Validation of COLA score for predicting wound infection in patients undergoing surgery for rectal cancer

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A M: The *purpose of our study was to estimate the incidence of SSI (Surgical site infection) and the effect of COLA (contamination, obesity, laparotomy and ASA grade) score on SSI in patients undergoing rectal surgical procedures for rectal cancer.*

MATER AL OF STUDY: *A total of 92 patients who underwent operation for rectum cancer were enrolled in this study. Wound surveillance was performed in all patients by a staff surgeon identified infected wounds during the hospital stay, and collected information for up to 30 days after operation.*

RESULTS: *The overall rate of incisional SSI and organ/space SSI was 22.8% and 7.6% respectively. Surgical site infection rates were 14.2%, 20.58%, 40.7%, 57.1% for COLA 1,2,3 and 4 scores respectively. The area under the receiver/operator characteristic curve for the score was 0,660.*

CONCLUSION: *COLA scoring systems predict, with reasonable accuracy, the risk of SSI in rectal cancer patients undergoing elective rectal surgery.*

KEY WORDS: COLA score Rectal surgery, Surgical site infection, Risk prediction, Wound infection

Abbreviations:

Surgical site infections (SSI);
Study on the Efficacy of Nosocomial Infection Control (SENIC);
National Nosocomial Infections Surveillance (NNIS);
American Society of Anesthesiologist risk (ASA);
COLA (contamination, obesity, laparotomy and ASAgrade) score.

Introduction

Surgical site infections (SSIs) account for 20% of health care associated infecti [1]. Approximately 5% of patients who undergo surgery develop SSI [2]. The term 'surgical site infection' (SSI) was introduced in 1992 to replace the previous term 'surgical wound infection'[3]. The postoperative wound infection after colorectal surgery was the one of the reasons for increasing medical cost such as, using antibiotics; changing of gauze or dressing materials several times in a day, and prolonging hospitalization [4].

SSIs are defined as infections occurring within 30 days after a surgical operation (or within one year if an implant is left in place after the procedure) and affecting either the incision or deep tissue at the operation site. These infections may be superficial or deep incisional infections, or infections involving organs or body spaces [5]. SSI is typically defined according to procedure

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and location of infection. Some of the highest reported rates of SSI occur in the context of colorectal surgery. Overall infection rates for colorectal surgery have been reported to be as high as 26% [6]. Given this high rate of infection; colorectal surgical procedures offer an excellent opportunity to identify risk factors for SSI.

For many years wound contamination class was the only factor that was well described for predicting the risk for SSI. During the Study on the Efficacy of Nosocomial Infection Control (SENIC) Project, an index was developed that provided a better assessment of the risk of SSI than had the traditional wound classification system. In 1991, a modification of the SENIC risk index by Culver et al. led to the National Nosocomial Infections Surveillance (NNIS) System risk index. [7]. Not all experts concede that the NNIS risk index is the best method for the risk stratification of all surgical procedures; as a result, the authors of these studies have proposed modifications that improve risk scoring systems [8].

A new, simple, scoring system based on preoperative risk factors contamination, obesity, laparotomy and American Society of Anesthesiologist risk (ASA) grade (COLA) was created to predict SSI risk following colorectal surgery [9]. Therefore in this study we aimed to identify the ratio of SSI and also the validity of the COLA score in elective rectal surgery, among Turkish rectal cancer patients.

Material and Method

A total of 92 patients who underwent elective rectal surgery for rectal cancer in Ankara Numune Education and Research Hospital between January 2001 and July 2011 were included the study. Data are collected prospectively by dedicated audit officers from hospital computer and paper records, and from the patients themselves. Minor procedures such as creation or reversal of an ileostomy or colostomy as the sole procedure were excluded. All operations were performed by staff surgeons. Patients underwent preoperative mechanical colon cleansing the day before surgery. All patients received intravenous prophylactic antibiotics, consisting of metronidazole and second-generation cephalosporins. The regimen of oral antibiotic administration (type, timing, and duration) was at the discretion of the surgeon.

Wound surveillance was performed in all patients by a staff surgeon identified infected wounds during the hospital stay, and collected information for up to 30 days after operation. Patients with insufficient clinical data were excluded from the study. COLA score for these patients were calculated using the retrospectively collected values.

