Annals of Surgery Publish Ahead of Print
DOI:10.1097/SLA.0000000000005667

Racial and Ethnic Differences in Elective vs. Emergency Surgery for Colorectal Cancer

Original Study

Ryan Howard, MD[1]; Samantha Hendren, MD, MPH[1,2]; Minal Patel, PhD, MPH[3]; Vidhya Gunaseelan, MBA, MS, MHA[4]; Matthew Wixson, MD[4]; Jennifer Waljee, MD, MPH, MS[1]; Michael Englesbe, MD[1,2]; Mark C. Bicket, MD, PhD[3,4,5]

Author Affiliations

1. Department of Surgery, Michigan Medicine, Ann Arbor, Michigan
2. Michigan Surgical Quality Collaborative, Ann Arbor, Michigan
3. School of Public Health, University of Michigan, Ann Arbor, Michigan
4. Department of Anesthesiology, Michigan Medicine, Ann Arbor, Michigan
5. Opioid Prescriging Engagement Network, Institute for Health Policy and Innovation, University of Michigan, Ann Arbor, Michigan

Corresponding Author:
Mark Bicket, MD, PhD
Department of Anesthesiology
University of Michigan
1500 East Medical Center Dr.
Ann Arbor, MI 48109
Phone: 734-936-4280
Email: mbicket@med.umich.edu

Disclosures: RH receives unrelated funding for research from Blue Cross Blue Shield of Michigan Foundation and the National Institute of Diabetes and Digestive and Kidney Diseases (5T32DK108740-05). SH and ME receive partial salary support from Blue Cross Blue Shield of Michigan. MP, VG, and MW have no disclosures. JW, ME, and MB receive unrelated funding from the Michigan Department of Health and Human Services and the National Institute on Drug Abuse (R01DA042859). MB reports past consultation with Axial Healthcare and Alosa Health not related to this work. No funder or sponsor had any role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; or decision to submit the manuscript for publication. VG had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Structured Abstract

Objective: To evaluate differences in presentation and outcomes of surgery for colorectal cancer.

Summary Background Data: Although racial and socioeconomic disparities in colorectal cancer outcomes are well-documented, disparities in access affecting disease presentation are less clear.
Methods: We conducted a statewide retrospective study of patients who underwent resection for colorectal cancer between January 1, 2015 and April 30, 2021. The primary outcome was undergoing emergency surgery. Secondary outcomes included preoperative evaluation and postoperative outcomes. Covariates of interest included race/ethnicity, social deprivation index (SDI), and insurance type.

Results: 4,869 patients underwent surgery for colorectal cancer, of whom 1,122 (23.0%) underwent emergency surgery. 28.1% of Black non-Hispanic patients and 22.5% of White non-Hispanic patients underwent emergency surgery. On multivariable logistic regression, Black non-Hispanic race was independently associated with a 5.8 (95% CI 0.3-11.3) percentage point increased risk of emergency surgery compared to White non-Hispanic race. Patients who underwent emergency surgery were significantly less likely to have preoperative CEA measurement, staging for rectal cancer, and wound/ostomy consultation. Patients who underwent emergency surgery had a higher incidence of 30-day mortality (5.5% vs. 1.0%, P<0.001), positive surgical margins (11.1% vs. 4.9%, P<0.001), complications (29.2% vs. 16.0%, P<0.001), readmissions (12.5% vs. 9.6%, P=0.005), and reoperations (12.2% vs. 8.2%, P<0.001).

Conclusions: Among patients with colorectal cancer, Black non-Hispanic patients were more likely to undergo emergency surgery than White non-Hispanic patients, suggesting they may face barriers to timely screening and evaluation. Undergoing emergency surgery was associated with incomplete oncologic evaluation, increased incidence of postoperative complications including mortality, and increased surgical margin positivity. These results suggest that racial and ethnic differences in the diagnosis and treatment of colorectal cancer impact near- and long-term outcomes.

