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THE USEFULNESS OF THE MANNHEIM PERITONITIS INDEX SCORE IN ASSESSING THE CONDITION OF PATIENTS TREATED FOR PERITONITIS*

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The aim of the study was to verify the Mannheim Peritonitis Index (MPI) suitability to determine the probability of death among patients in Polish population operated due to peritonitis and to assess the possibility of using the Index to determine the risk of postoperative complications, relaparotomy and need for postoperative hospitalization in intensive care unit.
Material and methods. Retrospective analysis covered 168 patients (M: F = 83: 85, mean age = 48.45 years, SD ± 22.2) treated for peritonitis. The MPI score was calculated for each patient. According to MPI results, patients were divided to the appropriate groups (<21, 21-29, > 29) and within analyzed. The statistical analysis used Chi-square, Mann Withney U and Kolmogorov-Smirnov test. The best cut-off point for MPI was calculated on the basis of ROC analisys.
Results. Mortality in the study group was 13.1%. In groups <21, 21-29 and > 29 points according to MPI mortality was 1.75%, 28.13% and 50% respectively, the difference was statistically significant (p = 0.0124). Significant differences were observed in mortality depending on the diagnosis. Based on the ROC curve the cut-off point was identified as 32 with an accuracy of 85.9% and AUC = 81%. There has been a significant correlation between the MPI count and and the occurrence of: cardio-respiratory failure, acidosis, electrolyte imbalance, surgical wound complications, the need for treatment in the intensive care unit after surgery.
Conclusions. The MPI is a simple and effective predictor of death among patients operated due to peritonitis. It can also provide assistance in assessing the risk of postoperative complications and the need for treatment in the intensive care unit.
Key words: peritonitis, mortality, Mannheim Peritonitis Index (MPI)

Despite the progress in medicine, peritonitis remains associated with the risk of developing systemic instability and, in consequence, death (1-5). Management of such patients requires dynamic diagnostic and therapeutic actions. In order to facilitate identification of patients in the high-risk group, many prognostic scoring systems have been developed, including one of the simplest in use – the Mannheim Peritonitis Index (MPI).

The simplicity of the MPI results from the fact that it is based on measurable clinical parameters, in most cases routinely tested at admission to hospital, and on intraoperative assessment. It was developed in 1983 in Germany by Wach and Linder based on a retrospective analysis of medical records of patients with peritonitis. It had taken into account 16 possible risk factors. Finally, after clinical and statistical analysis of the collected material, 8 of them were used to create the scale (3). Since the creation of the scoring system, its usefulness has been confirmed on multiple occasions in clinical studies, e.g. in

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Germany, Brazil, Turkey or India (3, 4, 6-9).

The MPI is a scoring system created for easier prediction of death among patients with peritonitis and it has been used as such. A question arises whether it can be used for quick assessment of the risk of postoperative complications, the necessity of postoperative hospitalisation in an intensive care unit (ICU) and the need for relaparotomy in these patients. If so, assessment performed according to the MPI at admission may help plan further diagnostic and therapeutic steps and select the appropriate treatment, thus providing the best possible care.

The aim of the study was to verify the usefulness of the MPI in establishing the probability of death among patients in the Polish population undergoing surgery for peritonitis. The analysis included also the possibility of using the MPI score for quick assessment of the risk of postoperative complications, the necessity of postoperative hospitalisation in ICU and the need for relaparotomy in these patients.

MATERIAL AND METHODS

The analysis included patients treated for peritonitis in the 2nd Department of General Surgery Jagiellonian University in Cracow in 2012–2013. The studied group comprised 168 patients, including 83 (49.4%) males and 85 (50.6%) females. The mean age was 48.45 (17–93, SD ± 22.2) years. The most frequent cause of peritonitis in the analysed group was acute appendicitis – 85 (45.7%), followed by intestinal perforation (16 cases, 9.52%), acute gallbladder and bile duct diseases (14 cases, 8.33%) and intestinal necrosis (12 cases, 1.14%).

Other causes were markedly less common. Details are presented in tab. 1.

Each patient was assessed according to the MPI score (tab. 2). The MPI score is a prognostic scale used in patients with peritonitis. Selected clinical parameters are assigned a certain number of points at admission and during intraoperative assessment. Their sum constitutes the assessment of death prediction in these patients.

