

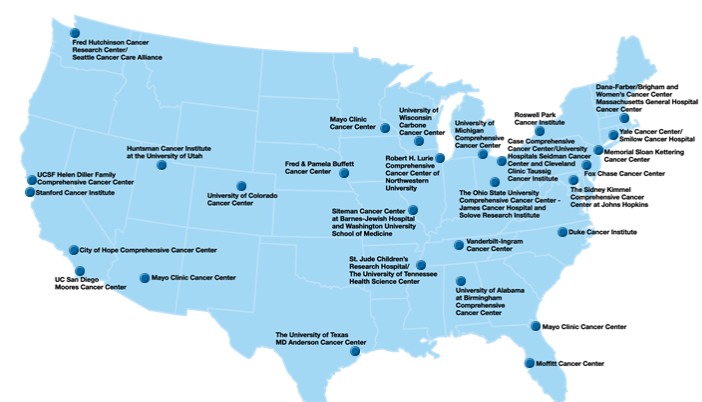
Risk Adjustment of Surgical Site Infection Rates Following Colon Surgery

Teresa Childers, MPH, CIC¹, Mini Kamboj, MD¹, Jessica Sugalski, MPPA², Donna Antonelli, BS, CPHQ³, Juliane Bingener-Casey, MD⁴, Jamie Cannon, MD⁵, Karie Cluff, BSN, RN⁶, Kimberly a. Davis, MD, MBA⁷, Patchen E. Dellinger, MD⁸, Sean Dowdy, MD⁹, Kim Duncan, MD¹⁰, Julie Feddersen, MD¹⁰, Robert Glasgow, MD¹¹, Bruce Hall, MD, PhD¹², Marilyn Hirsch, RN, MS¹³, Matthew Hutter, MD¹⁴, Lisa Kimbro, MBA, CPA², Boris Kuvshinoff II, MD, MBA¹⁵, Martin Makary, MD, MPH¹⁶, Melanie Morris, MD⁵, Sharon Nehring, RN, BSN¹⁷, Sonia Ramamoorthy, MD, FACS, FASCRS¹⁸, Rebekah Scott, MSN, MBA/HC, PHN, RN¹⁸, Mindy Sovel, MPH, MA¹⁹, Vivian Strong, MD¹⁹, Ashley Webster, RN, BSN, CNOR²⁰, Elizabeth Wick, MD¹⁶, Julio Garcia Aguilar, MD^{1,19}, Martin Weiser, MD¹, Robert Carlson, MD² and Kent Sepkowitz, MD^{1,21}

Background

- The Centers for Disease Control and Prevention (CDC) estimate surgical site infections (SSI) following colo-rectal surgery (CRS) are among the leading causes of healthcare-associated infection (HAI).
- Twenty-two percent of all HAI's are surgical site infections—15% of these are associated with CRS (1).
- Cancer is among the top indications for CRS. The reported rates of SSI after CRS vary widely across several studies ranging from 3-30% (2,3). Specifically for oncologic resection, a single observational study that examined more than 600 elective CRS procedures found that 25% of patients developed SSI within 30 days (4).
- The above findings imply that infectious complications fall among the higher end of the spectrum for persons undergoing surgery for colo-rectal cancer.
- Previous to the current study, multi-center and standardized assessment of SSI risk among patients with colo-rectal cancers was not available.

