RAPID COMMUNICATION

Evaluation of prognostic factors and scoring system in colonic perforation

Atsushi Horiuchi, Yuji Watanabe, Takashi Doi, Kouichi Sato, Syungo Yukumi, Motohira Yoshida, Yuji Yamamoto, Hiroki Sugishita, Kanji Kawachi

Atsushi Horiuchi, Yuji Watanabe, Takashi Doi, Kouichi Sato, Syungo Yukumi, Motohira Yoshida, Yuji Yamamoto, Hiroki Sugishita, Kanji Kawachi, Department of Surgery 2, Ehime University School of Medicine, Japan
Correspondence to: Atsushi Horiuchi, Department of Surgery 2, Ehime University School of Medicine, Shitsukawa, Toon-city, Ehime 791-0295, Japan. atsushi@m.ehime-u.ac.jp
Telephone: +81-89-9605331 Fax: +81-89-9605335
Received: 2007-03-12 Accepted: 2007-04-11

Abstract

AIM: To study the significance of scoring systems assessing severity and prognostic factors in patients with colonic perforation.

METHODS: A total of 26 patients (9 men, 17 women; mean age 72.7 ± 11.6 years) underwent emergency operation for colorectal perforation in our institution between 1993 and 2005. Several clinical factors were measured preoperatively and 24 h postoperatively. Acute physiology and chronic health evaluation II (APACHE II), Mannheim peritonitis index (MPI) and peritonitis index of Altona (PIA II) scores were calculated preoperatively.

RESULTS: Overall postoperative mortality rate was 23.1% (6 patients). Compared with survivors, non-survivors displayed low blood pressure, low serum protein and high serum creatinine preoperatively, and low blood pressure, low white blood cell count, low pH, low PaO₂/FiO₂, and high serum creatinine postoperatively. APACHE II score was significantly lower in survivors than in non-survivors (10.4 ± 3.84 vs 19.3 ± 2.87, P = 0.00003). Non-survivors tended to display high MPI score and low PIA II score, but no significant difference was identified.

CONCLUSION: Pre- and postoperative blood pressure and serum creatinine level related to prognosis of colonic perforation. APACHE II score is most associated with prognosis and scores ≥ 20 are associated with significantly increased mortality rate.

© 2007 The WJG Press. All rights reserved.

Key words: Scoring system; Colonic perforation; Prognostic factor

Horiuchi A, Watanabe Y, Doi T, Sato K, Yukumi S, Yoshida M, Yamamoto Y, Sugishita H, Kawachi K. Evaluation of prognostic factors and scoring system in colonic perforation. World J Gastroenterol 2007; 13(23): 3228-3231

http://www.wjgnet.com/1007-9327/13/3228.asp

INTRODUCTION

Colonic perforation is a major life-threatening condition associated with high morbidity and mortality rates. Despite recent advances in surgical treatment and intensive medical care, mortality rates remain around 15%-30%[1-7]. One reason for this high mortality rate is that perforation due to perforation affects the general condition and leads to complications causing multiple organ failure such as respiratory failure, renal failure and sepsis. Thus, any study of the factors affecting mortality in colonic perforation requires not only measurement of individual clinical and laboratory data, but also evaluation of disease severity from a systemic perspective. To assess severity, scoring systems such as the acute physiology and chronic health evaluation II (APACHE II) and Mannheim peritonitis index (MPI) have been used[8-10]. However, consensus has not yet been reached regarding an ideal and generally accepted scoring system. We reviewed our experience with surgical and intensive treatment of colonic perforation, and retrospectively studied factors affecting the prognosis and significance of scoring systems for this disease.

MATERIALS AND METHODS

Between 1993 and 2005, we operated on 26 patients (9 men, 17 women) with perforation due to colonic perforation. Medical records were reviewed and data were collected regarding clinical data such as sex, age, degree of perforation (Hinchey's stage[11]), blood pressure preoperatively and 24 h postoperatively, white blood cell count (WBC), levels of serum protein, potassium, creatinine and BUN, PaO₂/FiO₂ ratio (P/F ratio), and pH. Preoperative and Postoperative Acute Physiology Score (APS), APACHE II[12], MPI[13] and Peritonitis Index of Altona (PIA II)[14] were calculated. Patients were divided into survivors and non-survivors, and clinical data and scores were compared between groups.

