

Accuracy of the ACS NSQIP surgical risk calculator to predict morbidity and mortality in Mexican patients

Precisión de la calculadora de riesgo quirúrgico ACS NSQIP para predecir morbilidad y mortalidad en pacientes mexicanos

José J. Macías-Cervantes*, Rafael S. Vázquez-Rentería, Sandra C. López-Romero, and Noé I. Gracida-Mancilla

General Surgery Department, Acute Surgical Pathology Clinic, General Hospital of Mexico "Dr. Eduardo Liceaga", Mexico City, Mexico

Abstract

Background: American College of Surgeons (ACS) developed the ACS NSQIP surgical risk calculator that predicts the results of elective and emergency surgical procedures. This tool has been useful improving the morbidity and mortality in hospitals in the United States and Canada. **Objective:** To evaluate the usefulness of the ACS NSQIP risk calculator for predicting postoperative complications in Mexican population. **Method:** Prospective, observational, analytical study. Patients undergoing abdominal surgery were recorded, 21 preoperative variables were captured and entered into the calculator. They were followed up to 30 days postoperatively, identifying 14 types of postoperative complications. **Results:** 109 patients were registered and a comparison was made between the calculated and observed complications, obtaining a good correlation in the complications of cardiac arrest, surgical site infection, reoperation, sepsis and mortality ($p < 0.05$). **Conclusions:** ACS NSQIP risk calculator is useful in the Mexican population, since the score obtained predicts most postoperative complications including mortality. The use of this tool offers an opportunity to improve decision-making in the care of the surgical patient.

Keywords: Morbidity. Mortality. Mexico.

Resumen

Antecedentes: El American College of Surgeons (ACS) desarrolló la calculadora de riesgo quirúrgico ACS NSQIP que predice los resultados de los procedimientos quirúrgicos electivos y de emergencia. Esta herramienta ha sido útil para mejorar la morbilidad y mortalidad en hospitales de Estados Unidos y Canadá. **Objetivo:** Evaluar la utilidad de la calculadora de riesgo ACS NSQIP para predecir complicaciones postoperatorias en población mexicana. **Método:** Estudio prospectivo, observacional, analítico. Se registraron los pacientes sometidos a cirugía abdominal, se capturaron 21 variables preoperatorias y se ingresaron a la calculadora. Fueron seguidos hasta 30 días después de la operación, identificándose 14 tipos de complicaciones postoperatorias. **Resultados:** se registraron 109 pacientes. Se realizó una comparación entre las complicaciones calculadas y observadas, obteniendo una buena correlación en las complicaciones de paro cardíaco, infección del sitio quirúrgico, reoperación, sepsis y mortalidad ($p < 0.05$). **Conclusiones:** la calculadora de riesgo ACS NSQIP es útil en la población mexicana, ya que el puntaje obtenido predice la mayoría de las complicaciones postoperatorias, incluida la mortalidad. El uso de esta herramienta ofrece una oportunidad para mejorar la toma de decisiones en el cuidado del paciente quirúrgico.

Palabras clave: Morbilidad. Mortalidad. México.

*Correspondence:

José J. Macías-Cervantes

E-mail: jesusmaciascerv@gmail.com

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Introduction

The American College of Surgeons (ACS) has been developing since 2005 the *National Surgical Quality Improvement Program* (NSQIP). This program collected high-quality data including preoperative risk factors and postoperative complications from 1,414,006 patients from 393 NSQIP hospitals^{1,2}. The information was used by the ACS to develop the ACS NSQIP Surgical Risk Calculator (<http://riskcalculator.facs.org>)². Universal calculator uses 21 predictor variables (demographics and comorbidity) and planned procedure, and reports eight 30-day postoperative outcomes². It is worth mentioning that this tool is constantly improving, being calibrated and updated frequently to offer more accurate and reliable results^{2,3}.

Some studies have found that the accuracy of the ACS NSQIP calculator in elective surgery is quite good⁴⁻⁷; however, the accuracy in emergency surgery has not been widely evaluated. In this emergency scenario, some series show an adequate precision of the tool^{8,9}, but other studies report underestimated figures for morbidity and mortality¹⁰⁻¹³. There are few studies on the effectiveness of the ACS NSQIP calculator in both elective and emergency surgery in the Mexican population¹⁴.

The objective of this study is to evaluate the usefulness of the risk calculator to predict postoperative complications in patients operated on in the emergency setting by the general surgery service.

Method

Type of study

A prospective, observational, analytical and single-center study was carried out.

