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Mannheim Index versus APACHE II Score as Predictors of Mortality in Abdominal Sepsis in a 4th Level Ecuadorian Hospital

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Abstract | **Original Research Article**

Introduction: In the last 30 years, scoring systems have been developed to determine patients' illness severity or prognosis. In the present work, the role of the Mannheim Prognostic Index (MPI) to predict the risk of mortality, complications, prolonged hospital-stay, and the need for ICU was determined in all the patients who presented secondary peritonitis, and to validate the test as a useful and an easy tool to apply in the clinical practice of the surgeon and critical care physician. ***Materials and methods:*** An observational, retrospective, cross-sectional and analytical study was conducted. ***Results:*** The effectiveness of the MPI was compared to another widely used mortality prediction system such as Apache II; 279 patients from the Luis Vernaza were included. The prediction rate was 93.3% and 86.9%, respectively. ***Conclusions:*** Although Mannheim presents an excellent response as a predictor of mortality, its assessment is not infallible since other factors remain unconsidered; and these may cause a patient who was assessed as having a low risk of mortality to be deceased.
Keywords: Secondary peritonitis, acute abdomen, abdominal cavity, intra-abdominal infection, abdominal pain.

INTRODUCTION

Peritonitis, defined as localized or diffuse inflammation of the peritoneal membrane, represents a common human disease [1, 2] and produces severe humoral and hormonal consequences that commonly lead to death. Currently, mortality from this cause can reach up to 80% [3, 4].

Continuous postoperative peritoneal lavages to treat persistent intra-abdominal infection, the application of antimicrobials with increasingly "higher" and broad-spectrum activity, and admission to intensive care units (ICU), have significantly reduced mortality from this cause [3, 5]. Given this panorama, it is interesting to know the factors that, regardless of the treatment, can determine an unfavorable patient outcome.

Despite scientific and technological advances, this entity continues to be one of the most frequent health problems faced by surgeons and their team. Approximately, 13% of surgical patients are admitted to the surgery department with this diagnosis [6].

In the last thirty years, multiple scoring systems have been developed to determine the severity of peritonitis, especially for those with a septic component; those with the best prognosis accuracy are the APACHE II and the MPI [7-10].

The latter was the first severity scoring system designed to assess and provide prognosis for individual postoperative mortality in patients with peritonitis, who can receive surgical treatment. Described by Wacha *et al*., [11], it was based on the results of 1253 patients with peritonitis treated between 1963 and 1979 in Germany and was developed by discriminative analysis of 17 possible risk factors, of which eight were significant for prognosis, obtaining the information during the first laparotomy, allowing an immediate and easy-to-apply classifications [4]. Multivariate analysis has shown that the most clinically relevant factors are preoperative organ failure and purulent or fecaloid peritonitis [12]; and it has also shown a high sensitivity and specificity applied in different surgical scenarios in different multicentric studies [9]. In a review presented by Biling [13], the score was divided into groups according to the score, the first having 26 as the cut-off point, which had a 86% sensitivity and 74% specificity and 83% accuracy in predicting death; for patients with a score < 21, mortality was 2.3%; a 21 to 29 score had a 22.5% mortality and for those > 29, mortality was 59.1% [13].

MPI can be rapidly applied and is based on the assessment of clinical parameters and intraoperative findings, with which we can estimate the severity of the disease and carry out an appropriate and early therapeutic intervention. This is how the Mannheim Prognostic Index (MPI) was created; being of easy and quick application, it is a specific index for peritonitis, has a low cost and can be performed at the patient's bedside. MPI is a simple score that allows the surgeon to determine soon and early the risk of an unfavorable outcome, mostly in patients with secondary peritonitis [6].

It measures different parameters: age equal to or greater than 50 years (5 points); female sex (5 points); multiorgan failure (7 points); malignancy (4 points); preoperative duration of peritonitis > 24 hours (4 points); sepsis of non-colonic origin (4 points); generalized peritonitis (6 points); and type of exudate (clear 0 points, purulent 6 points., fecal 12 points).

The maximum score is 47 points; results can be grouped in low and high mortality, being 26 the cut-off point (50% mortality with scores ≥26; and 1-3% mortality with scores <26), with a 95.9% sensitivity and 80% specificity, with a 98.9% positive predictive value and 50% negative predictive value [11, 14]. Patients with a higher score will have a higher probability of complications, hospital-stay, intensive care requirement and, of course, higher morbidity and mortality [15].

