


# Prognostic Nutritional Index Predicts Short-Term Postoperative Outcomes After Bowel Resection for Crohn's Disease

Nutrition in Clinical Practice  
 Volume 32 Number 1  
 February 2017 92–97  
 © 2016 American Society  
 for Parenteral and Enteral Nutrition  
 DOI: 10.1177/0884533616661844  
 journals.sagepub.com/home/ncp  


Wei Zhou, MD, PhD<sup>1,2</sup>; Qian Cao, MD, PhD<sup>2,3</sup>; Weilin Qi, MD<sup>1</sup>;  
 Yunyun Xu, MD<sup>1</sup>; Wei Liu, MD<sup>1</sup>; Jianjian Xiang, MD<sup>1</sup>; and Bangbo Xia, MD<sup>1</sup>

## Abstract

**Background:** Bowel resection is required in the majority of patients with Crohn's disease (CD) during their lifetime. The Prognostic Nutritional Index (PNI) is a useful tool for predicting postoperative outcomes in patients undergoing cancer surgery. We examined the ability of the PNI to predict short-term outcomes in patients with CD-related bowel resection. **Materials and Methods:** Seventy-three patients who underwent bowel resection for CD were retrospectively enrolled in the study. The PNI was calculated as follows:  $10 \times$  serum albumin (g/dL) +  $0.005 \times$  total lymphocyte count (per mL). Patients were divided into 2 groups: PNI <40 (n = 30) and PNI  $\geq$ 40 (n = 43). **Results:** A significant difference was found in body mass index ( $17.9 \pm 2.4$  vs  $19.2 \pm 2.2$ ,  $P = .018$ ) between the 2 groups. Postoperative overall and infectious complications occurred more frequently in patients with PNI <40 than in those with PNI  $\geq$ 40 (50.0% and 46.7% vs 23.3% and 16.3%,  $P = .018$  and  $P = .005$ , respectively). In the univariate analysis, body mass index <18.5, penetrating behavior, open surgery, and PNI <40 were associated with an increased risk of overall complications and infectious complications. In the multivariate analysis, only PNI <40 was an independent prognostic factor for infectious complications (odds ratio: 3.846, 95% confidence interval: 1.145-12.821). **Conclusions:** Preoperative PNI is a useful predictor of postoperative infectious complications in patients with CD-related bowel resection. (*Nutr Clin Pract.* 2017;32:92-97)

## Keywords

Crohn's disease; Prognostic Nutritional Index; bowel resection; inflammation; inflammatory bowel diseases; postoperative complications

## Background

The incidence and prevalence of Crohn's disease (CD) appear to have steadily increased over the last 5 decades.<sup>1</sup> Despite the improvement in available medical treatment, surgery may be needed in up to 80% of patients with CD during their lifetime.<sup>2</sup> Intestinal resection is indicated for patients with complications such as obstruction, abdominal abscesses, and fistulization and for patients who are refractory to medical therapy. Surgery has proven effective in improving these patients' quality of life.<sup>3</sup>

Postoperative complications are not infrequent in CD surgery because of increased fragility of inflamed bowel, inflammatory masses, adhesions, malnourishment, infection, and immunosuppression.<sup>4</sup> It has been recognized that the occurrence of postoperative intra-abdominal septic complications is associated with an increased risk of recurrence in patients with CD.<sup>5</sup> Being able to estimate the risk of surgical complication is a key point for patients with CD.

Preoperative nutrition and immunologic statuses have been demonstrated to be associated not only with postoperative complications but also with the long-term outcomes of patients with CD.<sup>6</sup> The Prognostic Nutritional Index (PNI)—which can be calculated by serum albumin (ALB) concentration and total lymphocyte count (TLC) in peripheral blood—has shown to be a prognostic marker for various malignancies.<sup>7-9</sup> With regard to CD, however, the prognostic significance of the PNI has rarely

been mentioned, and the clinical significance and prognostic value of this marker remain uncertain. Therefore, the aim of the present study was to determine whether the PNI could be a useful predictor of short-term outcomes in patients undergoing bowel resection for CD.

