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### Authors

Moghadamyeghaneh, Zhobin  
Hanna, Mark H  
Hwang, Grace  
[et al.](#)

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# Outcomes of colon resection in patients with metastatic colon cancer

Zhobin Moghadamyeghaneh, M.D., Mark H. Hanna, M.D., Grace Hwang, M.D., Steven Mills, M.D., Alessio Pigazzi, M.D., Michael J. Stamos, M.D., Joseph C. Carmichael, M.D.\*

Department of Surgery, University of California, Irvine, School of Medicine, Irvine, 333 City Blvd West, Suite 850, Orange, CA, 92868, USA

## KEYWORDS:

*Metastatic colon cancer; Colon cancer; Disseminated cancer*

## Abstract

**BACKGROUND:** Patients with advanced colorectal cancer have a high incidence of postoperative complications. We sought to identify outcomes of patients who underwent resection for colon cancer by cancer stage.

**METHODS:** The National Surgical Quality Improvement Program database was used to evaluate all patients who underwent colon resection with a diagnosis of colon cancer from 2012 to 2014. Multivariate logistic regression analysis was performed to investigate patient outcomes by cancer stage.

**RESULTS:** A total of 7,786 colon cancer patients who underwent colon resection were identified. Of these, 10.8% had metastasis at the time of operation. Patients with metastatic disease had significantly increased risks of perioperative morbidity (adjusted odds ratio [AOR]: 1.44, P 5 .01) and mortality (AOR: 3.72, P 5 .01). Patients with metastatic disease were significantly younger (AOR: .99, P .01) had a higher American Society of Anesthesiologists score (AOR: 1.29, P , .2) and had a higher rate of emergent operation (AOR: 1.40, P , .01).

**CONCLUSIONS:** Overall, 10.8% of patients undergoing colectomy for colon cancer have metastatic disease. Postoperative morbidity and mortality are significantly higher than in patients with localized disease.

Colorectal cancer, with an estimated 150,000 new cases annually, is the 3rd most common malignant neoplasm and the 2nd leading cause of cancer deaths in the United States.<sup>1-3</sup> Most patients in the United States who present with stage IV disease will undergo noncurative primary resection of their tumor.<sup>4</sup> The debate whether colectomy is the correct initial choice for these patients is significant given the lack of good outcomes data. Many patients with metastatic colorectal cancer have been debilitated by the advanced malignancy and associated chronic anemia and are estimated to have a high rate of postoperative complications.<sup>5</sup> When considering surgery in a stage IV patient, it is important to fully understand the comparative acute outcomes of colectomy in these patients to guide clinician recommendations.

In the presence of localized colon cancer, the first-line treatment is usually resection. In patients with advanced metastatic disease, which is estimated to be 20% of cases,<sup>6</sup> the management becomes far more complicated and hotly debated. Some researchers have demonstrated that primary colectomy results in improved overall survival in patients with otherwise unresectable metastatic colon cancer and have been strong advocates of a surgical approach.<sup>7,8</sup> However, opponents point out that resection of the primary tumor in metastatic unresectable cases can certainly delay chemotherapy.<sup>6,9</sup> Other research has suggested that multiagent cytotoxic and biologic chemotherapy treatment alone does not compromise survival and asymptomatic patients should be spared noncurative surgical resection.<sup>10</sup> This lack of definitive data has led to the call for a controlled trial comparing the outcomes of resection vs nonresection in asymptomatic stage IV colon cancer patients.<sup>4</sup> There are limited published data

regarding the comparative acute outcomes of surgery for patients with colon cancer stratified by cancer stage. The aim of this research is to evaluate the acute outcomes of surgery on patients with colon cancer and specifically determine the comparative morbidity and mortality of patients with metastatic disease who underwent emergent and nonemergent surgery.