Introduction

Although timely surgical care is a cornerstone of high-quality healthcare, an abundance of evidence indicates that disparities in surgical treatment exist in the United States.[1] A recent systematic review identified over 200 separate studies documenting differences in provider evaluation, progression to surgery, and receipt of optimal care for common surgical conditions based on race, ethnicity, socioeconomic status, and insurance type.[2] These disparities can result in delayed treatment, increased costs and worse surgical outcomes including mortality.[3-5] It has been difficult, however, to delineate the extent to which these differences stem from differences in disease presentation versus variation in disease management. Patterns of seeking treatment differ across conditions, and baseline variation in surgical referral and treatment confound conclusions as to whether observed differences in care are related to barriers to care.[6,7]

The surgical treatment of colorectal cancer may present a unique clinical setting in which to assess these issues.[8] Although racial disparities in colorectal cancer outcomes are well-documented, identifying disparities in upstream events such as timely treatment of colorectal cancer is essential to inform targeted efforts to improve the quality of preoperative assessment.[9] In contrast to other surgical conditions, colorectal cancer is characterized by slow disease progression, universal screening measures, and clear guidelines regarding its treatment.[10,11] Accordingly, it is optimally diagnosed and managed in an elective setting. These features set colorectal cancer apart from other common surgical conditions such as abdominal wall hernia, where some de novo hernias require immediate surgical intervention, or even other acute conditions in which patients present almost exclusively on an emergency basis. Patients undergoing emergency surgery for colorectal cancer, on the other hand, may represent those who were unable to obtain appropriate screening and evaluation. Prior studies have established a link

between access to care and emergency presentation.[12] Evaluating differences in the presentation and outcomes of patients with colorectal cancer may identify actionable opportunities to improve upstream management such as screening. While prior work has investigated the association of insurance status and race with undergoing emergency colorectal surgery, these studies include colorectal surgery for any reason, such as trauma, limiting conclusions about the implications of emergency surgery.[13] Additionally, while this work accounts for baseline differences between patients of different race and ethnicity using a single comorbidity score, that fails to account for specific differences in conditions such as diabetes, obesity, and tobacco use that are prevalent in patients with colorectal cancer and known to differ between heterogeneous patient groups.[14]

Within this context, we evaluated differences in undergoing emergency surgery, receipt of standard preoperative evaluation, and subsequent postoperative outcomes in a statewide surgical cohort. Specifically, we analyzed the association of race/ethnicity, socioeconomic status, and insurance status with receipt of emergency versus elective surgery and 30-day adverse events after surgery. To do so, we utilized data from the Michigan Surgical Quality Collaborative (MSQC) which contains information regarding patient demographics, urgency of surgery, and colorectal cancer-specific evaluation. We hypothesized that, consistent with prior literature, minority and uninsured patients would be more likely to undergo emergency surgery and incur worse postoperative outcomes.

Methods

Data Source and Study Cohort

This study was a retrospective cohort study of patients prospectively captured in a clinical registry maintained by the Michigan Surgical Quality Collaborative (MSQC). The

MSQC is a statewide quality improvement collaborative comprised of 70 hospitals in Michigan and funded by the largest private payer in the state.[15] Member hospitals represent a diverse range of practice settings including small community and large academic hospitals. The MSQC prospectively collects data on patient demographics, clinical characteristics, and postoperative outcomes.[16] Data are abstracted directly from patients' medical records by trained nurses who have access to the complete medical record. Regular data audits are performed to ensure data reliability and representativeness.[17] This secondary data analysis was deemed exempt from review by the Institutional Review Board of the University of Michigan. This study follows the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline.[18] This study followed a preregistered protocol available at dx.doi.org/10.17504/protocols.io.bxefpjbn.

We identified adult patients (age ≥18 years) undergoing surgical resection for colon and rectal cancer between January 1, 2015, and April 30, 2021, using appropriate International Classification of Disease 9th and 10th Edition (ICD-9/10) diagnosis codes and Current Procedural Terminology (CPT) procedure codes (Supplemental Table 1, Supplemental Digital Content 1, http://links.lww.com/SLA/E179) at the time of surgery. We included patients who underwent open and minimally invasive colectomy, low anterior resection and abdominoperineal resection (LAR/APR), proctectomy, and transanal excision. Patients were excluded if any race/ethnicity, clinical characteristics, or outcomes data were missing. Only patients undergoing a single procedure were included.

