Biological and Clinical Sciences Research Journal
eISSN: 2708-2261; pISSN: 2958-4728
www.bcsrj.com
DOI: https://doi.org/10.54112/bcsrj.v2024i1.1064
*Biol. Clin. Sci. Res. J., Volume, **2024**: 1064*
Original Research Article

DIAGNOSTIC ACCURACY OF BOEY SCORE TO PREDICT 30 DAYS MORTALITY IN PERFORATED PEPTIC ULCER PATIENTS

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(Received, 10th July 2024, Revised 09th September 2024, Published 20th September 2024)

Abstract: *Perforated peptic ulcers remain a life-threatening condition despite advancements in surgical and medical treatments. Accurate risk stratification of patients can improve outcomes by guiding clinical decision-making. The Boey scoring system is widely used for predicting mortality in patients with perforated peptic ulcers, yet its diagnostic accuracy warrants further evaluation.* ***Objective:*** *This study aimed to evaluate the diagnostic accuracy of the Boey score in predicting 30-day mortality among patients with perforated peptic ulcers.* ***Methods:*** *This cross-sectional study was conducted at the Department of Surgical Unit VI, Civil Hospital Karachi, over a six-month period from December 7, 2020, to June 7, 2021. A total of 149 patients diagnosed with perforated peptic ulcers were included using non-probability consecutive sampling. The Boey score was calculated for each patient based on preoperative shock, comorbid illness, and duration of perforation >24 hours. The primary outcome measure was 30-day mortality. Descriptive statistics were used to assess the frequency distribution of mortality, and the association between Boey score and mortality was analysed using appropriate statistical methods, with significance set at $p < 0.05$.* ***Results:*** *The study included 149 patients, with a minimum age of 21 and a maximum age of 50. Of the total, 32 patients (21.5%) experienced 30-day mortality. Among patients with a Boey score of 1, 2.68% had 30-day mortality, and 0.67% of patients with a Boey score of 2 died. Patients with a Boey score of 3 had the highest mortality rate, with 18.1% of this group experiencing 30-day mortality. In contrast, 81.9% of patients with a Boey score of 1 to 3 survived beyond 30 days.* ***Conclusion:*** *The Boey scoring system demonstrated vital predictive accuracy for 30-day mortality in patients with perforated peptic ulcers. This scoring tool effectively identifies high-risk patients, allowing for timely and appropriate management. Despite modern treatment advances, perforated peptic ulcer remains associated with significant mortality, particularly in high-risk patients, as identified by the Boey score.*

Keywords: Boey Score; Mortality Prediction; Perforated Peptic Ulcer; Risk Stratification; Surgical Outcomes; Peritonitis; 30-Day Mortality

Introduction

Perforated peptic ulcers are a typical surgical emergency faced by General Surgeons. They are known to be associated with short-term mortality in about 30% of patients and morbidity in up to 50% (1). A perforated peptic ulcer manifests as an acute abdominal condition characterised by either localised or generalised peritonitis and carries a significant risk of progressing to sepsis and eventual mortality. Early diagnosis benefits patients; however, clinical signs can be obscured in older adults or immunocompromised patients, resulting in a delay in diagnosis. Risk factors for ulcers include helicobacter pylori, non-steroidal anti-inflammatory drugs, and smoking. When predicting complications and mortality, notable indicators include delayed treatment after perforation, geriatric population, presence of hypotension, tachycardia, low urine output, and leukocyte counts reaching the upper limit and dropping lower limits on admission. (2-7). A delay of more than 24 hours escalates the risk of mortality by seven to eightfold and the complication rate by threefold. (8).

In cases of general peritonitis, it is crucial not to postpone surgical repair, as each passing hour of delay increases the mortality risk. Peptic ulcer disease can lead to complications like perforation, bleeding, and obstruction. (9, 10). However, bleeding is far more common than perforation, but its frequency is (about 1:6 ratio) and has become an indication for emergency surgery. The prevalence of perforated peptic ulcers is approximately 45% (11). In a study conducted by Makela JT et al., overall 30-day mortality was 9% (n = 13:11 with sepsis, 1 with acute myocardial infarction, and 1 with acute hepatic failure) (12). Various scoring systems are now being introduced to predict mortality in PPU patients.

In 1987, Boey Factor et al. introduced the scoring system, which incorporates three independent risk factors: the duration of perforation, co-morbid diseases, and preoperative shock. This scoring system's simplicity and ease of emergency implementation make it highly valuable. The Boey score is predictive; the Boey scoring system can be considered a simple and appropriate prognostic marker in managing PPU patients. In patients with perforated peptic ulcers, the Boey score is a valuable tool to predict the outcomes, with a sensitivity of 64.3 % and specificity of 94.4% (11).