**Table 1** Perioperative and demographic factors of colon cancer patients underwent colon resection

Variables	Stage 0–III (6,947), n (%)	Stage IV (839), n (%)	<i>P</i> value
Age, y			
Mean ± SD, y	67 ± 13	63 ± 13	<.01
Median, y	68	63	<.01
Sex			
Female	3,512 (50.6)	423 (50.4)	.61
Race			
White	5,043 (82)	606 (81.7)	.99
Black or African American	698 (11.3)	97 (13.1)	.84
Asian	370 (6)	36 (4.9)	.95
Other	42 (.7)	3 (.4)	.84
Comorbidity			
Hypertension	3,924 (56.5)	388 (46.2)	.57
Diabetes mellitus	1,377 (19.8)	121 (14.4)	.03
Chronic obstructive pulmonary disease	424 (6.1)	45 (5.4)	.82
Chronic steroid use	237 (3.4)	36 (4.3)	.92
Congestive heart failure	103 (1.5)	5 (.6)	.07
Obesity	2,293 (33.4)	234 (28.4)	.41
Ascites	40 (.6)	24 (2.9)	<.01
Renal failure need to dialysis	58 (.8)	2 (.2)	.11
Weight loss	420 (6)	96 (11.4)	.09
Operation			
Elective	5,584 (80.4)	549 (65.6)	<.01
Nonelective	1,361 (19.6)	288 (34.4)	<.01
Operation time			
Mean ± SD, min	164 ± 84	197 ± 114	<.01
Median	149	173	<.01
Surgical approach			
Open	2,083 (30)	481 (57.3)	<.01
Laparoscopic	4,862 (70)	358 (42.7)	<.01
Procedure			
Partial colectomy	6,758 (97.3)	812 (96.8)	.34
Total colectomy	189 (2.7)	27 (3.2)	.34
Emergent situations			
Obstruction	193 (2.8)	46 (5.5)	<.01
Perforation	59 (.8)	21 (2.5)	<.01
Bleeding	31 (.4)	5 (.6)	<.01
Other factors			
ASA score >2*	4,158 (59.9)	540 (64.5)	.02
Preoperative sepsis	219 (3.2)	70 (8.3)	.47
Smoking	888 (12.8)	151 (18)	.23
Hypoalbuminemia	1,360 (26.7)	256 (36.8)	.14
Mechanical bowel preparation	3,939 (66.2)	432 (59.8)	.78
Oral antibiotic bowel preparation	1,968 (32.8)	188 (26.5)	.01
Preoperative chemotherapy (in 90 days of surgery)	197 (2.9)	164 (20)	<.01

ASA = American Society of Anesthesiologists; SD = standard deviation.

\*The American Society of Anesthesiologists score more than two.

**Table 2** Postoperative complication rates of patients with stages 0–IV colon cancer who underwent colon resection

	Stage 0 (154), n (%)	Stage I (1,886), n (%)	Stage II (2,903), n (%)	Stage III (2,004), n (%)	Stage IV (839), n (%)
Mortality	0	19 (1)	62 (2.1)	42 (2.1)	30 (3.6)
Overall morbidity	30 (19.9)	551 (29.2)	1,098 (37.8)	740 (36.9)	393 (46.8)
Prolonged ileus	18 (11.7)	216 (11.5)	462 (15.9)	288 (14.4)	182 (21.8)
Pulmonary embolism	0	9 (.5)	32 (1.1)	17 (.8)	4 (.5)
Hemorrhagic complications	5 (3.2)	143 (7.6)	386 (13.3)	232 (11.6)	139 (16.6)
Deep incisional SSI	0	9 (.5)	40 (1.4)	21 (1)	13 (1.5)
Urinary tract infection	2 (1.3)	47 (2.5)	78 (2.7)	43 (2.1)	24 (2.9)
Unplanned readmission	6 (3.9)	150 (8)	251 (8.6)	161 (8)	106 (12.6)
Sepsis	3 (1.9)	45 (2.4)	76 (2.6)	69 (3.4)	51 (6.1)
Deep vein thrombosis	0	20 (1.1)	38 (1.3)	28 (1.4)	21 (2.5)
Acute renal failure	0	3 (.2)	14 (.5)	13 (.6)	4 (.5)
Ventilator dependency	0	17 (.9)	48 (1.7)	37 (1.8)	19 (2.3)
Septic shock	2 (1.3)	22 (1.2)	57 (2)	35 (1.7)	22 (2.6)
Unplanned reoperation	5 (3.2)	69 (3.7)	123 (4.2)	89 (4.4)	48 (5.7)
Wound disruption	0	10 (.5)	23 (.8)	15 (.7)	14 (1.7)
Organ space SSI	3 (1.9)	64 (3.4)	98 (3.4)	65 (3.2)	59 (7)
Anastomosis leakage	4 (2.6)	54 (2.9)	44 (2.5)	50 (2.5)	42 (5)
Pneumonia	2 (1.3)	32 (1.7)	86 (3)	46 (2.3)	28 (3.3)
Hospitalization >30 days	0	22 (1.2)	45 (1.6)	33 (1.6)	21 (2.5)
Myocardial infarction	0	18 (1)	33 (1.1)	14 (.7)	5 (.6)
Cardiac arrest	0	6 (.3)	16 (.6)	12 (.6)	7 (.8)
Unplanned intubation	1 (.6)	34 (1.8)	72 (2.5)	44 (2.2)	23 (2.7)
Progressive renal insufficiency	0	9 (.5)	16 (.6)	18 (.9)	3 (.4)
Superficial SSI	7 (4.5%)	84 (4.5%)	172 (5.9%)	117 (5.8%)	52 (6.2%)