Outcomes

The primary outcome was undergoing an emergency operation for colorectal cancer (e.g., obstruction, hemorrhage, perforation). The MSQC database has a dedicated indicator for whether an operation was elective or non-elective (emergency or urgent) which is generated from review of the medical record (including the preoperative history and physical examination, operative report, and anesthesia record). For the purposes of the current study, both emergency and urgent surgical status were counted as "emergency surgery," while elective surgical status was counted as "elective surgery."[19] As previously described, the MSQC defines an emergency operation as one that takes place for a life-threatening indication within 12 hours of the decision to operate, an urgent operation as one that takes place for a non-life-threatening condition for which the patient needs intervention during admission and cannot be discharged home prior to intervention, and an elective operation as one that is scheduled in advance and takes place on a scheduled date.[20]

We secondarily assessed the comprehensiveness of preoperative evaluation and postoperative outcomes. Three specific preoperative evaluation components that are part of recommended routine evaluation were assessed, including documentation of a preoperative carcinoembryonic antigen (CEA) level, performance of a preoperative staging test for patients with rectal cancer (via transrectal endoscopic ultrasound (TEUS) or pelvic magnetic resonance imaging (MRI)), and preoperative consultation by a wound, ostomy, and continence nurse.[21] Patients were identified as having preoperative staging tests if there was documentation of TEUS or MRI in their medical record, and identified as having a wound/ostomy consult if there was documentation that a wound/ostomy nurse had evaluated them in their medical record. These secondary process measures were evaluated for subsets of patients in whom the specific variables were applicable: CEA assessed among 4048 patients given required collection of this variable starting 1/1/2017, preoperative staging assessed among 809 patients with diagnosis

codes for rectal cancer, and preoperative wound/ostomy consultation assessed among 828 with CPT codes for ostomy creation (patients with missing wound/ostomy consultation data were excluded).

Finally, other postoperative outcomes assessed included margin status, 30-day postoperative mortality, complications (Supplemental Table 2, Supplemental Digital Content 1, http://links.lww.com/SLA/E179), emergency department visit, readmission, reoperation, length of stay, and discharge destination after surgery, all stratified by emergency vs. elective surgery.

Explanatory Variables

The goal of this study was to identify differences – specifically comparing Black and Hispanic patients to White patients – in undergoing emergency surgery for colorectal cancer. To date, there is an abundance of evidence that differences in access to healthcare are strongly associated with race/ethnicity, socioeconomic status, and insurance.[2] Therefore, we utilized three explanatory variables corresponding to these characteristics.

The first explanatory variable of interest was race/ethnicity, which was abstracted from the medical record and defined as White non-Hispanic, Black non-Hispanic, Hispanic, and other race/ethnicity consistent with previous studies and in accordance with guidance on reporting race/ethnicity from the American Medical Association.[13,22] The "other race/ethnicity" group was comprised of 61 patients of Asian race, 21 patients of American Indian or Alaskan Native race, and 4 patients of Native Hawaiian or Pacific Islander race.

The second explanatory variable of interest was the Social Deprivation Index (SDI), which is a composite measure of area level deprivation based on 7 demographic characteristics collected in the American Community Survey.[23] This index ranges from 0 (no social deprivation)

to 100 (maximum social deprivation) and is specifically used to quantify socioeconomic variation in health outcomes. SDI was assigned based on patient zip code. Finally, the third explanatory variable of interest was insurance type, which was defined as the primary insurance payer at the time of discharge. This was categorized using a previously described methodology as private insurance, Medicare, Medicaid, Medicare and Medicaid, no insurance, other insurance (self-pay and other public insurance), and unknown.[24]

Other explanatory demographic characteristics included patient age and sex. Patient characteristics included American Society of Anesthesiologists (ASA) classification, body mass index (BMI), tobacco use in the year prior to surgery, diabetes, chronic obstructive pulmonary disease (COPD), congestive heart failure (CHF), hypertension, chronic steroid use, dialysis, disseminated cancer, ascites, preoperative sepsis, ventilator dependence, metastatic colorectal cancer, and functional status (independent vs. non-independent). Clinical variables included hospital bed size and year of surgery.

Statistical Analysis

We calculated descriptive statistics for all explanatory variables and outcomes. Univariate differences in patient characteristics and outcomes were calculated using the Chi-squared test, analysis of variance (ANOVA), or Wilcoxon rank-sum test as appropriate. The main analysis of this study was a multivariable logistic regression with an interaction between race and age to estimate the association of all explanatory variables with undergoing emergency surgery, with the explanatory variables of interest being race, SDI, and insurance type. Multivariable logistic regression models were also calculated for performance of a preoperative staging test, documentation of preoperative CEA, and preoperative wound/ostomy consultation.