Other authors have studied isolated variables and have observed that septic shock or concomitant diseases are predictors of postoperative mortality in colonic perforation. Different risk factors with predictive value for postoperative morbidity and mortality have been identified, and valid prognostic indices have been developed for surgical patients, although not specific to emergency procedures or colorectal disease [11].

On the other hand, the Acute Physiologic and Chronic Health Evaluation II (APACHE II) is probably the most widely known and used severity index with prognostic significance in clinical practice. It was specially designed for patients with severe disease admitted to an ICU; and consists in 12 variables that include physiological, clinical, analytical, and hemodynamic parameters, considering, for each variable, the worst of the values recorded during the first 24 hours of admission [10].

The APACHE II has demonstrated its usefulness in patients with abdominal sepsis who are elective for surgery, with a high degree of correlation between score and mortality. However, it is not a specific index for surgical patients, it does not consider the prognostic significance of factors related to the intervention, such as the characteristics of the peritoneal fluid and the origin of the peritonitis, and it does not distinguish between urgent and elective surgery. Its management is difficult in emergency departments as it contemplates some complex parameters that require monitoring, limiting its application only to patients admitted to ICU [16].

There are studies that conclude that this index provides better prognosis when applied to patients undergoing emergency surgery compared to those who underwent elective surgery; others consider that the APACHE II underestimates mortality in non-surgical and high-risk surgical patients, while it overestimates the possibility of death in low-risk patients [17].

The main advantages of MPI over APACHE II are an easy-to-apply system which offers an estimation of the individual mortality risk: each variable can be calculated in usual clinical conditions, fast and without requiring invasive measurements; and that is recorded only at the time of the intervention [8]. Also, comparative studies have shown that its postoperative predictive applicability is superior to the APACHE II score, due to its great advantages in terms of usefulness in estimating individual risk, and especially applied to patients with a diagnosis of peritonitis of an urgent surgical nature [7].

In this study, the objective was to compare the MPI versus APACHE II as predictors of mortality in patients with severe abdominal sepsis. Also, the role of the MPI to predict the risk of mortality, complications, prolonged hospitalization and the need for ICU in all patients who presented secondary peritonitis was determined; and the test was validated to apply in the surgical and critical care areas, emphasizing the need for and importance of an early identification of peritonitis severity to offer multidisciplinary and appropriate therapeutic strategies for the management of local and systemic complications.

Materials and Methods

This was an observational, retrospective, comparative and analytical study.

Population and sample

Total number of patients with secondary peritonitis at Luis Vernaza Hospital from December 2018 to December 2019 was 3443. Probabilistic sampling was calculated with a 5% margin of error and 95% confidence interval (CI), resulting in 346 patients. Of these, 67 patients were excluded after inclusion criteria were not met or had incomplete clinical data. Finally, 279 patients were included.

Inclusion criteria

- Patients ≥16 years old
- Diagnosis of abdominal sepsis due to secondary peritonitis
- Primary surgery performed at Luis Vernaza Hospital

Exclusion criteria

- Incomplete clinical history
- Patients with peritonitis who did not undergo surgery due to their serious condition or who were transferred to other units
- Primary surgery performed by other surgical specialty or in another center

Data collection and statistics

Data was collected from electronic clinical history using Google Forms ®, organized in a Microsoft Excel ® database and then processed with the statistical package SPSS ® version 27.0

A descriptive report of clinical and demographic characteristics was made; qualitative variables were reported by frequency and percentage and quantitative variables with percentage and central tendency and dispersion measures: mean, median, mode and standard deviation.

Multivariate analysis was performed using Chi square test, ROC and Odds ratio.

Results

Clinical-demographic data

A total of 279 patients treated in the emergency room underwent surgery for acute abdomen, 49.8% (n = 139) were 16 to 40 years old, 25.8% (n = 72) were 41 to 63 years old and 24.4% (n = 68) were > 64 years old; 47.67% (n = 133) were male and 52.33% (n = 146) were female.

Hospital-stay was 1 to 15 days for 89.2% of patients (n = 249), 16 to 30 days for 6.8% patients (n = 19) and >30 days for 3.9% (n = 11).

Acute appendicitis was the main diagnosis in 62.7% patients (n = 175), followed by acute cholecystitis in 11.8% (n = 33) and complicated hernias in 8.2% (n = 23) patients.

