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Peritonitis Outcome Prediction using Mannheim Peritonitis Index at St. Francis Hospital Nsambya, Kampala - Uganda

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Background: ***A wide variety of disease states give rise to intra-abdominal infection [1]. While varying according to age, gender and geography, the three most common causes of generalized peritonitis in low-income countries are probably appendicitis, perforated duodenal ulcer and typhoid perforations, in no particular order [2].The management of peritonitis for a long time has presented a challenge to surgeons despite different advancements in the field of medicine. This led to the development of disease severity grading systems that would aid in classifying patients by individual risk factors and hence appropriately predict possible outcome. Mannheim Peritonitis Index (MPI) which was developed by Wacha and Linder in 1983 is one of the scoring tools being used to predict outcome. MPI was used to assess outcome in patients with peritonitis at Nsambya hospital. The objective was to predict outcome using the MPI in patients with peritonitis at Nsambya Hospital.***
Methods: ***Retrospective and Prospective evaluation of the MPI score was performed for patients with peritonitis who underwent surgical treatment at Nsambya Hospital for 15 months (Jan 2012- march 2013).***
Results: ***Of the 62 patients included, 29 patients were retrospective and 33 patients prospective, 46 (74.2%) were males while 16 (25.8%) were females, giving a male to female ratio of 3:1. The mean age of presentation was 30.79 (Sd15.55) years, the youngest being 11 years and the oldest 77 years.***
The mean MPI was 21.92±6.02 points with 10 points as the lowest score and 37 points as the highest score. 58.1% of our patients had an MPI score < 21and 29% MPI 21-29 and 12.9% MPI>29. No death was noted at MPI<21, 2 deaths at MPI 21-29 and 1 death at MPI >29.
The most significant predictive factors for morbidity/mortality in this study were the presence of organ failure and female gender. The ROC curve for morbidity showed a predictive power of 0.875 with a sensitivity of 84.2% and a specificity of 90.7% at MPI of ≥26 points. The predictive power of the MPI for mortality was 0.579 with a sensitivity of 15.8% and a specificity of 100% at MPI score of ≥26 points. The positive predictive value and negative predictive value for morbidity and mortality at MPI≥26 points were 75.9%, 94.4% and 100%, 95.9% respectively.
Conclusion: ***The MPI score is a good tool in predicting morbidity than mortality at Nsambya hospital and can be used to evaluate outcome in patients with peritonitis.***

Key words: Peritonitis, Prediction, Outcome, Mannheim Peritonitis Index

Introduction

Peritonitis, the inflammation of the serosal membrane lining the abdominal cavity and contained viscera, is associated with a high mortality rate [3]. Despite surgical treatment, sophisticated intensive care units, latest generation antibiotics and a better understanding of peritonitis's pathophysiology, the mortality rates are still high, ranging from 10-30% even in good centers [4, 5].

The outcome of an abdominal infection depends on the complex interaction of many different factors and the success obtained with the early onset of specific therapeutic procedures [3]. Early prognostic evaluation of abdominal sepsis is desirable to identify high-risk patients for more aggressive therapeutic procedures such as radical debridement, lavage systems, open management, and planned reoperations in cases where source control has not been achieved [5,6].

Many scoring systems have been invented for assessing risks of death in patients with peritonitis. Nevertheless similar results have been achieved with the Mannheim Peritonitis Index (MPI) which was developed by Wacha and Linder[7] in 1983. It was developed based on the retrospective analysis of data from 1253 patients with peritonitis, in which 20 possible risk factors were considered. Of these only 8 proved to be of prognostic relevance and were entered into the MPI, classified according to their predictive power. Patients with a score exceeding 26 were defined as having a high mortality rate. The index takes into account the patients age and gender, organ failure, malignancy as the source of contamination, preoperative duration of symptoms greater than 24 hours, origin of sepsis other than colonic, extent of spread and character of peritoneal fluid. The effectiveness of the MPI as a reliable predictor of the peritonitis outcome was also confirmed after investigation exceeding two thousand patients from several European surgical units [8, 9]. Prognosis in peritonitis is strongly influenced by the health status of the patient at the start of treatment, and hence prediction of outcome can be made on the basis of risk scores determined then.