Regression models controlled for all patient characteristics. Given the multifactorial nature of known disparities in access and outcomes of surgical care, we performed additional sensitivity analyses to evaluate the interaction of race with gender, and SDI for each outcome. All analyses were performed using Stata version 17.0 and P values were 2-tailed with a significance level of P=0.05.

Results

During the study period 4,869 patients underwent colorectal surgery for cancer of whom 3,241 (66.6%) underwent colectomy, 1,428 (29.3%) underwent LAR/APR, 159 (3.3%) underwent proctectomy, and 41 (0.8%) underwent transanal excision. 4,222 (86.7%) patients were White non-Hispanic, 474 (9.7%) were Black non-Hispanic, 87 (1.8%) were Hispanic, and 86 (1.8%) were categorized as other race (Table 1). Among the 43 sites in which the operations were performed, 22 (51.2%) had <300 beds, 11 (25.6%) had 300-499 beds, and 10 (23.3%) had ≥500 beds. Six (14.0%) sites were teaching hospitals and 36 (83.7%) were located in metropolitan areas. The mean (SD) age of the cohort was 67.5 (13.5) years and there were 2,465 (50.6%) male patients. Mean (SD) SDI was 42.4 (26.5) and was significantly higher among Black non-Hispanic (72.9 [25.6]) and Hispanic (52.5 [27.5]) patients compared to White patients (38.9 [24.3]). Compared to White patients, more Black non-Hispanic patients had Medicaid (14.6% vs. 6.7%), dual Medicare/Medicaid (6.5% vs. 3.2%), and no insurance (1.5% vs. 0.6%).

Patient Presentation

Overall, 1,122 (23.0%) patients underwent emergency surgery (875 urgent and 247 emergent). The rate of emergency surgery was highest among Black non-Hispanic patients

(28.1%), followed by Hispanic patients (26.4%), White non-Hispanic patients (22.5%), and patients of other race (18.6%). In a multivariable logistic regression accounting for demographic and clinical characteristics, Black non-Hispanic patients (aOR 6.46 [95% CI 1.89-22.08, P=0.003]) and patients of other race (aOR 18.17 [95% CI 1.66-199.11]) had higher odds of undergoing emergency surgery compared to white non-Hispanic patients, although the odds decreased slightly with each year of age among Black non-Hispanic patients compared to White non-Hispanic patients (aOR 0.98 [95% CI 0.96-0.99, P=0.028]) (Table 2). Compared to White non-Hispanic patients, Black non-Hispanic patients had a 5.8 percentage point (95% CI 0.3-11.3 percentage point) increased adjusted risk of emergency surgery (Supplemental Figure 1, Supplemental Digital Content 2, http://links.lww.com/SLA/E180).

Older patients (aOR 1.03 [95% CI 1.02-1.04]), patients with other insurance (aOR 1.96 [95% CI 1.01-3.79]), and patients with higher ASA classifications (ASA 3 aOR 1.43 [95% CI 1.17-1.75], ASA 4-5 aOR 3.20 [95% CI 2.36-4.34]) were also more likely to undergo emergency surgery. Compared to patients who underwent surgery at hospitals with fewer than 300 beds, patients who underwent surgery at hospitals with 500 or more beds had lower odds (aOR 0.49 [95% CI 0.26-0.93]) of undergoing emergency surgery. Hispanic race (aOR 5.77 [95% CI 0.46-71.79]), other insurance types (Medicare aOR 0.81 [95% CI 0.59-1.09], Medicaid aOR 1.28 [95% CI 0.92-1.79], Medicare/Medicaid aOR 1.32 [95% CI 0.73-2.40], uninsured aOR 2.28 [95% CI 0.91-5.71]), and SDI (aOR 1.00 [95% CI 1.00-1.01]) were not significantly associated with undergoing emergency surgery. On separate multivariable analysis, there were no significant associations between race/ethnicity, SDI, or insurance type and the performance of a preoperative staging test, preoperative CEA measurement, or preoperative wound/ostomy consultation (Supplemental Table 3, Supplemental Digital Content 1,

http://links.lww.com/SLA/E179). Additional sensitivity analyses are presented in Supplemental Tables 5-6, Supplemental Digital Content 1, http://links.lww.com/SLA/E179.