SSI = surgical site infection.

**Table 3** Risk-adjusted analysis of postoperative complications of patients with stage IV colon cancer compared with patients with stages II and III colon cancer

Complications	Stage II, III (4,907), n (%)	Stage IV (839), n (%)	AOR (95% CI)	P value
Mortality	104 (2.1)	30 (3.6)	2.30 (1.29–4.11)	<.01
Overall morbidity	1,798 (36.6)	393 (46.8)	1.20 (1.01–1.48)	.04
Prolonged ileus	750 (15.3)	182 (21.7)	1.31 (1.02–1.68)	.03
Pulmonary embolism	49 (1)	4 (.5)	.50 (.14–1.76)	.28
Hemorrhagic complications	618 (12.6)	139 (16.6)	1.06 (.80–1.42)	.64
Deep incisional SSI	61 (1.2)	13 (1.5)	.70 (.28–1.72)	.44
Urinary tract infection	121 (2.5)	24 (2.9)	.92 (.48–1.75)	.81
Unplanned readmission	412 (8.4)	106 (12.6)	1.44 (.83–1.56)	.40
Sepsis	145 (3)	51 (6.1)	1.44 (.90–2.28)	.12
Deep vein thrombosis	66 (1.3)	21 (2.5)	1.48 (.74–2.98)	.26
Acute renal failure	27 (.6)	4 (.5)	1.19 (.31–4.55)	.79
Ventilator dependency	85 (1.7)	19 (2.3)	1.60 (.79–3.21)	.18
Septic shock	92 (1.9)	22 (2.6)	1.08 (.56–2.08)	.80
Unplanned reoperation	212 (4.3)	48 (5.7)	1.19 (.77–1.83)	.41
Wound disruption	38 (.8)	14 (1.7)	2.08 (.84–5.12)	.10
Organ space SSI	163 (3.3)	59 (7)	1.50 (.98–2.29)	.06
Anastomosis leakage	148 (3)	42 (5)	1.26 (.76–2.07)	.35
Pneumonia	132 (2.7)	28 (3.3)	1.21 (.69–2.11)	.49
Hospitalization >30 days	78 (1.6)	21 (2.5)	1.18 (.58–2.42)	.63
Myocardial infarction	47 (1)	5 (.6)	1.13 (.36–3.47)	.83
Cardiac arrest	28 (.6)	7 (.8)	1.05 (.33–3.31)	.93
Unplanned intubation	116 (2.4)	23 (2.7)	1.09 (.57–2.06)	.78
Progressive renal insufficiency	34 (.7)	3 (.4)	.22 (.03–1.47)	.12
Superficial SSI	289 (5.9)	52 (6.2)	.83 (.55–1.24)	.31

AOR = adjusted odds ratio; CI = confidence interval; SSI = surgical site infection.

