	7.4
Gastric Perforation	4	4.2
Diverticular Perforation	3	3.2
Colonic Perforation	3	3.2
Caecal Perforation or Sloughed off Caecum	3	3.2
Jejunal	2	2.1
Type of peritonitis		
Localized	11	11.6
Generalized	84	88.4
Surgical procedure		
EL with loop ileostomy	21	22.1
Cellan Jones repair	20	21.1
Modified Graham's patch repair	19	20
Resection with end ileostomy	7	7.4
Primary repair with diversion ileostomy	5	5.3
Appendicectomy	7	7.4
T-tube repair of duodenal perforation	3	3.2
Resection with anastomosis of ileal perforation	3	3.2
EL with loop jejunostomy	1	1
Limited ileocaecal resection	1	1
Resection with end jejunostomy	1	1
Bilroth II gastrectomy		
Left hemicolectomy		
Subtotal colectomy		

Table 2: Operative data

Postoperative outcomes and follow-up data include inflammatory marker levels (CRP and PCT) at 48 hours, incidence of surgical site infections (SSIs), ICU admissions, and 30-day mortality. The Mannheim Peritonitis Index (MPI) and hospital stay duration are also included.

Parameters	Number
Lab Investigations	
CRP at 48 hours postoperatively (mg/L)	
< 3 mg/L	2
> 3 mg/L	93
PCT at 48 hours postoperatively(ng/mL)	
< 0.5	55
> 0.5	40
Outcomes	
Mannheim peritonitis index	
< 25	47
> 25	48
Prolonged hospital stay (> 7 days)	
Yes	48
No	47
Surgical site infections	
Yes	53
No	42
Postoperative ICU admission and mechanical ventilatory support	
Yes	19
No	76
Mortality	
Survivors	82
Non-survivors	13

Table 3. Postoperative data

Discussion

Perforation peritonitis is among the most common surgical emergencies requiring admission in our country. Patients typically present with generalized abdominal pain, associated with nausea and vomiting, fever, constipation, and/or loss of appetite [3].

The mean age of presentation in our study was 40.6 years, with a range of 18 to 74 years. The highest incidence was observed in those aged 18 to 30 years, and the highest mortality was observed in those aged 41 to 50 years.

These findings were similar to those observed in a study by *Jhobta et al.* of 504 patients with perforation peritonitis, in which the mean age at presentation was 36.8 years and most patients were in the 31-50-year age group [3].

The gender distribution showed a male predominance, with 81 male patients comprising 85.3% of the total study population and a male-to-female ratio of 5.78:1. These observations were similar to those reported in other studies by *Ghosh et al.* in 2016 [7].

Among the demographic variables, age > 50 years was associated with a longer ICU stay and higher MPI scores. Chronic smoking was observed primarily in male patients, who most often presented with gastroduodenal perforations.

The results of our study were similar to those observed by *Meena et al.,* in which 106 of 442 patients were chronic smokers, and the majority had duodenal perforation [8]. However, no significant association could be established between age, gender, smoking, obesity, or chronic corticosteroid exposure and mortality in our study.

The ileum was the most common site of perforation, observed in 35 patients, followed by prepyloric perforation in 26 patients. *Bali et al.* (2014) studied 400 patients with perforated peritonitis and found that duodenal perforation was the most common, occurring in 37.5% of cases, followed by ileal perforation in 22.5% [9]. However, these findings contrast with those observed in the Western world.

Salamone et al. (2016) from Italy reported in their study on perforation peritonitis that rectosigmoid perforation (22.11%) was the most common type, followed by appendicular (16.34%), gastroduodenal (14.42%), and ileal perforation (10.58%) [10].

These findings reflect the high prevalence of smoking, analgesic abuse, and tropical infections in the Indian population, whereas malignancy is the leading cause in Western countries.

In our study population, surgical management primarily involved exploratory laparotomy with loop ileostomy (22.1%), followed by omental patch repair of gastroduodenal perforations (21.1%).

Postoperatively, the most prevalent complication was SSIs, observed in 55.8% of patients, and over half of patients (50.5%) had prolonged hospital stays lasting more than seven days. Furthermore, 20% required mechanical ventilation and ICU admission following surgery.

Through multivariate analysis, several predictors of surgical site infection were identified, including procalcitonin levels above 0.5 ng/mL at 48 hours ($p = 0.011$), CRP levels >100 mg/dL at 48 hours after surgery ($p = 0.041$), and MPI scores greater than 27 ($p = 0.049$).

Significant predictors of postoperative mechanical ventilation and ICU admission were MPI scores above 27 ($p < 0.001$) and procalcitonin levels greater than 1.28 ng/mL at admission ($p = 0.001$). However, none of the parameters in our study were significant predictors of prolonged hospital stay.

