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Independent Predictors of Extended Hospitalization Following Cholecystectomy: A Multivariate Analysis

H A Nazmul Hakim[1*], ANM. Nure Azam[2], Md. Tuhin Talukder[3], Kazi Mazharul Islam[4], Mohammad Mahbub Elahi[5], Mohammad Abdul Awal[6], Golam Mahmud Rayhan[7]

[1]Associate Professor, Department of Surgery, Dhaka Medical College Hospital, Dhaka, Bangladesh
[2]Junior Consultant, Department of Surgery, Sheikh Hasina National Institute of Burn and Plastic Surgery, Dhaka, Bangladesh
[3]Junior Consultant, Department of Surgery, Dhaka Medical College Hospital, Dhaka, Bangladesh
[4]Junior Consultant, Department of Surgery, Dhaka Medical College Hospital, Dhaka, Bangladesh
[5]Senior Consultant, Department of Surgery, Dhaka Medical College Hospital, Dhaka, Bangladesh
[6]Senior Consultant, Department of Surgery, Dhaka Medical College Hospital, Dhaka, Bangladesh
[7]Junior Consultant, Department of Surgery, Bangabandhu Sheikh Mujib Medical University, Dhaka, Bangladesh

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***Corresponding author:** H A Nazmul Hakim
Associate Professor, Department of Surgery, Dhaka Medical College Hospital, Dhaka, Bangladesh

Abstract **Original Research Article**

Introduction: Cholecystectomy, the surgical removal of the gallbladder, is one of the most commonly performed surgical procedures worldwide, particularly in patients with symptomatic cholelithiasis and cholecystitis. This study aimed to assess the independent predictors of extended hospitalization following cholecystectomy. ***Methods:*** This prospective observational study was conducted at the various surgical units of the inpatient Department of Surgery, Dhaka Medical College Hospital, Dhaka, from July 2018 to June 2019. Patients with cholecystitis attending in the outdoor or emergency, admitted with cholecystitis in Dhaka Medical College Hospital, Dhaka were considered as the study population. A total of 50 patients were selected as study subjects by purposive sampling technique. Statistical Package for Social Science (SPSS) version 21 for Windows was used to analyze the data. A p-value < 0.05 was considered to be significant. ***Result:*** The median length of stay (LOS) was 5.0 days (range: 1–21 days), with the 80th percentile at 6 days. Patients were classified into two groups: control (LOS <6 days) and prolonged LOS (≥6 days). Univariate analysis revealed that factors such as patient age (p <0.002), male gender (p =0.026), preoperative leukocyte count (p =0.002), preoperative NLR (p <0.002), and admission through the ED (p <0.002) were linked to prolonged LOS. Multivariate analysis identified three independent predictors of prolonged LOS: age ≥50 years (OR 2.212, 95% CI 1.372 – 3.530, p <0.002), preoperative NLR ≥3.0 (OR 1.776, 95% CI 1.146–2.725, p =0.004), and admission via the ED (OR 1.664, 95% CI 1.070–2.560, p =0.008). ***Conclusion:*** This study identifies key independent predictors of extended hospitalization (≥6 days) following cholecystectomy, highlighting the roles of advanced age (≥50 years), elevated neutrophil-lymphocyte ratio (NLR ≥3), and admission through the emergency department (ED). Through multivariate analysis, these factors were shown to significantly increase the odds of prolonged length of stay, underscoring the need for targeted preoperative risk assessment and management strategies.

Keywords: Length of hospital stay, Cholecystectomy, Cholecystitis.

INTRODUCTION

Cholecystectomy, the surgical removal of the gallbladder, is one of the most commonly performed surgical procedures worldwide, particularly in patients with symptomatic cholelithiasis and cholecystitis. Over recent decades, the procedure has evolved considerably, primarily through the adoption of minimally invasive laparoscopic techniques, which have significantly reduced recovery times and hospital stays for patients compared to traditional open procedures [1]. However, despite these advancements, there remains considerable variability in post-operative hospital length of stay (LOS) among cholecystectomy patients, influenced by a complex interplay of demographic, clinical, and procedural factors [2]. Extended hospitalization not only increases healthcare costs but also places additional strain on hospital resources and exposes patients to greater risks of hospital-acquired complications, underscoring the importance of identifying factors that predict prolonged LOS [3]. Multiple studies have investigated factors associated with extended LOS in cholecystectomy patients. Age, sex, preoperative leukocyte count, neutrophil-lymphocyte ratio (NLR),

