

Fever Evaluations after Colorectal Surgery: Identification of Risk Factors that Increase Yield and Decrease Cost

ORIGINAL CONTRIBUTION

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PURPOSE: This study was designed to evaluate the yield and cost of fever evaluations in average-risk inpatients after elective colorectal surgery.

METHODS: A 12-month, retrospective study was performed on patients who developed a postoperative fever $\geq 38^{\circ}\text{C}$ after elective colorectal surgery. A positive fever evaluation was defined as a blood culture, urine culture, chest x-ray, or abdominal CT result that led to a change in patient management. Logistic regression, Fisher's exact test, and chi-squared test were used; odds ratios were calculated.

RESULTS: Of 133 patients, 26 percent had a positive evaluation. Blood culture, urine culture, chest x-ray, and CT were positive in 3, 8, 7, and 46 percent, respectively. Risk factors for a positive fever evaluation were temperature $\geq 38.5^{\circ}\text{C}$, fever evaluation after postoperative Day 6, and a clinical manifestation of systemic inflammatory response syndrome other than fever (all, $P < 0.01$). The cost per positive fever evaluation for the entire group, patients with 2 risk factors, or patients with 3 risk factors was \$5,600, \$4,200, and \$2,140, respectively.

CONCLUSIONS: The current approach to fever evaluation after elective colorectal surgery is low yield and costly. High fever, late postoperative fever, and systemic inflammatory response syndrome are risk factors for a positive fever evaluation after colorectal surgery.

KEY WORDS: Fever; Colon; Rectum; Surgery.

Postoperative fever occurs commonly after abdominal surgery and many other types of surgical procedures.^{1,2} Despite an understanding that early postoperative fever most often results from the normal inflammatory response to surgery, an extensive search for an infectious etiology often is pursued.^{3,4} In the evaluation of fever after major abdominal and pelvic surgery, blood cultures, urine

cultures, and chest x-ray (CXR) have proven to be of little value when they are used nonselectively.^{1-3,5-9} Although previous studies did not exclude patients who underwent small bowel or colorectal surgery, no study has focused on the utility of fever evaluations in this patient population. This study was designed to determine the yield and cost of routine fever evaluations after major elective small bowel and colorectal surgery.

PATIENTS AND METHODS

We performed a single-center, retrospective analysis of fever evaluations performed after major elective small bowel and colorectal surgery, between January and December of 2005. Fellowship-trained colorectal surgeons performed all operations. Study inclusion criteria were the following: nonemergent, open, or laparoscopic colorectal or small-bowel surgery, postoperative fever $\geq 38^{\circ}\text{C}$, and at least one blood culture obtained during the postoperative period. Exclusion criteria were nonoperated patients, initial fever evaluation in an intensive care unit (ICU), presence of long-term indwelling intravenous catheters, acquired immunodeficiency syndrome (AIDS), and recipients with organ transplants. Study patients were identified from colorectal surgery and microbiology departmental databases. Data were collected for demographics, diagnosis, comorbidities, smoking history, steroid use, surgical procedure, interval from surgery to fever evaluation, vital signs (temperature, respiratory rate, heart rate, blood pressure), complete blood count, blood and urine culture results, chest x-ray results, and abdominal computed tomography (CT) results. A positive fever evaluation was defined as temperature $\geq 38^{\circ}\text{C}$ and a blood culture, urine culture, CXR, or CT result that triggered a change in treatment (e.g., antibiotic therapy, percutaneous abscess drainage, operative therapy). Blood and urine cultures contaminated by skin flora were discounted. Subgroup analysis was performed by stratification of the study population into three groups determined by the interval from the day of surgery to the day of fever: 0 to 2 days, 3 to 6 days, and more than 6 days after surgery. The day of fever was defined as the day that the fever evaluation was initiated. Study patients with evidence of the systemic inflammatory response syndrome (SIRS), including heart rate > 90 beats per minute, respiratory rate > 20 breaths per minute, leukocytosis ($> 12,000$ cells/mm³), or

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Table 1. Positive fever evaluations