Statistical analyses between groups were performed using the Chi-square test or Student's t test. Values of P <
Table 1 Comparison of clinical factors between survivors and non-survivors

| Variable                      | Survivors (n = 20) | Non-survivors (n = 6) | P     |
|-------------------------------|-------------------|-----------------------|-------|
| Age                           | 71.9 ± 12.7       | 75.1 ± 6.96           | 0.356 |
| Sex                           |                   |                       |       |
| Male                          | 6                 | 3                     | 0.678 |
| Female                        | 14                | 3                     | 0.572 |
| Hinchey’s stage               |                   |                       |       |
| I/II                          | 8                 | 1                     |       |
| III/N                         | 12                | 5                     |       |
| Preoperative data             |                   |                       |       |
| Mean blood pressure (mmHg)    | 93.9 ± 21.8       | 69.8 ± 17.9           | 0.023 |
| WBC count (/mm³)              | 11247 ± 8629      | 6683 ± 5036           | 0.238 |
| Total protein (g/dL)          | 5.95 ± 0.84       | 4.76 ± 1.44           | 0.032 |
| Potassium (mEq/L)             | 3.85 ± 0.08       | 3.88 ± 1.23           | 0.938 |
| Creatinine (mg/dL)            | 0.91 ± 0.45       | 1.48 ± 0.58           | 0.019 |
| BUN (mg/dL)                   | 30.4 ± 31.7       | 27.0 ± 12.3           | 0.790 |
| PaO₂/FiO₂ ratio               | 380.9 ± 273.5     | 314.2 ± 280.1         | 0.625 |
| pH                            | 7.426 ± 0.080     | 7.319 ± 0.170         | 0.050 |
| Postoperative data            |                   |                       |       |
| Mean blood pressure (mmHg)    | 90.6 ± 12.7       | 76.0 ± 19.1           | 0.040 |
| WBC count (/mm³)              | 10305 ± 6202      | 3416 ± 4411           | 0.019 |
| Total protein (g/dL)          | 5.45 ± 0.76       | 5.45 ± 0.26           | 0.936 |
| Potassium (mEq/L)             | 3.85 ± 0.06       | 3.88 ± 1.23           | 0.938 |
| Creatinine (mg/dL)            | 0.88 ± 0.50       | 1.43 ± 0.69           | 0.045 |
| BUN (mg/dL)                   | 27.0 ± 27.6       | 25.8 ± 15.4           | 0.923 |
| PaO₂/FiO₂ ratio               | 278.1 ± 125.6     | 126.2 ± 98.6          | 0.014 |
| pH                            | 7.443 ± 0.049     | 7.315 ± 0.173         | 0.009 |

*Student’s t-test; Chi-squared test.

Table 2 Comparison of prognostic score between survivors and non-survivors

| Score       | Survivors (n = 20) | Non-survivors (n = 6) | P (Student’s t-test) |
|-------------|--------------------|-----------------------|----------------------|
| APACHE II   | 10.4 ± 3.84        | 19.3 ± 2.87           | 0.00003              |
| MPI         | 25.1 ± 4.68        | 28.6 ± 5.95           | 0.141                |
| PIA II      | 1.42 ± 0.99        | 0.39 ± 1.54           | 0.066                |

0.05 were considered statistically significant.

RESULTS

The mean age of the patients at time of surgery was 72.7 ± 11.6 years (range, 35-95 years). Sites of colonic perforation were the cecum-ascending colon (n = 3), transverse colon (n = 4), descending colon (n = 1), sigmoid colon (n = 15) and rectum (n = 3). Causes of colonic perforation were idiopathic or diverticulum (n = 15), carcinoma (n = 2), trauma (n = 3), and others (n = 6). Surgical procedures were colostomy with resection of the perforation site (n = 20), simple colostomy (n = 3), anastomosis (n = 1), and direct closure (n = 2). Continuous hemodialfiltration (CHDF) was performed in 10 patients. The overall mortality rate was 23.1% (6/26).

