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RESEARCH ARTICLE

Anticipated Morbidities Assessed by NSQIP Surgical Risk Calculator in Patients with Pneumoperitoneum Undergoing Laparotomy

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ABSTRACT

Background: **The American College of Surgery National Surgical Quality Improvement Program (NSQIP) calculator is a tool to assess the risk stratification of a patient undergoing major surgical procedures. We used this calculator to assess morbidities in patients with pneumoperitoneum.**

Method: **A prospective study of patients with pneumoperitoneum undergoing exploratory laparotomy was conducted in the General Surgery Department, Liaquat National Hospital. Surgical risks were calculated preoperatively and were compared with the actual outcomes.**

Results: **The NSQIP surgical risk calculator calculated morbidities in comparison with actual morbidities, which were surgical site infection in 28 (17.8%) vs. 49 (31.2%) patients, urinary tract infection in 26 (16.6%) vs. 4 (2.5%), pneumonia in 28 (17.8%) vs. 24 (15.3%) and cardiac event in 25 (15.9%) vs. 14 (8.9%).**

Conclusion: **The NSQIP surgical risk calculator adequately anticipated morbidities such as SSI, UTI, pneumonia, and cardiac events in comparison with actual morbidities.**

Keywords: Morbidity, peri-operative risk, pneumoperitoneum, surgical risk.

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1. Introduction

The pneumoperitoneum is the presence of free air in the peritoneal cavity as a result of hollow viscus perforation [1]. It is a surgical emergency that accounts for approximately 85% of all cases; the remaining 15% are caused by non-surgical causes in which the gut is intact and there is no visceral content contamination [2]. In this condition, exploratory laparotomy is carried out to confirm the exact cause of pneumoperitoneum and the definitive procedure to stop the leak. Exploration of the abdomen in an emergency setting carries significant risk and needs to be understood beforehand by the clinician, patient, and attendants.

The hospitals' rigorous data-keeping, networking, and resources to improve their risk-adjusted outcomes have resulted in significant improvement in the quality of surgical care and a significant influence on the culture of quality improvement. In this way, hospitals and healthcare providers are continually challenged to improve the care they provide. Hospitals that participate in quality improvement efforts reduce complications and mortality after surgical procedures [3]. When surgeons provide patients with detailed information about their personal risks of overall morbidity and mortality prior to the surgery, making reliable decisions and obtaining informed consent becomes relatively simple [4]. This requires an accurate establishment of risks both before and post-surgery.

Procedure-specific risk calculators were constructed due to a rapidly expanding necessity for impartial appraisal of post-operative consequences such as colectomy, laparotomy, and pancreatectomy-specific calculators that incorporated standardized pre-operative clinical parameters to facilitate physicians in counselling patients regarding procedure-specific post-operative morbidities [5]. The universal risk calculator was created by the American College of Surgeons in 2013, utilizing data from over 1.4 million instances in the NSQIP [6]. The NSQIP is a consumer-friendly, interactive online application

for estimating customizable, patient-specific risks for interventions in practically all surgical specialties [7].

Recent international studies have shown that using NSQIP is largely accurate in predicting post-operative outcomes. However, local research is limited in this tool [8]. So, there is a need to conduct this study to find out the important pre-operative variables that can be used to predict the post-operative morbidity of the patient using an efficient American College of Surgeons NSQIP risk calculator [9].

We conducted a study in which the NSQIP algorithms were used to identify high-risk patients with pneumoperitoneum who underwent laparotomy, and the actual findings were assessed against the results predicted by the NSQIP calculator to fill the gaps in knowledge and to predict post-operative morbidity of the patient after emergency surgery for pneumoperitoneum [10], [11].

This study was done for the thesis, which is the requirement by the College of Physicians and Surgeons, Pakistan, to appear in the postgraduate fellowship exam. It was submitted by the first author of this article and was reviewed by the corresponding author.