Table 1: Most frequent pathologies

Most frequent pathologies		
	Frequence (n)	**Percentage (%)**
Acute appendicitis	175	62.7
Acute cholecystitis	33	11.8
Complicated hernias	23	8.2
Intestinal obstruction	22	7.9
Hollow organ perforation	4	1.4
Oncological pathology	21	7.5
Others	1	0.4
Total	279	100

Complications

Surgical site infection was the most frequent with 4.3% (n = 12), pneumonia accounted for 3.6% (n = 10), and organ failure for 1.4% (n = 4); 74.2% (n = 207) did not have any complication.

Table 2: Complications

Complications		
	Frequency (n)	**Percentage (%)**
Surgical site infection	12	4.3
Pneumonia	10	3.6
Multiorganic failure	4	1.4
Intraabdominal abscess	3	1.1
Others	43	15.4
None	207	74.2
Total	279	100

Hospital-stay

For hospital-stay mean was 7.62 days (SE: ± 10.62), median and mode were 4.00 and 2, respectively; this data variability can be attributed to the fact that hospital-stay may be heterogenous itself, ranging from 1 to > 30 days.

For this reason, the mode is taken as a reference since it reflects the most frequent hospital-stay with the highest patient concentration.

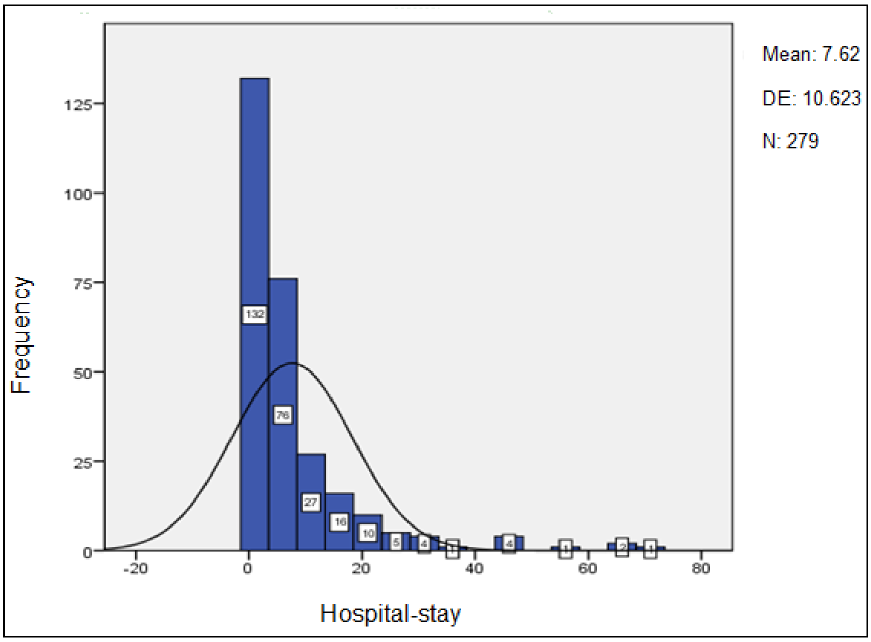

Figure 4: Hospital-stay

ICU admission

The total percentage of ICU admitted patients for postoperative management was 14.3% (n = 40), while the remaining 85.7% (n = 239) did not require admission to this unit; determining that the percentage of patients requiring it is very low.