Based on the obtained Mannheim score, patients were assigned to one of three groups, which limits were determined on the basis on the studies conducted by the authors of the scoring system. The first group included patients who obtained a total of points lower than 21; the second group – patients who obtained between 21 and 29 points; and the third – those who obtained more than 29 points (3).

Based on a plotted ROC curve, the optimum cut-off point was identified for the MPI. The optimum cut-off point in the ROC curve is a diagnostic value which most adequately divides the studied population into two groups: the first where a given phenomenon occurs with a significantly higher frequency, and the second where it is less frequent or non-existent. In the case of the MPI this value is the number of points enabling to divide admitted patients into the group of high risk of death and the group of low risk of death. The sensitivity, specificity and effectiveness of the MPI decision rule were noted for the selected cut-off point.

The statistical analysis was performed using Statsoft Statistica 10 software, based on the following tests: chi-square test, Mann Whitney U test and Kolmogorov-Smirnov test. Statistical significance was assumed for $p < 0.05$.

RESULTS

Significant differences in mortality were observed depending on diagnosis. Mortality

Table 1. Causes of peritonitis in the analysed group – demographic data

Cause	n	%	Females n (%)	Males n (%)	Mean age (years)
Acute appendicitis	85	50,6	39 (45,88%)	46 (54,12%)	36±16
Intestinal perforation	16	9,52	9 (56,25%)	7 (43,75%)	68±13
Acute bile duct and gallbladder diseases	14	8,33	8 (57,14%)	6 (42,86%)	63±18
Intestinal necrosis	12	7,14	8 (66,67%)	4 (33,33%)	79±8
Peptic ulcer perforation	9	5,36	3 (33,33%)	6 (66,67%)	46±21
Other	32	19,05	18 (56,25%)	14 (43,75%)	54±21

Table 2. Mannheim Peritonitis Index (MPI)

Risk factor		Score
Age > 50 years		5
Female sex		5
Organ failure		7
Cause associated with a neoplastic process		4
Diffuse peritonitis		6
Presence of symptoms > 24 h prior to procedure		4
Exit site outside of the colon		4
Nature of fluid in the peritoneal cavity	clean	0
	purulent	6
	faecal	12

rate in the overall studied group was 13.1%. The highest mortality rate was noted among patients with intestinal perforation or necrosis and amounted to 56.25% and 41.67%, respectively. Zero mortality was observed among patients with acute appendicitis and peptic ulcer perforation. The causes of peritonitis, along with mean MPI score, mortality and frequency of ICU admissions as well as division into respective groups based on MPI score, are presented in tab. 3.

In the vast majority of patients (114 cases, 67.86%) MPI score ranged between 0 and 20 points. Patients in this group were significantly younger than the remaining ones. The mean age was 39.31 years (± 17.68). Less frequently (32 cases, 19.05%) MPI score ranged between 21 and 29 points. Here the mean age was 62.66 years (± 1.41). In 22 patients this index was above 29. Those patients were the oldest, 75.18 years (± 4.95).

Mortality rate depended in a statistically significant manner on the number of points in the MPI score. Among patients who obtained less than 21 points it was 1.75%. In the group of patients who obtained between 21 and 29 points mortality was 28.13%, while in patients who obtained more than 29 points in the MPI score mortality was the highest, amounting to more than 50%. The difference was statistically significant (p = 0.0124). The demographic structure of these groups is presented in tab. 4.

Based on a plotted ROC curve, the optimum cut-off point of 32 for the Mannheim score was identified. This means that patients who obtained the score not exceeding 32 were assigned to the group of low risk of death, while those who obtained more than 32 points were assigned to the high-risk group. The effectiveness of the MPI decision rule for the cut-off point of 32 was 85.9%. To assess the predictive power of the Mannheim score, area under curve was analysed, amounting in this case to exactly 81%. The noted sensitivity and specificity were 66.7% and 97.9%, respectively.

The most frequently observed postoperative complications are presented in tab. 5.