2. Method

2.1. Study Design and Settings

This prospective study was conducted in the Department of General Surgery Liaquat National Hospital Karachi from December 28, 2020, to June 28, 2020, after obtaining informed and written consent and approval from the Research Evaluation Unit of the College of Physicians and Surgeon Pakistan. The sample size of 157 patients was calculated using the WHO sample size calculator using morbidity (P) = 7%, the margin of error (d) = 4%, and the 95% confidence interval and non-probability consecutive sampling technique were used.

2.2. Study Population

All patients with signs and symptoms of pneumoperitoneum (14–60 years of age) were included, and all nonemergent cases, gunshot injuries, and elective surgeries were excluded from the study. Patient parameters, as mentioned in the National Surgical Quality Improvement Program (NSQIP), were entered into the surgical risk calculator, including procedure-specific CPT code, age, sex, functional status, ASA class, steroid use for a chronic condition, ascites within 30 days before surgery, ventilator-dependent, disseminated cancer, diabetes, hypertension, dyspnoea, acute renal failure, chronic obstructive pulmonary disease, and BMI which then estimates the chances of unfavourable outcomes.

2.3. Statistical Analysis

SPSS v23.0 was used to analyse data. Means and standard deviations were calculated for age, height, weight, BMI, and duration of stay in the hospital. Frequency and percentage were calculated for gender. A Chi-square test was used to compare the morbidities between actual and NSQIP calculated. A p-value less than and equal to 0.05 was taken as significant. Effect modifiers like age, gender, BMI, and duration of stay were addressed through stratification. The post-stratification chi-square test was applied. A p-value less than 0.05 was considered significant.

3. Results

A total of 157 patients with pneumoperitoneum undergoing exploratory laparotomy were included in the study. There were 63.7% male and 36.3% female patients with a mean age of 42.46 ± 18.11 years. The mean body mass index and hospital stay duration were 22.81 ± 4.30 kg/m^2 and 7.33 ± 2.94 days, respectively. Baseline features for patients under study are presented in Table I.

In our study, NSQIP surgical risk calculator calculated morbidities, i.e., surgical site infection in 28 (17.8%) patients, urinary tract infection in 26 (16.6%) patients, pneumonia in 28 (17.8%) patients, and cardiac event in 25 (15.9%) patients while the actual morbidities were surgical site infection in 49 (31.2%) patients, urinary tract infection in 4 (2.5%) patients, pneumonia in 24 (15.3%) patients and cardiac event 14 (8.9%) patients, as shown in Table II. There was a significant association for actual and anticipated surgical site infection (p = 0.001), urinary tract infection (p = 0.001), pneumonia (p = 0.001), and cardiac events (p = 0.001), as shown in Table II.

Surgical site infection rates were 12.1% and 5.7%, Urinary tract infection rates were 8.9% and 7.6%, and pneumonia rates were 9.6% and 8.3%. Cardiac events rates were 9.6% and 6.4% for males and females, according to NSQIP surgical risk calculator, while surgical site infection rates were 20.4% and 10.8%, Urinary tract infection rates were 1.9% and 0.6%, pneumonia rates were 8.3% and 7.0%, cardiac events rates were 5.1% and 3.8% for male and females as shown in Tables III and IV, respectively.

We found a significant association between age groups and anticipated surgical site infection (p = 0.001). Anticipated urinary tract infection (p = 0.001), pneumonia, and cardiac event (p = 0.001). There was a significant association of age groups with actual surgical site infection (p

TABLE I: Baseline Features

	n (%)	Mean ± SD	Range
Age (years)		42.46 ± 18.11	16 years to 91 years
Weight (kg)		66.16 ± 13.16	22 to 103 kg
Height (m)		1.68 ± 0.15	0.6 to 1.85 m
BMI (kg/m^2)		22.81 ± 4.30	2.80 to 38.30
Hospital stay duration (days)		7.33 ± 2.94	1 day to 23 days

TABLE II: The Frequency of Morbidities

	n (%)		P-value
	Actual morbidities	Anticipated morbidities	
Surgical site infection	49 (31.2)	28 (17.8)	0.001
Urinary tract infection	4 (2.5)	26 (16.6)	0.001
Pneumonia	24 (15.3)	28 (17.8)	0.001
Cardiac event	14 (8.9)	25 (15.9)	0.001

Note: Chi-square/Fisher exact test was applied. P-value < 0.05 is considered significant.