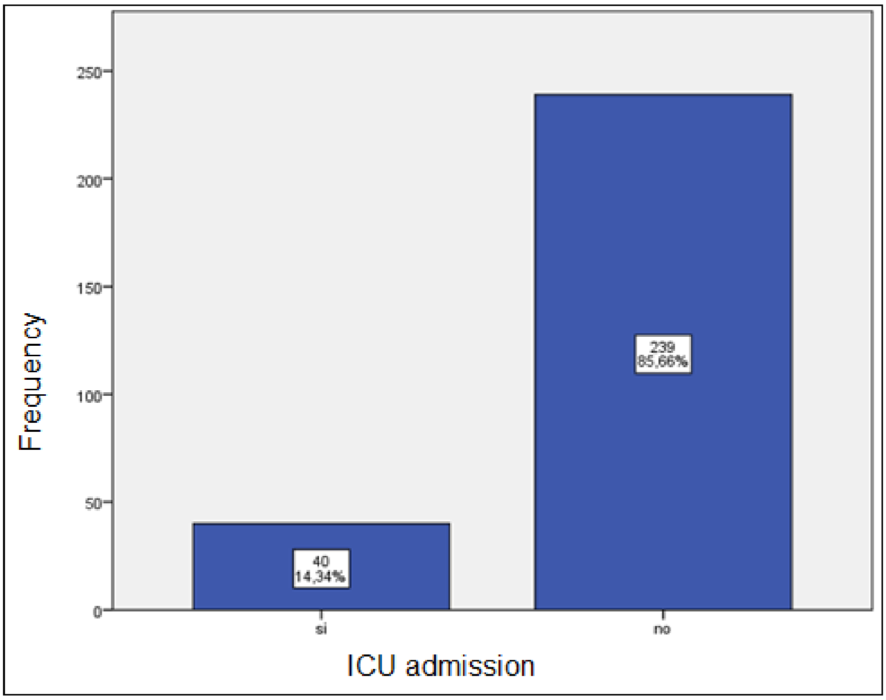

Figure 5: ICU admitted patients

Mortality and survival

Ninety-five-point-three percent (n = 266) were discharged from hospital in a stable condition, 4.7% (n = 13) patients were deceased.

Mortality prediction scores

Considering the intraoperative and pre-surgical results, there was weak concordance and significant differences between the MPI and APACHE II score.

The ROC curve was used to determine the effectiveness of each score and to assess patient mortality in an emergent surgical intervention for acute abdomen in the setting of secondary peritonitis, concluding that the higher the index, the greater the mortality.

The ROC curve was calculated for specificity, sensitivity, and relative risk in each of the scales. MPI area under the curve was 0.933 (0.873 to 0.993, CI: 95%, without asymptotic significance (0.00), standard error [SE]: 0.031), null hypothesis was considered 0.5 (true area), meaning that the area under the curve is significant to predict sensitivity (92.3%) and specificity (90.6%) with a cut-off point of 23.5pts (Graph 7, Table 7 and 8).

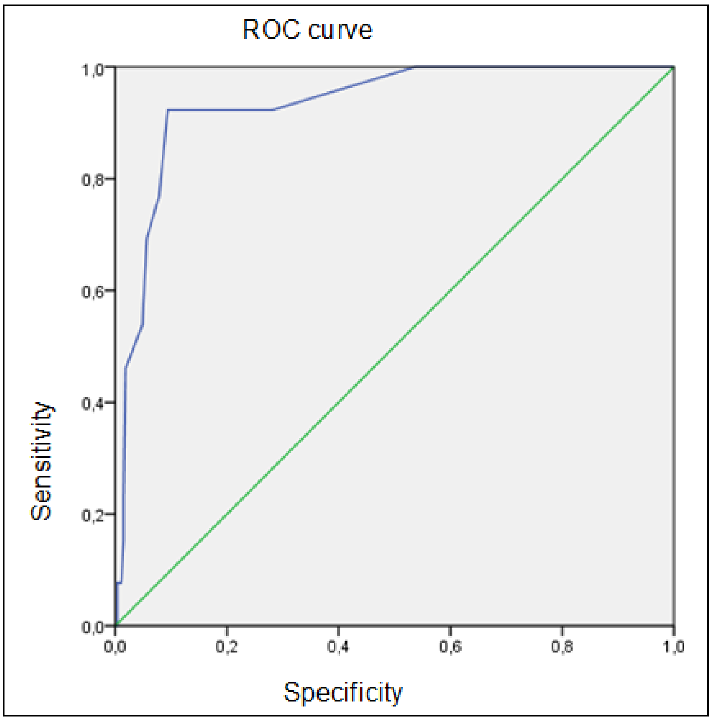

Figure 1: ROC curve to determine MPI specificity and sensitivity

Mortality rate for patients who scored <23 points on MPI was 7.7% (n = 1), and survival rate was 86.8% (n = 231). In contrast, in patients with a > 23-point score, a 92.3% (n = 12) mortality rate and a 13.2% (n = 35) survival rate was observed.

Based on this, it can be concluded that MPI is more effective as a mortality predictor.

Table 3: MPI mortality rate

			Survival rate	Mortality rate
MPI Score	> 23	N	35	12
		% within patient mortality	13.2%	92.3%
	< 23	N	231	1
		% within patient mortality	86.8%	7.7%
Total		N	266	13
		%	100%	100%

Odds ratio was 79.2 (9.98 to 628.11, CI: 95%), with a cohort value of 1.337 for survivors and of 0.017 for deceased patients, concluding that the test is valid for this result to be irrelevant, interval should exceed the margins.