and route of hospital admission have been explored as potential predictors of prolonged hospital stay, with varying degrees of significance across studies. Age, for instance, has frequently been highlighted as a significant predictor, with older patients typically exhibiting longer recovery times due to a higher prevalence of comorbidities and reduced physiological resilience [4]. Gender has also been examined, with mixed findings; some studies suggest that males tend to have longer hospital stays due to increased perioperative complications, while others report minimal or no effect of gender on LOS [5,6]. The preoperative leukocyte count and neutrophil-lymphocyte ratio (NLR) are established inflammatory markers that have gained attention as potential indicators of surgical outcomes, particularly in predicting postoperative morbidity and LOS in various surgical populations, including cholecystectomy patients [7]. An elevated leukocyte count and high NLR reflect a heightened inflammatory response, which may be associated with worse surgical outcomes and prolonged recovery. Elevated NLR has also been associated with increased complication rates in patients undergoing abdominal surgeries, making it a useful marker for assessing patient risk preoperatively [8]. Although some of these factors have been individually linked to prolonged LOS, there is limited research examining the collective impact of these variables on hospital stay in cholecystectomy patients, especially in a unified multivariate model. The findings from such an analysis could be pivotal in developing targeted preoperative assessments and interventions that mitigate the risk of extended hospitalization. For example, identifying patients with elevated NLR or advanced age might allow healthcare providers to implement preventive strategies such as enhanced recovery protocols, optimized perioperative monitoring, and early discharge planning to minimize LOS [9,10]. This study hypothesizes that specific demographic and clinical variables—such as advanced age, male gender, elevated preoperative leukocyte count, high NLR, and emergency admission—are associated with a greater likelihood of prolonged LOS among cholecystectomy patients.

METHODS

This prospective observational study was conducted at the various surgical units of the inpatient Department of Surgery, Dhaka Medical College Hospital, Dhaka, from July 2018 to June 2019. Data were collected through a pre-designed data sheet. Patients with cholecystitis attending in the outdoor or emergency, admitted with cholecystitis in Dhaka Medical College Hospital, Dhaka were considered as the study population. A total of 50 patients were selected as study subjects by purposive sampling technique. Eligible participants were explained the study procedures in detail and written informed consent was obtained from all patients. Data analysis was conducted by descriptive and analytical techniques including mean, SD, frequency distribution, computation of percentage, etc. The continuous variables were compared using independent t-tests while the categorical variables were compared using the chi-square test. The logistic regression model was used for multivariate analyses. Statistical Package for Social Science (SPSS) version 21 for Windows was used to analyze the data. A p-value < 0.05 was considered to be significant. Before starting this study, the research protocol was submitted and approved by the Institutional Review Board of Dhaka Medical College and Hospital, Dhaka.

Inclusion criteria:

- Patients with symptomatic cholecystitis.
- Patients above the age of 18 years

Exclusion criteria:

- Minor patient (Below 18 years)
- Patients with associated other conditions e.g. acute pancreatitis and patients with malignancy confirmed on histopathology.

RESULTS

Table 1: Distribution of the patients by age (N=50)

Age in years	Simple Cholecystitis	Severe Cholecystitis	Total
<18	0	0 (0%)	0 (0%)
18-28	6 (12%)	0 (0%)	6 (12%)
28-38	13 (26%)	2 (4%)	15 (30%)
38-48	9 (18%)	1 (2%)	10 (20%)
48-58	8 (16%)	3 (6%)	11 (22%)
>58	5 (10%)	3 (6%)	8 (16%)
Total	41 (82%)	9 (18%)	50 (100%)

Out of 50 respondents, near about one-third (30%) of the patients were in the age group of 28-38 years of age, 22% were in the age group of 48-58 years and 20% of the patients were in the age group of 38-48 years (Table 1). The age of the patients ranged from 18 years to 67 years with a mean of 53.45±16.073 years.