Preoperative Evaluation and Outcomes

Patients who underwent emergency surgery were less likely to have a preoperative CEA documented, undergo preoperative staging for rectal cancer, and have preoperative wound/ostomy consultation (Table 3). These patients also had a higher incidence of 30-day mortality (5.5% vs. 1.0%, P<0.001), positive surgical margins (11.1% vs. 4.9%, P<0.001), complications (29.2% vs. 16.0%, P<0.001), readmissions (12.5% vs. 9.6%, P=0.005), and reoperations (12.2% vs. 8.2%, P<0.001), as well as longer length of stay (10 (7-14) vs. 4 (3-6) days, P=0.001). Emergency/urgent surgical patients were also less likely to be discharged home (39.1% vs. 65.9%, P<0.001).

Discussion

Colorectal cancer is a unique clinical situation in which emergency management is likely to reflect limited access to care. In this contemporary statewide cohort of patients undergoing surgical resection of colorectal cancer, we found Black non-Hispanic patients were significantly more likely to undergo emergency surgery compared to White patients. Specifically, Black non-Hispanic patients had an estimated 5.8 percentage point increased absolute risk, or roughly 25% increased relative risk, of undergoing emergency surgery compared to White patients. Undergoing emergency surgery was associated with adverse postoperative outcomes. Specifically, although patients undergoing emergency surgery made up 23% of the cohort, they accounted for 63% of the deaths. Patients who underwent emergency surgery also had a higher

incidence of positive surgical margins and postoperative complications. Overall, these results suggest that racial and ethnic differences persist in presentation and management of colorectal cancer and that these differences likely contribute to differential postoperative outcomes among these groups.

The findings of the current study build upon prior work demonstrating disparities in colorectal cancer care. Pruitt et al. analyzed a large cohort from the Surveillance, Epidemiology, and End Results (SEER) database and found that Black patients, especially those in high poverty neighborhoods, were more likely to receive emergency diagnosis and treatment of colorectal cancer compared to White patients.[25] Others have also found that Black patients are more likely to present with life-threatening symptoms at the time of cancer diagnosis.[26] The current study adds to this evidence by corroborating similar patterns of presentation and treatment in a statewide cohort of patients across a variety of practice settings. This study also demonstrated that not only are Black patients more likely to undergo emergency treatment for colorectal cancer, but that emergency treatment was associated with adverse outcomes, consistent with prior work.[27] Preoperative oncologic evaluation was more often incomplete, immediate postoperative outcomes were worse, and surgical margin positivity was higher in patients undergoing emergency surgery, suggesting that even long-term cancer outcomes are impacted by these differences in disease presentation.

Addressing these differences and their obvious negative consequences for patient outcomes requires understanding and addressing their cause. While the current study did not investigate the factors underlying differences in cancer treatment, others have uncovered several factors associated with delays in cancer treatment. Mitchell et al., for example, performed a systematic review of over 200,000 emergency presentations of lung and colon cancer and found

that factors such as lack of regular primary care and lower primary care use were associated with increased likelihood of emergency diagnosis.[28] This is consistent with the trend toward increased odds of emergency surgery among patients with Medicaid and no insurance in the current study, given the abundance of evidence showing that these patients face barriers to accessing regular primary care.[29] Failures in processes of care have also been shown to underly disruptions in appropriate evaluation and referral for symptoms concerning for colorectal cancer, such as rectal bleeding.[30] Greater travel distance to obtain healthcare has even been associated with more advanced disease at presentation.[31] By highlighting the existence of differences in colorectal cancer presentation within this collaborative network of hospitals, this study can inform targeted work to identify and modify the factors that underly them.