Population and sample

The data of the patients undergoing emergency abdominal surgery by the acute surgical pathology service of general surgery of the General Hospital of Mexico, from May to July 2019, were recorded, and the clinical evolution was monitored until 30 days postoperatively. A non-probabilistic convenience sample was obtained with the patients attended, who were registered in the clinic's database as the study population. Patients undergoing elective surgery, those in whom the 30-day postoperative surveillance period

was not completed, those undergoing surgery by another surgical service, and those who did not want to be part of the study protocol were excluded.

Procedure and statistical analysis

The ACS NSQIP surgical risk calculator, which is available on the Internet (<http://riskcalculator.facs.org/RiskCalculator/index.jsp>), was used. This calculator was used to predict the probabilities of postoperative complications, and the percentage probability and the calculated hospital stay were recorded. Descriptive statistics were used to present the analyzed data. The ordinal variables were presented as means, medians, ranges and variances, in contingency tables, and for the comparison between groups they were presented in box plots. Regarding the quantitative variables, means, standard deviations and test of variances using the Levene test were used. The groups were divided according to the results obtained: those who did not present the complication and those who did. Both populations were compared using Student's t-test and the hypothesis test was subsequently performed using the Mann-Whitney U non-parametric test of independent samples on all possible postoperative outcomes. A value of $p < 0.05$ was considered as a criterion to reject the null hypothesis of differences between groups.

Ethical and biosafety aspects

The protocol was approved by the ethics committee of the General Hospital of Mexico, in May 2019, with the registry key DI/19/305/03/033. The information collected was used exclusively for academic and research purposes. The information was handled in such a way that the protection of individual rights and confidentiality were guaranteed. The signing of the informed consent was requested from all patients for inclusion in the study protocol.

Results

From the period from May to July 2019, it was possible to integrate a sample of 109 patients operated on by the general surgery service who met the inclusion criteria. In Table 1 demographic data of the study population are summarized, as well as predictive preoperative clinical variables that are used by the ACS NSQIP calculator to predict surgical risk for morbidity and mortality.

Table 1. Demographic data and preoperative clinical variables

	Frequency (n = 109)	Percentage (%)
Average age, years	43 (18-88)	
Sex		
Male	57	52
Female	52	48
Body mass index		
Normal	46	42.2
Overweight	40	36.7
Obesity	23	21.1
Functional status		
Independent	100	91.7
Partially dependent	7	6.4
Totally dependent	2	1.8
ASA Classification		
1	17	15.6
2	57	52.3
3	31	28.4
4	3	2.8
5	1	0.9
Steroid use		
No	109	100
Ascites		
No	109	100
Preoperative sepsis		
No	39	35.8
SIRS	25	22.9
Sepsis	44	40.4
Septic shock	1	0.9
Preoperative mechanical ventilation		
No	108	99.1
Yes	1	0.9
Disseminated cancer		
No	107	98.2
Yes	2	1.8
History of severe COPD		
No	109	100
Diabetes		
No	98	89.9
Oral treatment	6	5.5
Insulin	5	4.6
Systemic arterial hypertension		
No	93	85.3
Yes	16	14.7
Preoperative heart failure		
No		
Yes	108	99.1
	1	0.9
Preoperative dyspnea		
No	109	100

(Continues)

Table 1. Demographic data and preoperative clinical variables (continued)

	Frequency (n = 109)	Percentage (%)
Smoking patient		
No	91	83.5
Yes	18	16.5
Dialysis use		
No	109	100
Preoperative kidney failure		
No	96	88.1
Yes	13	11.9
Surgeon fit		
No adjustment	98	89.9
High risk of complications	10	9.2
Very high risk of complications	1	0.9

ASA: American Society of Anesthesiologists; COPD: chronic obstructive pulmonary disease; SIRS: systemic inflammatory response syndrome.

Postoperative results

Once the preoperative assessment and risk prediction were completed, the patients underwent surgical procedures, with appendectomy being the most frequent procedure, with 53 (48.7%) interventions, of which 38 (34.9%) were open and 15 (13.8%) laparoscopic. The rest of the procedures were 26 (23.9%) exploratory laparotomies, 16 (14.7%) laparoscopic cholecystectomies and 4 (3.7%) open cholecystectomies, 4 (3.7%) femoral plasties, 4 (3.7%) inguinal plasties and 2 (2.7%) wall plasties.

Postoperative diagnoses are displayed on table 2.

Complication frequency

The observed postoperative complications are detailed in table 3. It is necessary to mention that no patient presented venous or pulmonary thromboembolism or postoperative cerebrovascular event.