TABLE III: Anticipated Morbidities

			Frequency (Percentage)							
			Age group		Gender		BMI		Duration of stay	
			1–84 years	85–168 years	Male	Female	2.80–20.60 kg/m^2	20.61–38.30 kg/m^2	1–12 days	13–23 days
Anticipated morbidities	Surgical site infection	Yes	11 (7)	17 (10.8)	19 (12.1)	9 (5.7)	5 (3.2)	23 (14.6)	25 (15.9)	3 (1.9)
		No	101 (64.3)	28 (17.8)	81 (51.6)	48 (30.6)	36 (22.9)	93 (69.2)	125 (79.6)	4 (2.5)
		P-value	0.001		0.613		0.272		0.077	
	Urinary tract infection	Yes	9 (5.7)	17 (10.8)	14 (8.9)	12 (7.6)	8 (5.1)	18 (11.5)	24 (15.3)	2 (1.3)
		No	103 (65.6)	28 (17.8)	86 (54.8)	45 (28.7)	33 (21)	98 (62.4)	126 (80.3)	5 (3.2)
		P-value	0.001		0.253		0.554		0.382	
	Pneumonia	Yes	9 (5.7)	19 (12.1)	15 (9.6)	13 (8.3)	8 (5.1)	2 (12.7)	26 (16.6)	2 (1.3)
		No	103 (65.6)	26 (16.6)	85 (54.1)	44 (28)	33 (21)	96 (61.1)	124 (79)	5 (3.2)
		P-value	0.001		0.219		0.744		0.448	
	Cardiac event	Yes	5 (3.2)	20 (12.7)	15 (9.6)	10 (6.4)	6 (3.8)	19 (12.1)	23 (14.6)	2 (1.3)
		No	107 (68.2)	25 (15.9)	85 (54.1)	47 (29.9)	35 (22.3)	97 (61.8)	127 (80.9)	5 (3.2)
		P-value	0.001		0.675		0.793		0.349	

Note: Chi-square/Fisher exact test was applied. P-value < 0.05 is considered significant.

TABLE IV: Actual Morbidities

			Frequency (Percentage)							
			Age group		Gender		BMI		Duration of stay	
			16–53 years	54–91 years	Male	Female	2.80–20.60 kg/m^2	20.61–38.30 kg/m^2	1–12 days	13–23 days
Actual morbidities	Surgical site infection	Yes	26 (16.6)	23 (14.6)	32 (20.4)	17 (10.8)	7 (4.5)	42 (26.8)	45 (28.7)	4 (2.5)
		No	86 (54.8)	22 (14)	68 (43.3)	40 (25.5)	34 (21.7)	74 (47.1)	105 (66.9)	3 (1.9)
		P-value	0.001		0.777		0.029		0.130	
	Urinary tract infection	Yes	1 (0.6)	3 (1.9)	3 (1.9)	1 (0.6)	3 (1.9)	1 (0.6)	4 (2.5)	0 (0)
		No	111 (70.7)	42 (26.8)	97 (61.8)	56 (35.7)	38 (24.2)	115 (73.2)	146 (93)	7 (4.5)
		P-value	0.038		0.634		0.024		0.662	
	Pneumonia	Yes	4 (2.5)	20 (12.7)	13 (8.31)	11 (7)	5 (3.2)	19 (12.1)	20 (12.7)	4 (2.5)
		No	108 (68.8)	25 (15.9)	87 (55.4)	46 (29.3)	36 (22.9)	97 (61.8)	130 (82.8)	3 (1.9)
		P-value	0.001		0.292		0.522		0.002	
	Cardiac event	Yes	4 (2.5)	10 (6.4)	8 (5.1)	6 (3.8)	1 (0.6)	13 (8.3)	13 (8.3)	1 (0.6)
		No	108 (68.8)	35 (22.3)	92 (58.6)	51 (32.5)	40 (25.5)	103 (65.6)	137 (87.3)	6 (3.8)
		P-value	0.001		0.593		0.090		0.61	

Note: Chi-square/Fisher exact test was applied. P-value < 0.05 is considered significant.