Table 4: MPI risk estimation

	Value	CI 95 %	
		Inferior	Superior
Odds ratio for MPI mortality rate (< 23 / > 23)	79.200	9.987	628.111
For mortality cohort = survivor	1.337	1.131	1.581
For mortality cohort = deceased	0.017	0.002	0.127
N	279		

The ROC curve was made for specificity, sensitivity, and relative risk in each of the scales. For the APACHE II score, the area under the curve was 0.869 (0.729 to 1.00, CI: 95%) without asymptotic significance (0.00) and with a SE of 0.031. Knowing that the null hypothesis is 0.5 (true area), a standard error of 0.071 has no asymptotic significance, with a 84.6% sensitivity and 73.3% specificity for a cut-off point of 14.50 points (Graph 8 Chart 9 and 10).

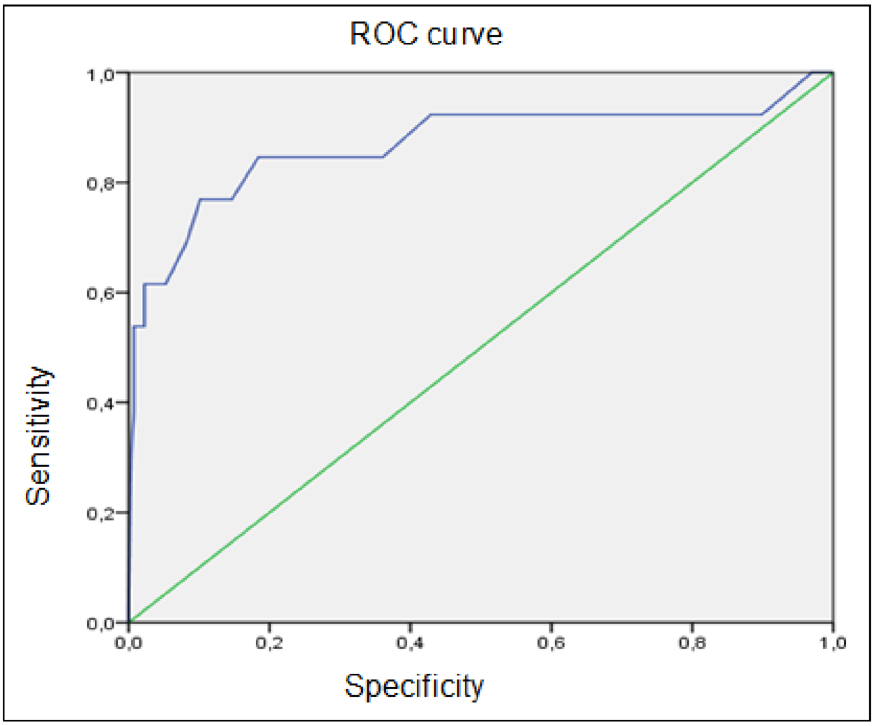

Figure 2: ROC curve to determine APACHE II Score specificity and sensitivity

From patients who scored <14 points, 15.4% (n = 2) were deceased and 63.9% (n = 170) survived. On the other hand, patients who scored >14 points, had an 84.6% (n = 11) mortality rate and a 36.1% (n = 96) survival rate.

Based on this, it can be concluded that the APACHE II score is less effective as a mortality predictor.

Table 5: APACHE II score mortality rate

			Survival rate	Mortality rate
APACHE II score	> 14	N	96	11
		% within patient mortality	36.1%	84.6%
	< 14	N	170	2
		% within patient mortality	63.9%	15.4%
Total		N	266	13
		%	100%	100%

Odds Ratio was 9.74 (2.115 to 44.85, CI: 95%), with a 1.102 cohort value for survivors and 0.113 for deceased patients. Concluding that the Odds Ratio test is valid, however, since the value is closer to the lower limit than with MPI, its relevance is lower.

Table 6: APACHE II score risk estimation

	Value	CI 95%	
		Inferior	Superior
Odds ratio for APACHE II mortality rate (< 14 / > 14)	9.740	2.115	44.857
For mortality cohort = survivor	1.102	1.031	1.177
For mortality cohort = deceased	0.113		
N	279	0.026	0.500

It is observed that the MPI ROC curve has greater coverage area than the plotted curve for APACHE II score. By simple visual inspection it is concluded that the effectiveness of mortality prediction with MPI is superior and allows a better assessment of the post-surgical management.