Methods

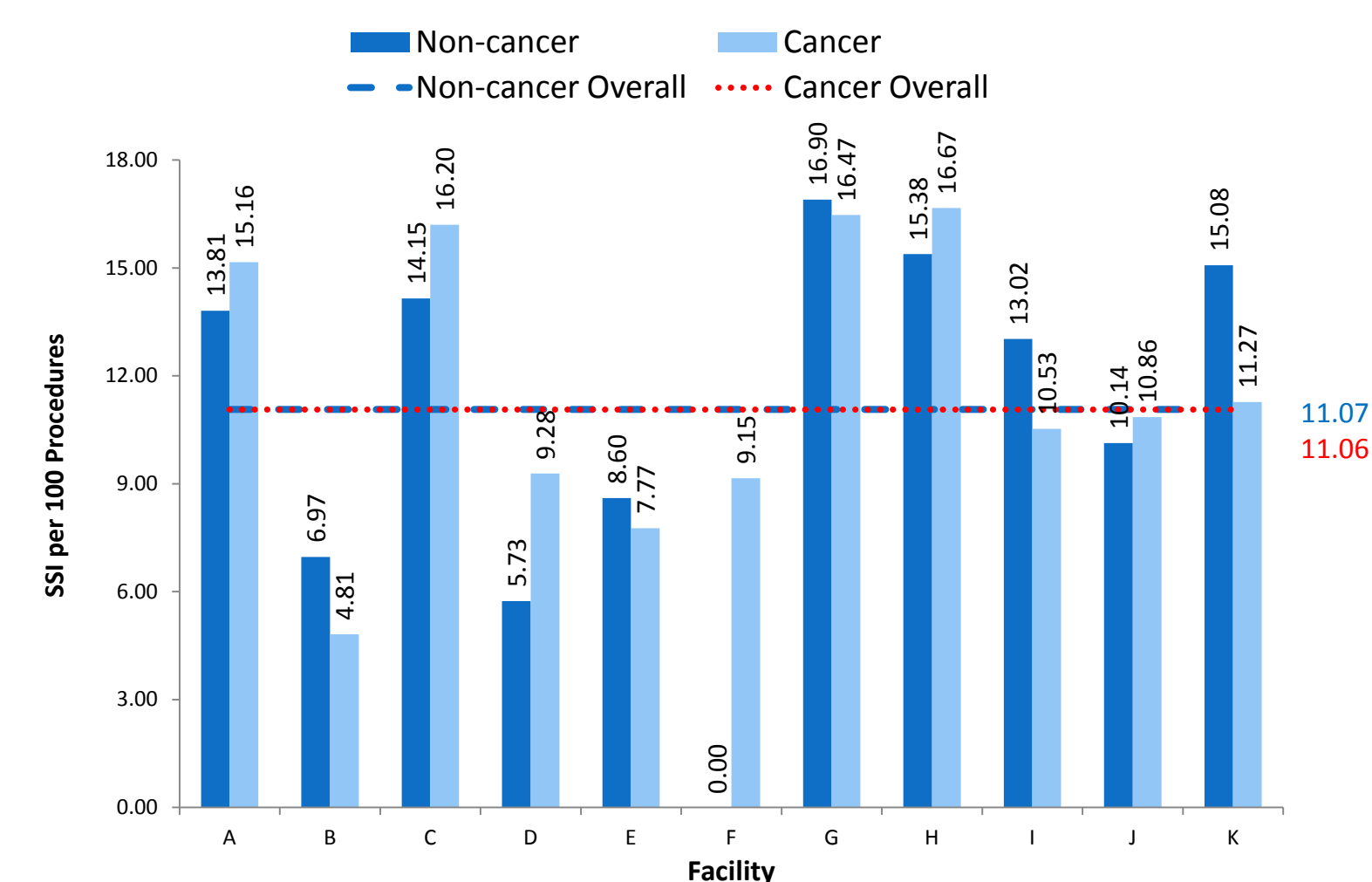


- Twenty-two National Comprehensive Cancer Network (NCCN) Member Institutes were invited to participate.
- Eleven centers were included in the study: 2 stand alone oncology centers and 9 large multispecialty teaching hospitals.
- Patients who had undergone incision, resection or anastomosis of the large intestine based on primary Current Procedural Terminology (CPT) codes were identified from the ACS NSQIP databases from January 1, 2011, through December 31, 2013.
- Institutions submitted a de-identified ACS-NSQIP Participant Use File that was combined with the files of all participating institutions.
- A pooled oncology-specific SSI rate was derived from this dataset based on differentiation of cancer and non-cancer by ICD-9-CM code.
- The primary NSQIP outcome of interest was 30 day surgical site infection.
- For procedures with more than one SSI, only one SSI was counted.

Results

- From January 1, 2011, to December 31, 2013, a total of 5893 colon procedures met criteria for inclusion—among these, 652 SSI occurred within 30 days (overall rate =11.06%; range 5.93-16.67%).
- The overall SSI rates among cancer and non-cancer cohorts were 11.06% (347/3137) and 11.07% (305/2756) respectively (Figure 1). No statistically significant differences were seen between the two groups in the combined cohort and within facilities.
- The SSI rate among disseminated cancers was 17.5%.

