Research Square

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The Predictive Value of Admission SIRS on Bile Duct Injury Outcome

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Abstract

Background

Bile duct injuries (BDIs) are rare yet critical complications of laparoscopy and laparotomy, carrying a heavy toll on patients' morbidity and increasing mortality risks. Particularly, in patient with systemic inflammation response (SIRS), BDI could rapidly turn into septic shock. This research aims to shed light in the use of assessing the patient's admission SIRS score to predict future major complications in hopes of providing clinician with a simple, effective, and universal triage tools.

Methods

A retrospective cohort study was conducted at Dr. Moewardi General Hospital, Surakarta, involving 65 BDI patients admitted between June 2024 and July 2026. Data were analyzed using Pearson's Chi-square or Fisher's exact tests. The predictive performance of the SIRS score was evaluated using Receiver Operating Characteristic (ROC) curve analysis, with $p < 0.05$ considered statistically significant.

Results

Patients with bile duct injuries were further stratified into SIRS-positive admission group (47.6%, n = 31) and SIRS-negative admission group (52.4%, n = 34). Results revealed a significant positive association between SIRS-positive admission status and major postoperative complications (Clavien-Dindo ≥ IIIa) (RR = 3.84; 95% CI: 1.73–8.52; $p < 0.001$). Positive SIRS demonstrated 77.8% sensitivity and 73.7% specificity in predicting patients who developed major postoperative complications.

Conclusion

This study highlights the importance of assessing admission SIRS in patients with BDI to predict future major complications. Given the accessible nature of SIRS score, we hope that clinicians are able to identify high-risk patients and initiate appropriate management, leading to a better patient outcome.

BACKGROUND

Bile duct injury (BDI) is a rare but critical complication of laparoscopy and open cholecystectomy, with an incidence ranging from 0.5% to 0.85% during laparoscopic procedures [1]. BDI cases yield severe long-term clinical consequences and increase mortality rate of up to 3.5% [2, 3]. Therefore, it is crucial for clinicians to identify and manage BDI patients accordingly in order to achieve optimal outcome.

Recent study found that the development of systemic inflammation response (SIRS) and sepsis in BDI patients is a prominent factor that increases morbidity and mortality. BDI causes bile leakage,

consequently causing intra-abdominal fluid collections often presented as acute abdomen or localized infection. This condition triggers SIRS and could potentially lead to severe sepsis or septic shock [4, 5]. Moreover, secondary biliary peritonitis is a severe prognostic indicator and a strong independent risk factor for mortality [6], similar to the foundational literature of HPB reinforcing the uncontrolled intra-abdominal sepsis as one of the primary factors of surgical failure and death [7, 8].

Considering how briefly a localized bile leak could turn into a life-threatening systemic response, early physiological markers could provide effective risk stratification [9]. Assessing a patient's SIRS status upon admission provides a simple, universally available triage tool. Identifying patients who arrived with elevated SIRS parameters can help clinicians predict the likelihood of severe adverse outcomes, thereby guiding earlier targeted interventions, and ultimately improving survival in patients suffering from major bile duct injuries.

METHODS

Study Design and Patient Selection

This retrospective cohort study was conducted at Dr. Moewardi General Hospital, Indonesia, from June 2024 to June 2026. The study population included all adult patients (≥ 18 years old) presented with BDIs post cholecystectomy. The patient’s diagnosis requires clinical symptoms, laboratory testing, and proven imaging reviewed by a digestive surgeon. We also screened previous medical history by including the ICD-10 coding for bile duct injury diagnosis (S36.13). Patients with pre-existing end-stage liver disease, prior definitive biliary reconstruction at an outside facility, or those with incomplete medical records—specifically missing vital signs or laboratory data within the first 24 hours of admission—were excluded.

Data Extraction and Variable Definitions

Data extraction was performed using a standardized, structured clinical checklist. Extracted data included baseline demographic characteristics, primary surgical details, radiological findings, and admission SIRS score (body temperature, heart rate, respiratory rate, and white blood cell count). Based on these physiological parameters upon admission, patients were stratified into two distinct cohorts: the SIRS-positive group (fulfilling ≥ 2 criteria) and the SIRS-negative group (fulfilling < 2 criteria).