Patients and Methods

It was both a retrospective and prospective observational study done over a period of 15 months. The Retrospective arm from January 2012 to August 2012 and Prospective arm from September 2012 to March 2013. Patients in the retrospective arm were recruited when their medical files had satisfactory information required for the study. In the Prospective arm, patients were consecutively enrolled until the sample size was achieved. The study was conducted in the department of Surgery of Nsambya Hospital which is a tertiary referral faith based private not for profit hospital founded by Franciscan Sisters in 1903. All surgically managed patients with peritonitis were included meanwhile all patients with peritonitis who were medically managed or transferred in after laparotomy for peritonitis, or transferred out to continue treatment elsewhere were excluded. The sample size was calculated using Fisher's formula and was 60 patients. Patients who met the inclusion criteria were enrolled in the study.

Prospective candidates for inclusion in the study were recruited by investigator at the initial visit at the emergency department. Following a complete history taking and physical exam and a diagnosis of peritonitis, full blood count, urea and electrolytes, liver function tests were done and imaging studies ultra sound scan, plain abdominal X-ray were done to confirm or exclude the diagnosis. The patients were resuscitated and targeting systolic BP > 100mmHg, pulse <100 beats. They were prepared for emergency surgery, unless they were unfit for surgery where further resuscitation and monitoring were continued from the ward until they were fit for surgery. Following anesthetic evaluation, the patients were transferred to theatre. At operation the diagnosis was made or confirmed and the underlying cause of peritonitis determined. According to the findings the following were done; appendisectomy, abscess drainage, repair of perforation was done. Medical peritonitis was not further explored. The colon, small bowel were explored and quantity and distribution of peritoneal fluid or abscess were recorded. Copious lavage with 6 litres or more of normal saline was undertaken until the last effluent was free of pus, inflammatory exudates or fibrinous sediments. Where abscess was found, a peritoneal closed drain directed to the sub diaphragmatic spaces was left in situ.

Postoperatively patients were monitored for resolution abdominal signs and return of bowel sounds. The complications that occurred were also recorded. The end point of the treatment was complete resolution of abdominal signs and return of bowel function. The study was terminated when the patient was discharged from the hospital or died. There was no follow up study. All specimens recovered from operation were subjected to histopathology for malignancy. The Total MPI score was obtained by appropriately scoring as shown in the table 1 below. Total patient MPI score was the sum total of all the positive risk factor scores. Morbidity was considered if patient's hospital stay exceeded 14 days or if any of the following complications arose: chest infection, surgical site infection, wound dehiscence, fistulation or ileus lasting more than 5 days, DVT and pulmonary embolism.

Table 1. Mannheim Peritonitis Index (MPI) Score.

Risk factor	Yes	No
Age >50 years	5	**0**
Female gender	5	**0**
Organ failure	7	**0**
Malignancy	4	**0**
Preoperative duration >24 hours	4	**0**
Origin of sepsis not colonic	4	**0**
Diffuse peritonitis	6	**0**
***Exudates:* Clear**	**0**	**0**
Cloudy/purulent	**6**	**0**
Faecal	**12**	**0**

In the Retrospective arm, Theatre operation records and ward admission records were used to generate a list of patients who had been managed for peritonitis within the study period. Using the list, admission files for patients who had peritonitis from January 2012 to August 2012 were retrieved. The data in the files were analyzed and used to complete the questionnaires and only files with required information were included in the study.

From the data collection sheets, data were progressively entered in Microsoft Excel Sheet. At the end of collection, data was transferred to Medcalc Biomedical statistical software version 12.5.0for analysis. Descriptive statistics used included mean, mode, median, standard deviation, measure of central tendencies and 2 x 2 tables were used for comparison of outcomes. Confidence intervals of 97% were applied as necessary. Chi-square was used as a statistical test. Individual patient MPI score and respective outcome were determined followed by stratification of the scores into 3 main groups of <21 points, 21-29 points and >29 points. Morbidity and mortality rates for the stratified MPI scores were calculated and the predictive power of the MPI, sensitivity and specificity derived from receiver-operator characteristic (ROC) curve analysis. Negative and positive predictive values were also calculated.