Results comparison

A comparison was made between the calculated results and those observed in the morbidity and mortality variables of the patients operated during the study period. In table 4 a summary of the multivariate analysis of the calculated and observed results is shown, as well as the comparison using the hypothesis test using the Mann-Whitney U test. The variables

Table 2. Postoperative diagnoses

	Frequency	Percentage
Appendicitis		
Uncomplicated	25	23
Complicated	30	27
Acute cholecystitis	20	18
Hernias		
Inguinal	5	4.6
Femoral	5	4.6
Ventral	4	3.7
Cancer	4	3.7
Intestinal perforation	3	2.8
Complicated diverticular disease	2	1.8
Intestinal occlusion due to adhesions	2	1.8
Pelvic inflammatory disease	2	1.8
Internal hernia	2	1.8
Gallstone ileus	2	1.8
Penetrating trauma	2	1.8
Non-therapeutic laparotomy	1	0.9

Table 3. Frequency of observed complications

	Frequency (n = 109)	Percentage
Mortality	5	4.5
Pneumonia	3	2.75
Cardiorespiratory arrest	3	2.75
Surgical site infection		
Superficial	5	4.6
Deep	2	1.8
Organ-space	9	8.3
Urinary tract infection	5	4.59
Postoperative renal failure	1	1.05
Unscheduled surgical reintervention	9	8.26
Postoperative sepsis	11	10
Hospital readmission	3	2.75
Surgical wound dehiscence	3	2.75

Table 4. Comparison of calculated versus observed complications

Observed variables	n	Calculated risk (%)		p
		Mean	OF	
Serious complications				< 0.001
No	90	8.48	6.92	
Yes	19	20.95	11.04	
Any complication				< 0.001
No				
Yes	85	11.05	8.18	
	24	25.03	12.40	
Postoperative pneumonia				0.118
No	106	2.01	2.51	
Yes	3	4.26	3.05	
Cardiorespiratory arrest				0.007
No	106	1.18	2.25	
Yes	3	6.86	5.20	
Surgical site infection				0.026
No	93	3.40	2.31	
Yes	16	4.41	1.27	
Urinary tract infection				0.250
No	104	0.79	0.98	
Yes	5	1.32	0.97	
Hospital readmission				0.311
No				
Yes	106	7.44	4.44	
	3	10.46	6.08	
Unscheduled surgical reintervention				0.003
No	100	2.74	2.05	
Yes	9	4.78	1.80	
Sepsis				0.011
No	98	0.49	1.15	
Yes	11	1.48	1.38	
Mortality				0.002
No	104	2.93	6.89	
Yes	5	25.08	20.79	

SD: standard deviation.

of serious complications, total complications, cardiorespiratory arrest, surgical site infection, unscheduled surgical reintervention, postoperative sepsis, and mortality obtained a value of $p < 0.05$, therefore we consider that the risk calculator adequately estimated the patients with probability of having such complications. In contrast, with the variables of pneumonia, urinary tract infection and hospital readmission, it was not accurate to determine who would present them,

obtaining a p value of 0.118, 0.256 and 0.311, respectively. Venous thromboembolism and acute kidney injury are not included, since there is not enough sample to carry out a comparative analysis.

The days of hospital stay were estimated using the ACS NSQIP risk calculator ($\bar{x}$: 4.87 days) and were compared with the actual days of hospital stay of the patients ($\bar{x}$: 5.37 days). Student's t test was used to compare the populations, obtaining a p value of < 0.001 .

Discussion

In our study, 109 patients were included, a representative sample of the general population, since it is made up of 47.7% women and 52.3% men, with a mean age of 43 years (standard deviation: ± 18.6). The body mass index coincides with that of the general population, being slightly lower in terms of overweight and obesity rates, since we obtained a combined prevalence of 57.8%, which contrasts with the combined prevalence of overweight and obesity of 72.5% in the adult Mexican population¹⁵.

The ACS NSQIP Risk Calculator is an effective tool for estimating the probability of postoperative complications in an individual surgical patient.^{3,5} The purpose of this study was to determine if the calculator is capable of predicting postoperative complications in the Mexican population and in an emergency setting. In emergency surgery, the patient is at higher risk of complications due to the nature of their disease and the inability to optimize comorbidity¹⁶.

The results of our study indicate that the score obtained with the ACS NSQIP calculator predicts most postoperative complications, including cardiac arrest, surgical site infection, unscheduled reoperation, sepsis, and mortality. However, the calculator was not accurate in predicting the probability of pneumonia, urinary tract infection, and hospital readmission, similar to what was reported in another Mexican study¹⁷. In the case of pulmonary thromboembolism and acute renal failure, the sample was insufficient to determine the accuracy of the calculator.