A study conducted in India aimed to evaluate the accuracy of the Boey scoring system in predicting postoperative morbidity and mortality in patients who underwent surgery

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for peptic perforation. The study revealed an overall postoperative mortality rate of 13.9%. Among the 25 patients who did not survive, 17 succumbed to septicemia and subsequent multi-organ failure, while six patients passed away following the leak and its complications. Additionally, one patient had acute myocardial infarction, and another patient did not survive due to respiratory complications during the postoperative period (13).

Another study conducted in 2016 at Safdarjung Hospital in New Delhi, India, by the Department of Surgery concluded that the Boey score is a simple and precise predictor of the post-operative status of patients with perforated peptic ulcer patients. Preoperative prediction using the Boey score significantly reduces mortality and morbidity rates, provided that timely and aggressive management is undertaken for high-risk patients. The mortality rate increased progressively with higher Boey scores: 1%, 8%, 33%, and 38% for 0, 1, 2, and 3 scores, respectively (p\0.001) (14).

This study aims to assess the significance of the Boey score and its applicability of the Boey score in predicting mortality among patients with perforated peptic ulcer disease. As there are variations in the overall population, understanding the predictive accuracy of the Boey score in our setting will affect the management strategy and will ultimately enhance the overall outcomes of patients who arrive at the Emergency Department with peritonitis resulting from a perforated peptic ulcer. Many research studies have been done worldwide to determine the predictive value of the Boey score. International data reveals a direct correlation between increasing Boey scores and rising mortality rates: 1%, 8%, 33%, and 38% for 0, 1, 2, and 3 scores, respectively. However, locally, there is a notable scarcity of such data available. Therefore, conducting this study within our hospital is essential to investigate the statistical patterns and mortality rates among peptic ulcer patients, leading to improved categorisation and tailored management strategies for these individuals.

Methodology

This cross-sectional study was conducted at the Department of Surgical Unit VI, Civil Hospital Karachi, over six months, from December 7, 2020, to June 7, 2021. The College of Physicians and Surgeons Pakistan (CPSP) granted ethical approval for the study. Non-probability consecutive sampling was utilised for participant selection.

The sample size was determined using the WHO sample size calculator, based on a literature-reported mortality prevalence of 27% in patients with perforated peptic ulcer (PPU) disease, a sensitivity of the Boey score of 64%, and a specificity of 94.4%. The confidence interval was 95%, with a margin of error of 15%. This resulted in a total sample size of 149 participants.

Eligible participants included all patients aged between 30 and 60 years, of either gender, presenting with acute peritonitis within 24 hours of symptom onset. Patients with peptic ulcer perforation confirmed on surgical exploration and classified as ASA II-V (American Society of Anesthesiologists Physical Status Classification) were included. Exclusion criteria included patients who did not provide consent, pregnant patients, individuals with perforation due to trauma or gunshot wounds, and those with ASA I (regular healthy patients) or ASA VI (brain-dead patients) scores, as these categories are not candidates for surgical management.

Following ethical approval and informed written consent, eligible participants were enrolled. Data were collected at the Surgical Unit VI of Civil Hospital Karachi (CHK) from patients admitted through the Emergency Department who met the inclusion criteria. A structured questionnaire was completed within 24 hours of surgical management to capture demographic, clinical, and personal health information, ensuring accuracy and comprehensiveness in the data collection process.

Stratification was performed based on potential effect modifiers, including age, gender, duration of symptoms, BMI, diabetes status, hypertension, shock, and site and size of perforation. Post-stratification diagnostic accuracy, sensitivity, specificity, PPV, and NPV were also calculated to assess the performance of the Boey score across different subgroups.

Data analysis was performed using SPSS software version 22. Descriptive statistics were computed, including means and standard deviations for continuous variables such as age, Boey score, duration of symptoms, and body mass index (BMI). Categorical variables, including gender, presence of diabetes, hypertension, and shock, were analysed using frequencies and percentages. Diagnostic accuracy, including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy, was calculated for the Boey score, using 30-day mortality as the reference standard.

Results

A total of 149 patients admitted to the Department of Surgical Unit VI of Civil Hospital Karachi who met the inclusion and exclusion criteria were included in this study. Out of 149 patients, the minimum age of the patient was 21, while the maximum age of the patients was 50 years. The mean age in our study was 36.08 years, with a standard deviation of ±9.29. Frequency distribution of gender showed that out of 149 patients, 126 (84.6%) were male and 23 (15.4%) were female, respectively. The demographic details are shown below in Table 1.