## Methods

Prospectively collected databases were used to identify a cohort of consecutive patients with CD who underwent

---

From the <sup>1</sup>Department of General Surgery, Sir Run Run Shaw Hospital, School of Medicine, Zhejiang University, Hangzhou, China; <sup>2</sup>Inflammatory Bowel Disease Center, Sir Run Run Shaw Hospital, School of Medicine, Zhejiang University, Hangzhou, China; and the <sup>3</sup>Department of Gastroenterology, Sir Run Run Shaw Hospital, School of Medicine, Zhejiang University, Hangzhou, China.

Financial disclosure: Supported by grants from Zhejiang Natural Science Foundation (LY15H160031).

Conflicts of interest: None declared.

This article originally appeared online on August 26, 2016.

## Corresponding Author:

Wei Zhou, MD, PhD, Department of General Surgery, Sir Run Run Shaw Hospital, 3 East Qingchun Road, Hangzhou 310016, China.  
 Email: nuzwlvran@aliyun.com

elective abdominal surgery at the Department of Surgery, Sir Run Run Shaw Hospital, from January 2012 to December 2014. All patients underwent surgery with the same surgical team. During this period, open or laparoscopic bowel surgery was offered to all patients presenting for operation. Patients with intestinal resection and anastomoses, with or without a covering stoma, were included. Perianal surgery, surgery of stoma closure, and stricturoplasty alone were excluded. The protocol for the current study was approved by the institutional review board.

We performed a retrospective review of these patients' records to retrieve specific data, such as demographics (age, sex, body mass index [BMI], etc), preoperative variables (C-reactive protein [CRP], Crohn's Disease Activity Index [CDAI], etc) and medications, previous surgical procedures, indications for surgery, intraoperative surgical data (procedure, type of anastomosis, temporary stoma, etc), histopathologic analysis of the resected specimen, postoperative complications, and length of postoperative hospital stay. For medications, immunomodulator use was defined as thiopurine or methotrexate use within 2 weeks before surgery; anti-tumor necrosis factor  $\alpha$  (anti-TNF $\alpha$ ) therapy was defined as infliximab use within 4 weeks before surgery; steroid use was defined as prednisolone (>20 mg/d) within 2 weeks before surgery. Penetrating CD was defined via radiographic, intraoperative, or pathologic findings of perforation, fistula, abscess, or phlegmon.<sup>10</sup>

Preoperative nutrition risk assessment was routinely performed within the first 24 hours of admission through use of the Nutritional Risk Screening 2002.<sup>11,12</sup> Patients with a total score  $\geq 3$  were considered to be at nutrition risk and received enteral nutrition or parenteral nutrition for 2–4 weeks. One day before the operation, peripheral blood samples were collected to measure ALB and TLC for PNI calculation. The PNI was calculated according to the following formula:  $10 \times \text{ALB (g/dL)} + 0.005 \times \text{TLC (per mL)}$ . The cutoff value for the PNI was determined to be 40, based on the original investigation by Onodera et al.<sup>13</sup>

The indication for surgery was discussed by a multidisciplinary team. The strategy of preoperative optimization was used in our center. Besides nutrition therapy, attempts were made to withdraw steroids and biologics. All intra-abdominal abscesses accessible to percutaneous drainage were drained. For laparoscopic surgery, the dissection was continued until the diseased bowel and mesentery were free enough to reach the abdominal wall. Bowels were then exteriorized by extending the supraumbilical port site for  $\leq 5$  cm with extracorporeal anastomosis, either stapled or hand sewn. The open technique was performed as routine through a midline incision. The decision to form a stoma was made by the operating surgeon, with the reasons usually being concurrent distal disease (colonic/perianal) or severe disease with abscess formation. Abdominal drains were used only in cases of perforation and abscess. Nasogastric tubes were not used postoperatively, and oral feeding was allowed after the return of bowel function.<sup>4</sup> Postoperative complications and postoperative mortality were defined as occurring within 30 days after operation according to

Clavien-Dindo classification.<sup>14</sup> Complications were divided into 2 groups, infectious and noninfectious, according to the clinical criteria.<sup>12,14,15</sup> The decision to discharge patients was based on the following criteria: afebrile for >24 hours, passage of stools or flatus, tolerance of an oral soft diet, and adequate pain control with oral medication.<sup>4</sup>

## Statistical Analysis

SPSS 17.0 (IBM, Chicago, IL) was used for all statistical analyses. Continuous variables were expressed as mean  $\pm$  SD and/or medians (range). Comparisons between groups were determined through Pearson's chi-square test for discrete variables and Student's *t* test for continuous variables. Factors previously shown to influence the risk of complications, as well as factors found to be predictive on univariate analysis, were entered into a multivariate logistic regression analysis to compute odds ratios.<sup>12</sup> Confidence intervals were set at 95%. Results were considered statistically significant if  $P < .05$ .