Patient	Diagnosis	Operation	Fever day	Test	Test result	Treatment
1	Indeterminate colitis	Takedown ileostomy, Ventral hernia repair	1	CXR	Pneumonia	Antibiotics
2	Ulcerative colitis	Takedown ileostomy	1	UC	UTI	Antibiotics
3	FAP	Exploratory laparotomy	2	BC	Bacteremia	Antibiotics
4	Cancer	Low anterior resection	2	CXR	Pneumonia	Antibiotics
5	Cancer	Left colectomy	2	UC	UTI	Antibiotics
6	FAP	Exploratory laparotomy	2	UC	UTI	Antibiotics
7	Ulcerative colitis	IPAA	3	CT	Abdominal hematoma	TPN
8	Crohn's	Ventral hernia repair	3	CXR	Pneumonia	Antibiotics
9	Crohn's	Small-bowel resection	3	CXR	Pneumonia	Antibiotics
10	Ulcerative colitis	Total abdominal colectomy, ileostomy	4	BC/CT	Abdominal abscess	Laparotomy
11	Cancer	Small-bowel resection	4	UC/CT	Abdominal abscess / UTI	CT-guided drainage/ABX
12	Ulcerative colitis	IPAA	4	CXR	Pneumonia	Antibiotics
13	Ulcerative colitis	IPAA	5	CT	Abdominal hematoma	CT-guided drainage/ABX
14	Ulcerative colitis	IPAA	5	CXR	Pneumonia	Antibiotics
15	ECF	Small Bowel Resection	5	UC	UTI	Antibiotics
16	Crohn's	Ileocolic resection	5	UC	UTI	Antibiotics
17	FAP	IPAA	6	CT	Abdominal hematoma	Antibiotics
18	Cancer	Takedown ileostomy	6	BC	Bacteremia	Antibiotics
19	FAP	IPAA	7	CT	Cholecystitis	Antibiotics
20	Ulcerative colitis	Koch pouch	7	CT	Abdominal abscess	CT-guided drainage/ABX
21	Cancer	Low anterior resection	7	CT	Abdominal abscess	CT-guided drainage/ABX
22	Ulcerative colitis	Total abdominal colectomy, ileostomy	7	CT	Pneumonia	Antibiotics
23	Cancer	Low anterior resection	8	BC/CT	Intestinal ischemia	Laparotomy
24	Cancer	Abdominoperineal resection	8	CT	Abdominal abscess	Laparotomy
25	Rectal prolapse	Perineal proctosigmoidectomy	8	CT/ C. diff Toxin A	Presacral hematoma / C. diff colitis	Antibiotics
26	Cancer	Total abdominal colectomy, ileostomy	8	UC	UTI	Antibiotics
27	Ulcerative colitis	Takedown ileostomy	8	UC	UTI	Antibiotics
28	Cancer	Right colectomy	9	CT	Abdominal abscess	CT-guided drainage/ABX
29	Ulcerative colitis	IPAA	9	CT	Abdominal abscess	CT-guided drainage/ABX
30	Cancer	Right colectomy	11	CT	SBO	TPN
31	Radiation proctitis	Loop ileostomy creation	11	UC	UTI	Antibiotics
32	FAP	Takedown ileostomy	17	CT	Abdominal wall cellulitis	Antibiotics
33	Cancer	Takedown ileostomy	20	CT	Intra-abdominal abscess	CT-guided drainage/ABX
34	Ulcerative colitis	IPAA	20	CT	PVT	Anticoagulation

IPAA = ileal pouch-anal anastomosis; BC = blood culture; UC = urine culture; CXR = chest x-ray; CT = abdominopelvic CT; UTI = urinary tract infection; SBO = small-bowel obstruction; PVT = portal vein thrombosis; ABX = antibiotics; c. diff = clostridium difficile colitis; FAP = familial adenomatous polyposis; ECF = enterocutaneous fistula; TPN = total parental nutrition.

leukopenia ($<4,000$ cells/mm³), or > 10 percent immature neutrophils also were identified.^{10,11} The direct cost of all laboratory and radiologic tests included in the fever evaluation tests were determined. The Cleveland Clinic Institutional Review Board approved this study.