Out of 149 patients, 86 had Boey score 1, 04 had Boey score 2, and 59 had Boey score 3.

Frequency distribution of 30-day mortality showed that out of 149 patients, 32 (21.5%) and 117 (78.5%) did not have 30-day mortality, respectively. As shown in Figure 1:

Out of 32 mortalities, four patients had a Boey Score of 1, 1 had a Boey Score of 2, and 27 had a Boey Score of 3, respectively.

Table 2 summarises the frequency distribution of crucial patient characteristics. It shows the breakdown of patients by age group, with 50.3% of patients in the 20-35 years group and 49.7% in the 36-50 years group. Additionally, 46.3% of the patients had diabetes mellitus type II, while 53.7% did not. The table also highlights that 47% of patients had hypertension, and 11.4% were classified as obese, with the remaining 88.6% not being obese.

Table 3 provides the frequency distribution of the patients' duration of perforation and shock status. The most common perforation duration was 24 hours (32.25%), followed by 48 hours (26.17%) and 72 hours (22.82%). For shock status,

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35.6% of patients were in shock class I, 30.2% in class II, 26.8% in class III, and 7.4% in class IV, indicating the severity of shock in these patients.

Out of 149 patients, the sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy of a Boey score of 3 for predicting mortality were found to be 71.8%, 96.5%, 85.1%, 92.6%, and 91.2%, respectively (Table 4, 5).

Table 6 summarises the stratification of sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy for predicting mortality using Boey score three across different clinical subgroups, including age, gender, diabetes, hypertension, shock status, and obesity.

In terms of age, the 20-35-year-old group had a sensitivity of 76.1%, specificity of 96.2%, and diagnostic accuracy of 90.1%, while the 36-50-year-old group had a lower sensitivity (63.6%) but similar specificity (96.8%), with a diagnostic accuracy of 91.8%.

For gender, male patients had higher sensitivity (76.1%) and specificity (98%), with a diagnostic accuracy of 94.4%, compared to females, where sensitivity was 63.6%, specificity was 83.3%, and diagnostic accuracy was 73.9%. Among diabetic patients, sensitivity was 76.1%, and specificity was 95.8%, with an accuracy of 89.8%. In nondiabetic patients, sensitivity was lower, at 63.6%, but specificity was higher (97.1%), with an accuracy of 92.5%.

For hypertensive patients, sensitivity was 76.1%, and specificity was 95.9%, with an accuracy of 90%. In non-hypertensive patients, sensitivity was 63.6%, and specificity was 97%, with an accuracy of 92.4%.

Regarding shock status, sensitivity was 71.4% in shock class I and 87.5% in class IV, while diagnostic accuracy was highest in class I (94.3%) and lowest in class IV (81.8%).

Finally, in obese patients, sensitivity was 63.6%, specificity was 66.6%, and diagnostic accuracy was 64.7%, whereas in non-obese patients, sensitivity was 76.1%, specificity was 98.1%, and diagnostic accuracy was 94.6%. Boey scored three in performing better in non-obese, younger, and male patients and those with diabetes and less severe shock.

Table 1: Demographic Characteristics of the Patients

Variable	Mean+/- SD	Standard deviation	Min-max
Age (years)	36.08	±9.29	21-50
Duration of symptoms (hours)	38.71	± 22.49	6-72
Boey score	1.81	±0.97	1-3
BMI (kg/m2)	22.2	± 2.87	14.6-26
Height (cm)	146.5	± 10.41	138-162
Weight (kg)	63.5	± 7.34	45-75