Statistical analysis

Continuous data are presented as mean (SD) and differences between groups were analyzed by means of tests. Categorical variables were analyzed with χ^2 tests. Model discrimination was measured by the area under the receiver–operator characteristic (ROC) curve (AUC). The discrimination of a prognostic model is considered perfect if AUC=1, good if AUC>0.8, moderate if AUC is 0.6-0.8, and poor if AUC<0.6 (10). Calibration refers to the agreement between predicted probabilities and true probabilities. Of course, the true probability of a patient's outcome is not known; otherwise there would be no need to develop prognostic models. However, true probabilities can be approximated by taking the mean of the observed outcomes within predefined groups of patients. Calibration was assessed using the Hosmer-Lemeshow goodness-of-fit test and the corresponding calibration curves. Small P value, implying significant difference between observed and predicted mortality, thus indicate a lack of fit of the model [11]. SPSS for Windows 11.5 (Chi. IL., USA) was used for statistical analysis.

Results

There were 31 women and 61 men with a mean age of 57.2 (22-84) years. During follow-up, 28 patients (30.4%) developed SSI: superficial/ deep incisional infection in 21 patients (22.8%), and organ/space infection in 7 (7.6%) patients.

Among 66 cases with anastomosis (excluding abdominoperineal resection and Hartmann cases), 9 (13.6%) developed clinical anastomotic leakage. The most common type of procedure performed was low anterior resection 55 (59.7%) followed by abdominoperineal resection 24 (26%), and anterior resection 13 (14.1%). Forty-five (48.9%) patients also had a stoma created at the time of the case (either ileostomy or colostomy). Of the infected patients, 13 (46.4%) were inpatients at diagno-

TABLE I - *Demographic characteristics of the patient group*

Patient characteristics	Total Number of patients	No. with SSI
Mean age (range)	57.2(22-84)	28
Male to female patients	61m/31f	18/10
Stoma		
None	47	15
Ileostomy	18	6
Colostomy	27	7
Procedure		
Anterior resection	13	2
Low anterior resection	55	18
Abdomino-perineal resection	24	8
ASA grade		
I	6	1
II	30	5
II	44	17
IV	12	7

TABLE II - *Observed risk of surgical-site infection for each level of risk score*

COLA score	Total No. of patients	Total No. of SSI(%)	Incisional infections(%)	Organ/space infections(%)
1	14	2(14.2)	2(14.2)	-(0)
2	35	7(20.58)	5(14.7)	2(5.88)
3	27	11(40.7)	8(29.6)	3(11.1)
4	14	8(57.1)	6(35.2)	2(11.7)

TABLE III - *Performance summary of the COLA score according to ROC analysis*

AUC (%95 CI)	
COLA	0.660 (0.542 - 0.778)

AUC: Area Under Curve

TABLE IV - *Performance summary of the COLA score according to Hosmer-Lemeshow goodness-of-fit test.*

Score	χ^2	df	*P*
COLA	2.705	3	. 439

df = degrees of freedom

sis, and 15 (53.6%) were diagnosed postdischarge in the outpatient setting. The median time to diagnosis was 8 days (4 to 17 days). Re-operations were required in 2 of 7 organ space infections. In the remaining patients, purulent fluid collections were drained percutaneously by the interventional radiology service.

Sixteen wound swabs for bacterial culture were taken, including: polymicroorganisms in 10 (62.5%) samples, single organisms in 4 (25%) samples and the remaining two samples had no bacterial growth. These 14 cultures resulted in 42 isolates. The predominant bacteria cultured were Escherichia coli (50% of isolates); Enterobacter cloacae (35%); methicillin-resistant Staphylococcus aureus (28%). The other organisms isolated were P. aeruginosa, Staphylococcal spp, and K. pneumoniae.

Table I summarizes the demographic and clinical features of the study population, and their association with SSI. Surgical site infection rates were 14.2%, 20.58%, 40.7%, 57.1 % for COLA 1,2,3 and 4 scores respectively (Table II).

The COLA scoring system showed moderate discriminating value with areas under the ROC curve at 0.660 (Table III). On the other hand; as shown in Table IV, the COLA scoring system showed good calibration.

Discussion

Colorectal surgical patients are at increased risk of SSI in the presence of cancer. Operations are frequently long and involve extensive pelvic dissection. According to a Japanese Nosocomial Infection Surveillance report, for colon surgery patients SSI incidence was 17%, and for those with rectal surgeries the SSI incidence was 20.7%[12]. For comparison of SSI rates between hospitals or within a hospital over time, it is important to correct for risk factors related to the patient, surgery or hospital The risk of developing SSI varies greatly according to the nature of the operative procedure and the specific clinical characteristics of the patient undergoing that procedure Accurate prediction of outcome can increase the precision of individual prognosis and allow improved treatment planning and resource allocation. Ultimately, it is necessary to consider a broad range of risk factors for developing preventative measures. The CDC (Centers for Disease Control and Prevention) wound classification system is widely used to capture some of the risk of infection related to the type of operative procedure [5,13]. This classification scheme focuses primarily on the degree of contamination likely to be present during the operation.