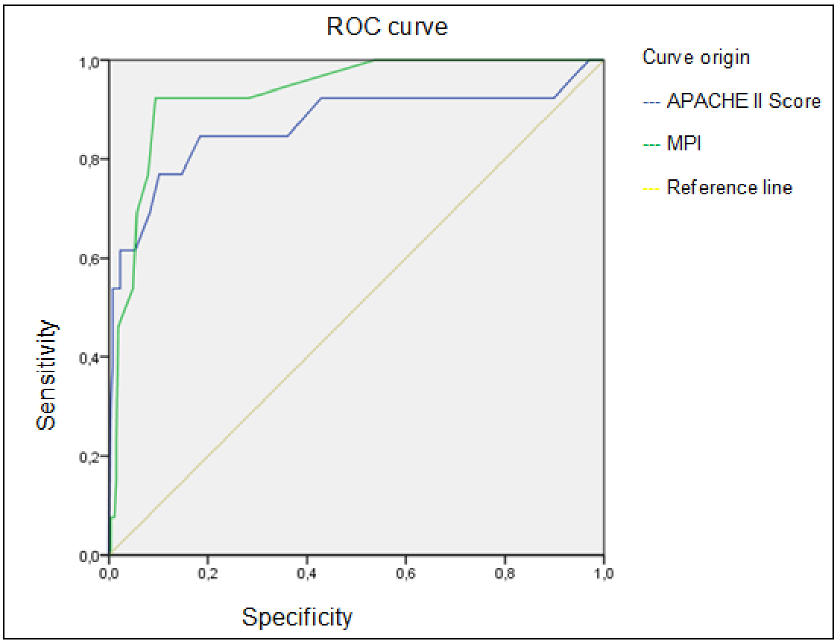

Figure 3: ROC curve to determine specificity and sensitivity of MPI versus APACHE II score

DISCUSSION

Generalized peritonitis is a frequent cause of death in many patients, despite the introduction of new surgical techniques, powerful antimicrobial agents, and the development of ICU [4, 18]. Currently, it occurs in 13% of patients admitted to surgery services [6] and mortality from this cause ranges from 35 to 80% [3].

This problem cannot be modified without knowing the factors that affect its prognosis. Its timely evaluation is fundamental to offer a correct therapeutic strategy, select the highest-risk patients for more aggressive procedures; scores are available to define the severity of the disease, thus, reducing morbidity and mortality.

Many studies have validated the MPI in countries with different socioeconomic, cultural and ethnic characteristics; however, validity of this test to determine the prognosis of patients with secondary peritonitis in our setting was needed. In this context, it was found that MPI is a very useful, simple, mortality predictor that integrates clinical variables and surgical findings with a high sensitivity and specificity.

Most patients in this study were female and mean age was 40 years, consistent with the Mexican MPI study, where female sex was predominant and average age range from 40-45 years [19]. The most common underlying cause of secondary peritonitis was acute appendicitis, followed by acute cholecystitis, differing from a Cuban study conducted in 2019, where the main cause was perforation syndrome [20].

Scores were applied to patients prior to the surgical intervention, which allowed a time frame to evaluate the evolution of the patients. After the surgery, however, it should be noted that the complications that occurred at the time of the surgical procedure fed the assessment scores and allowed changing the previous criteria.

MPI was the mortality predictor whidh presented the greatest effectiveness, with a 93.3%, within the ROC curve, and a slight margin of error; in contrast to APACHE II, with an 86.9% effectiveness.

It is important to indicate that these values could only be compared against the real result, that is, after patient evolution; this allowed that within the present study other assessments could be applied, such as cross tables with a cut-off point in the Jouden index of each curve, and risk index to determine the relevance of each predictor; finding that both presented significant relevance for the surgeon, although MPI had an advantage due to its high sensitivity and specificity.

The opportunity to estimate postoperative risk through a pre-surgical assessment is very useful to implement an appropriate therapeutic strategy. The ease of the MPI in terms of assessment of its parameters and utility in prediction of mortality (92.3% sensitivity, 90.6% specificity), showed superiority versus APACHE II score (72.09% sensitivity and 71.43% specificity) [8]; also, direct correlation of MPI with the mortality of our sample was demonstrated.

Despite diagnostic advances and predictive scores, mortality associated with bacterial peritonitis in our study was 4.3%, below the mortality found in a Cuban study, where its mortality rate reached up to 40% (1), this is due to the fact that in the Luis Vernaza Hospital the most frequent pathology treated in an emergency as a cause of abdominal sepsis was acute appendicitis, similar to the study by Reyes Dominguez et al. where the incidence of this pathology was 54.6% (20), this would also explain why mortality in our study is not significant [11].