Figure 1: Crude facility-specific rates of SSI among eleven participating centers and rates of SSI in cancer versus non-cancer



- The most common SSI type was superficial (n=325, 49%), followed by organ space (n=248, 38%) and deep incisional (n=79, 12.1%) (Table 1).
- Among patients with disseminated cancer, the majority of SSI are deep and organ space infections.

Table 1: Type of SSI among patients with underlying cancer-Localized versus disseminated

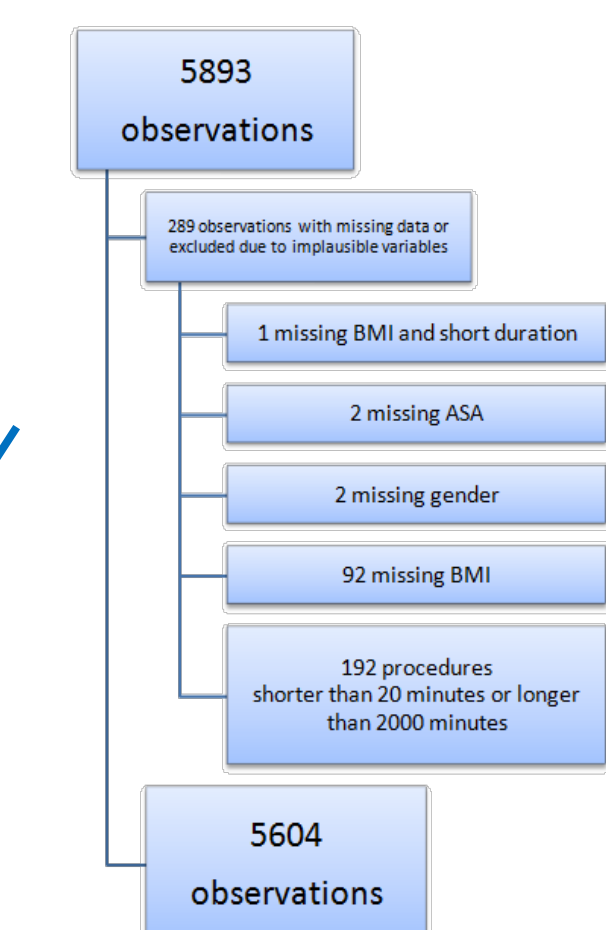
	Overall		Non-cancer		Localized Cancer		Disseminated Cancer	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Superficial	325	49.85	158	51.8	146	56.59	21	23.60
Deep	79	12.12	35	11.48	26	10.08	18	20.22
Organ/Space	248	38.01	112	36.72	86	33.33	50	56.18
	652		305		258		89	