Of the 95 patients in our study group, 13 died postoperatively within 30 days of surgery, yielding a mortality rate of 13.7%. This is consistent with the expected mortality rates of 10 to 30% observed among patients with perforation peritonitis [11]. Of these non-survivors, 8 were older than 50 years, resulting in a mortality rate of 46.2% in this age group, which was significantly higher than the 20.7% mortality observed in those younger than 50 years.

Similar observations were reported by *Singh et al.,* who found a 60% mortality rate among those older than 50 years [4]. Factors associated with mortality in our study included advanced age, delayed hospital admission, acidosis, elevated lactate levels, and the need for mechanical ventilation and ICU care. An MPI score above 27 was statistically significant in predicting mortality, with a sensitivity and specificity of 92% and 61%, respectively (p value 0.001).

Additionally, admission serum procalcitonin levels above 1.28 ng/mL significantly predicted non-survival, with a sensitivity of 92% and a specificity of 55% (p = 0.001).

The limitations of our study include the relatively small sample size, which may limit the generalizability of the findings. Additionally, C-reactive protein (CRP) and procalcitonin levels were measured only at admission and again 48 to 72 hours post-surgery. A more comprehensive analysis would have required serial measurements over time to assess trends more accurately.

Conclusion

Serum PCT and CRP levels are significant predictors of mortality and SSIs in patients with secondary peritonitis. PCT levels >1.28 ng/mL at admission and >0.5 ng/mL at 48 hours postoperatively were strongly associated with non-survival and SSIs, respectively. Early diagnosis and intervention are crucial for improving outcomes in these patients. Larger studies with serial biomarker measurements are needed to validate these findings.

Abbreviations

SSIs - Surgical Site Infections; PCT - Procalcitonin; CRP - C-reactive protein; MODS - Multi-Organ Dysfunction Syndrome; ICU – Intensive Care Unit; WBC – White Blood Cell; SPSS - Statistical Package for Social Sciences; MPI - Mannheim Peritonitis Index;

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References

1. Thompson J. The peritoneum, omentum, mesentery, and retroperitoneal space. In: Williams NS, O'Connell PR, McCaskie AW, editors. Bailey & Love's Short Practice of Surgery. 27th ed. Boca Raton, FL: CRC Press; 2018. p. 1048–55.
2. Lu ML, Agarwal A, Sloan J, Kosmin A. Infected ascites: distinguishing secondary peritonitis from spontaneous bacterial peritonitis in a cirrhotic patient with classic symptoms. IDCases. 2017; 8:29–31. doi:10.1016/j.idcr.2017.02.010
3. Jhobta RS, Attri AK, Kaushik R, Sharma R, Jhobta A. Spectrum of perforation peritonitis in India—review of 504 consecutive cases. World J Emerg Surg. 2006; 1:26. doi:10.1186/1749-7922-1-26
4. Wichmann MW, Inthorn D, Andress HJ, Schildberg FW. Incidence and mortality of severe sepsis in surgical intensive care patients: the influence of patient gender on disease process and outcome. Intensive Care Med. 2000;26(2):167–172. doi:10.1007/s001340050041
5. Bhattacharya A, Singh R, Vajifdar H, Kumar N. Preoperative predictors of mortality in adult patients with perforation peritonitis. Indian J Crit Care Med. 2011;15(3):157–163. doi:10.4103/0972-5229.84897
6. Pupelis G, Drozdova N, Mukans M, Malbrain MLNG. Serum procalcitonin is a sensitive marker for septic shock and mortality in secondary peritonitis. Anaesthesiol Intensive Ther. 2014;46(4):262–273. doi:10.5603/AIT.2014.0043
7. Ghosh PS, Mukherjee R, Sarkar S, Halder SK, Dhar D. Epidemiology of secondary peritonitis: analysis of 545 cases. Int J Sci Stud. 2016;3(12):83–88. doi:10.17354/ijss/2016/126
8. Meena LN, Jain S, Bajiya P. Gastrointestinal perforation peritonitis in India: a study of 442 cases. Saudi Surg J. 2017;5(3):116–121. doi: 10.4103/ssj.ssj_33_17
9. Bali RS, Verma S, Agarwal PN, Singh R, Talwar N. Perforation peritonitis and the developing world. ISRN Surg. 2014;2014:105492. doi:10.1155/2014/105492
10. Salamone G, Licari L, Falco N, Augello G, Tutino R, Campanella S, et al. Mannheim Peritonitis Index (MPI) and elderly population: prognostic evaluation in acute secondary peritonitis. G Chir. 2016;37(6):243–249. doi:10.11138/gchir/2016.37.6.243
11. Chakma SM, Singh RL, Parmekar MV, Singh KHG, Kapa B, Sharatchandra KH, et al. Spectrum of perforation peritonitis. J Clin Diagn Res. 2013;7(11):2518–2520. doi:10.7860/JCDR/2013/5768.3596