## Results

A total of 73 patients with CD were included in our study. Demographics and clinical characteristics are shown in Table 1. The mean age at diagnosis was 36.14 years. Over half the cohorts were men, and almost 20% were current smokers at the time of surgery. The majority of patients (63.0%) had ileocolonic involvement; others had isolated ileal or colonic disease. Nearly half of the patients were receiving an immunomodulator or infliximab at the time of surgery. We always avoided steroid use perioperatively. The indications for surgery were stenosis of inflamed bowel segment or a previous anastomosis ( $n = 43$ ) and penetrating disease ( $n = 30$ ). Fifty-nine patients received primary anastomosis, while 14 had a stoma formation. The median value of PNI was 41.1 (range: 24.2–53.4).

A PNI <40 was recorded in 30 patients (41.1%). For parameters such as age, sex, CRP, CDAI, disease location, biological behavior, previous surgery, and medication, there were no differences between the patients with PNI <40 and  $\geq 40$  (Table 2). However, PNI <40 was associated with a lower BMI ( $P = .018$ ), more postoperative overall complications ( $P = .018$ ), and infectious complications ( $P = .005$ ). The median postoperative hospital stay was 9 days (range: 4–90). Although PNI <40 was associated with longer postoperative hospital stay, it did not reach a significant difference ( $P = .138$ ).

No patient died during the study. Postoperative complications occurred in 25 patients (34.2%). Of these, 21 had infectious complications, and 4 had other complications. Infectious complications included wound infection in 12 patients, intra-abdominal abscess in 5 (3 were related to anastomotic leakage), and extra-abdominal infection in 5. Postoperative overall complications occurred in 15 (50.0%) of 30 patients with PNI <40, compared with 10 (23.3%) of 43 patients with PNI  $\geq 40$ . For infectious complications, 14 (46.7%) occurred in patients with PNI <40, whereas 7 (16.3%) occurred in patients with PNI  $\geq 40$ .

**Table 1.** Characteristics of the Study Population.

Characteristics	Mean $\pm$ SD or n (%)
Age, y	36.14 $\pm$ 11.9
Sex	
Female	27 (37.0)
Male	46 (63.0)
Disease duration, y	5.28 $\pm$ 4.7
Smoker	14 (19.2)
Disease location	
Ileal	19 (26.0)
Colonic	8 (11.0)
Ileocolonic	46 (63.0)
Medications before surgery	
Antibiotic	3 (4.1)
Mesalazine	14 (19.2)
Immunomodulator	31 (42.5)
Infliximab	5 (6.8)
Previous IBD-related surgery	40 (54.8)
Penetrating behavior	30 (41.1)
Stoma formation	14 (19.2)
Laparoscopically assisted surgery	36 (49.3)
PNI, median (range)	41.1 (24.2–53.4)

IBD, inflammatory bowel disease; PNI, Prognostic Nutritional Index.

The univariate and multivariate analyses of factors associated with overall complications and infectious complications are presented in Table 3. Of the factors examined in the univariate analysis, BMI  $<18.5$  was associated with an increased rate of overall complications ( $P = .009$ ), as were penetrating behavior ( $P = .018$ ), open surgery ( $P = .033$ ), and PNI  $<40$  ( $P = .018$ ). However, on the multivariate logistic regression analysis, these were not significant risk factors for overall complications. BMI  $<18.5$  ( $P = .024$ ), penetrating behavior ( $P = .005$ ), open surgery ( $P = .024$ ), and PNI  $<40$  ( $P = .005$ ) were also significantly associated with an increased risk of postoperative infectious complications on the univariate analysis. But only PNI  $<40$  was an independent risk factor for infectious complications on the multivariate analysis ( $P = .029$ ), with an odds ratio of 3.846 (95% confidence interval: 1.145–12.821). Other possible factors—age, CRP  $\geq 5$  mg/dL, ALB  $<30$  g/L, CDAI  $\geq 150$ , primary anastomosis, use of immunomodulators, prior surgery, and operative time  $\geq 3$  hours—were not significant factors for either overall or infectious complications.