Table 2: Demographics and clinical characteristics of colon surgery patients

	Total (%) (n=5893)	Surgical Site Infection		%SSI	p value
		Yes n (%) (n=652)	No n (%) (n=5241)		
Demographics					
Age					
65+	2345 (39.79)	2083(39.74)	262 (40.18)	11.17	0.8287
<64	3548 (60.21)	3158 (60.26)	390 (59.82)	10.99	
Gender					
Male	2798 (47.48)	320 (49.08)	2478 (47.28)	11.44	0.3905
Female	3093 (52.49)	332 (50.92)	2761 (52.68)	10.73	
Missing Gender	2 (0.03)	0(0)	2 (0.04)	0.00	
Preoperative Risk Factors					
BMI					
< 18.5	229 (3.89)	25 (3.83)	204 (3.89)	10.92	0.0006
18.5 - 24.9	1991 (33.79)	184 (28.22)	1807 (34.38)	9.24	
25 - 29.9	1865 (31.65)	196 (30.06)	1669 (31.85)	10.51	
>= 30	1715 (29.10)	234 (35.89)	1481 (28.26)	13.64	
Missing BMI	93 (1.58)	13 (1.99)	80 (1.53)	13.98	
ASA Class					
ASA >= 3	2793 (47.40)	413 (63.34)	2685 (51.23)	14.79	< 0.0001
ASA < 3	3098 (52.57)	238 (36.5)	2555 (48.75)	7.68	
Missing ASA	2 (0.03)	1 (0.15)	1 (0.02)	50.00	
Procedure Related Risk Factors					
Emergency Case					
Yes	610 (10.35)	78 (11.96)	532 (10.15)	12.79	0.1519
No	5283 (89.65)	574 (88.04)	4709 (89.85)	10.87	
Wound Classification					
Contaminated or Dirty/Infection	1400 (23.76)	184 (28.22)	1216 (23.20)	13.14	0.0045
Clean or Clean Contaminated	4493 (76.24)	468 (71.78)	4025 (76.8)	10.42	
Open Wound					
Yes	175 (2.97)	17 (2.61)	158 (3.01)	9.71	0.5634
No	5718 (97.03)	635 (97.39)	5083 (96.99)	11.11	
Mean Duration (10 minute units)					
18.43 (SD 12.9)	21.82 (SD 14.9)	18.01 (SD12.5)			<0.0001
More than 1 Procedure					
> 1 Other Procedures	1384 (23.49)	176 (26.99)	1208 (23.05)	12.72	0.025
<= 1 other Procedure	4509 (76.41)	476 (73.01)	4033 (76.95)	10.56	
Surgical Approach					
Open	3028 (51.38)	377 (57.82)	2651 (50.58)	12.45	0.0005
Lap	2865 (48.62)	275 (42.18)	2590 (49.42)	9.60	
Wound Closure					
Only deep or no layers closed	152 (2.58)	15 (2.3)	137 (2.61)		0.7964
All layers closed	3887 (65.96)	409 (62.73)	3478 (66.36)		
Missing Wound Closure	1854 (31.46)	228 (34.97)	1626 (31.02)		
Comorbidities					
Diabetes					
Yes	737 (12.51)	123 (18.87)	614 (11.72)	16.69	< 0.0001
No	5156 (87.49)	529 (81.13)	4627 (88.28)	10.26	
COPD					
Yes	298 (5.06)	55 (8.44)	243 (4.64)	18.46	< 0.0001
No	5595 (94.94)	597 (91.56)	4498 (95.36)	10.67	
Ascites					
Yes	79 (1.34)	15 (2.3)	64 (1.22)	18.99	0.0238
No	5814 (98.66)	637 (97.7)	5177 (98.78)	10.96	
Cancer					
Yes	3137 (53.23)	347 (53.22)	2790 (53.23)	11.06	0.9949
No	2756 (46.77)	305 (46.78)	2451 (46.77)	11.07	
Disseminated Cancer					
Yes	510 (8.65)	89 (13.65)	421 (8.03)	17.45	< 0.0001
No	5383 (91.35)	563 (86.85)	4820 (91.97)	10.46	
Chronic Steroid Use					
Yes	859 (14.58)	112 (17.18)	747 (14.25)	13.04	0.0459
No	5034 (85.42)	540 (82.82)	4494 (85.75)	10.73	
Bleeding Disorders					
Yes	283 (4.8)	38 (5.83)	245 (4.67)	13.43	0.1939
No	5610 (95.2)	614 (94.17)	4996 (95.33)	10.94	
Hypertension					
Yes	2585 (43.87)	327 (51.15)	2258 (43.08)	12.65	0.0006
No	3308 (56.13)	325 (49.85)	2983 (56.92)	9.82	
Preoperative SIRS/Sepsis					
Yes	613 (10.4)	77 (11.81)	536 (10.23)	12.56	0.2119
No	5280 (89.6)	575 (88.19)	4705 (89.77)	10.89	
Dialysis					
Yes	59 (1.0)	8 (1.23)	51 (0.97)	13.56	0.5391
No	5834 (99.0)	644 (98.77)	5190 (99.03)	11.04	
Behavioral Risk Factors					
Smoking Status					
Yes	967 (16.41)	127 (19.48)	840 (16.03)	13.13	0.0248
No	4296 (83.59)	525 (80.52)	4401 (83.97)	12.22	

- The age range of the 5893 patients was between 18-101 years, with a mean of 58 (± 16.38) years and median = 59.
- Forty-seven percent of patients were men.
- Body mass index (BMI) was ≥ 30 kg/m² in 29% of patients.
- The mean duration of surgery in ten minute units was 18.4 (± 12.9).

Figure 2: Analytic Sample



Out of 5893 colon procedures, 5604 procedures were retained as the analytic sample due to reasons shown in Figure 2.

Patients with disseminated cancer who undergo CRS are at a higher risk for developing SSI.