Outcome Assessment and Follow-up

The cohorts were followed through their treatment period and up to 90 days post-intervention to assess clinical trajectories, intervention efficacy, and survival rates. The primary outcome of interest was the incidence of major post-procedural or surgical complications, strictly defined as Grade IIIa or higher (≥ IIIa) according to the Clavien-Dindo classification system (indicating complications requiring surgical, endoscopic, or radiological intervention), alongside overall 90-day mortality.

Statistical Analysis

All statistical analyses were performed using SPSS software version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were utilized to summarize patient baseline characteristics; continuous variables were presented as means with standard deviations (SD), while categorical variables were reported as frequencies and percentages. We conducted Pearson Chi-square test, or Fisher's exact test ($n < 5$) to find the association between admission SIRS status and the incidence of major clinical outcomes (Clavien-Dindo ≥ IIIa). Furthermore, the predictive performance and discriminative ability of the SIRS score were assessed using Receiver Operating Characteristic (ROC) curve analysis by calculating the Area Under the Curve (AUC). A two-sided *p*-value of < 0.05 was considered a statistical significance.

RESULTS

Baseline Patient Characteristics

A total of 65 patients with bile duct injuries were included, comprising 34 patients in the SIRS-negative cohort and 31 patients in the SIRS-positive cohort. Females accounted for 55.4% of the cohort (n = 36). The mean overall age was 45.53 ± 12.67 years in the SIRS-negative group vs. 48.06 ± 13.76 in the SIRS-positive group. The majority of subjects are normoweight (56.9%), followed by overweight (23.1%) and obese (20.0%) individuals. The anatomical severity of the bile duct injuries varied according to the Strasberg classification. Type A (n = 17) and type E1 (n = 20) are the most common types in the overall population.

Association Between Admission SIRS and Major Complications

Bivariate analysis (Table 2) revealed a significant association between positive admission SIRS status and major postoperative complications (Clavien-Dindo≥IIIa). Major complications occurred in 67.7% (n = 21) of SIRS-positive cohort and 17.6% (n = 6) in the SIRS-negative cohort. Patient admitted with a positive SIRS status had a 3.84 times higher risk of developing major post-procedural complications compared to those without SIRS (RR = 3.84; 95% CI: 1.73–8.52; $p < 0.001$).

Table 1
Baseline Demographic and Clinical Characteristics of Patients

Variable	Admission SIRS		p-value
	Negative (n = 34)	Positive (n = 31)	
Age	45.53 ± 12.67	48.06 ± 13.76	0.442
Gender			
Male	13 (38.2%)	16 (51.6%)	0.279
Female	21 (61.8%)	15 (48.4%)	
BMI			
Normoweight	24 (70.6%)	13 (41.9%)	0.039
Overweight	4 (11.8%)	11 (35.5%)	
Obese	6 (17.6%)	7 (22.6%)	
Strasberg			
A	8 (23.5%)	9 (29.0%)	0.933
B	1 (2.9%)	1 (3.2%)	
C	1 (2.9%)	0 (0.0%)	
D	5 (14.7%)	4 (12.9%)	
E1	10 (29.4%)	10 (32.3%)	
E2	5 (14.7%)	2 (6.5%)	
E3	1 (2.9%)	1 (3.2%)	
E4	2 (5.9%)	1 (3.2%)	
E5	1 (2.9%)	3 (9.7%)	

Table 2
Association Between Admission SIRS Status and the Incidence of Major Postoperative Complications (Clavien-Dindo ≥ IIIa).

Admission SIRS	Major Complications (n = 27)	Minor Complications: (n = 38)	Relative Risk (95% CI)	*p*-value
Positive	21 (67.7%)	10 (32.3%)	3.84 (1.73–8.52)	< 0.001
Negative	6 (17.6%)	28 (82.4%)	1.00 (Reference)	

Predictive Performance of the SIRS Score (ROC Curve Analysis)

To assess the diagnostic accuracy and predictive performance of admission SIRS status for major clinical outcomes, a Receiver Operating Characteristic (ROC) curve analysis was conducted (Fig. 1). The analysis yielded an Area Under the Curve (AUC) of 0.820 (95% CI: 0.720–0.920, Std. Error = 0.051, $p < 0.001$). At the clinical decision cutoff (≥ 1.5000), positive admission SIRS demonstrated a sensitivity of 77.8% and a specificity of 73.7% (1 - Specificity = 0.263) in predicting patients who developed major postoperative complications.