Results

A total of 62 patients were recruited in the study, 29 retrospectively and 33 prospectively. Forty six (74.2%) of the patients were males and 16 (25.8%) were females with a male to female sex ratio of 2.9:1. Their ages ranged between 11 and 77 with a mean of 30.8 years (Table 2). Table 3 shows the risk factors included in the MPI. Table 4 shows the source of infection. Perforated

duodena ulcer and perorated appendix were the commonest source of sepsis. The two accounted for two thirds (66.1%) of the cases. Perforated ileum was the third and accounted for 8 (12.9%) of the causes. There was one case of primary peritonitis. Only 12 of the 62 patients in this study were operated within 24 hours of onset of symptoms. Seventy seven percent were operated within 5 days after onset of symptoms and 8% of patients were operated after 14 days of onset of symptoms. The longest preoperative duration of symptom was 30 days and this was due to the fact that the patient had atypical presentation of peritonitis.

Table 2. Sex and age distribution

Variable		Frequency/Value	Percentage
Sex	Male	46	74.2
	Female	16	25.8
Age	<50	55	88.7
	>50	7	11.3
	Mean	30.8 years	-
	Youngest	11 years	-
	Oldest	77 years	-

Table 3. Risk factors included in MPI

Variable		Frequency/Value	Percentage
Organ dysfunction	Yes	13	21.0
	No	49	79.0
Preoperative Duration of symptoms	<24 hours	12	19.4
	1 - 5 days	36	58.1
	6 - 10 days	9	14.5
	>10 days	5	8.0
	Mean	4.5 days	-
	Range	1-30 days	-
Organ dysfunction	Ileus	5	8.0
	Renal	2	3.2
	Shock	6	9.8
	None	49	79
Malignancy	Gastric adenocarcinoma	1	1.6
Extend of exudate	4 quadrants	27	43.6
	2-3 quadrants	23	37.1
	Localized	12	19.1
Character of exudates	Cloudy	56	90.0
	Fecal	6	10.0

Table 4. Source of sepsis

Source	Frequency/Value	Percentage
Appendicitis	3	4.8%
Ovarian Abscess	1	1.6%
Para Nephric Abscess	1	1.6%
Pelvic Abscess	1	1.6%
Perforated Appendix	**14**	**22.6%**
Perforated Duodenal Ulcer	**27**	**43.5%**
Perforated Gastric Ulcer	4	6.5%
Perforated Ileum	**8**	**12.9%**
Perforated Sigmoid Colon	2	3.2%
Primary Peritonitis	1	1.6%

Table 5. Morbidity and Mortality

Variable		Frequency/Value	Percentage (%)	Overall %
Causes of morbidity	Enterocutaneous Fistula	2	3.2	-
	Pneumonia	1	1.6	-
	Septic shock	3	4.8	-
	Wound sepsis	14	22.6	-
Morbidity	Male	8	17.4%	32.0
	Female	12	75.0	
Mortality	Female	2	12.5	4.8
	Male	1	2.2	
Hospital stay	Mean	8.7 days	-	-
	Range	1-54 days	-	-
	In morbidity (mean)	13.6 days	-	-
	No morbidity(mean)	6.4 days	-	-
	Survivors (mean)	9.1 days	-	-
	Non survivors(mean)	2.0 days	-	-
Reoperations		3	4.8 %	-

Those who were operated within 24 hours after onset of symptoms had a morbidity of 8.3% and mortality of 16.7% meanwhile those who were operated after 24 hours of onset of symptoms had a morbidity of 38.8% and mortality of 2%. Table 5 shows the morbidity and mortality associated with peritonitis. The commonest cause of morbidity was surgical site infection recorded in 14 (22.6%) of the cases. Three patients had re-operation. Two patients developed entero-cutaneous fistulas. There were three deaths (mortality rate = 4.8%).