Comparison of clinical variables as predictive factors for mortality in colonic perforation is shown in Table 1. Age, sex and Hinchey’s stage displayed no significant differences between groups. Compared with survivors, non-survivors had low blood pressure, low serum protein and high serum creatinine preoperatively and low blood pressure, low WBC, low pH, low P/F ratio and high serum creatinine postoperatively.

Mean APS tended to be slightly higher preoperatively (6.32 ± 4.29) than postoperatively (5.72 ± 5.75, P = 0.520). Mean preoperative APS was significantly higher in non-survivors (11.0 ± 4.24) than in survivors (4.84 ± 3.16, P = 0.0008). Similarly, mean postoperative APS was significantly higher in non-survivors (10.6 ± 7.03) than in survivors (4.15 ± 4.43, P = 0.012). Distributions of APACHE II, MPI and PIA II scores for survivors and non-survivors are shown in Figure 1. More than 80% of patients with APACHE II score > 15, and patients with APACHE II score > 20 all died. Conversely, patients with APACHE II score ≤ 15 displayed a high survival rate, and all patients with APACHE II score ≤ 10 survived. For MPI, number of non-survivors increased for scores > 20, but many survivors were still seen with the same scores. For PIA II, all patients with score ≤ -1.0 died, but survivors and non-survivors coexisted with scores ≥ 1.0.

Scoring systems are compared in Table 2. Mean APACHE II was significantly lower in survivors (10.4 ± 3.84) than in non-survivors.
non-survivors (19.3 ± 2.87, \( P = 0.00003 \)). Non-survivors tended to have higher MPI (28.6 ± 5.95 vs 25.1 ± 4.68) and lower PIA II (0.392 ± 1.54 vs 1.42 ± 0.99), but no significant differences were identified.

We examined scoring systems between patients with and without CHDF. Mean APACHE II score was significantly higher in patients with CHDF (15.3 ± 4.64) than in patients without CHDF (10.8 ± 5.00, \( P = 0.033 \)). Similarly, mean MPI was significantly higher in patients with CHDF (28.5 ± 4.52) than in patients without CHDF (24.3 ± 4.92, \( P = 0.040 \)). Mean PIA II tended to be lower in patients with CHDF (0.798 ± 1.31) than in patients without CHDF (1.45 ± 1.05, \( P = 0.183 \)), but no significant difference was seen.

**DISCUSSION**

Factors influencing the prognosis of patients with colonic perforation have been reviewed from various perspectives, including pre- and postoperative laboratory data, intraoperative findings, and operative procedures. Age > 70 years, preoperative base excess (BE), presence of shock, platelet count, postoperative WBC and number of organ failures have all been reported as factors influencing prognosis[1-7]. The present study showed that preoperative mean blood pressure and serum creatinine level are associated with mortality following colonic perforation. In addition, postoperative respiratory function influences mortality. Non-survivors P/F ratio decreased substantially from a preoperative mean of 314.2 to a postoperative mean of 126.2, while P/F ratio in survivors decreased only slightly. These findings indicate that respiratory function became lower in non-survivors than in survivors following operative stress.

Various scoring systems have been used to indicate prognosis of patients with colonic perforation[10]. These systems can be broadly divided into two groups: disease-independent scores for evaluation of serious patients requiring care in the intensive care unit (ICU) such as APACHE II, Simplified Acute Physiology Score (SAPS II)[14]; and peritonitis-specific scores such as MPI and PIA II. MPI is calculated using simple factors such as degree of peritonitis, age, sex and time from perforation to operation, and offers a useful tool. Actually, MPI has been reported to be strongly associated with prognosis of patients with colonic perforation[5,6,10]. However, the present study revealed that survivors included patients with high and low MPI. No significant difference in MPI was identified between survivors and non-survivors. Although macroscopic degree of peritonitis seemed equal, the actual damage to the body of individual patients differed in degree. Time from perforation to operation could not be precisely measured, as it is difficult to detect the time of perforation in elderly patients[11]. Whether preoperative duration was more or less than 24 h represented a vague division, so patients with various degrees of injury were judged to display the same score. In contrast, physiological scoring systems such as APACHE II or SAPS II seem to reveal preoperative status of the patient more precisely than MPI, as such scoring systems put > 10 kinds of laboratory data together in calculation.