32 patients required continuation of treatment in ICU. 10 patients required reoperation. Analysis of complications that occurred in the observed patients revealed a statistically significant relationship between MPI scores and

Table 3. Causes of peritonitis in the analysed group – obtained MPI scores

Cause	ICU	Mortality (%)	MPI (± SD)	Group I (0-20)	Group II (21-29)	Group III (>29)
Acute appendicitis	2 (2,35%)	0	11,5± 17	81	4	0
Intestinal perforation	8 (50%)	56,25	29,2±9,2	1	8	7
Acute bile duct and gallbladder diseases	1 (7,14%)	7,14	19,3±20,5	9	3	2
Intestinal necrosis	8 (66,67%)	41,67	26,8±10,6	3	4	5
Peptic ulcer perforation	0	0	21,1±9,9	5	2	2
Other	7 (21,88%)	21,88	21,9±11,3	15	11	6

Table 4. Characteristics of groups formed based on the obtained MPI score

MPI group	I (0-20)	II (21-29)	III (>29)	p value
N	114	32	22	
Sex (F/M)	48 (42%)/66 (58%)	20 (62,5%)/12(37,5%)	17 (77,3%)/5(22,7%)	0,0032
Age	39,31±17,68	62,66±1,41	75,18±4,95	<0,0001
ICU	4 (3,51%)	8 (25%)	14 (63,64%)	<0,0001
Death	2 (1,75%)	9 (28,13%)	11 (50%)	<0,0001

the occurrence of cardiorespiratory failure ($p < 0.0001$), acidosis ($p = 0.0001$), electrolyte disorders ($p = 0.0002$), necessity to continue treatment in ICU after surgery ($p < 0.0001$) and postoperative wound complications ($p = 0.021$) (tab. 6). The difference in MPI scores in patients who required relaparotomy and patients in case of which there was no such requirement is not statistically significant ($p = 0.0712$).

DISCUSSION

As late as in the end of the 19th century, 90% of treated peritonitis cases led to death (10). Since that time, thanks to the progress of surgical techniques, new drugs and antibiotics, modern intensive care, better access to medical aid and better understanding of the pathophysiology of this disease, mortality rates decreased markedly. Unfortunately, despite the progress of medicine, peritonitis is still associated with high mortality of 10–20%, in some studies even exceeding 60% (1, 4, 11, 12).

Many factors contribute to the final treatment outcome of patients with peritonitis. They include factors associated with the cause of the condition, patient-dependent factors as well as those connected to diagnostic and therapeutic steps taken or lack thereof. The multitude of factors influencing the final outcome of treatment renders prognosis difficult (13). Early stratification of patients depending on the seriousness of their condition would facilitate taking adequate diagnostic and therapeutic steps and thus allow reduction in mortality and frequency of serious complications. An adequately selected scoring system would also allow for better comparison of different diagnostic and therapeutic strategies as well as treatment outcomes. The analysed Mannheim score seems a simple and effective predictor of death among patients undergoing surgery for peritonitis (7, 9, 14, 15, 16).

After assuming 32 as the cut-off point of the score, the effectiveness of the decision rule was 85.9%, and the predictive power was very high – the area under the ROC curve in this case was 81%, with sensitivity and specificity amounting to 66.7% and 97.9%, respectively. In the original study by Wach and Linder, the calculated cut-off point was 26 points. In the

Table 5. Most frequently observed complications

Complication		No. of cases	Degree according to the Clavien–Dindo classification
Cardiorespiratory failure		24	IVb
Acidosis		14	IVa
Electrolyte disorders		9	I
Intra-abdominal complications (haematomas, dehiscence of anastomosis, necrosis, ulcers, fistulae)		12	IIIa/III
Post-operative wound complications	wound infection and suppuration	7	I/II
	postoperative wound dehiscence, haematomas and necrosis within the wound	7	I
Septic shock		6	IVb
Pneumonia		2	II
Embolism/thrombosis		2	II
Acute coronary syndrome		1	IVa

Table 6. Complications associated with MPI score in a statistically significant manner