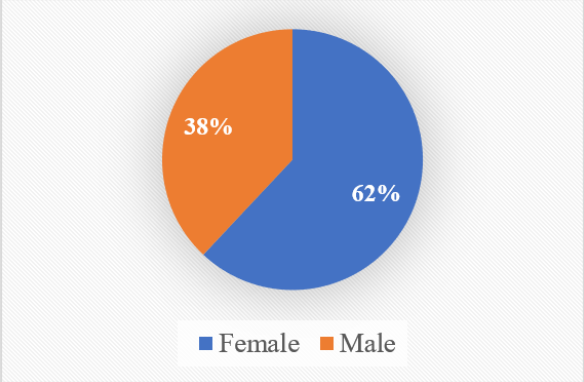

Fig 1: Distribution of the patients by sex (N=50)

Among a total of 50 patients, nearly two-thirds (31, 62%) were females and the rest one-third (19, 38%) were males (Fig 1).

Table 2: Category of the respondents according to preoperative characteristics (N=50)

Attributes	Total (N=50)	NLR<3 (n=41)	NLR ≥3 (n=9)	p-value
Admission route				
ED	16 (32%)	8 (19.5%)	8 (88.9%)	<0.002
OPD	34 (68%)	33 (80.5%)	1 (11.1%)	
Symptoms				
Abdominal Pain	46 (92%)	37 (90.2%)	9 (100%)	
Discomfort	8 (16%)	6 (14.6%)	2 (22.2%)	
Nausea/ Vomiting	19 (38%)	13 (31.7%)	6 (66.7%)	0.004
Fever	31 (62%)	28 (68.3%)	3 (33.3%)	
Others	20 (40%)	11 (26.8%)	9 (100%)	
Serum Leukocyte	7700 (1800039300)	6200 (270016500)	13500 (160039300)	<0.004

Among the 50 respondents, the majority (34, 68%) of the respondents got admitted through our patient, and the rest 16 (32%) were admitted through the emergency department. The majority (46, 92%) of the respondents had abdominal pain, 19 (38%) had nausea/ vomiting, 8 (16%) had discomfort,31 had fever (62%) 20 (40%) had others. The serum leukocyte count ranged from 18000-39300 and the mean serum leukocyte count was 7700/mm^3 with a significant difference between the mean serum leukocyte count of the two groups of respondents (P <0.004). The mean serum leukocyte count was higher among the group of respondents with NLR ≥3 (13500/mm^3) than the group of respondents with NLR<3 (6200/mm^3) (Table 2).

Table 3: Odds ratio for increased length of hospital stay (≥6 days) associated with clinical variables in patients undergoing cholecystectomy (N=50)

Attributes	Odds Ratio	95% CI	P value	Odds Ratio	95% CI	P value
Age						
<50 years ≥ 50 years	2.453	1.542 – 3.870	< 0.002	2.212	1.372 – 3.530	< 0.002
Sex						
Woman Man	1.408	1.026 – 2.095	0.026	-	-	-
Leukocyte Count/ mm3						
<10,000 ≥10,000	1.828	1.207 – 2.744	0.002	-	-	-
NLR						
<3 ≥3	2.382	1.596 – 3.533	< 0.002	1.776	1.146 – 2.725	0.004
Route of Admission						
OPD ED	2.072	1385 – 3.078	< 0.002	1.664	1.070 – 2.560	0.008

The median LOS was 5.0 days (range, 1–21 days), and the 80th percentile of LOS was 6 days. The patients were then divided as either control (LOS <6 days) or those with prolonged LOS (≥6 days). Univariate and multivariate analyses were conducted to identify the factors associated with prolonged LOS. On univariate analysis, patient age (p <0.002), male gender (p =0.026), preoperative leukocyte count (p =0.002), preoperative NLR (p <0.002), and admission via the ED (p <0.002) were all associated with prolonged LOS. A subsequent multivariate analysis identified that patients aged≥50 years (OR 2.212, 95% CI 1.372 – 3.530, p <0.002), preoperative NLR ≥3.0 (OR 1.776, 95% CI 1.146–2.725, p =0.004) and admission via the ED (OR 1.664, 95% CI 1.070–2.560, p =0.008) were independent factors associated with prolonged LOS (Table 3).