Statistical Analysis

Fisher's exact test, chi-squared, Wilcoxon's rank-sum, classification and regression tree were used to assess

potential categorical and continuous risk factors for a positive fever evaluation. Logistic regression was used to derive estimates of odds ratios with 95 percent confidence intervals. Among risk factors deemed significant at the 0.05 level univariably, the number of risk factors present per patient was itself used as predictor of positive evaluation, with odds ratios for number of risk factors present computed relative to a combined group of 0 or 1 risk factor.

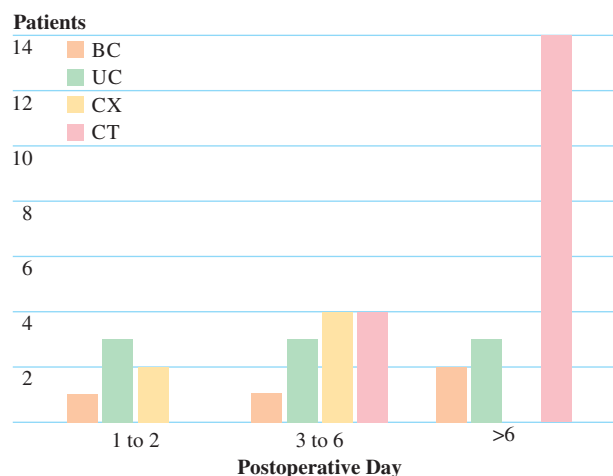


FIGURE 1. Positive fever evaluations in postoperative time groups. BC = blood culture; UC = urine culture; CX = chest x-ray; CT = computed tomography.

RESULTS

There were 1,769 inpatient colorectal and small-bowel operations performed during the study period. Of these, 301 patients had a postoperative fever and a blood culture performed; 133 met all of the study inclusion criteria. We excluded 168 patients who had their initial fever evaluation performed in an ICU, had a long-term indwelling intravenous catheter, AIDS, or an organ transplant. The median age for the included patients was 50 (range, 18–86) years and 56 percent were males. Abdominal (laparotomy or laparoscopy) and anorectal surgery were performed in 95 and 5 percent, respectively. The indications for surgery were colorectal cancer (30 percent), ulcerative colitis (25 percent), Crohn's disease (24 percent), diverticular disease (5 percent), familial adenomatous polyposis (4 percent), enterocutaneous fistula (4 percent), and others, including rectal prolapse and motility disorders (8 percent).

Of 133 patients evaluated for fever, 34 (26 percent) had a positive fever evaluation (Table 1). A total of 133 blood cultures, 116 urine cultures, 86 CXR, and 39 CT were performed. Blood culture, urine culture, CXR, and CT were positive in 4 (3 percent), 9 (8 percent), 6 (7 percent), and 18 (46 percent) patients in whom each test was performed, respectively. Two patients with UTI had a bladder catheter in place at the time of fever evaluation. All patients with urinary tract infection or pneumonia were treated with antibiotics. CT diagnosed abdominal abscess in eight patients, of which CT-guided percutaneous drainage or laparotomy was the treatment in six and two patients, respectively. One patient diagnosed with a presacral hematoma by CT also had clostridium difficile colitis, both treated with antibiotics.

Fever evaluations performed 0 to 2 days, 3 to 6 days, and more than 6 days after surgery were positive in 16, 20, and 46 percent, respectively ($P < 0.01$). Of the 18

positive CT studies, 13 (72 percent) were performed after postoperative Day 6 (Fig. 1). A clinical manifestation of SIRS, in addition to fever, was present in 29 of 34 patients (85 percent) with a positive test result and 54 of 97 patients (56 percent) with a negative test result ($P < 0.001$). Patients with fever of $\geq 38.5^\circ\text{C}$ had a positive fever evaluation in 31 of 97 cases (32 percent) and patients with fever $< 38.5^\circ\text{C}$ had a positive evaluation in 2 of 31 cases (6 percent; $P < 0.01$).