Addressing racial and ethnic differences in the diagnosis and treatment of colorectal cancer is essential. Multiple randomized clinical trials have demonstrated that interventions such as telephone-based outreach, dedicated patient navigators, and community outreach can increase rates of colorectal cancer screening and diagnosis among minority and low-income populations.[32-34] A particularly pragmatic and effective program, the Delaware Cancer Treatment Program, employed targeted community outreach, patient navigation, and reimbursement for costs of screening.[35] In its first five years, it eliminated colorectal cancer screening disparities, reduced the proportion of Black patients presenting with advanced disease from 79% to 40%, and nearly equalized the difference in colorectal cancer-related mortality between Black and White patients. These achievements were possible through simple, pragmatic, and affordable interventions. Insofar as the current study suggests that similar differences continue to persist in other parts of the country, these methods provide a promising roadmap that could be applied to the current population. Moreover, to the extent that the current study took place within a

statewide quality improvement collaborative, initiatives such as targeted screening incentives, creation of dedicated quality metrics for access to care, and coordinated community outreach are feasible and could be employed as next steps in response to these findings. Prior quality improvement efforts within the MSQC have used these methods to successfully change practice and improve outcomes across the collaborative.[36-38]

Despite the strengths of this study including a population-based cohort and use of granular perioperative outcome metrics, it has important limitations to acknowledge. First, the observational, non-randomized nature of this study introduces the possibility of selection bias, although the selection of colorectal cancer as a study population and our use of multivariable modeling likely controlled for the effect of observed confounding to some degree. Additionally, the use of a surgical cohort of patients in Michigan may limit the generalizability of our results to other populations. For example, the demographic composition of our cohort differed slightly from that of the overall population in Michigan. Nevertheless, the demographics of these patients are similar to other surgical cohorts and, as discussed, there is ample evidence that the trends observed in the current study are present in nationally representative populations of patients with colorectal cancer.[25] Another limitation of this study is that it may be underpowered to detect significant racial and ethnic differences in rates of emergency surgery given the small sample size, particularly of the Hispanic and "other race" groups. This limitation of the current data set suggests that differences in surgical care begin even before data are collected, insofar as certain minority groups are minimally- or under-represented. Others have highlighted the importance of targeted oversampling of minoritized populations and use of more representative databases (e.g., Medicaid claims) as ways to address these limitations and improve the validity of studies seeking to assess health disparities.[39] We were also unable to assess whether patients had undergone

previous colorectal cancer screening, making additional studies necessary to determine whether patients presenting emergently had never been screened, or had been screened but never referred to treatment or lost to follow up. Additionally, we did not examine other factors which may influence management and outcomes, such as the type of emergency (perforation, obstruction, bleeding), hospital transfer policies, and subspecialty training among surgeons. We also did not stratify our analysis to separate colon and rectal cancers, which can have different management in the emergent setting. Another limitation of this study is that while it demonstrates differences in treatment and outcomes, it did not directly assess access to care or the appropriateness of treatment and does not offer any information regarding how to ameliorate these differences. For example, preoperative staging tests are not ordered or performed for emergency cases. Future quality improvement efforts informed by these results are crucial to not just to describe existing disparities in healthcare, but address them as well. The quality improvement organization and mission of the MSQC provides the ideal framework within which to take action to improve access to high quality healthcare for all persons in Michigan.

Conclusion

Among patients with colorectal cancer, Black patients were more likely to undergo emergency surgery. Specifically, Black patients had approximately a 25% increased relative risk of emergency surgery compared to White patients. Undergoing emergency surgery was associated with incomplete preoperative oncologic evaluation, increased incidence of postoperative complications including mortality, and increased surgical margin positivity. Overall, these results suggest that racial and ethnic differences in the diagnosis and treatment of colorectal cancer persist and impact near- and long-term outcomes. Targeted efforts to address

and ameliorate these differences are essential to improving the quality of surgical care for all patients.