DISCUSSION

In this study, out of 50 respondents, nearly about one-third (30%) of the patients were in the age group of 28-38 years of age, 22% were in the age group of 48-58 years and 20% of the patients were in the age group of 38-48 years. The age of the patients ranged from 18 years to 67 years which corresponds to the findings of two retrospective cohort studies [11,12] which revealed that the age of the patients ranged from 17 years to 91 years [12] and 13 years to 91 years [11]. The mean age of the patients was 53.45 ± 16.073 years which corresponds to the findings of a hospital-based observational study [13], a non-randomized, prospective study [14], and another retrospective cohort study [11] which revealed that the mean age of the patients was 38.85 years [13], 53.41±14.14 years [14], 55.18 years [11]. Among a total of 50 patients, nearly two-thirds (31, 62%) were females and the rest one-third (19, 38%) were males which corresponds to the findings of a hospital-based observational study [13], two retrospective cohort studies [11,12] and a non-randomized, prospective study [14] which revealed that men to women ratio was 8.5: 91.5 [13], 58.2: 41.8 [12], 58.1: 41.9 [14] and 47: 53 [11]. The majority (34, 68%) of the respondents were admitted through outpatient and the rest 16 (32%) were admitted through the emergency department which corresponds to the findings of another retrospective cohort study [11] which revealed that 55.7% of the respondents got admitted through outpatient and the rest 44.3%) was admitted through emergency department [11]. Among the 50 respondents, the majority (46, 92%) of the respondents had abdominal pain, 19 (38%) had nausea/ vomiting, 8 (16%) had discomfort, and 20 (40%) had others. The serum leukocyte count ranged from 18000-39300 and the mean serum leukocyte count was 7700/mm^3 with a significant difference between the mean serum leukocyte count of the two groups of respondents (P <0.004). The mean serum leukocyte count was higher among the group of respondents with NLR ≥3 (13500/mm^3) than the group of respondents with NLR<3 (6200/mm^3) which corresponds to the findings of a hospital-based observational study [13] and another retrospective cohort study [11] which revealed that the percentage of abdominal pain of the respondents was 95.7% [13] and 92.7% [11], the percentage of indigestion of the respondents were 48.9% [13] and 4% [11], the percentage of fever of the respondents was 2.1% [13] and 1.1% [11] respectively. A hospital-based observational study [13] also found that 4.3% had nausea, and 14.9% had vomiting [13]. Overall, the median LOS was 5.0 days (range, 1–21 days), and the 80th percentile of LOS was 6 days. Then the patients were divided into either control (LOS <6 days) or those with prolonged LOS (≥6 days). Univariate and multivariate analyses were conducted to identify the factors associated with prolonged LOS. On univariate analysis, patient age (p <0.002), male gender (p =0.026), preoperative leukocyte count (p =0.002), preoperative NLR (p <0.002), and admission via the ED (p <0.002) were all associated with prolonged LOS. A subsequent multivariate analysis identified that patient age ≥50 years (OR 2.212, 95% CI 1.372 – 3.530, p <0.002), preoperative NLR ≥3.0 (OR 1.776, 95% CI 1.146–2.725, p =0.004), and admission via the ED (OR 1.664, 95% CI 1.070–2.560, p =0.008) were independent factors associated with prolonged LOS which corresponds to the findings of another retrospective cohort study which revealed that on univariate analysis, patient age (p <0.001), male gender (p =0.036), preoperative leukocyte count (p =0.001), preoperative NLR (p <0.001), and admission via the ED (p <0.001) were all associated with prolonged LOS [11]. A subsequent multivariate analysis identified that patient age ≥50 years (OR 2.321, 95%CI 1.47–3.630, p <0.001), preoperative NLR ≥3.0 (OR 1.876, 95% CI 1.246–2.825, p =0.003), and admission via the ED (OR 1.764, 95% CI 1.170–2.660, p =0.007) were independent factors associated with prolonged LOS.

Limitations of The Study

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community.

CONCLUSION

This study identifies key independent predictors of extended hospitalization (≥6 days) following cholecystectomy, highlighting the roles of advanced age (≥50 years), elevated neutrophil-lymphocyte ratio (NLR ≥3), and admission through the emergency department (ED). Through multivariate analysis, these factors were shown to significantly increase the odds of prolonged length of stay, underscoring the need for targeted preoperative risk assessment and management strategies.