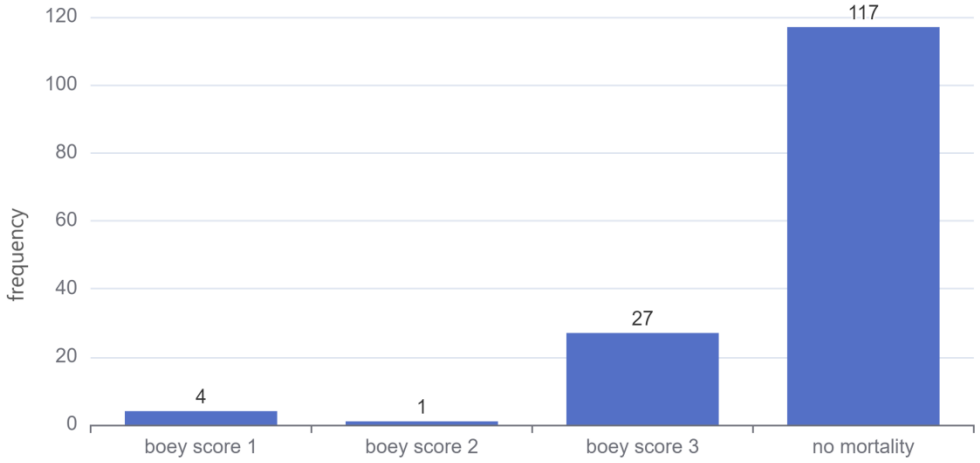

Figure 1: Frequency Distribution of 30-Day Mortality Based on Boey Score

Table 2: Frequency Distribution of Patient Characteristics

Characteristic	Category	Frequency (n=149)	Percentage (%)
Age Group (years)	20-35	75	50.3%
	36-50	74	49.7%
Diabetes Mellitus Type II	Present	69	46.3%
	Absent	80	53.7%
Hypertension	Present	70	47%
	Absent	79	53%
Obesity Status	Obese	17	11.4%
	Not Obese	132	88.6%

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Table 3: Frequency Distribution of Perforation Duration and Shock Status

Characteristic	Category	Frequency (n=149)	Percentage (%)
Duration of Perforation	6 hours	9	6.04%
	12 hours	19	12.75%
	24 hours	48	32.25%
	48 hours	39	26.17%
	72 hours	34	22.82%
Shock Status	Class I	53	35.6%
	Class II	45	30.2%
	Class III	40	26.8%
	Class IV	11	7.4%

Table 4: Mortality in Boey Score of 3 and 30-Day Mortality Distribution

MORTALITY IN BOEY SCORE OF 3	MORTALITY IN 30 DAYS		TOTAL
	YES	NO	
YES	23 (TP)	4(FP)	27
NO	9(FN)	113(TN)	122
TOTAL	32	117	149

Table 5: Predictive Values for Mortality with Boey Score 3

VARIABLES	FORMULA	PREDICTION OF MORTALITY WITH BOEY SCORE 3 (%)
SENSITIVITY	TP/TP + FN X100	71.8%
SPECIFICITY	TN/TN+FP X100	96.5%
POSITIVE PREDICTED VALUE	TP/TP+FPX100	85.1%
NEGATIVE PREDICTED VALUE	TN/FN+TNX100	92.6%
DIAGNOSTIC ACCURACY	TP+TN/TOTAL PATIENTS X100	91.2%

Table 6: Stratification of Sensitivity, Specificity, PPV, NPV, and Diagnostic Accuracy of Boey Score 3 for Mortality Prediction

Category	TP	FP	FN	TN	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Diagnostic Accuracy (%)
Age 20-35 years	16	2	5	52	76.1%	96.2%	88.8%	91.2%	90.1%
Age 36-50 years	7	2	4	61	63.6%	96.8%	77.7%	93.8%	91.8%
Male	16	2	5	103	76.1%	98%	88.8%	95.3%	94.4%
Female	7	2	4	10	63.6%	83.3%	77.7%	66.6%	73.9%
Diabetes (Yes)	16	2	5	46	76.1%	95.8%	88.8%	90.1%	89.8%
Diabetes (No)	7	2	4	67	63.6%	97.1%	77.7%	94.3%	92.5%
Hypertension (Yes)	16	2	5	47	76.1%	95.9%	88.8%	92.1%	90%
Hypertension (No)	7	2	4	66	63.6%	97%	77.7%	94.2%	92.4%
Shock Class I	5	1	2	45	71.4%	97.8%	83.3%	95.7%	94.3%
Shock Class II	5	1	3	36	62.5%	97.2%	83.3%	92.3%	91.1%
Shock Class III	6	1	3	30	66.6%	96.7%	85.7%	90.9%	90%
Shock Class IV	7	1	1	2	87.5%	66.6%	87.5%	66.6%	81.8%
Obesity (Yes)	7	2	4	4	63.6%	66.6%	77.7%	50%	64.7%
Obesity (No)	16	2	5	109	76.1%	98.1%	88.8%	95.6%	94.6%