The American Society of Anesthesiologists (ASA) physical status classification is widely used as a measure for intrinsic host susceptibility, with a higher score indicating an increased infection risk. An advantage of the ASA classification is that it is already available before the start of surgery. A drawback is that it represents a subjective parameter, which might result in interphysician variations [14].

The existing scoring systems for postoperative morbidity and mortality are the APACHE II scoring system (Acute Physiology and chronic Health Evaluation II), POSSUM (Physiological and operative severity score for enumeration of mortality and morbidity), ACPGBI (Association of Coloproctology of Great Britain and Ireland) and the surgical Apgar score (based on blood loss, lowest heart rate, and lowest mean arterial blood pressure).

POSSUM calculates expected death and expected morbidity based on 12 physiologic variables and six operative variables. Disadvantages include not taking into account differences among the surgeons, anesthetists, and operating time; all of which may influence outcome [15]. Although surgeon's 'gut feeling' can quite accurately predict the risk for complications, its subjective nature hinders effective communication with other staff and does not allow for objective quality assurance [16]. The ACPGBI scoring system consists of five variables: age, cancer resection, American Society of Anesthesiologists (ASA) grade, Duke's stage and operative urgency [17]. The APACHE II scoring system consists of an acute physiology score, which includes 12 physiological measurements, plus points for age and chronic health. The computer models, such as APACHE II and POSSUM, achieve these goals but the extensive dataset required and the complexity of the calculations restricts their utility in clinical practice [15].

The most widely used reporting system used currently is the National Nosocomial Infections Surveillance

(NNIS) system. It is based on a large sample from multiple institutes throughout the United States. Previous studies have pointed out the limitations in the NNIS system: The data are voluntary and self reported, they include infrequently infection diagnosed after discharge, and it does not include all procedures [5,18]. For all of these reasons, NNIS probably underestimates the overall rate of infection for colorectal surgery [5,14].
Gervaz et al examined 534 patients (6.7% superficial SSI and 7.3% organ/space SSI). In this study, multivariable analysis of risk factors for SSI was performed in patients who underwent resection of the colon or rectum, and were followed during the first month after operation. In multivariable analysis, four parameters correlated with an increased risk of SSI: obesity (odds ratio (OR) 2.93, 95 percent confidence interval 1·71 to 5·03), contamination class 3-4 (OR 3·33, 2·08 to 5·32), American Society of Anesthesiologists grade III-IV (OR 1·82, 1·14 to 2·90) and open surgery (OR 2·22, 1·01 to 4·88). Each of these contributed 1 point to the risk score. Surgical site infection rates were 5%, 12.0%, 18.7%, 44%, 68 % for COLA 0,1,2,3 and 4 scores respectively. The area under the receiver operating characteristic curve for the score was 0·729. The authors concluded that, the COLA score for SSI is at least as accurate as the NNIS index.
Konishi [19] showed that the incidence of incisional SSI is higher in elective rectal surgery than in elective colonic surgery and that the risk factors for incisional SSI are different between these two surgical procedures (9.4% and 18.0% respectively). In another study, SSI incidences, characteristics, and risk factors seem to be different among right colon surgery (RCS), left colon surgery (LCS), and rectum surgery (RS) [18]. We think that SSI surveillance for these surgeries should be performed separately because the risk factors differ from each other.
The study by Glenny et al. suggested that the surgical wound infection rate was 12.9% for the antibiotic-treated group and 40.2% for the untreated group [20]. In another study, the effects of polyethylene glycol (PEG) and sodium phosphate (SP) on SSI have been reported to result in a SSI incidence rate of 34% with PEG and 24% with SP [21]. Those studies revealed a higher SSI incidence than that of the NNIS data. We reported a cumulative SSI incidence of 30.4%. Those figures were not significantly different from our data.
The few reported randomized controlled trials that compared the incidence of SSI conventional open surgery (OS) versus laparoscopic surgery (LS) in colorectal carcinoma cases, showed a significantly lower incidence of SSI for LS compared to OS [22]. Although individually, the large randomized studies have demonstrated no difference in SSI, the meta-analyses, including multiple small studies, have shown a decrease in SSI with laparoscopic surgery for colorectal cancer. Therefore it is probable that laparoscopic surgery does not increase the risk of SSI and may well reduce the risk [21,23]. Differently from previous study [9], we analyzed open surgical operations for rectal cancer.
Obesity has been identified as a risk factor for infections and wound complications after a wide variety of surgical procedures. Several studies have reported that increased patient BMI is independently associated with wound infection in colorectal surgery [6,24].
The increased risk due to obesity has been variously attributed to decreased oxygen tension in relatively avascular adipose tissue, immune impairment, ischemia along suture lines, greater wound area, difficulties resulting in contamination and prolonged surgery [24].
Anastomotic leaks after curative colorectal resections for malignancy associated with a higher local recurrence rate[25]. In cases of mild sepsis and localised abscesses, computed tomography (CT)-guided drainage can be attempted.
Patient factors had traditionally been considered to have an important role in SSI. Age, severe comorbidity, malnutrition, immunosuppression, diabetes, smoking, ASA score, smoking, steroid use, and obesity were commonly reported to be risk factors for SSI [5,24,26]. Among all of them, the ASA risk score was probably the most important factor. Based on a large epidemiological study, a risk index was developed by the NNIS system for prediction of surgical wound infection [26]. Predicting factors in the NNIS risk index included ASA risk score and 2 operative factors.
The use of the NNIS Index in a wide range of procedures does not permit extending the results to specific populations and procedures. Compared with the NNIS index, the COLA score has a major advantage; it includes parameters readily available before surgery.
No previous study evaluated COLA scoring in patients with rectal cancer. Due to the view of the physiological variables included in COLA, the younger, relatively healthy patient with inflammatory bowel disease is likely to have a different score than the elderly with an extensive medical history operated for rectal carcinoma. This study proposed a new SSI risk prediction model in patients undergoing surgery for rectal cancer. The SSI's discriminatory power to detect true positive cases in the chosen model was calculated and also visualized through the ROC Curve. The COLA scoring system showed an area of 0.660 under the curve, revealing good accuracy or good predictive power of the test to detect patients with SSI. Clinicians can use this score to predict their patient's risk of an SSI and implement appropriate prevention strategies.