In this research, the main limitation was the large number of patients, as acute abdominal pathology is very frequent. Also, incomplete patient information limits the results, as this was a retrospective study. Another cause of exclusion was already being surgically intervened in another health home, very frequent due to the health care level of the center. Follow-up was difficult to conduct since Luis Vernaza Hospital is a reference hospital and post-surgical consultation must be done at the primary hospital from which the patient comes; additionally, many patients do not live in the same city, coming from different cities in Ecuador, which further complicates continuing medical control.

Finally, other limitation was related to the surgical findings about the exudate sample, which are not always well detailed; the sample is sent to the laboratory and the laboratory only details the origin of the exudate but not its characteristics.

CONCLUSIONS

The most common pathology was acute appendicitis, the main complication was surgical site infection.

MPI presents greater sensitivity (92.3%) and specificity (90.6%) compared to the APACHE II score with a sensitivity (84.6) and specificity (73.3%), with a 95% CI and SE of 0.031.

Mortality was defined according to MPI cut-off score of 23 points: the higher the score above this cut-off point, the less survival the patient will have; APACHE II score revealed that with a cut-off point of > 14 points, there is a greater risk of death.

MPI showed superiority for demonstrating postoperative risk through direct surgical assessment and exudate characteristics as a finding, making it of easy application for a surgeon in an emergency setting, versus APACHE II score, which is more about clinical parameters that can greatly affect the time of sample collection and the failure of laboratory sample handling.

Although MPI presents an excellent response as a predictor of mortality, its assessment is not infallible since other factors remain unconsidered; and these may cause a patient who was assessed as having a low risk of mortality to be deceased.

ETHICS: This work was constructed based on the Helsinki Declaration.

Conflict of Interest: The authors declare no conflict of interest.

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REFERENCES

1. Rodríguez, C., Arce Aranda, C., & Samaniego, C. (2014). Peritonitis aguda secundaria. Causas, tratamiento, pronóstico y mortalidad.: Acute generalize peritonitis. Causes, treatment, prognosis and mortality. *Rev. Cir. Parag*, 18-21. Available from: http://scielo.iics.una.py/scielo.php?script=sci_arttext&pid=S2307-04202014000100004&lng=en&nrm=iso&tlng=es
2. RC, S., & SC, C. (1994). Laparoscopic Repair of Perforated Peptic Ulcer. *Semin Laparosc Surg*, 1(3), 182-189. Available from: https://pubmed.ncbi.nlm.nih.gov/10401055/
3. Ross, J. T., Matthay, M. A., & Harris, H. W. (2018). Secondary peritonitis: principles of diagnosis and intervention. *Bmj*, *361*. Available from: https://pubmed.ncbi.nlm.nih.gov/29914871/
4. Patterson, J. W., Kashyap, S., & Dominique, E. (2017). Acute abdomen. Available from: https://pubmed.ncbi.nlm.nih.gov/29083722/
5. Tochie, J. N., Agbor, N. V., Leonel, T. T. F., Mbonda, A., Abang, D. A., & Danwang, C. (2020). Global epidemiology of acute generalised peritonitis: a protocol for a systematic review and

meta-analysis. *BMJ open*, *10*(1), e034326. Available from: /pmc/articles/PMC6955529/