## Discussion

In the present study, PNI is shown to be an independent predictor of postoperative infectious complications in patients with CD-related bowel resection. Although this is a retrospective single-center study, it is the first to compare PNI with other clinicopathologic variables in terms of postoperative short-term outcomes of patients with CD. Although BMI  $<18.5$ , penetrating behavior, and open surgery were associated with overall and infectious complications by the univariate analysis, the

multivariate analysis revealed that only PNI had a prognostic value for infectious complications.

Patients with CD often show mild to severe malnutrition due to reduced oral intake, malabsorption, increased systemic inflammation, and nutrition requirement.<sup>16</sup> Malnutrition has been shown to be an independent risk factor for CD surgery in some studies.<sup>6</sup> However, the conclusion is still controversial.<sup>17</sup> The reason may be that malnutrition is difficult to define and lack ideal objective parameters. The PNI was initially designed to assess the nutrition status of patients undergoing surgery for gastrointestinal malignancy.<sup>9,13</sup> Although the prognostic significance of the PNI has been reported in several types of cancer,<sup>3-5</sup> its usage in predicting postoperative outcomes for patients with CD has not been fully examined. In our study, we showed a statistically significant difference in overall and infectious complications between patients with PNI  $<40$  and  $\geq 40$ , in favor of PNI  $\geq 40$ . Although we noticed a longer postoperative hospital stay in patients with PNI  $<40$ , it failed to reach a significant difference, which may be explained by the relative small sample size of the study and the heterogeneity of hospital stay data.

The basis of the independent correlation between the PNI and postoperative outcomes in patients undergoing surgery for CD is not very clear. Previous studies have suggested that ALB and TLC had a close relationship with the presence of inflammatory response in cancer patients.<sup>18</sup> Therefore, although initially considered purely a reflection of a patient's nutrition status, it is likely that the PNI is a reflection of systemic inflammation and a more aggressive disease phenotype of CD. Enhancement of the systemic inflammatory response may be involved in the mechanisms behind postoperative complications.<sup>19</sup> A larger randomized prospective study to evaluate whether improvement of preoperative PNI minimizes postoperative morbidity remains to be carried out.

Less than half (41.1%) of our patients were classified as having penetrating disease. This is in accord with the rate of 43.9% reported in a recent meta-analysis that included  $>3000$  patients with ileocolic resection for CD.<sup>20</sup> We also noted that penetrating behavior was associated with postoperative complications by univariate analysis. Consistent with our reports, studies have found that penetrating disease is a significant determinant of postoperative intra-abdominal infections,<sup>21,22</sup> possibly because penetrating disease usually refers to patients who present with intra-abdominal abscesses, fistulas, phlegmon, or even free perforations with peritonitis.

Overall, 49.3% of our patients had surgery performed laparoscopically. Univariate analysis also found that laparoscopic surgery offered the short-term advantage of a significant reduction in postoperative complications. Similarly, Frolkis et al found that open laparotomy is a predictor for in-hospital postoperative complications for CD.<sup>23</sup> In selected subgroups of patients with CD, laparoscopic surgery is associated with reduced postoperative pain, a lower incidence of ileus, cardiorespiratory complications, wound infections, and a shorter hospital stay when compared with the open approach.<sup>24,25</sup> A recent