**Table 4** Risk-adjusted analysis of mortality and morbidity of colon cancer after colon resection by cancer stage

Colon cancer stage	Mortality		Morbidity	
	AOR and 95% CI	<i>P</i> value	AOR and 95% CI	<i>P</i> value
Stage I	Reference	Reference	Reference	Reference
Stage II	1.53 (.68–3.41)	.29	1.08 (.90–1.30)	.38
Stage III	1.36 (.55–3.34)	.49	.99 (.80–1.21)	.93
Stage IV	3.72 (1.36–10.11)	.01	1.44 (1.08–1.92)	.01

AOR = adjusted odds ratio; CI = confidence interval.

## Methods

We used the Participant User Files and colon surgery targeted files in the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) database from 2012 to 2014. American College of Surgeons NSQIP is a nationwide outcome-based database which provides preoperative to 30-day postoperative information of surgical patients based on clinical data in the United States.<sup>11</sup> We analyzed the available data on patients with colon cancer who underwent colon resection. Patients' colon cancer stages were identified according to the original variables of the NSQIP target files. We only included patients who underwent colon resection based on the Current Procedural Terminology codes of 44,140 to 44,160 and 44,204 to 44,212. Patients younger than 18 years and patients without information of colon cancer stage were excluded from the study.

Patient variables that were analyzed included demographic data (age, sex, and race); comorbid conditions, American Society of Anesthesiologists (ASA) score, hypoalbuminemia (preoperative serum albumin level lower than 3.5 g/dL), preoperative chemotherapy (within 90 days before the operation), admission status (emergent and/or urgent vs elective), surgical approach (laparoscopic vs open), operation time, colon cancer tumor nodes metastasis stage (stages I to IV according to the American joint committee on cancer guideline<sup>12</sup>), wound classification (clean, clean contaminated, contaminated, and dirty), and type of procedure performed. The primary end point investigated was postoperative complications. Secondary end points were perioperative factors that were significantly different in patients with and without metastatic disease.

## Statistical analysis

We used SPSS software statistical package version 22 (SPSS Inc., Chicago, IL, USA) for analysis of the data. The main analysis method was multivariate analysis using logistic regression to eliminate effects of confounding variables and estimate the independent association between preoperative factors and postoperative complications. The adjusted odds ratio with a 95% confidence interval was calculated, and *P* values less than .05 indicate statistical significance. Adjustments were made for all variables of the study.

## Results

During the study period, a total of 7,786 colon cancer patients who underwent colon resection were identified and included in the study. The median age was 67-year old and most of the patients were Caucasian (82%) and female (50.5%). The most common comorbidities included hypertension (54.2%), obesity (32.7%), and diabetes mellitus (18.6%). Demographics of the patient population based on the colon cancer stage are described in Table 1.

Overall rates for stages 0 to IV colon cancer were 2%, 24.2%, 37.3%, 25.2%, and 10.8%, respectively. The median lengths of stay after surgery were 4, 5, 6, 6, and 7 days for stage 0 to IV colon



cancer patients, respectively. Patients with stage IV colon cancer had a significantly longer total hospitalization length compared with patients without metastatic disease (mean difference 5.2 day, confidence interval: .69 to 1.68, P, .01).

Overall, patients with metastatic disease had significantly higher mortality and morbidity rates as well as postoperative complication rates (Table 2). In multivariate analysis, patients with metastatic disease had significantly higher mortality and morbidity compared with patients with stage II or III colon cancer (Table 3). Prolonged ileus was significantly higher in patients with metastatic disease (adjusted odds ratio: 1.31, P 5 .03).