RECOMMENDATION

To reduce extended hospitalization following cholecystectomy, it is recommended that clinicians incorporate age, NLR, and route of admission into preoperative assessments. For patients aged 50 years or older, those with elevated NLR, and those admitted

through the ED, enhanced preoperative planning and closer postoperative monitoring should be considered. Tailored interventions, such as optimizing preoperative health, improving perioperative management, and expediting discharge planning for at-risk individuals, could help reduce the length of stay and improve surgical outcomes.

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REFERENCES

1. Keus, F., de Jong, J., Gooszen, H. G., Laarhoven, C. J., & Cochrane Hepato-Biliary Group. (1996). Laparoscopic versus open cholecystectomy for patients with symptomatic cholecystolithiasis. *Cochrane database of systematic reviews*, *2010*(1).
2. Kendrick, M. L., & Cusati, D. (2010). Total laparoscopic pancreaticoduodenectomy: feasibility and outcome in an early experience. *Archives of surgery*, *145*(1), 19-23.
3. Chow, W. B., Rosenthal, R. A., Merkow, R. P., Ko, C. Y., & Esnaola, N. F. (2012). Optimal preoperative assessment of the geriatric surgical patient: a best practices guideline from the American College of Surgeons National Surgical Quality Improvement Program and the American Geriatrics Society. *Journal of the American College of Surgeons*, *215*(4), 453-466.
4. Bingener, J. (2009). Evidence-Based Practice: Acute Cholecystitis. *Acute Care Surgery and Trauma*, 368.
5. Stey, A. M., Russell, M. M., Ko, C. Y., Sacks, G. D., Dawes, A. J., & Gibbons, M. M. (2015). Clinical registries and quality measurement in surgery: a systematic review. *Surgery*, *157*(2), 381-395.
6. Giger, U. F., Michel, J. M., Opitz, I., Inderbitzin, D. T., Kocher, T., Krähenbühl, L., ... & Group, T. S. S. S. (2006). Risk factors for perioperative complications in patients undergoing laparoscopic cholecystectomy: analysis of 22,953 consecutive cases from the Swiss Association of Laparoscopic and Thoracoscopic Surgery database. *Journal of the American College of Surgeons*, *203*(5), 723-728.
7. Forget, P., Machiels, J. P., Coulie, P. G., Berliere, M., Poncelet, A. J., Tombal, B., ... & De Kock, M. (2013). Neutrophil: lymphocyte ratio and intraoperative use of ketorolac or diclofenac are prognostic factors in different cohorts of patients undergoing breast, lung, and kidney cancer surgery. *Annals of surgical oncology*, *20*, 650-660.
8. Azab, B., Jaglall, N., Atallah, J. P., Lamet, A., Raja-Surya, V., Farah, B., ... & Widmann, W. D. (2011). Neutrophil-lymphocyte ratio as a predictor of adverse outcomes of acute pancreatitis. *Pancreatology*, *11*(4), 445-452.
9. Kehlet, H., & Wilmore, D. W. (2008). Evidence-based surgical care and the evolution of fast-track surgery. *Annals of surgery*, *248*(2), 189-198.
10. Ljungqvist, O., Scott, M., & Fearon, K. C. (2017). Enhanced recovery after surgery: a review. *JAMA surgery*, *152*(3), 292-298.
11. Lee, S. K., Lee, S. C., Park, J. W., & Kim, S. J. (2014). The utility of the preoperative neutrophil-to-lymphocyte ratio in predicting severe cholecystitis: a retrospective cohort study. *BMC surgery*, *14*, 1-7.
12. Beliaev, A. M., Angelo, N., Booth, M., & Bergin, C. (2017). Evaluation of neutrophil-to-lymphocyte ratio as a potential biomarker for acute cholecystitis. *journal of surgical research*, *209*, 93-101.
13. Meena, L., & Saxena, D. M. (2018). Neutrophil to lymphocyte ratio: A new marker for early insight into severity of cholecystitis: an observational study. *J Dent Sci*, *17*(1), 48-51.
14. Micić, D., Stanković, S., Lalić, N., Đukić, V., & Polovina, S. (2018). Prognostic value of preoperative neutrophil-to-lymphocyte ratio for prediction of severe cholecystitis. *Journal of medical biochemistry*, *37*(2), 121.