Table 3: Multi variate analysis: Surgical site infections among all CRS patients; CRS patients with cancer; and CRS patients without cancer

	Total (n=5604)				Underlying cancer (n=2944)				Non-cancer (n=2660)			
	OR	CI 95%	p		OR	CI 95%	p		OR	CI 95%	p	
Surgical Site Infections (%)	623 (11.12)				329 (11.17)				294 (11.06)			
BMI [≥ 30] vs [18.5 - 24.9]	1.29	1.03 - 1.61	0.0238		1.32	0.96 - 1.79	1.7930		1.28	0.93 - 1.78	1.7780	
ASA >= 3	1.38	1.67 - 1.14	0.0010		1.51	1.96 - 1.15	0.0026		1.22	1.62 - 0.91	0.9200	
History of Diabetes	1.42	1.80 - 1.11	0.0047		1.08	1.49 - 0.77	0.7788		2.02	2.90 - 1.41	0.0001	
History of COPD	1.61	2.25 - 1.15	0.0049		1.70	2.63 - 1.09	0.0172		1.58	2.68 - 0.93	0.9372	
Disseminated Cancer	1.66	2.22 - 1.24	0.0005		1.69	2.29 - 1.24	0.0008		--	n/a	--	
Duration of Procedure (10min units)	1.02	1.01 - 1.02	<.0001		1.02	1.01 - 1.03	0.0001		1.02	1.02 - 1.03	<0.0001	
Chronic Steroid Use	1.30	1.64 - 1.02	0.0315		1.05	1.68 - 0.64	0.6481		1.43	1.89 - 1.07	0.0135	

Affiliations

(1)Infection Control, Memorial Sloan Kettering Cancer Center, New York, NY, (2)National Comprehensive Cancer Network, Fort Washington, PA, (3)Department of Surgery, Massachusetts General Hospital, Boston, MA, (4)Department of Surgery, Mayo Clinic - Minnesota, Rochester, MN, (5)UAB Medicine, Birmingham, AL, (6)University of Utah Medical Center, Salt Lake City, UT, (7)Surgery, Yale University School of Medicine, New Haven, CT, (8)Department of Surgery, University of Washington, Seattle, WA, (9)Department of Surgery, Mayo Clinic, Rochester, MN, (10)University of Nebraska Medical Center, Omaha, NE, (11)Department of Surgery, University of Utah Medical Center, Salt Lake City, UT, (12)Barnes-Jewish Hospital, Washington University in Saint Louis, St. Louis, MO, (13)Yale-New Haven Hospital, New Haven, CT, (14)General & Gastrointestinal Surgery, Massachusetts General Hospital, Boston, MA, (15)Department of Surgical Oncology, Roswell Park Cancer Institute, Buffalo, NY, (16)Department of Surgery, Johns Hopkins Medicine, Baltimore, MD, (17)Surgery Clinical Research Office, Mayo Clinic - Minnesota, Rochester, MN, (18)University of California, San Diego Health System, San Diego, CA, (19)Memorial Sloan Kettering, New York, NY, (20)Quality Improvement, UAB Hospital, Birmingham, AL, (21)Quality and Safety, Memorial Sloan Kettering Cancer Center, New York, NY

Conclusions

- Patients with disseminated cancer who undergo CRS are at a higher risk for developing SSI. Majority of SSI in this group are deep and organ space infections. Localized cancer was not associated with increased risk for SSI.
- Other variables that predicted SSI risk in our cohort were BMI>=30, diabetes, ASA score>=3, COPD, immunosuppressant /steroid use, and longer duration of surgery. Our study further corroborate the findings from previous reports (Table 3).
- Diabetes, BMI and use of immunosuppression were not independent predictors of SSI in the subset of patients with underlying cancer (Table 3).
- NSQIP risk adjustment model excludes cases with disseminated cancer. Our data supports this approach and proposes exclusion of disseminated cancer from the National Healthcare Safety Network (NHSN) reporting to improve risk adjusted measures of CRS related SSI.
- There are several limitations to our study.
 - Breakdown of cancer vs non-cancer was based on ICD-9-CM diagnosis and subject to coding errors.
 - We did not examine risk factors by level of infection.
 - Our study was limited to large specialized care centers and the findings cannot be generalized.
- Cancer related variables should be further evaluated when generating risk-adjusted outcomes.

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