Significant risk factors for a positive fever evaluation were fever $\geq 38.5^\circ\text{C}$, fever evaluation after postoperative Day 6, and a clinical manifestation of SIRS in addition to fever (all, $P < 0.01$). Patient age, gender, diagnosis, comorbid conditions (diabetes, chronic lung disease, cardiovascular disease, obesity [BMI > 30]), smoking history, steroid use, type of surgery, white blood cell count, and anemia were not significantly associated with positive fever evaluations (Table 2). In patients with zero, one, two, or three significant risk factors, fever evaluation was positive

Table 2. Assessment of potential risk factors for positive evaluation

Variable	(+) Fever evaluation	(-) Fever evaluation	P value
Median age (yr)	51 (18–86)	47 (18–85)	0.5
Gender			0.2
Female	18 (30.5)	41 (69.5)	
Male	16 (21.6)	58 (78.4)	
Comorbid conditions			
Diabetes	4 (25)	12 (75)	1
Chronic lung disease	0 (0)	1 (100)	1
Cardiovascular disease	1 (33.3)	2 (66.7)	1
obesity	1 (14.3)	6 (85.7)	0.7
Any	6 (20)	21 (80)	0.5
Steroid use			0.15
No	23 (23.2)	76 (76.8)	
Yes	11 (36.7)	19 (63.3)	
Median hemoglobin (g/dl)	10.4 (5.9–12.5)	9.7 (7.2–15.5)	0.95
Median WBC (k/ul)	11.6 (2.9–36.1)	9.5 (1.8–24.4)	0.2
SIRS			< 0.001
No	4 (8.5)	43 (91.5)	
Yes	29 (34.9)	54 (65.1)	
Temperature ($^\circ\text{C}$)			< 0.01
< 38.5	2 (6.5)	29 (93.5)	
≥ 38.5	31 (32)	66 (68)	
Days after surgery			< 0.01
≤ 2	6 (16.3)	31 (83.7)	
3–6	12 (19.7)	49 (80.3)	
> 6	16 (45.7)	19 (54.3)	

WBC = white blood cell; SIRS = systemic inflammatory response syndrome. * Data are numbers with percentages or ranges in parentheses unless otherwise indicated.

Table 3. Correlation of risk factors with positive fever evaluation

Risk factors*	All patients	(-) Fever evaluation	(+) Fever evaluation	OR [†]	95% CI
0	13 (10)	13 (100)	0	—	—
1	40 (30)	38 (95)	2 (5)	—	—
2	65 (49)	43 (66)	22 (34)	13	6–28
3	15 (11)	5 (33)	10 (67)	51	21–126

OR = odds ratio; CI = confidence interval. • Data are numbers with percentages in parentheses or ranges unless otherwise indicated. • *Risk factors: Fever $\geq 38.5^{\circ}\text{C}$, Fever evaluation after postoperative Day 6, SIRS • [†]Relative to a combined group of ≤ 1 risk factor.

in 0, 5, 34, and 67 percent, respectively. Of the 34 positive fever evaluations, 32 (94 percent) occurred in patients with two or more risk factors (Table 3). The total direct costs for fever evaluation tests in the 133 study patients, the 65 patients with 2 risk factors, and the 15 patients with 3 risk factors were \$190,000, \$93,000 and \$21,000, respectively. The cost per positive evaluation for the entire group, those with two risk factors, and those with three significant risk factors was \$5,600, \$4,200, and \$2,140, respectively.