Complications	Yes		No		p-value
	No.	median MPI	No.	median MPI	
Requiring treatment in an ICU	26	30	142	15	p<0,0001
Cardiorespiratory failure	24	29,5	144	15	p<0,0001
Electrolyte disorders	9	29	159	15	p=0,0002
Acidosis	14	28	154	15	p=0,0001
Post-operative wound complications	14	24	154	15	p=0,021

original study, the values of the effectiveness of the decision rule, sensitivity and specificity were, respectively, 81%, 84% and 79% (3). Other authors also observed high sensitivity (86–100%) and low specificity (16–74.8%) of the score in their studies (6, 8, 9, 15, 17). Biling, in his meta-analysis, reported mean sensitivity of 86% (54–98%), specificity of 74% (58–97%) and accuracy of 83% (70–94%) for 26 points (4). In later years there appeared several reports of the best cut-off point of 29, which in Wabwires' studies had predictive power of 91.6% with sensitivity of 88.9% and specificity of 85.2% (18), while in Ntirenganya's works the values were, respectively, 90.3%, 88.2% and 74.8% (19). By contrast, Correira in an analysis of MPI use in cancer patients, adopted the cut-off point of 21, where AUC equalled 69.5%, accuracy – 69.7%, and sensitivity – 87.3% (9).

In Wach and Linder's study, in the group of patients who obtained less than 21 points, mortality rate was 6%, while among patients who achieved more than 29 points it exceeded 50% (3). In other studies, mortality among patients who obtained < 21 points varied between 0% and 2.3%, in the 21–29-point group – between 3.85% and 60% and in patients with score of > 29 – between 15% and 100% (11, 20-23). Biling's meta-analysis demonstrated the following mean mortality rates in the groups with less than 21 points, between 21 and 29 points and above 29 points: 2.3% (0–11%), 22.5% (10.6–50%) and 59.1% (41–87%), respectively (4). In the present study, mortality rates among patients in the respective groups were 1.75%, 28.13% and 50%. In Paduszyńska's analysis, in a group of patients who obtained up to 15, between 16 and 30 and above 30 points mortality amounted to 0.9%, 4.8% and 44.2%, respectively (24). Such big differences in mortality may result from demographic differences of the studied patients, different exclusion criteria and differences in diagnostic and therapeutic processes.

What draws one's attention when comparing the results of studies of the MPI conducted in the last 30 years is the repetition of the most important risk factors in a significant number of studies, namely: organ failure, age above 50 years, faecal nature of fluid in the peritoneal cavity, neoplastic cause, exit site outside of the colon, diffuse peritonitis and presence of symptoms more than 24 h before the procedure. The greatest discrepancies may be noted in the case of sex, which is not confirmed e.g. by Correira's and Ntirenganya's studies. What needs to be taken into account, however, are demographic differences of the studied groups (6, 8, 9, 19, 21, 23, 25).

Analysis of the collected material revealed that division of patients based on the obtained MPI score may help assess the risk of developing serious disturbances of the general condition in the postoperative period as well as the necessity of continued treatment of the patient in an intensive care unit or relaparotomy. Sensible use of the score will facilitate identification of patients in the high-risk group, thus possibly raising awareness of their increased risk of postoperative complications, such as: cardiorespiratory failure, acidosis, electrolyte disorders and postoperative wound complications.

Despite the fact that the Mannheim score is easy to use and effective in predicting mortality, it cannot be used as a preoperative system used at admission to stratify patients based on the risk of death, since it requires consideration of intraoperative assessment, such as the nature of fluid in the peritoneal cavity and anatomical exit site as well as histopathological assessment (a cause of neoplastic or non-neoplastic origin). Other disadvantage of the score is the fact that it does not take into account chronic diseases and major systemic disorders, which are very important risk factors for death and serious complications.

To sum up, stratification of patients with peritonitis to different risk groups is beneficial. Thanks to it the management, diagnostics and treatment of patients may be optimised, avoidance of serious complications – more effective, and a decision to start intensive treatment – easier and quicker to take. Such division also facilitates making a decision to perform the most beneficial surgical procedures for a given risk – radical for lower-risk patients and more restricted or less burdening in the case of patients from the high-risk group (1). Furthermore, using a system of assigning patients to different groups allows for accurate and reliable comparison of different diagnostic and therapeutic actions in clinical studies (24). It is recommended, however, to establish an optimum cut-off point for each studied group depending on the demographic characteristics of the studied population in order to achieve the highest possible predictive power.

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