Riassunto

Lo scopo del nostro studio era di valutare l'incidenza del SSI (Surgical Site Infection) e gli effetti di dei parametri COLA (Contamination, Obesity, Laparotomy e ASA)

su SSI inn pazienti sottoposti a procedimenti chirurgici sul retto per cancro.
Nello studio sono stati arruolati 92 pazienti sottoposti ad intervento per cancro del retto. La sorveglianza della ferita è stata effettuata su tutti i pazienti da una squadra chirurgica dedicata all'identificazione delle ferite infette durante la degenza ospedaliera, ed a raccogliere informazioni connesse fino a 30 giorni dall'intervento.
L'incidenza globale delle SSI dell'incisione e dello spazio liberato dal retto è stato rispettivamente del 22,8% e del 7,6%.
L'infezione dell'area chirurgica in rapporto a 1,2,3 e 4 COLA è stata rilevata rispettivamente nel 14,2%, nel 20,58%, nel 40,7%, nel 57,1%.
L'area sotto la caratteristica curva paziente/operatore per punteggio è stata 0,660.
Si cinclude per una ragionevole accuratezza del valore predittivo del sistema di punteggio COLA nei confronti del rischio di SSI nel pazienti affetti da cancro del retto sottoposti a chirurgia rettale elettiva.

References

1. De Lissovoy G, Fraeman K, Hutchins V, Murphy D, Song D, Vaughn BB: *Surgical site infection: Incidence and impact on hospital utilization and treatment costs*. Am J Infect Control, 2009; 37:387-97.

2. Gottrup F: *Prevention of surgical-wound infections*. N Engl J Med, 2000; 342:202-04.

3. Horan TC, Gaynes RP, Martone WJ, Jarvis WR, Emori TG: *CDC definitions of noscomial surgical site infections, 1992: A modification of CDC definitions of surgical wound infections*. Infect Control Hosp Epidemiol, 1992; 13:606-08.

4. Perez Ruiz L, Gomez L, Vinas J, Torres S, Andreoni B: *Prognostic significance of postoperative septic complications in rectal cancer surgery*. Minerva Chirurgica 1996; 51:447-50.

5. Mangram AJ, Horan TC, Pearson ML, Silver LC, JarviS WR: G*uideline for prevention of surgical site infection, 1999. Hospital infection control practice advisory committe*e. Infect Control Hosp Epidemiol, 1999; 20:247-78.