DISCUSSION

Postoperative fever is commonly associated with surgical procedures that involve the gastrointestinal tract, gynecologic surgery, and a broad variety of other types of surgery.¹ In studies that have focused on patients who underwent major gastrointestinal or gynecologic operations, postoperative fever was noted in 15 to 39 percent of patients.^{2,3,5–9} These studies have demonstrated that the evaluation of postoperative fever with blood and urine cultures, and CXR, infrequently leads to the identification of an infectious cause of fever. For postoperative fever evaluation, the rate of positive blood cultures, positive urine cultures, and positive CXR ranges from 0 to 10 percent, 7 to 19 percent, and 2 to 14 percent, respectively.^{2,5–7} In an effort to decrease the number of negative postoperative fever evaluations, Schwandt and colleagues performed a prospective study in which a sign or symptom of infection, in addition to fever, was prerequisite for diagnostic laboratory or imaging studies to be performed.⁸ With this selective approach, fever evaluation was performed in only 3 of 28 postoperative febrile patients, each of whom had an infectious cause of fever identified. The selective use of blood and urine cultures and CXR resulted in a substantial decrease in the number of studies performed, a significant increase in the percentage of positive study results, and a substantial cost savings.⁸ These studies have indicated that infection is an uncommon cause of postoperative fever. On the contrary, there is evidence that fevers in the postoperative period result mainly from a surge in blood-borne inflammatory mediators.^{4,12} Despite these reports, postop-

erative fevers are typically evaluated with a battery of blood, urine, and radiologic studies. In our study, a fever and blood culture was performed in 301 of 1,769 (17 percent) patients during the study period. To determine the yield of fever evaluations in average-risk patients, after elective colorectal or small-bowel surgery, we excluded patients who were initially evaluated in an ICU, patients with a long-term indwelling intravenous catheter, AIDS, or an organ transplant. In the 133 patients who met our inclusion criteria, blood, urine, and CXR yielded a positive result in 3, 8, and 7 percent, respectively. These results, for patients who underwent small-bowel or colorectal surgery, are in-line with those reported for patients who underwent gynecologic or major abdominal surgery.^{2,3,5–9} As previous authors have demonstrated, the yield of blood cultures also was exceedingly low in our study. In fact, when the cumulative results of five relevant published reports are included with our result, the rate of positive blood cultures was 16 of 681 tests (2 percent).^{2,5–8}

A transurethral bladder catheter was inserted in nearly all of our patients who underwent laparotomy or laparoscopy. The bladder catheter was typically removed on postoperative Day 1 after laparoscopic cases involving the small bowel or colon. For most open operations, and for laparoscopic operations that involve partial or complete removal of the rectum, the bladder catheter was typically removed on postoperative Day 2 or 3. Our timing of bladder catheter discontinuation has two goals: to prevent UTI and urinary retention after catheter removal.¹³ With this approach, our 8 percent rate of UTI was in-line with the results from the above-cited studies that addressed fever etiology after gynecologic and major abdominal surgery. We did not evaluate the rate of urinary retention after catheter removal. In our study, UTI were diagnosed between postoperative Days 2 and 11 (median, 5). In two of nine patients with UTI a bladder catheter was in place at the time of UTI diagnosis. These results imply that UTI is more common in patients who require long-term bladder catheterization and that urine culture will be highest yield when performed to evaluate fevers on or after postoperative Day 2.

In our study, as in the reports on fever evaluation after gynecologic and major abdominal surgery, the yield of CXR was low in postoperative fever evaluations. The most common positive CXR result was pneumonia. Although some of our febrile patients likely had clinical signs to suggest pneumonia, and CXR was obtained to confirm the diagnosis, the precise clinical scenario, for each febrile patient, cannot be determined in our study. Therefore, a limitation of our study is that the clinical signs that triggered a fever evaluation may not have been adequately documented, thus making it difficult to determine the reason for some of the evaluations. However, CXR was negative in 93 percent, which suggests

that this test was used indiscriminately for fever evaluations, a practice that cannot be supported by our findings or the previously mentioned studies. The substantially increased yield of CXR in patients with clinical signs or symptoms of pneumonia, as reported by Schwandt and colleagues,⁸ suggests that the selective use of CXR, as with blood and urine culture, will increase the yield of these studies in patients with postoperative fever.