**Table 5** Percentage of patients by stage who underwent surgery for complications of the primary tumor

Complication	Stage 0 (154)	Stage I (1,886), n (%)	Stage II (2,903), n (%)	Stage III (2,004), n (%)	Stage IV (839), n (%)
Obstruction	0	10 (.5)	94 (3.2)	89 (4.4)	46 (5.5)
Perforation	0	2 (.1)	35 (1.1)	21 (1)	21 (2.5)
Bleeding	0	7 (.3)	14 (.5)	7 (.3)	5 (.6)
Totals	0	19 (1.0)	143 (4.9)	117 (5.8)	72 (8.6)

The risk-adjusted analysis for mortality and morbidity of colon cancer patients after colon resection by cancer stage is reported in Table 4. Patients with stages II and III colon cancer did not have significant higher mortality and morbidity compared with stage I disease. However, patients with stage IV colon cancer had a significantly higher mortality and morbidity compared with patients with stage I disease (Table 4).

Overall, 1,649 patients underwent emergent surgery for complications of the primary tumor. Of these, 61.6% had obstruction, 20.6% had colonic perforation, and 9.3% had bleeding as indication for emergent surgery. Stage IV patients had the highest incidence of surgery for complications of the primary tumor with 8.6% undergoing surgery for complications of the primary tumor. Complications of the primary tumor by the disease stage are reported in Table 5.

Overall, 10.8% of patient had metastatic colon cancer. Patients with metastatic disease were significantly younger with higher ASA score (Table 6). Among patients with metastatic disease 34.4% had emergent operation. Patients with stage IV colon cancer who underwent emergent operation had higher risks of morbidity, prolonged ileus, and prolonged hospitalization (Table 7). Also, such patients had a higher rate of preoperative sepsis and hypoalbuminemia (Table 8). However, preoperative chemotherapy was significantly lower in patients who needed emergent surgery in treatment of stage IV colon cancer (Table 8).

## Comments

Whether surgery was elective or emergent, metastatic disease was found to be a significant risk factor for perioperative morbidity and mortality in colon cancer patients. We found mortality rates of 0%, 1%, 2.1%, 2.1%, and 3.6% for stages 0 to IV colon cancer patients, respectively. Our study results show stage IV colon cancer is associated with a 200% increase in mortality and 23% increase in morbidity compared with colon cancer without metastatic disease and that a minimally invasive approach was not associated with significant risk improvement. Clearly the decision to surgically intervene in a patient with stage IV disease is a significant one, and intensive perioperative care is suggested for patients with metastatic colon cancer who undergo colon resection. Although 34.4% of patients with stage IV disease were compelled to the operating room because of complications of the primary tumor, 65.6% had no such emergent indication. Surgeons must take into account the dramatically increased morbidity and mortality when electively operating on a stage IV patient and truly consider if the potential benefit

outweighs the risk. In addition, strategies with the goal of decreasing the need for palliative surgical resection need to be evaluated.<sup>10</sup> For example, a recent retrospective series of stage IV patients showed that most patients (93%) with stage IV colorectal cancer who receive up-front multiagent chemotherapy never require palliative surgery for complications of the intact primary tumor.<sup>13</sup>

**Table 6** Risk-adjusted analysis of perioperative factors of patient with and without metastatic colon cancer

Variables	Adjusted odds ratio	95% CI	P value
Age, y	.97	.96–.97	<.01
Sex			
Female	1.05	.86–1.27	.61
Comorbidity			
Hypertension	1.06	.85–1.33	.57
Diabetes mellitus	.73	.55–1	.05
Chronic obstructive pulmonary disease	1.04	.69–1.57	.82
Chronic steroid use	1.02	.63–1.63	.92
Congestive heart failure	.37	.12–1.11	.07
Obesity	.91	.72–1.14	.41
Ascites	2.80	1.46–5.37	<.01
Renal failure need for dialysis	.19	.02–1.46	.11
Weight loss	1.31	.95–1.80	.09
Surgical approach			
Laparoscopic	Reference	Reference	Reference
Open	2.13	1.72–2.62	<.01
Type of surgery			
Nonemergent	Reference	Reference	Reference
Emergent	1.40	1.10–1.79	<.01
Other factors			
Hypoalbuminemia	1.18	.94–1.50	.14
Smoking	1.17	.90–1.52	.23
Preoperative sepsis	1.15	.77–1.73	.47
Mechanical bowel preparation	1.03	.82–1.28	.78
Oral antibiotic bowel preparation	.73	.58–.93	.01
Preoperative chemotherapy	6.50	4.83–8.74	<.01
ASA score > 2*	1.29	1.03–1.62	.02

AOR = adjusted odds ratio; ASA = American Society of Anesthesiologists; CI = confidence interval.  
\*The American Society of Anesthesiologists score more than two.