6. Smith RL, Bohl JK, McElearney ST, Et Al: *Wound infection after elective colorectal resection.* Ann Surg, 2004; 239:599-605.

7. Brandt C, Hansen S, Sohr D, Daschner F, Rüden H, Gastmeier P: *finding a method For optimizing risk adjustment when comparing surgical-site infection rates.* Infect Control Hosp Epidemiol, 2004; 25:313-18.

8. Anderson D, Chen L, Sexton D, Kaye K: *Complex surgical site infections and the devilish details of risk adjustment: Important implications for public reporting.* Infect Control Hosp Epidemiol, 2008; 29:941-46.

9. *Gervaz, P, Bandiera-Clerc C, Buchs NC et al: Scoring system to predict the risk of surgical-site infection after colorectal resection.* Br J Surg, 2012; 99:589-95.

10. Hanley JA, Mcneil BJ: *The meaning and the use of the area under a receiver operating characteristic (ROC) curve.* Radiology 1982;143:29-36.

11. Lemeshow S, Hosmer DW JR: *A review of goodness of fit statistics for use in the development of logistic regression models.* Am J Epidemiol, 1982; 115:92-106.

12. Kobayashi M, Mohri Y, Inoue Y, Okita Y, Miki C, Kusunoki M: *Continuous follow-up of surgical site infections for 30 days after colorectal surgery.* World J Surg, 2008; 32:1142-46.

13. Kirby JP, Mazuski JE: *Prevention of surgical site infection*. Surg Clin North Am, 2009; 89:365-89.

14. De Oliveira AC, Ciosak SI, Ferraz EM, Grinbaum RS: *Surgical site infection in patients submitted to digestive surgery: Risk prediction and the NNIS risk index*. Am J Infect Control, 2006; 34:201-07.

15. Chandra A, Mangam S, Marzouk D: *A review of risk scoring systems utilised in patients undergoing gastrointestinal surgery*. J Gastrointest Surg, 2009; 13:1529-38.

16. Markus PM, Martell J, Leister I, Horstmann O, Brinker J, Becker H: *Predicting postoperative morbidity by clinical assessment*. Br J Surgery, 2005; 92:101-06.

17. Tekkis PP, Poloniecki JD, Thompson MR, Stamatakis JD: *Operative mortality in colorectal cancer: Prospective national study.* BMJ 2003;327:1196-201.

18. Degrate L, Garancini M, Misani M, et al.: *Right colon, left colon, and rectal surgeries are not similar for surgical site infection development. Analysis of 277 elective and urgent colorectal resections.* Int J Colorectal Dis, 2011; 26:61-69.

19. Konishi T, Watanabe T, Kishimoto J, Nagawa H: *Elective colon and rectal surgery differ in risk factors for wound infection: Results of prospective surveillance*. Ann Surg, 2006; 244:758-63.

20. Glenny AM, Song F: *Antimicrobial prophylaxis in colorectal surgery*. Qual Health Care, 1999; 8:132-36.

21. Itani KM, Wilson SE, Awad SS, Jensen EH, F NN TS, Abramson MA: *Polyethylene glycol versus sodium phosphate mechanical bowel preparation in elective colorectal surgery*. Am J Surg, 2007; 193:190-94.

22. Schwenk W, Haase O, Neudecker J, Muller JM: *Short term benefits for laparoscopic colorectal resection*. Cochrane Database Syst Rev, 2005; 20:3 CD003145.

23. Neudecker J, Klein F, Bittner R, Carus T, Stroux A, Schwenk W: *Short-term outcomes from a prospective randomized trial comparing laparoscopic and open surgery for colorectal cancer*. Br J Surg, 2009; 96:1458.467.

24. Fujii T, Tsutsumi S, Matsumoto A, et al.: *Thickness of subcutaneous fat as a strong risk factor for wound infections in elective colorectal surgery: Impact of prediction using preoperative CT*. Dig Surg, 2010; 27:331-35.

25. Mıccını M, Borghese O, Scarpını M, et al.: *Anastomotic leakage and septic complications: Impact on local recurrence in surgery of low rectal cancer*. 2011; 82:117-23.

26. Gaynes RP, Culver DH, Horan TC, Edwards JR, Richards C, Tolson JS: *Surgical site infection (SSI) rates in the United States, 1992-1998: The National Nosocomial Infections Surveillance System basic SSI risk index*. Clin Infect Dis, 2001; 33:69-77.