Globally, the populations that presented serious complications and those that did not were compared, and using the Mann-Whitney U test it was observed that the calculator is accurate in differentiating patients with serious complications (8.48% vs. 20.95%; $p < 0.001$) and to predict the presentation of any complication, including superficial surgical site infection, ventilatory support and Cerebrovascular Disease (CVD) (11.05% vs. 25.03%; $p < 0.001$).

The overall mortality of our population was 4.5%, with a total of five patients: three due to septic shock due to secondary peritonitis that required management in the intensive care unit, one that presented bronchial aspiration with a diagnosis of intestinal occlusion due to adhesions, and another who presented acute renal failure in the postoperative period and did not accept renal replacement therapy (otherwise, there was a possibility of improvement). The calculator was able to predict postoperative mortality by comparing the scores

of both populations (2.93% vs. 25.08%; $p = 0.002$). These results coincide with what has been published in the international medical literature^{8,9,11,16}, although a Mexican study reports a low precision of the calculator in the mortality variable¹⁷.

In the surgical site infection scenario, we observed a prevalence of 14.68%, with a distribution of 4.6% superficial, 1.8% deep and 8.3% organ-space. The general prevalence of surgical site infection is similar to that reported in other studies^{6,8}. However, a high prevalence of organ-space infection (8.3%) was observed compared to the other types of infection, which may be due to several factors: our high incidence of acute appendicitis complicated by perforation or peritonitis, the inconsistent use of antibiotics preoperatively, which can delay diagnosis and mask the underlying pathology, or the increase in bacterial resistance due to their use. More studies are needed to define the main risk factors for surgical site infection in our hospital. Although the ACS NSQIP risk calculator preoperatively does not allow for the inclusion of more than one surgical procedure or consider the admission diagnosis, it was able to predict surgical site infection in our study (3.4% vs. 4.41%; $p = 0.026$).

The surgeries performed during the study period were, in order of frequency, appendectomy, laparotomy, and cholecystectomy; these are reported in a similar way in the literature, as well as in the annual records of our hospital¹⁶. However, some of the patients required more procedures in addition to the planned surgery, such as intestinal resection, intestinal anastomosis, stomatal formation, drainage of collections, and enterotomies, among others. We consider a calculator flaw that only one planned procedure (CPT Code) can be entered; clearly, performing multiple procedures simultaneously can alter postoperative results. Some authors have reported that concurrent procedures impact the estimate of serious complications in ventral hernia repair⁶, radical cystectomy¹² and hepatobiliary surgery¹³. We believe that the inclusion of more additional procedures in the surgical risk calculator may improve its accuracy in predicting complications.

Regarding the length of hospital stay, the calculator accurately estimated the days of hospital stay: 4.8 calculated days vs. 5.3 observed days ($p < 0.001$). In some studies it is considered that the calculator underestimates the length of stay^{5,6,8,17}. Velez-Perez et al.¹⁷, in their study carried out in a private hospital in Mexico City, they report a low accuracy of the calculator to estimate the hospital stay; however, in our study the calculator was accurate.

Limitations of the study

We can consider that it is a prospective study of a single hospital in Mexico City, so our results may be different from those of other Mexican hospitals¹⁷. We also consider that the population sample, both because of its size and because it was obtained for non-probabilistic convenience, although it is sufficient to carry out the study, limits the ability to make inferences about all the results predicted by the ACS NSQIP risk calculator, which is why to continue our research on a larger scale.

Conclusions

The ACS NSQIP risk calculator is useful in the Mexican population, since the score obtained predicts most postoperative complications (cardiac arrest, surgical site infection, unscheduled reoperation, sepsis, and mortality), and also allows estimation of days of Hospital stay of patients operated on in the emergency setting. However, it is necessary to carry out a study on a larger scale in order to define its precision in the Mexican population.

The use of this tool offers an opportunity to improve decision-making in the care of the surgical patient, and likewise raises the expectations of the surgery and the patient's recovery in an objective and realistic manner. The NSQIP has shown better results in surgical care, with a decrease in morbidity and mortality, and even in health care costs. We believe that it is a good tool to use in other hospitals in our country.

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Conflicts of interest

The authors declare that they have no conflicts of interest.

Ethical disclosures

Protection of people and animals. The authors declare that no experiments were carried out on humans or animals for this research.

Data confidentiality. The authors declare that they have followed the protocols of their work center regarding the publication of patient data.

Right to privacy and informed consent. The authors declare that no patient data appears in this article.

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