Table 6. Analysis of MPI Scores

Variable		Value/ Frequency	Percentage	Morbidity	Mortality
MPI	Mean	21.92(Sd 6.05) points	-	27.8 points	28.3 points
	Range	10- 37 points	-	-	-
	Female (mean)	28 points	-	-	-
	Male (mean)	19.8 points	-	-	-
MPI groups	<21 points	36	58.1%	2 (5.6%)	0 (0%)
	21-29 points	18	29%	11 (61%)	2(11.1%)
	>29 points	8	12.9%	7 (87.5%)	1(14.3%)
MPI ≥ 26 points		19	30.6%	16 (84.2%)	3 (15.8%)
	Relative risk	-	-	9.05 times (P<0.0001)	15.4 times (p= 0.066)
	Wound sepsis	12	63.2%	-	-
	Septic shock	3	15.8%	-	-
	Fistula	1	5.2%	-	-
	Pneumonia	1	5.2%	-	-
	Reoperation	1	5.2%	-	-
	Sensitivity	-	-	84.2%	15.8%
	Specificity	-	-	90.7%	100%
	Positive predictive value	-	-	75.9%	100%
	Negative predictive value	-	-	94.2%	95.9%

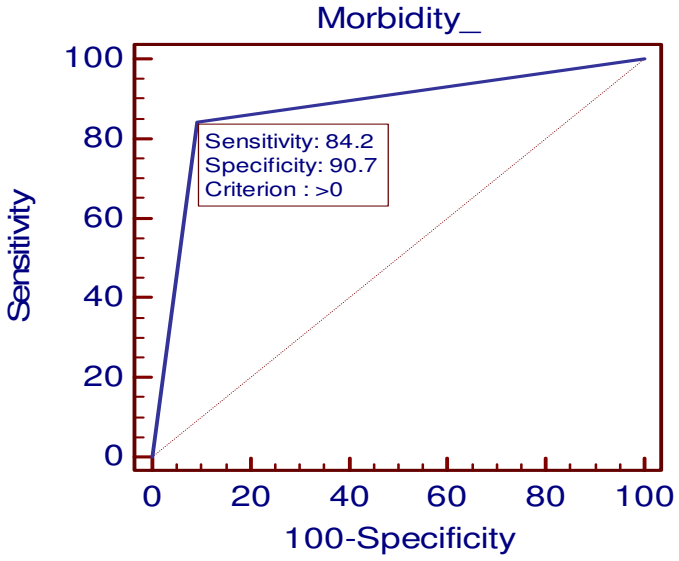

Figure 1. Morbidity ROC Curve for MPI≥26, AUC = 0.875

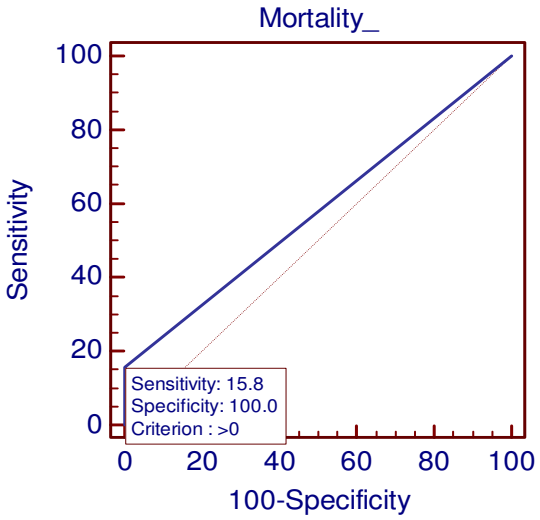

Figure 2. Mortality ROC Curve at MPI ≥26, AUC=0.579

The average hospital for the survivors and non-survivors was 9.1 and 2.0 days respectively. The mean MPI for morbidity in this study was 27.8 points (19.2points for no morbidity) with group morbidity rates rising progressively from 5.6% at MPI< 21 points to 87.5% at MPI >29 points. Mortality also rose from 0% at MPI <21 points to 14.3% at MPI>29 (Table 7).