6. Yadav, S., Suthar, R., Meena, R., & Meena, R. S. (2020). A prospective study of effectiveness of Mannheim peritonitis index scoring system in predicting the morbidity and mortality in peritonitis due to hollow viscous perforation. *International Surgery Journal*, *7*(7), 2255-2260. Available from: https://www.researchgate.net/publication/342490312_A_prospective_study_of_effectiveness_of_Mannheim_peritonitis_index_scoring_system_in_predicting_the_morbidity_and_mortality_in_peritonitis_due_to_hollow_viscous_perforation
7. Fraccalvieri, D., & Biondo, S. (2009). Índices pronósticos de mortalidad postoperatoria en la peritonitis del colon izquierdo. *Cirugia española*, *86*(5), 272-277. Available from: https://www.elsevier.es/es-revista-cirugia-espanola-36-articulo-indices-pronosticos-mortalidad-postoperatoria-peritonitis-S0009739X09002061
8. Muralidhar, V. A., Madhu, C. P., & Sudhir, S. (2014). Efficacy of Mannheim peritonitis index (MPI) score in patients with secondary peritonitis. *Journal of clinical and diagnostic research: JCDR*, *8*(12), NC01. Available from: /pmc/articles/PMC4316291/
9. Godínez-Vidal, A. R., Vázquez-Rentería, R., Guerrero-Ponce, A. E., Hernández-Rodríguez, G. E., López-Romero, S. C., González-Calatayud, M., & Gracida-Mancilla, N. I. (2020). Uso de la escala WSES para predecir la mortalidad en pacientes con infección intraabdominal. *Rev Mex de Cirugía del Aparato Digestivo*, *9*(2), 65-70. Available from: https://www.imbiomed.com.mx/articulo.php?id=114700
10. Knaus, W. A., Draper, E. A., Wagner, D. P., & Zimmerman, J. E. (1985). APACHE II: a severity of disease classification system. *Critical care medicine*, *13*(10), 818-829. Available from: https://pubmed.ncbi.nlm.nih.gov/3928249/
11. Wacha, H., Hau, T., Dittmer, R., & Ohmann, C. P. S. G. (1999). Risk factors associated with intraabdominal infections: a prospective multicenter study. *Langenbeck's archives of surgery*, *384*(1), 24-32. Available from: https://pubmed.ncbi.nlm.nih.gov/10367626/
12. Sharma, R., Ranjan, V., Jain, S., Joshi, T., Tyagi, A., & Chaphekar, R. (2015). A prospective study evaluating utility of Mannheim peritonitis index in predicting prognosis of perforation peritonitis. *Journal of Natural Science, Biology, and Medicine*, *6*(Suppl 1), S49. Available from: /pmc/articles/PMC4630763/
13. Billing, A., Fröhlich, D., & Peritonitis Study Group. (1994). Prediction of outcome using the Mannheim peritonitis index in 2003 patients. *British journal of surgery*, *81*(2), 209-213. Available from: https://pubmed.ncbi.nlm.nih.gov/8156338/
14. Neri, A., Marrelli, D., Scheiterle, M., Di Mare, G., Sforza, S., & Roviello, F. (2015). Re-evaluation of Mannheim prognostic index in perforative peritonitis: prognostic role of advanced age. A prospective cohort study. *International Journal of Surgery*, *13*, 54-59. Available from: https://pubmed.ncbi.nlm.nih.gov/25475872/
15. Nerlekar, H., & Saygaonkar, H. V. V. (2020). MPI score assessment of perforation peritonitis patients. *International Journal of Research in Pharmaceutical Sciences*, 11(3), 4047–4053. Available from: https://ijrps.com/index.php/home/article/view/973/3683
16. Grynchuk, A. F., Polianskiy, I. I., Grynchuk, F. V., Sheremet, M. I., Moroz, P. V., Bocharov, A. V., & Andriets, V. V. (2020). Management of postoperative complications in patients with acute peritonitis. *Biointerface Research in Applied Chemistry*, *10*(2), 5273-5276. Available from: https://doi.org/10.33263/BRIAC102.273276
17. Koperna, T., Semmler, D., & Marian, F. (2001). Risk stratification in emergency surgical patients: is the APACHE II score a reliable marker of physiological impairment?. *Archives of surgery*, *136*(1), 55-59. Available from: https://pubmed.ncbi.nlm.nih.gov/11146778/
18. Paul, A. J., Toussaint, S., & Alouidor, J. (2020). Descriptive and correlational study of peritonitis in the surgical department of the State University hospital of Haïti (HUEH): A cross sectional study. *International Journal of Surgery Open*, *24*, 105-111.
19. Lada, P. E., Mariot, A., Tasonne, C. S., Mansilla, D., Casares, G., Caballero, F., & Saliba, J. (2016). Indice de Mannhein en el abdomen agudo perforado en pacientes mayores de 65 años. *Revista de la Facultad de Ciencias Médicas de Córdoba*, *73*(4), 240-245. Available from: https://revistas.unc.edu.ar/index.php/med/article/view/9459
20. Mesa Izquierdo, O., Ferrer Robaina, H., Mora Batista, R., Matos Ramos, Y. A., & Travieso Peña, G. (2019). Morbilidad y mortalidad por peritonitis secundaria en el servicio de cirugía. *Revista Cubana de Cirugía*, *58*(2). Available from: http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S0034-74932019000200006