**Table 2.** Relationship Between Clinical Laboratory Characteristics and PNI.

Variable	Patients, Mean ± SD or n		P Value
	PNI <40 (n = 30)	PNI ≥ 40 (n = 43)	
Age, y	38.9 ± 11.7	34.2 ± 11.9	.095
Sex			.656
Male	18	28	
Female	12	15	
BMI, kg/m <sup>2</sup>	17.9 ± 2.4	19.2 ± 2.2	.018
CRP, mg/dL	19.2 ± 24.3	29.3 ± 49.3	.303
CDAI	254.6 ± 81.8	222.7 ± 69.8	.078
Location			.221
L1 (ileal)	11	8	
L2 (colonic)	3	5	
L3 (ileocolonic)	16	30	
Behavior			.419
Penetrating	14	16	
Nonpenetrating	16	27	
Previous IBD-related surgery			.492
Yes	15	18	
No	15	25	
Preoperative medication			.931
No	7	13	
Antibiotic	1	2	
Mesalazine	7	7	
Immunomodulator	13	18	
Infliximab	2	3	
Postoperative overall complications			.018
Yes	15	10	
No	15	33	
Postoperative infectious complications			.005
Yes	14	7	
No	16	36	
Postoperative hospital stay, d	15.03 ± 15.33	10.88 ± 8.10	.138

BMI, body mass index; CDAI, Crohn's disease activity index; CRP, C-reactive protein; IBD, inflammatory bowel disease; PNI, Prognostic Nutritional Index.

meta-analysis of this published literature demonstrates reduced perioperative complications in patients undergoing laparoscopic resection versus open resection.<sup>26</sup> Although many of the studies had similar baseline characteristics in both groups, selection bias did exist. Choosing healthier patients with fewer comorbidities likely occurred more frequently in the laparoscopic group. However, studies have reported that laparoscopic surgery for complex CD with associated phlegmon or abscess is feasible and safe with similar major complications and hospital stay.<sup>27</sup>

Although a previous study indicated that intra-abdominal infectious complications are significantly associated with preoperative low ALB level (<30 g/L),<sup>28</sup> we cannot get similar results in our study—perhaps because we had only 10 patients with ALB <30 g/L after preoperative nutrition therapy.

Preoperative steroid usage significantly increases the risk of septic abdominal complications following ileocolic resection for CD.<sup>17,29</sup> In our cohort of patients, steroids were usually withdrawn before surgery. We found no increase of complications after preoperative immunomodulator use. Reports in the literature give conflicting results regarding the impact of anti-TNF $\alpha$  therapy on surgical safety.<sup>30,31</sup> However, a recent meta-analysis has shown that anti-TNF $\alpha$  agents may increase the risk of infections and septic shock. A preoperative drug-free interval, when feasible, might be considered to reduce the risk of infections.<sup>32</sup>

There are several limitations of the current study. First, the number of patients is small, and a single-institution retrospective observational study is not sufficient to get the absolute conclusion. In addition, the low rate of preoperative biologic treatments in our study hinders the statistical analysis of

**Table 3.** Risk Factors Analysis for Postoperative Complications After Bowel Resection for Crohn's Disease.

Variable	Complications			P Value			Infectious Complications			P Value		
	Yes (n = 25)	No (n = 48)		Univariate	Multivariate	Odds Ratio (95% CI)	Yes (n = 21)	No (n = 52)		Univariate	Multivariate	Odds Ratio (95% CI)
Age $\geq 40$ y	7	19		.327			6	20		.424		
BMI $< 18.5$	18	19		.009	.131	2.427 (0.768–7.671)	15	22		.024	.422	1.671 (0.477–5.856)
ALB $< 30$ g/L	5	5		.258			5	5		.110		
CRP $\geq 5$ mg/dL	21	34		.216			17	38		.480		
CDAI $\geq 150$	19	38		.756			17	40		.706		
Primary anastomosis	19	40		.605			17	42		.915		
Immunomodulators	11	20		.848			9	22		.966		
Prior surgery	16	24		.254			14	26		.195		
Penetrating behavior	15	15		.018	.277	1.99 (0.575–6.883)	14	16		.005	.098	3.133 (0.809–12.138)
Open surgery	17	20		.033	.345	1.815 (0.527–6.250)	15	22		.024	.440	1.706 (0.439–6.622)
Operative time $\geq 3$ h	9	22		.420			8	23		.631		
PNI $< 40$	15	15		.018	.113	2.451 (0.808–7.407)	14	16		.005	.029	3.846 (1.145–12.821)

ALB, albumin; BMI, body mass index; CDAI, Crohn's Disease Activity Index; CRP, C-reactive protein; PNI, Prognostic Nutritional Index.

relation between biologics and postoperative outcomes. Third, the PNI values were recorded 1 day before surgery, while Nutritional Risk Screening 2002 was assessed on admission. We cannot evaluate the correlation between these tools or the improvement of PNI after preoperative nutrition therapy.