Discussion

The implementation of a standardised, evidence-based in-hospital care protocol has led to a decrease in both mortality and morbidity rates in PPU. However, prioritising individual risk stratification becomes crucial when there are limited ICU and high-dependency unit beds and a high volume of referrals from across the country. Early and accurate identification of patients with increased risk of adverse outcomes is needed to plan and effectively tailor perioperative monitoring and treatment. Therefore, a clinical scoring system capable of accurately predicting adverse outcomes is of paramount significance in a resource-limited setting like ours. Ideally, the scoring system should be easy to calculate, preferably at the bedside and before surgery. Boey's scoring system incorporates three easily assessable parameters: comorbidity, preoperative shock, and duration of peptic ulcer perforation, facilitating swift stratification of critically ill patients. Our study included 149 patients who met the inclusion and exclusion criteria. Mean age, duration of symptoms, Boey score, BMI, height and weight in our study was 36.08±9.29 years, 38.71±22.49 hours, 1.81±0.97, 2.2±2.87 kg/m2, 146.5±10.41 cm and 63.5±7.34 kg. 126 (84.6%) were male

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and 23 (15.4%) were female. For mortality prediction, we found that a Boey score of 3 had a sensitivity of 71.8%, specificity of 96.5%, positive predictive value of 85.1%, negative predictive value of 92.6%, and an overall diagnostic accuracy of 91.2%.

A study conducted in Nepal included 50 cases undergoing emergency surgery for PPU. The 30-day mortality rate was found to be 18%, and postoperative morbidity was recorded in 64% of cases. ROC curve analysis demonstrated that the Boey score had an area under the curve (AUC) of 0.802 for predicting mortality and 0.778 for predicting morbidity. Patients who experienced morbidity and mortality had statistically significantly higher mean ± SD values of the Boey score. Besides the Boey score, the Peptic Ulcer Perforation (PULP) score predicted much better. (15). In another study that included 152 patients, the average age was 52 years (ranging from 15 to 88 years), and 78% of the participants were male. The most common site of PPU was the prepyloric region (74%). The most frequently performed procedure was primary closure and omental graft. The mortality rate was 9%, and the complication rate was 30%. The mortality rate increased progressively with increasing numbers of the Boey score: 1%, 8% (OR=2.4), 33% (OR=3.5), and 38% (OR=7.7) for 0, 1, 2, and 3 scores, respectively ($p<0.001$). The morbidity rates for 0, 1, 2, and 3 Boey scores were 11%, 47% (OR=2.9), 75% (OR=4.3), and 77% (OR=4.9), respectively ($p<0.001$). The study suggested that both Boey scores and ASA classification were superior to the MPI (Mannheim Peritonitis Index) in predicting poor surgical outcomes. (12). According to an Indian study, the mortality rate progressively increased with higher Boey scores: 1.9%, 7.1%, 31.7% and 40% for 0, 1, 2, and 3 scores, respectively ($p<0.001$). The morbidity rates for 0, 1, 2, and 3 Boey scores were 13%, 45.7%, 70.7% and 73.3% respectively ($p<0.001$). Boey score is an effective tool for assessing the prognosis of patients undergoing surgery for peptic perforation. It aids in evaluating both the mortality and morbidity outcomes in these patients. (13).

In a separate study done on 50 patients in 1 year with complaints of acute abdominal pain, with air under the diaphragm, the results demonstrated a progressive increase in Odds ratio and associated mortality of 0%, 13.8%, 27.3%, and 100% with Boey scoring of 0, 1, 2 and 3 respectively, similar to original Boey score. The study observed a progressive increase in Odds ratios calculated for individual morbidity outcomes among the patients included in the study. A sample size of 50 patients showed less significance on the calculated p-value (>0.05) associated with mortality and morbidity. (16) Furthermore, a study by Koirala et al. involved forty-seven patients, with a significant male predominance at a ratio of nearly 4:1.. among the patients, eighteen (38%) had a Boey's score of 1, and seven (15%) had a Boey's score of 3. The overall postoperative mortality rate in this study was 15%, which amounted to 7 patients (17).

A study concluded that the Boey scoring system is a simplified, clinically easy to perform and accurate system to predict morbidity and mortality in patients with peptic ulcer perforations. (18).

Conclusion

The Boey scoring system demonstrated vital predictive accuracy for 30-day mortality in patients with perforated peptic ulcers. This scoring tool effectively identifies high-risk patients, allowing for timely and appropriate management. Despite modern treatment advances, perforated peptic ulcer remains associated with significant mortality, particularly in high-risk patients, as identified by the Boey score.

Declarations

Data Availability statement

All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department concerned. (IRBEC-TCIS986/22)

Consent for publication

Approved

Funding

Not applicable

Conflict of interest

The authors declared the absence of a conflict of interest.

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IQRA ANEES RAJPUT
Study Design, Review of Literature.
NOMAN AHMED KHAN
Conception of Study, Development of Research Methodology Design, Study Design, manuscript Review, and final approval of manuscript.

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