References

1. Institute of Medicine (U.S.). Committee on Monitoring Access to Personal Health Care Services., Millman ML. Access to health care in America. Washington, D.C.: National Academy Press; 1993.
2. de Jager E, Levine AA, Udyavar NR, et al. Disparities in Surgical Access: A Systematic Literature Review, Conceptual Model, and Evidence Map. J Am Coll Surg. 2019;228(3):276-298.
3. Haider AH, Scott VK, Rehman KA, et al. Racial disparities in surgical care and outcomes in the United States: a comprehensive review of patient, provider, and systemic factors. J Am Coll Surg. 2013;216(3):482-492 e412.
4. Reames BN, Birkmeyer NJ, Dimick JB, Ghaferi AA. Socioeconomic disparities in mortality after cancer surgery: failure to rescue. JAMA Surg. 2014;149(5):475-481.
5. Haider AH, Obirieze A, Velopulos CG, et al. Incremental Cost of Emergency Versus Elective Surgery. Ann Surg. 2015;262(2):260-266.
6. Young AL, Adair R, Culverwell A, et al. Variation in referral practice for patients with colorectal cancer liver metastases. Br J Surg. 2013;100(12):1627-1632.
7. Vu JV, Gunaseelan V, Krapohl GL, et al. Surgeon utilization of minimally invasive techniques for inguinal hernia repair: a population-based study. Surg Endosc. 2019;33(2):486-493.
8. Siegel RL, Miller KD, Goding Sauer A, et al. Colorectal cancer statistics, 2020. CA Cancer J Clin. 2020;70(3):145-164.
9. Silber JH, Rosenbaum PR, Ross RN, et al. Racial disparities in colon cancer survival: a matched cohort study. Ann Intern Med. 2014;161(12):845-854.
10. Lauby-Secretan B, Vilahur N, Bianchini F, Guha N, Straif K, International Agency for Research on Cancer Handbook Working G. The IARC Perspective on Colorectal Cancer Screening. N Engl J Med. 2018;378(18):1734-1740.
11. Dekker E, Tanis PJ, Vleugels JLA, Kasi PM, Wallace MB. Colorectal cancer. Lancet. 2019;394(10207):1467-1480.
12. Bradley CJ, Dahman B, Sabik LM. Differences in emergency colorectal surgery in Medicaid and uninsured patients by hospital safety net status. Am J Manag Care. 2015;21(2):e161-170.
13. Schwartz DA, Hui X, Schneider EB, et al. Worse outcomes among uninsured general surgery patients: does the need for an emergency operation explain these disparities? Surgery. 2014;156(2):345-351.
14. Daw J. Contribution of Four Comorbid Conditions to Racial/Ethnic Disparities in Mortality Risk. Am J Prev Med. 2017;52(1S1):S95-S102.
15. Share DA, Campbell DA, Birkmeyer N, et al. How a regional collaborative of hospitals and physicians in Michigan cut costs and improved the quality of care. Health Aff (Millwood). 2011;30(4):636-645.
16. Campbell DA, Jr., Kubus JJ, Henke PK, Hutton M, Englesbe MJ. The Michigan Surgical Quality Collaborative: a legacy of Shukri Khuri. Am J Surg. 2009;198(5 Suppl):S49-55.
17. Healy MA, Regenbogen SE, Kanters AE, et al. Surgeon Variation in Complications With Minimally Invasive and Open Colectomy: Results From the Michigan Surgical Quality Collaborative. JAMA Surg. 2017;152(9):860-867.

18. von Elm E, Altman DG, Egger M, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. Lancet. 2007;370(9596):1453-1457.
19. Smith M, Hussain A, Xiao J, et al. The importance of improving the quality of emergency surgery for a regional quality collaborative. Ann Surg. 2013;257(4):596-602.
20. Choi D, Hendren S, Chang MI, Abunayla A, Battaglia MA, Cleary RK. The impact of obesity and morbid obesity on urgent/emergency colorectal resections: a regional database analysis. Surg Endosc. 2022;36(3):1876-1886.
21. Macrae F. Clinical presentation, diagnosis, and staging of colorectal cancer. UpToDate, Tanabe K (Ed), UptoDate, Waltham, MA. Accessed January 31, 2022.
22. Flanagin A, Frey T, Christiansen SL, Committee AMAMoS. Updated Guidance on the Reporting of Race and Ethnicity in Medical and Science Journals. JAMA. 2021;326(7):621-627.
23. Butler DC, Petterson S, Phillips RL, Bazemore AW. Measures of social deprivation that predict health care access and need within a rational area of primary care service delivery. Health Serv Res. 2013;48(2 Pt 1):539-559.
24. Swenson CW, Kamdar NS, Levy H, Campbell DA, Jr., Morgan DM. Insurance Type and Major Complications After Hysterectomy. Female Pelvic Med Reconstr Surg. 2017;23(1):39-43.
25. Pruitt SL, Davidson NO, Gupta S, Yan Y, Schootman M. Missed opportunities: racial and neighborhood socioeconomic disparities in emergency colorectal cancer diagnosis and surgery. BMC Cancer. 2014;14:927.
26. Ahuja N, Chang D, Gearhart SL. Disparities in colon cancer presentation and in-hospital mortality in Maryland: a ten-year review. Ann Surg Oncol. 2007;14(2):411-416.
27. Diggs JC, Xu F, Diaz M, Cooper GS, Koroukian SM. Failure to screen: predictors and burden of emergency colorectal cancer resection. Am J Manag Care. 2007;13(3):157-164.
28. Mitchell ED, Pickwell-Smith B, Macleod U. Risk factors for emergency presentation with lung and colorectal cancers: a systematic review. BMJ Open. 2015;5(4):e006965.
29. Saunders MR, Alexander GC. Turning and churning: loss of health insurance among adults in Medicaid. J Gen Intern Med. 2009;24(1):133-134.
30. Weingart SN, Stoffel EM, Chung DC, et al. Delayed Workup of Rectal Bleeding in Adult Primary Care: Examining Process-of-Care Failures. Jt Comm J Qual Patient Saf. 2017;43(1):32-40.
31. Massarweh NN, Chiang YJ, Xing Y, et al. Association between travel distance and metastatic disease at diagnosis among patients with colon cancer. J Clin Oncol. 2014;32(9):942-948.
32. Dietrich AJ, Tobin JN, Cassells A, et al. Telephone care management to improve cancer screening among low-income women: a randomized, controlled trial. Ann Intern Med. 2006;144(8):563-571.
33. Jandorf L, Gutierrez Y, Lopez J, Christie J, Itzkowitz SH. Use of a patient navigator to increase colorectal cancer screening in an urban neighborhood health clinic. J Urban Health. 2005;82(2):216-224.
34. Percac-Lima S, Grant RW, Green AR, et al. A culturally tailored navigator program for colorectal cancer screening in a community health center: a randomized, controlled trial. J Gen Intern Med. 2009;24(2):211-217.