Table 7. Significant Risk Factors Included in the MPI

Risk factor		MPI		Statistical test		
		<26	≥ 26			
Female gender	Yes	5	11	χ2=12.415: (0.0004) significant	1df:	P<0.05
	No	38	8			
Organ dysfunction	Yes	1	11	χ2=22.631: (0.0001) significant	1df:	P<0.05
	No	42	8			
	No	40	13			

Discussion

The majority of the patients were young with a mean age of 30.79 ± 15.5 years and 75.8% of the study group falling in the 10-40 years age category. Rodolfo et al[10] in Mexico reported a similar distribution with a mean of 34.6 years and median of 27 years [11] but studies from Europe show a much older age group with a range of 44-58 years. The explanation could also be due to the major etiological cause of peritonitis being perforated diverticulum and malignant perforations in Europe which occurs in older age group [3, 5, 12, 13]. In contrast to our setting where the major

etiological cause of peritonitis was perforated peptic ulcers which is known to occur in younger age group and has a strong association with H. pylori that is prevalent in developing countries with low socioeconomic status like ours [14, 15].

Early operation within 24 hours carried a lower morbidity compared to operation after 24 hours of onset of symptoms. Though statistically there was no significant difference in morbidity (p = 0.103) and hospital stay (p = 0.257) between those who were operated within 24 hours of onset of symptoms and those operated after 24 hours of onset of symptoms. Wabwire [16] found similar findings however Ntirenganya, Ntakiyiruta and Kakande [17] and Seiler et al [3] found that operation after 24 hours of onset of symptoms was associated with morbidity and mortality. The explanation could be that in the later studies the major causes of peritonitis was ileal[17] and colonic perforation[(1)] respectively and therefore more virulent bacterial contamination from the sources accounted for the poorer outcome after 24 hours of onset of symptoms compared to our study where there was less virulent bacterial contamination from the perforated peptic ulcers.

Shock was the most frequent organ dysfunction encountered; 2 out of 13 of the patients who had organ dysfunction died. They presented with irreversible septic shock despite resuscitation and source control the outcome could not be changed. Eight out of the thirteen patients who had the organ dysfunction had morbidity. The influence of organ failure on outcome has been highlighted in previous studies, with some noting increasing mortality with more organs failing and as high as 100% mortality were reported where 4 organs were failing [3,4,18,19]. This study found organ failure was associated with morbidity and mortality though only two patients had more than one organ dysfunction (Septic Shock and renal dysfunction).

The mean MPI of 21.92 ± 6.05 points in this study compares well with previous studies. Sailer et al [3] analyzed 258 patients with an exclusive diagnosis of generalized peritonitis and reported so far the highest mean of 27.1 points. Bielecki , Karminski and Klukowski [20] found a mean of 24.2 points amongst patients with large bowel perforation. In this study, the mean male MPI score of 19.8 points was lower than the overall study mean compared to female's mean of 28 points. Females compared poorly to their male counterparts recording higher gender morbidity (73.3%) and mortality (12.5%) rates compared to males with 19.1% morbidity and 2.1% mortality. Like in other previous studies female gender was one of the risk factors for morbidity in this study [3, 20].

The MPI for morbidity and mortality trend in this study is similar to what other studies have found[3, 17, 20]. The overall mortality rate of 4.8% is quite lower than rates from European studies of 6% to 42% [3, 8, 10, 13, 20, 21]. Regionally, a rate of 12.9% was found in Kenya and 17% in Rwanda [16, 17]. The mean MPI for non survivors was 28.3 points (21.7 points in survivors) and compared favorably with other studies that gave a range of 26.3 -32.7 points [3, 8, 13, 21]. In a meta-analysis of results from 7 centers involving 2003 patients, Billing et al[(8)] reported an average group mortality rate of 2.3% for MPI <21 points, 22.5% at MPI of 21-29 points and 59% with MPI of >29 points. In this study, the group mortality rate were generally lower but appear to follow this pattern as no mortality occurred at MPI <21 points, was 11.1% with MPI 21-29 points and was14.3% with MPI >29points. Differences in patient's sex, age, sepsis source and co morbidities between our study populations may have been responsible for the lower mortality rates observed in this study. Also Nsambya hospital surgery department had an overall low annual mortality of 3.14% in 2012[(22)] which could have reflect good management of patients or the patients that were presenting were not very sick and not having co morbidities.