## Conclusion

The results of the present study suggest that preoperative PNI—a simple and useful indicator of immunonutritional status—is an independent predictor of postoperative infectious complications in patients who undergo elective bowel resection for CD. The PNI might be included in the routine assessment of patients with CD before surgery. For patients with low PNI values, preoperative strategies such as prolonged nutrition intervention and optimized sepsis control should be applied to improve their index values and reduce the possibility of postoperative complications.

## Statement of Authorship

W. Zhou, Q. Cao, and W. Qi contributed to the conception and design of the research; W. Qi and Y. Xu contributed to the acquisition of the data; and W. Zhou, Q. Cao, and W. Liu contributed to the interpretation of the data. All authors contributed to the analysis of the data, drafted the manuscript, critically revised the manuscript, agree to be fully accountable for ensuring the integrity and accuracy of the work, and read and approved the final manuscript.

## References

- Molodecky NA, Soon IS, Rabi DM, et al. Increasing incidence and prevalence of the inflammatory bowel diseases with time, based on systematic review. *Gastroenterology*. 2012;142:46-54.
- Carter MJ, Lobo AJ, Travis SP. Guidelines for the management of inflammatory bowel disease in adults. *Gut*. 2004;53(suppl 5):V1-V16.
- Wright EK, Kamm MA, De Cruz P, et al. Effect of intestinal resection on quality of life in Crohn's disease. *J Crohns Colitis*. 2015;9:452-462.
- Soop M, Larson DW, Malireddy K, Cima RR, Young-Fadok TM, Dozois EJ. Safety, feasibility, and short-term outcomes of laparoscopically assisted primary ileocolic resection for Crohn's disease. *Surg Endosc*. 2009;23:1876-1881.
- Iesalnieks I, Dederichs F, Kilger A, Schlitt HJ, Agha A. Postoperative morbidity after bowel resections in patients with Crohn's disease: risk, management strategies, prevention [in German]. *Z Gastroenterol*. 2012;50:595-600.
- Alves A, Panis Y, Bouhnik Y, Pocard M, Vicaut E, Valleur P. Risk factors for intra-abdominal septic complications after a first ileocecal resection for Crohn's disease: a multivariate analysis in 161 consecutive patients. *Dis Colon Rectum*. 2007;50:331-336.
- Kanda M, Fujii T, Kodera Y, Nagai S, Takeda S, Nakao A. Nutritional predictors of postoperative outcome in pancreatic cancer. *Br J Surg*. 2011;98:268-274.
- Pinato DJ, North BV, Sharma R. A novel, externally validated inflammation-based prognostic algorithm in hepatocellular carcinoma: the prognostic nutritional index (PNI). *Br J Cancer*. 2012;106:1439-1445.
- Mohri Y, Inoue Y, Tanaka K, Hiro J, Uchida K, Kusunoki M. Prognostic nutritional index predicts postoperative outcome in colorectal cancer. *World J Surg*. 2013;37:2688-2692.
- Bruining DH, Siddiki HA, Fletcher JG, Tremaine WJ, Sandborn WJ, Loftus EV Jr. Prevalence of penetrating disease and extraintestinal manifestations of Crohn's disease detected with CT enterography. *Inflamm Bowel Dis*. 2008;14:1701-1706.
- Kondrup J, Allison SP, Elia M, Vellas B, Plauth M; Educational and Clinical Practice Committee, European Society of Parenteral and Enteral Nutrition. ESPEN guidelines for nutrition screening 2002. *Clin Nutr*. 2003;22:415-421.
- Zhou W, Xu X, Yan J, Mou Y. Nutritional risk is still a clinical predictor of postoperative outcomes in laparoscopic abdominal surgery. *Surg Endosc*. 2013;27:2569-2574.
- Onodera T, Goseki N, Kosaki G. Prognostic nutritional index in gastrointestinal surgery of malnourished cancer patients [in Japanese]. *Nihon Geka Gakkai Zasshi*. 1984;85:1001-1005.
- Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann Surg*. 2004;240:205-213.
- Pacelli F, Bossola M, Papa V, et al. Enteral vs parenteral nutrition after major abdominal surgery: an even match. *Arch Surg*. 2001;136:933-936.
- Lucendo AJ, De Rezende LC. Importance of nutrition in inflammatory bowel disease. *World J Gastroenterol*. 2009;15:2081-2088.
- Tzivanakis A, Singh JC, Guy RJ, Travis SP, Mortensen NJ, George BD. Influence of risk factors on the safety of ileocolic anastomosis in Crohn's disease surgery. *Dis Colon Rectum*. 2012;55:558-562.
- Crumley AB, Stuart RC, McKernan M, McMillan DC. Is hypoalbuminemia an independent prognostic factor in patients with gastric cancer? *World J Surg*. 2010;34:2393-2398.
- Moyes LH, Leitch EF, McKee RF, Anderson JH, Horgan PG, McMillan DC. Preoperative systemic inflammation predicts postoperative infectious complications in patients undergoing curative resection for colorectal cancer. *Br J Cancer*. 2009;100:1236-1239.
- Simillis C, Yamamoto T, Reese GE, et al. A meta-analysis comparing incidence of recurrence and indication for reoperation after surgery for perforating versus nonperforating Crohn's disease. *Am J Gastroenterol*. 2008;103:196-205.
- Nasir BS, Dozois EJ, Cima RR, et al. Perioperative anti-tumor necrosis factor therapy does not increase the rate of early postoperative complications in Crohn's disease. *J Gastrointest Surg*. 2010;14:1859-1865.
- Bellolio F, Cohen Z, Macrae HM, et al. Outcomes following surgery for perforating Crohn's disease. *Br J Surg*. 2013;100:1344-1348.
- Frolkis A, Kaplan GG, Patel AB, et al. Postoperative complications and emergent readmission in children and adults with inflammatory bowel disease who undergo intestinal resection: a population-based study. *Inflamm Bowel Dis*. 2014;20:1316-1323.
- Milsom JW, Hammerhofer KA, Bohm B, Marcello P, Elson P, Fazio VW. Prospective, randomized trial comparing laparoscopic vs conventional surgery for refractory ileocolic Crohn's disease. *Dis Colon Rectum*. 2001;44:1-8.
- Benoist S, Panis Y, Beaufour A, Bouhnik Y, Matuchansky C, Valleur P. Laparoscopic ileocecal resection in Crohn's disease: a case-matched comparison with open resection. *Surg Endosc*. 2003;17:814-818.
- Patel SV, Ramagopalan SV, Ott MC. Laparoscopic surgery for Crohn's disease: a meta-analysis of perioperative complications and long term outcomes compared with open surgery. *BMC Surg*. 2013;13:14.
- Goyer P, Alves A, Bretagnol F, Bouhnik Y, Valleur P, Panis Y. Impact of complex Crohn's disease on the outcome of laparoscopic ileocecal resection: a comparative clinical study in 124 patients. *Dis Colon Rectum*. 2009;52:205-210.
- Yamamoto T, Allan RN, Keighley MR. Risk factors for intra-abdominal sepsis after surgery in Crohn's disease. *Dis Colon Rectum*. 2000;43:1141-1145.
- Nguyen GC, Elnahas A, Jackson TD. The impact of preoperative steroid use on short-term outcomes following surgery for inflammatory bowel disease. *J Crohns Colitis*. 2014;8:1661-1667.
- Kasperek MS, Bruckmeier A, Beigel F, et al. Infliximab does not affect postoperative complication rates in Crohn's patients undergoing abdominal surgery. *Inflamm Bowel Dis*. 2012;18:1207-1213.
- Rosenfeld G, Qian H, Bressler B. The risks of post-operative complications following pre-operative infliximab therapy for Crohn's disease in patients undergoing abdominal surgery: a systematic review and meta-analysis. *J Crohns Colitis*. 2013;7:868-877.
- Ahmed Ali U, Martin ST, Rao AD, Kiran RP. Impact of preoperative immunosuppressive agents on postoperative outcomes in Crohn's disease. *Dis Colon Rectum*. 2014;57:663-674.