Our study population included many patients who underwent bowel resection and anastomosis and were at risk for anastomotic complications, including anastomotic leak and/or perianastomotic abscess. Because fever is one of the signs of an intra-abdominal catastrophe, we chose to include the result of CT when it was obtained in the setting of postoperative fever. It is noteworthy that CT was the single highest yield study performed in our study population with 18 of 39 (46 percent) positive results, including 13 of 18 (72 percent) performed after postoperative Day 6. CT identified an abscess in 8 of 39 studies (20 percent) at a median of 7 days after surgery. It is reasonable to expect that some of these abscesses were related to anastomotic complications, which often occur after the first postoperative week.¹⁴ Therefore, in contrast to the low yield of blood and urine cultures and CXR, the relatively high yield of CT should be considered for fever evaluations performed in the second postoperative week or whenever there is a high index of suspicion for abdominopelvic abscess.

There are limitations of our study that result from the way in which we identified patients for study inclusion and from deficiencies associated with the methods used to identify the source of fever. We are certain that there were cases in which an obvious source for the postoperative fever was diagnosed, an appropriate treatment was initiated, and no blood culture was obtained. These febrile patients were not evaluated in our study. Targeted fever evaluations in which clostridium difficile infection, venous thromboembolism, or adrenal insufficiency was diagnosed and treated without a blood culture performed also were, by design, excluded from our study. A fever evaluation algorithm was not used for the study patients and thus different patients underwent different fever evaluation tests at the discretion of their resident and staff surgeons. This is a limitation of our study in that an infectious source may have been missed as a result of an inadequate evaluation. We suspect that there were some patients in the "no source for fever" group who had a false-negative fever evaluation. However, if an infection was missed it is likely that the patient would remain persistently febrile. In these cases, further diagnostic studies would be performed and an infectious disease specialist consultation often would be obtained. In cases in which the febrile episode spontaneously resolved and no infection was identified we suspect that the transient

temperature elevation was the result of the normal inflammatory response associated with major surgical procedures.^{4,12} Nonetheless, our study was limited in that we did not evaluate the impact of an infectious disease specialist consultation on the yield of fever evaluations and we did not perform tests to identify inflammatory or other noninfectious causes of postoperative fever. Therefore, the real utility of our study is not in the determination of the cause and outcome of all postoperative fevers in colorectal surgery patients but rather in the determination of the yield of the routine tests that are typically performed, in our patients, under our care, in this setting.

We have identified fever $\geq 38.5^{\circ}\text{C}$, fever after postoperative Day 6, and a clinical manifestation of SIRS in addition to fever as significant risk factors for a positive fever evaluation. When a patient had two or three of these risk factors, their odds for a positive fever evaluation were increased 13- and 51-fold, respectively. There were no positive fever evaluations in patients without the identified risk factors and one risk factor did not confer an increased risk of a positive evaluation. The total costs related to fever evaluations and the cost per positive fever evaluation would have been decreased by 40 percent and 25 to 63 percent if only the patients with two or more risk factors were evaluated. In this hypothetical scenario, only 2 of 34 positive fever evaluations may have been missed in our study. We suspect that these two missed patients would have remained febrile with clinical signs that would lead to the appropriate diagnostic evaluation even in the absence of the risk factors that we identified. Our results suggest that the yield of postoperative fever evaluations may be increased if the trigger for fever evaluation was something more than simply a temperature elevation. As one would expect, the overall cost of fever evaluations would be less if fewer evaluations were performed and the cost per positive evaluation would be decreased by a risk factor directed selective approach to postoperative fever.

CONCLUSIONS

The yield of postoperative fever evaluations after elective small-bowel and colorectal surgery is very low. Blood and urine cultures and CXR rarely identify an infectious cause of fever in this group of patients. On the contrary, CT is higher yield and more frequently identifies a cause of postoperative fever, particularly when performed in the late postoperative period. The yield of postoperative fever evaluations is increased in patients with high fever, a fever after postoperative Day 6, and in patients with a manifestation of SIRS in addition to fever. The selective use of postoperative fever evaluations based on these identified risk factors has the potential to increase the yield and decrease the cost of postoperative fever evaluations in patients after small-bowel or colorectal surgery.

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