Multi-organ failure is the most common cause of death in peritonitis. It is often a sequel of severe sepsis, the progenitor of systemic inflammatory response syndrome (SIRS) in this setting, which culminates in multi-organ dysfunction syndrome (MODS) and eventually multi-organ failure (MOF)[3, 8, 10, 13,21]. Two out of the 3 patients who died had developed irreversible septic shock, followed by renal failure and cardio-respiratory arrest despite aggressive resuscitation and source control. Morbidity increased hospital stay significantly to a mean of 13.6 days (6.4 days without morbidity) eventually pushing the overall mean hospital stay to 8.7 days, a finding that was in keeping with other studies [8, 21, 23]. The patients who had morbidity (wound sepsis, fistulae, and pneumonia) had longer hospital stay in order to have the complications managed. Prolonged hospital stay correlated with MPI ≥26 points in this study.

The most significant predictive factors for morbidity/mortality in this study were female gender and organ dysfunction. Sailer et al[3] whose study focused on generalized peritonitis reported similar findings except that they found preoperative duration of symptoms also to significantly influence eventual mean MPI from 23.2 to 29 points.

This study attained a morbidity predictive power of 0.875 by ROC curve analysis. This has shown an excellent discrimination, with a good sensitivity of 84.2% and good specificity of 90.7% at a score of ≥26 points. This means MPI of ≥ 26 points can predict morbidity with good precision and it is similar to other studies [3, 8, 11, 19, 21]. In the ROC curve for mortality, Biondo et al [21] reported a predictive power of 0.725 at a MPI score of ≥26 points. Billing et al [(8)] in a Meta analysis of 2003 patients reported a mean sensitivity of 86% (54%-98%) and specificity of 74% (58%-97%) at a score of ≥ 26 points. This study attained a mortality predictive power of 0.579 with a sensitivity of 15.8% and specificity of 100% at an MPI ≥26 points. This result shows no discrimination for mortality and is not statistically significant for predicting mortality though it is very specific for those who will not die. The low mortality recorded in the study could explain these findings.

Studies evaluating the usefulness of the MPI in outcome prediction in comparison with other scoring systems have shown that it compares well with most of them, if not superior. Validation studies comparing its strength in outcome prediction with established scoring systems like acute physiology and chronic health evaluation (APACHE) II have shown that the two are accurate predictors of early outcome in peritonitis [8, 19,21]. Overall, our results validate MPI usefulness in risk evaluation for morbidity. This study showed a statistically significant positive predictive value of 75.9% and negative predictive value of 94.2% for morbidity and positive predictive value of 100% and negative predictive value of 94.9% for mortality at MPI≥26

Conclusion

Increasing Mannheim Peritonitis Index score predicts poor outcome especially the morbidity. The MPI score of ≥26 had a good sensitivity of 84.2% and specificity of 90.7% in predicting morbidity. Paying close attention in these patients to maximally support vital systems and to prevent complications is crucial for their eventual prognosis. Therefore MPI can be a useful tool that can be used in our setting for predicting outcome in peritonitis and stratification of management.

Recommendations

From the findings of this study, it is recommended that:-

1) The MPI score be adopted as a risk evaluation tool in management of patients with secondary peritonitis at Nsambya hospital with the aim of identifying and aggressively managing high risk patients so as to improve outcome
2) Longer duration similar study could be done to further investigate the MPI and mortality with more cases of mortality included.
3) Findings of this study can be used to develop a protocol for management of patients with peritonitis and guidelines for admission of patients with peritonitis into HDU/ICU.