= 0.001) and body mass index (p = 0.029), actual urinary tract infection (p = 0.038), pneumonia (p = 0.001) and duration of stay (p = 0.002) and cardiac event (p = 0.001) as presented in Tables III and IV.

4. Discussion

Estimating peri-operative risk has several advantages. It is a key component of safe, high-quality patient care as it not only facilitates informed consent but also helps surgeons set realistic expectations of outcomes for specific procedures [12], [13]. If fully informed of the potential risks, some patients may choose to avoid surgery and instead choose non-operative treatment or palliative care [14], [15]. The National Surgical Quality Improvement Program (NSQIP) is an American, result-based, risk-adjusted software validated through consensus for the quantification and advancement of surgical services [16]. Patient-related risk factors, including general health status, cardiac, pulmonary, renal, neurological, and emergency case status, are entered into the calculator available online [17], [18], and the data is subsequently integrated into a linear analysis algorithm, which predicts 30-day rates of complications (cardiac arrest, myocardial infarction, pneumonia, surgical site infection, urinary tract infection, return to the operating room, discharge, and predicted length of hospital stay). For quality monitoring and enhancement, this data is then utilized to produce an actual to anticipated ratio–the observed and expected or O/E ratio–for morbidity [19].

The results of our study showed that anticipated morbidities estimated by the NSQIP surgical risk calculator versus actual outcomes were surgical site infection in 17.8% vs. 31.2%, urinary tract infection in 16.6% vs. 2.5%, pneumonia in 17.8% vs. 15.3% & cardiac events in 15.9% vs. 8.9% patients as shown in the tables above. The actual morbidities were surgical site infection in 49 (31.2%) patients, urinary tract infection in 4 (2.5%) patients, pneumonia in 24 (15.3%) patients, and cardiac events in 14 (8.9%) patients, as shown in the table above. There is a difference of 13.4% in the incidence of surgical site

infections–SSIs–as measured by the NSQIP tool versus the actual outcomes. The possible reasons could be the changes in BMI and increased duration of hospital stay. The tool does not measure the degree of immunosuppression or extent of pre-existing co-morbidity in the patients, all of which significantly contribute to SSIs [15], [20].

The main limitation of the ACS NSQIP calculator is that it predicts outcomes based on information fed into a central database [21], [22]. This database may not contain certain risks and clinical entities [23], [24] of laparotomies, such as anastomotic leaks and post-surgical fistulae that are prospectively recorded in post-operative outcomes.

Delayed presentation and its role in surgical outcomes, especially in cases of pneumoperitoneum, whether the emergency is post-interventional or self-arising, can also be an important addition to future studies because the presentation is a very strong prognostic factor in laparotomy for pneumoperitoneum.

Lastly, the entire tool is constructed upon data based on the American population. The population of Pakistan has a series of complex medical issues attributed to different ethnicities and socioeconomic backgrounds. This is a limitation of the tool, and in future studies, the calculator can be updated to include an algorithm that better suits the various other background differences.

5. Conclusion

The American College of Surgeons NSQIP Surgical Risk Calculator aids the practitioner in reliable decision-making using the patient's specific risk factors in depicting post-operative outcomes in both elective and emergency surgeries. Shared decision-making and informed consent increase the satisfaction of patients and their attendees. Our study was conducted in an emergency setting, adequately anticipated morbidities, such as SSI, UTI, pneumonia, and cardiac events, in comparison with actual morbidities.

6. Limitations

This is a single-centre study with a relatively small sample size.

Conflict of Interest

The authors declare that they do not have any conflict of interest.

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