DISCUSSION

Results from this study highlight the strengths of admission SIRS status as a predictor of major post-procedural complications in post cholecystectomy BDI patients. Cohort with a positive SIRS score demonstrated a 67.7% complication rate and a 3.84 times higher risk of major adverse. Furthermore, ROC curve analysis confirmed the good distinguishing performance of admission in identifying high-risk patients.

These findings align with existing literature emphasizing the impact of uncontrolled systemic inflammation and sepsis on surgical outcomes. Previous studies have highlighted the prognostic value of SIRS in similar contexts. Qiu et al. [10] reported that for predicting sepsis and predicting 7, 10, and 14-day mortality, SIRS demonstrated a high sensitivity (0.85 and 0.87 respectively), albeit a lower specificity of 0.41. Similarly, in cases of acute hepatobiliary infection, Mak et al. [11] found that SIRS possesses a sensitivity of 60% and 62.5% for predicting High Dependency Unit (HDU) and Intensive Care Unit (ICU) admissions, respectively.

The underlying pathway creating these severe outcomes is directly linked to the nature of extravasated bile [12]. Undetected segmental or sectoral duct injuries often lead to a complex postoperative course exacerbated by biliary peritonitis, sepsis, or secondary vascular complications [13]. Bile acts as a potent chemical irritant, prompting peritonitis due to tissue injury accompanied by inflammatory cascades [14, 15]. This process involves the cytokines (neutrophils and monocytes), chemokines, and adhesion molecules, causing vasodilation, and fluid sequestration [13]. If diagnosis or surgical intervention is delayed, this could induce bacterial superinfection, septic shock, and multi-organ failure escalating mortality rate substantially from 8% to 40% [15, 16]. An uncontrolled bile leak or ongoing sepsis creates a highly unfavorable environment for surgical repair, making biliary anastomosis difficult to perform and compromises healing; even after aggressive management, ongoing sepsis subjects patients to fibrosis and late anastomotic strictures [17]. Jain et al. [18] observed that all instances of mortality (2.34%) in a cohort of 128 BDI patients, occurred exclusively in patients who developed sepsis and organ failure. Therefore, timely intervention in cases of sepsis and biliary peritonitis is critical to improve clinical outcomes and reducing mortality [15, 18, 19].

From a clinical perspective, these results highlight the function of admission SIRS as a practical, rapid, and cost-effective triage tool. Because the physiological parameters required to calculate the SIRS score—body temperature, heart rate, respiratory rate, and white blood cell count—are routinely and universally collected upon patients' arrival, clinicians can immediately stratify patients by risk without relying on complex or expensive biomarker assays [20]. Identifying a SIRS-positive patient could suggest surgeons to shift towards more urgent and aggressive management strategies, including prioritizing early source control, broad-spectrum antibiotics, and adequate fluid resuscitation to stabilize hemodynamics before conducting definitive reconstructive surgery.

CONCLUSION

In conclusion, this study demonstrates that assessing admission SIRS in patients with bile duct injuries serves as a valuable, simple, and rapid prognostic tool for predicting major postoperative complications (Clavien-Dindo ≥ IIIa). Given that SIRS criteria are universally available and cost-effective, integrating this assessment into initial triage protocols allows clinicians to promptly identify high-risk patients and initiate timely sepsis control prior to definitive surgical reconstruction.

LIMITATION AND CONSIDERATION FOR FUTURE RESEARCH

This study has several limitations, including a single-center retrospective design and small sample size (n = 65), which restricts statistical power and prevents adjustment for clinical confounders. Additionally, the short 90-day follow-up excludes the evaluation of long-term complications.

To address these gaps, future large-scale, multi-center prospective studies are needed to validate the admission SIRS score. Additionally, comparing the prognostic performance of SIRS with other severity scores (e.g., qSOFA) and inflammatory biomarkers (e.g., procalcitonin, C-reactive protein) is highly recommended to further optimize risk stratification algorithms for patients with acute bile duct injuries.