References

1. Levinson M&BL. Peritonitis and Intra-abd Abscesses. In: Mandell B&D, editor. Principles and Practice of Infectious Diseases. Churchill Livingstone, 2005.
2. Gupta S, Kaushik R. Peritonitis - the Eastern experience. World J EmergSurg 2006; 1:13. PM:16759427
3. Seiler CA, Brügger L, Forssmann U, Baer HU, Büchler MW. Conservative surgical treatment of diffuse peritonitis. Surgery 2000; 127: 178-84.
4. Malangoni MA. Contributions to the management of intraabdominal infections. [Review] [30 refs]. American Journal of Surgery 2005; 190(2):255-259. http://hinari-gw.who.int/whalecomwww.sciencedirect.com/whalecom0/science/journal/00029610
5. Correira MM et al, Prediction of death using the Mannheim peritonitis Index in oncologic patients, RevistaBrasileira de Cancerologia, 2001, 47(1): 63-68
6. Wittman DH. Intra-abdominal infections: pathophysiology and treatment. New York: Marcel Dekker, 1991: 48-51.
7. Wacha H, Linder MM, Feldman U, WeschG, Gundlach E, Steifensand RA. Mannheim peritonitis index - prediction of risk of death from peritonitis: construction of a statistical and validation of an empirically based index. Theoretical Surg 1987; 1: 169-77.
8. Billing A, Frölich D, Schildberg FW. Prediction of outcome using the Mannheim peritonitis index in 2003 patients. Br J Surg 1994; 81:209-13.
9. Demmel M, Maag K, Osterholzer G.Wertigkeitklinischer parameter zurprognosebeurteilung der peritonitis - Validierung des Mannheimer peritonitis index. Langenbecks Arch Chir 1994;379: 152-8.
10. Rodolfo L. Bracho-Riquelme MC, M en C, Armando Melero-Vela MC, Aidee Torres-Ramírez MC.Mannheim Peritonitis Index Validation Study at the Hospital General de Durango (Mexico). Cir Ciruj 2002; 70: 217-225
11. Basnet RB, Sharma VK, Evaluation of predictive power of MannheimPeritonitis Index, Postgraduate Medical Journal of NAMS, Jul-Dec 2010 , Volume 10/ No 2
12. Koperna T, Schulz F. Prognosis and treatment of peritonitis. Do weneed new scoring system? Arch Surg 1996;131:180-186.
13. Ali Yaghoobi et al. Evaluation of Mannheim Peritonitis Index and Multiple organ failure in patients with peritonitis. Indian Journal of Gastroenterology, vol 24, sept- oct 2005
14. Epidemiology of helicobacter pylori. The helicobacter foundation, 2013 http://www.helico.com/?q=Epidemiology
15. Vikram Kate, N. Ananthakrishnan, Frank I. Tovey, Is Helicobacter pylori Infection the Primary Cause of Duodenal Ulceration or a Secondary Factor? A Review of the Evidence, Gastroenterology Research and Practice, Volume 2013 (2013),http://www.hindawi.com/journals/grp/2013/425840.
16. Benjamin Wabwire et al, Stratified outcome evaluation in peritonitis, M Med (Surgery) UoN dissertation 2009

17. F. Ntirenganya, G. Ntakiyiruta, I. Kakande. Prediction of Outcome Using the Mannheim peritonitis Index in Patients with Peritonitis at Kigali University Teaching Hospital, East Cent. Afr. J. Surg, 2012; 17 (2): 52-64.
18. Schein M, Gecelter G, Freinkel W, Gerding H, Becker PJ. Peritoneal lavage in abdominal sepsis. A controlled clinical study. Archives of Surgery 125(9):1132-5, 1990.
19. A.A. Malik, K.A. Wani, L.A. Dar, M.A. Wani, R.A. Wani, F.Q. Parray, Mannheim Peritonitis Index and APACHE II - Prediction of outcome in patients with peritonitis, Turkish Journal of Trauma & Emergency Surgery 2010;16 (1):27-32
20. Bielecki K, Karminski P, Klukowski M. Large bowel perforation: morbidity and mortality. *Tech Coloproctol* 2002; 6: 177-182
21. Biondo S, Ramos E, Fraccalvieri D, et al. Comparative study of left colonic peritonitis severity score and Mannheim peritonitis index. *Br J Surg* 2006; 93: 616-622
22. Surgical Audit, Department of surgery, Nsambya Hospital Kampala, Jan 2012- Dec 2012
23. Bosscha K, van Vroonhoven TJ, van der WC. Surgical management of severe secondary peritonitis.[see comment]. [Review] [85 refs]. British Journal of Surgery 86(11):1371-7, 1999.