Our study results show most patients with metastatic colon disease who underwent colon resection did not have any preoperative chemotherapy. We found only 19.5% of patients with stage IV colon cancer in our study had preoperative chemotherapy within 90 days of surgery. This confirms previous reports that most patients with stage IV colorectal cancer undergo colectomy before chemotherapy.<sup>14</sup> This high rate of surgery without preoperative chemotherapy is despite evidence that approximately 85% of stage IV patients have metastases that are unresectable for cure.<sup>15</sup> Given the recent findings of National Surgery Adjuvant Breast and Bowel Project (NSABP) Trial C-1010 supporting the use of mFOFOX6 with bevacizumab in stage IV colon cancer patients presenting with an asymptomatic primary tumor and synchronous unresectable metastatic disease, it will be interesting to see if the current rates of surgery hold or diminish with time. Furthermore, clinical trials are indicated to

evaluate the effects of preoperative chemotherapy on outcomes of stage IV colon cancer patients who will have planned resection.

**Table 7** Risk-adjusted analysis of postoperative complications of patients with stage IV colon cancer who underwent emergent and nonemergent operations

Complications	Nonemergent, stage IV (549), n (%)	Emergent, stage IV (288), n (%)	AOR (95% CI)	P value
Mortality	10 (1.8)	20 (6.9)	1.74 (.50–6.02)	.38
Overall morbidity	229 (41.7)	164 (56.9)	1.60 (1.01–2.51)	.04
Prolonged ileus	103 (18.8)	79 (27.5)	1.77 (1.06–2.97)	.02
Pulmonary embolism	2 (.4)	2 (.7)	1 (.99–1.01)	.97
Hemorrhagic complications	79 (14.4)	60 (20.8)	1 (.54–1.86)	.98
Deep incisional SSI	8 (1.5)	5 (1.7)	2.86 (.27–29.28)	.37
Urinary tract infection	15 (2.7)	9 (3.1)	.78 (.19–3.18)	.73
Unplanned readmission	73 (13.3)	33 (11.5)	.70 (.34–1.42)	.32
Sepsis	27 (4.9)	24 (8.3)	1.09 (.40–2.95)	.81
Deep vein thrombosis	16 (2.9)	5 (1.7)	.66 (.16–2.73)	.57
Acute renal failure	1 (.2)	3 (1)	1 (.99–1.1)	.99
Ventilator dependency	10 (1.8)	9 (3.1)	.31 (.06–1.47)	.14
Septic shock	10 (1.8)	12 (4.2)	.49 (.09–2.60)	.41
Unplanned reoperation	30 (5.5)	18 (6.3)	.38 (.13–1.06)	.06
Wound disruption	10 (1.8)	4 (1.4)	1.07 (.11–10.28)	.94
Organ space SSI	38 (6.9)	21 (7.3)	.45 (.17–1.18)	.10
Anastomosis leakage	25 (4.6)	17 (5.9)	1 (.33–1.03)	.99
Pneumonia	12 (2.2)	16 (5.6)	2.51 (.70–8.99)	.15
Hospitalization >30 days	6 (1.1)	15 (5.2)	6.24 (1.02–37.90)	.04
Myocardial infarction	5 (.9)	0	*	*
Cardiac arrest	5 (.9)	2 (.7)	1 (.99–1.1)	.97
Unplanned intubation	13 (2.4)	10 (3.5)	.37 (.07–1.74)	.21
Progressive renal insufficiency	1 (.2)	2 (.7)	1 (.99–1.1)	.99
Superficial SSI	31 (5.6)	21 (7.3)	1.04 (.43–2.54)	.92

CI = confidence interval; SSI = surgical site infection.