Abbreviations

AUC
Area Under the Curve
BDI
Bile Duct Injury
HDU
High Dependency Unit
HPB
Hepato-Pancreato Biliary
ICD
International Classification of Disease

ICU
Intensive Care Unit
OR
Odds Ratio
ROC
Receiver Operating Characteristics
RR
Relative Risks
SIRS
Systemic Inflammation Response Syndrome
SPSS
Statistical Package for the Social Sciences
qSOFA
quick Sepsis-related Organ Failure Assessment

Declarations

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

CONSENT FOR PUBLICATION

Not applicable

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study protocol was formally reviewed and approved by the Institutional Ethics Committee of Dr. Moewardi General Hospital (Protocol Number: 1.207/VII/HREC/2026). Given the retrospective nature of the observational design, the requirement for written informed patient consent was waived by the ethics committee, in accordance with standard ethical guidelines for retrospective data analysis.

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Author Contribution

ANN : Conception and design of study, Writing the manuscript, Analysis and/or interpretation of dataBIB : Conception and design of study, Revising the manuscriptMAFA : Analysis and/or interpretation of data, Drafting the manuscript, Acquisition of dataSRAM : Analysis and/or interpretation of data, Acquisition of data

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AVAILABILITY OF DATA AND MATERIALS

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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Figures

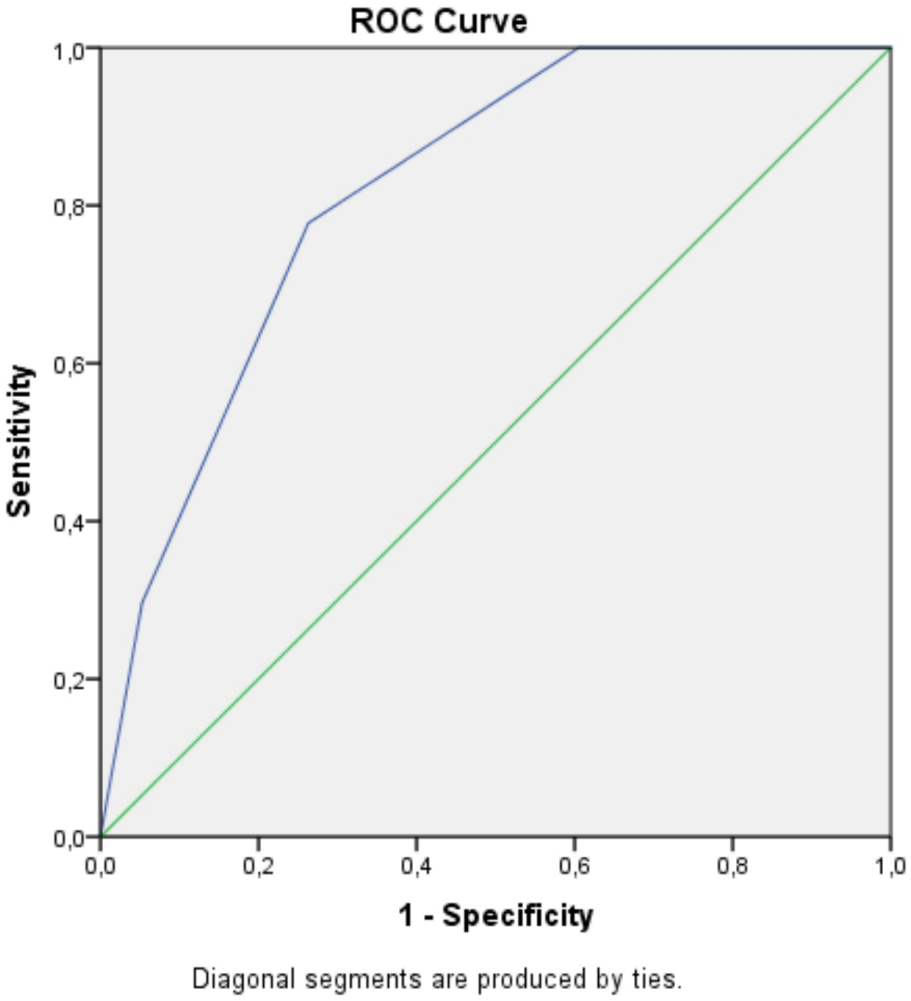


Figure 1

Receiver Operating Characteristic (ROC) Curve Demonstrating the Predictive Accuracy of Admission SIRS Score for Major Complications