A previous study compared changes in APACHE II score between survivors and non-survivors among emergency surgically-treated patients[18]. Scores in both groups increased immediately postoperatively. Scores of survivors subsequently decreased, and significant differences between groups were apparent by postoperative d 10. Various reports have indicated that preoperative scoring systems are useful in predicting risk of death in patients with colonic perforation. However, it is difficult to use scoring systems for postoperative monitoring because of the need to measure numerous laboratory parameters. In addition, development of a new scoring system to aid management of peritonitis has been described, including not only APACHE II, but also intraoperative findings such as operation success and organ failure score[19]. A larger number of cases need to be reviewed to assess this new scoring system.

Scoring systems for colonic perforation allow objective and systematic assessment of the severity of disease, and prediction of prognosis. Such systems seem useful in comparing the effectiveness of treatment by disease severity. Therapeutic choice may be facilitated by severity according to scoring systems in the future, but no ideal and generally accepted scoring system is presently available. APACHE II has been reported as a useful scoring system for predicting outcomes at the beginning of treatment with good discrimination, but the significance of APACHE II has been questioned when deciding therapies for patients with unsuccessful initial treatment[13,18]. Multiple organ system failure (MOSF) has been reported as the only indicator for therapeutic decision-making in such situations[14]. APACHE II may not be suitable for longitudinal evaluation of disease.

Treatment of colonic perforation involves resection of the perforated site with colostomy (Hartmann’s procedure) or primary anastomosis. Some studies have compared primary anastomosis with colostomy[5,8,17,20]. Gooszen et al[20] reported that anastomotic leakage rate in primary anastomosis in their study and the existing literature, was 5%-20%, and did not exceed the leakage rate reported for secondary elective reconstruction after Hartmann’s procedure. Nespoli et al[17] reported that APACHE II and MPI scores of patients with primary anastomosis were low, and colostomy was chosen for patients with high score, and the mortality rate was high. They concluded that the surgical procedure did not influence outcomes, but that mortality rate was related to the severity of peritonitis measured by APACHE II and MPI. They suggested that in Henchey's stage I and II disease such as localized peritonitis, generally associated with a low APACHE II score, primary resection and anastomosis might be considered optimal. We selected Hartmann’s procedure for most patients, with a focus on saving the life first and foremost, and then on decreasing operative stress. Based on the reports, primary anastomosis will be chosen in future for patients with low APACHE II score.

One of the treatments contributing to improved survival rate in colonic perforation is blood purification, such as CHDF. Patients whose postoperative renal and respiratory failure improve following cytokine adsorption or adaptation of water balance are more likely to
survive\textsuperscript{[21]}. Our study showed that APACHE II and MPI scores were higher in patients with CHDF than in patients without CHDF. CHDF thus appears to be indicated for patients with high scores. However, our study also showed that all patients with preoperative APACHE II > 20 died, and no treatment is expected to be effective in such patients. Judging the indications for CHDF by observing postoperative state is important, and indications for CHDF cannot be decided based on preoperative score alone. At least, patients with high preoperative score need to be treated in an institution that can perform blood purification treatment. Scoring systems seem likely to become one of the indices for deciding where patients should be treated.

Our study revealed that pre- and postoperative mean blood pressure and serum creatinine level are associated with prognosis of colonic perforation. Progression of postoperative respiratory failure was more extensive in non-survivors than in survivors. For scoring systems, APACHE II score was most strongly associated with poor prognosis, and scores > 15 were significantly correlated with mortality.