\*There is not any case at least in one group of patients.

Patients with stage IV colon cancer have a significantly higher morbidity rate. Our study results found morbidity rates of 19.9%, 29.2%, 37.8%, 36.9%, and 46.8% for stages 0 to IV colon cancer surgery, respectively. In multivariate analysis, we found metastatic disease is associated with significantly increased postoperative morbidity. It is theorized that the increased risks of postoperative morbidity and mortality in metastatic patients may be because of the suppression of the immune system in advanced malignancy or simply represent the impact of aggressive surgical resections required in patients with stage IV disease.<sup>16,17</sup> Our study found that mean and median stage IV operative times were significantly increased over surgeries done for nonmetastatic disease, and this supports the theory that stage IV patients are undergoing more challenging surgical resections.

In our study, multivariate analysis showed that preoperative immunosuppressive chemotherapy within 90 days of surgery was not associated with increased operative complications. Furthermore, we found patients with stage IV colon cancer who underwent colon resection had a significantly lower rate of need for emergent surgery compared with patients with metastatic disease who did not have preoperative chemotherapy (Table 8). This particular result should be interpreted with caution because preoperative chemotherapy may reduce complications of the primary tumor, but it may also have been complications of the primary tumor that were the first presenting symptom of stage IV cancer. Clearly, further clinical trials designed to evaluate the effects of preoperative chemotherapy on surgical outcomes of stage IV colon cancer patients are needed.

We found patients with metastatic colon cancer are significantly younger with higher ASA score compared with patients without metastatic disease. ASA score has been identified as an important



predictor of mortality and morbidity after colorectal surgery.<sup>18</sup> Younger age in patients with metastatic cancer has been previously reported and may be related to lack of screening of colorectal cancer in younger patients, which results in diagnosis of the disease at more advanced stages.<sup>19</sup> Some young adult populations may benefit from earlier colorectal screening, but it remains to be found which populations should be targeted for earlier screening.

**Table 8** Risk-adjusted analysis of perioperative factors of stage IV colon cancer patient according to type of the surgery (emergent vs nonemergent)

Variables	Stage IV with nonemergent surgery (549), n (%)	Stage IV with emergent surgery (288), n (%)	Adjusted odds ratio	95% CI	P value
Age, y					
Age (mean ± standard deviation)	62 ± 13	63 ± 15	.98	.96–1	.18
Sex					
Female	259 (47.2)	164 (56.9)	1.22	.78–1.92	.37
Comorbidity					
Hypertension	258 (47)	130 (45.1)	.64	.38–1.07	.09
Diabetes mellitus	73 (13.3)	48 (16.7)	1.43	.74–2.78	.28
Chronic obstructive pulmonary disease	24 (4.4)	20 (6.9)	2.04	.82–5.08	.12
Chronic steroid use	20 (3.6)	16 (5.6)	2.34	.87–6.29	.09
Congestive heart failure	2 (.4)	3 (1)	.11	.01–1.62	.10
Obesity	162 (29.7)	72 (26)	1.21	.72–2.03	.46
Ascites	7 (1.3)	17 (5.9)	1.06	.29–3.85	.92
Renal failure need for dialysis	1 (.2)	1 (.3)	1	.99–1	.99
Weight loss	37 (6.7)	58 (20.1)	2.18	1.12–4.25	.02
Surgical approach					
Laparoscopic	282 (51.4)	75 (26)	Reference	Reference	Reference
Open	267 (48.6)	213 (74)	2.43	1.51–3.90	<.01
Type of procedure					
Partial colectomy	533 (97.1)	277 (96.2)	Reference	Reference	Reference
Total colectomy	16 (2.9)	11 (3.8)	.89	.26–3.05	.85
Other factors					
Hypoalbuminemia	96 (21.9)	158 (62.2)	3.38	2.12–5.38	<.01
Smoking	80 (14.6)	71 (24.7)	.90	.50–1.62	.72
Preoperative sepsis	12 (2.2)	58 (20.1)	8.75	3.27–27.43	<.01
Mechanical bowel preparation	321 (71)	109 (40.7)	.40	.24–.65	<.01
Oral antibiotic bowel preparation	148 (33.3)	40 (13.9)	.46	.26–.81	<.01
Preoperative chemotherapy	132 (24.7)	31 (10.9)	.28	.15–.52	<.01
ASA score >2*	322 (58.8)	216 (75)	2.17	1.27–3.73	<.01

ASA = American Society of Anesthesiologists; CI = confidence interval.

\*The American Society of Anesthesiologists score more than two.

Finally, our study results show that emergently admitted patients with perforation, obstruction, and bleeding who underwent operation have significant higher mortality and morbidity risks compared with patients without an emergent indication of surgery. We found these complications occur more frequently in patients with advanced stages of the disease. In our study, we noted that 34.4% of colon resections in stage IV patients were performed for emergent complications of the primary tumor including bleeding, obstruction, and perforation. Other studies have demonstrated the overall rates of intestinal obstruction and bleeding in stage IV colon cancer when leaving the primary tumor in situ were reported 13.9% and 3.0%, respectively.<sup>9</sup> Most important, we found no significant difference in rate of complications of the primary tumor between patients with and without preoperative chemotherapy. Surprisingly, stage IV colon cancer patients with emergent operations had a significantly lower rate of preoperative chemotherapy compared with stage IV cancer patients who underwent a nonemergent operation. A recent retrospective series of stage IV patients showed that most patients (93%) with stage IV colorectal cancer who receive up-front multiagent chemotherapy never require palliative surgery for complications of the intact primary tumor.<sup>13</sup> Close monitoring of patients with endoscopy to make sure

someone is not getting obstructed and improvement in chemotherapy options could result in fewer emergent operations in such patients.

## **Study limitations**

The retrospective nature of the study was the main limitation, which makes any definitive conclusion difficult.

Data in this study were extracted from the NSQIP file, and coding errors could potentially have occurred.<sup>20</sup> NSQIP only provided information regarding the main procedure of patients and some colon cancer patients with advanced disease may have concomitant procedures, which can affect outcomes of patients, and we did not have this information. This study reported poor prognosis regarding surgical mortality and morbidity in 30 days of surgery in stage IV colon cancer patients who underwent colon resection. However, whether patients with unresectable metastatic disease derive any benefit from resection of asymptomatic primary colon cancers requires further detailed study. This study only investigated patients with metastatic colon cancer who underwent colon resection, and unfortunately, we did not have any information regarding patients with metastatic disease who were managed nonsurgically, and we could not investigate the percentage of stage IV patients who were asymptomatic from their primary cancers and required urgent intervention for the primary tumors because of complications during their predictably short life spans. Also, the NSQIP database does not include some tumor-specific details, pathologic nature of tumors, prior operation for colon cancer, ability of complete tumor resection, and long-term oncologic outcomes. Despite these limitations, this study is one of the first reports, which provides a large sample size to report outcomes of colon cancer surgery by disease stage.

## **Conclusions**

Overall, 10.8% patients undergoing colectomy for colon cancer have metastatic disease. Although there is not a significant difference in mortality and morbidity of stages I to III colon cancer after primary tumor resection, patients with IV colon cancer who underwent resection have a significantly increased mortality and morbidity. Prolonged ileus is more frequent after surgery for metastatic disease. Overall, 65.6% of stage IV patients were not experiencing significant complications of the primary tumor (bleeding, obstruction, or perforation) at the time of surgery. Only 19.5% of stage IV patients had received chemotherapy within 3 months before surgery. Given the risks associated with colon resection in stage IV patients, further studies are indicated to identify when it is more appropriate to leave the primary tumor in situ and proceed with systemic chemotherapy.

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\* Corresponding author. Tel.: 11-714-456-8511; fax: 11-714-456- 6027.

E-mail address: jcarmich@uci.edu