REFERENCES

1. Kiwanek S, Armbruster C, Beckerhinn P, Dittrich K. Prognostic factors for survival in colonic perforation. Int J Colorectal Dis 1994; 9: 158-162
2. Biondo S, Ramos E, Deiros M, Ragüé JM, De Oca J, Moreno P, Farran L, Jaurrieta E. Prognostic factors for mortality in left colonic perforation: a new scoring system. J Am Coll Surg 2000; 191: 635-642
3. Bielecki K, Kamiński P, Klukowski M. Large bowel perforation: morbidity and mortality. Tech Coloproctol 2002; 6: 177-182
4. Shinkawa H, Yasuhara H, Naka S, Yanagie H, Nojiri T, Furuya Y, Ariki K, Niwa H. Factors affecting the early mortality of patients with nontraumatic colorectal perforation. Surg Today 2003; 33: 13-17
5. Pisanu A, Cois A, Uccheddu A. Surgical treatment of perforated diverticular disease: evaluation of factors predicting prognosis in the elderly. Int Surg 2004; 89: 35-38
6. Mákelä JT, Kiviniemi H, Laitinen S. Prognostic factors of perforated sigmoid diverticulitis in the elderly. Dig Surg 2005; 22: 100-106
7. Komatsu S, Shimomatsu T, Nakajima M, Amaya H, Kobuchi T, Shiraishi S, Konishi S, Ono S, Maruhashi K. Prognostic factors and scoring system for survival in colonic perforation. Hepatogastroenterology 2005; 52: 761-764
8. Ohmann C, Wittmann DH, Wacha H. Prospective evaluation of prognostic scoring systems in peritonitis. Peritonitis Study Group. Eur J Surg 1993; 159: 267-274
9. Hincheny EJ, Schaal PG, Richards GK. Treatment of perforated diverticular disease of the colon. Adv Surg 1978; 12: 85-109
10. Knaus WA, Draper EA, Wagner DP, Zimmerman JE. APACHE II: a severity of disease classification system. Crit Care Med 1985; 13: 818-829
11. Linder MM, Wacha H, Feldmann U, Wesch G, Streefensand RA, Gundlach E. [The Mannheim peritonitis index. An instrument for the intraoperative prognosis of peritonitis. Chirurg 1987; 58: 84-92
12. Kologlu M, Elker D, Altun H, Sayek I. Validation of MPI and PIA II in two different groups of patients with secondary peritonitis. Hepatogastroenterology 2003; 48: 147-151
13. Ohmann C, Hau T. Prognostic indices in peritonitis. Hepatogastroenterology 1997; 44: 937-946
14. Le Gall JR, Lemeshow S, Saulnier F. A new Simplified Acute Physiology Score(SAPS II) based on a European/North American multicenter study. JAMA 1993; 270: 2957-2963
15. Koperna T, Semmler D, Marian F. Risk stratification in emergency surgical patients: is the APACHE II score a reliable marker of physiological impairment? Arch Surg 2001; 136: 55-59
16. Ohmann C, Yang Q, Hau T, Wacha H. Prognostic modelling in peritonitis. Peritonitis Study Group of the Surgical Infection Society Europe. Eur J Surg 1997; 163: 53-60
17. Nespoli A, Ravizzini C, Trivella M, Segala M. The choice of surgical procedure for peritonitis due to colonic perforation. Arch Surg 1993; 128: 814-818
18. Muller S, Penningckx F, Verwaest C, Filez L, Aerts R, Fieuws S, Lauwers P. Factors affecting mortality in generalized postoperative peritonitis: multivariate analysis in 96 patients. World J Surg 2003; 27: 379-384
19. Koperna T, Schulz F. Prognosis and treatment of peritonitis. Do we need new scoring systems? Arch Surg 1996; 131: 180-186
20. Gooszen AW, Tollenaar RA, Gielkerken RH, Smeets HJ, Bemelman WA, Van Schaardenburgh P, Gooszen HG. Prospective study of primary anastomosis following sigmoid resection for suspected acute complicated diverticular disease. Br J Surg 2001; 88: 693-697
21. Heering P, Grabensee B, Krause M. Cytokine removal in septic patients with continuous venovenous hemofiltration. Kidney Blood Press Res 2003; 26: 128-134