35. Grubbs SS, Polite BN, Carney J, Jr., et al. Eliminating racial disparities in colorectal cancer in the real world: it took a village. J Clin Oncol. 2013;31(16):1928-1930.
36. Vu JV, Howard RA, Gunaseelan V, Brummett CM, Waljee JF, Englesbe MJ. Statewide Implementation of Postoperative Opioid Prescribing Guidelines. N Engl J Med. 2019;381(7):680-682.
37. Howard R, Hallway A, Santos-Parker J, et al. Optimizing Postoperative Opioid Prescribing Through Quality-Based Reimbursement. JAMA Netw Open. 2019;2(9):e1911619.
38. Howard R, Delaney L, Kilbourne AM, et al. Development and Implementation of Preoperative Optimization for High-Risk Patients With Abdominal Wall Hernia. JAMA Netw Open. 2021;4(5):e216836.
39. Bilheimer LT, Klein RJ. Data and measurement issues in the analysis of health disparities. Health Serv Res. 2010;45(5 Pt 2):1489-1507.

Table 1 – Cohort characteristics and preoperative evaluation.

	Total	White, non-Hispanic	Black, non-Hispanic	Hispanic	Other	P value
	N=4,869	N=4,222	N=474	N=87	N=86	
Patient age, mean (SD)	67.5 (13.5)	68.0 (13.5)	63.8 (12.8)	65.8 (14.2)	61.0 (16.3)	<0.001
Male	2,465 (50.6)	2,148 (50.9)	232 (48.9)	49 (56.3)	36 (41.9)	0.220
SDI score, mean (SD)	42.4 (26.5)	38.9 (24.3)	72.9 (25.6)	52.5 (27.5)	35.3 (22.7)	<0.001
Payer type						
Private	1,423 (29.2)	1,228 (29.1)	133 (28.1)	26 (29.9)	36 (41.9)	
Medicare	2,656 (54.5)	2,372 (56.2)	213 (44.9)	41 (47.1)	30 (34.9)	
Medicaid	374 (7.7)	282 (6.7)	69 (14.6)	11 (12.6)	12 (14.0)	
Medicare and Medicaid	173 (3.6)	134 (3.2)	31 (6.5)	4 (4.6)	4 (4.7)	<0.001
Uninsured	34 (0.7)	25 (0.6)	7 (1.5)	1 (1.1)	1 (1.2)	
Other	70 (1.4)	56 (1.3)	9 (1.9)	4 (4.6)	1 (1.2)	
Unknown	139 (2.9)	125 (3.0)	12 (2.5)	0 (0.0)	2 (2.3)	
ASA class						
ASA 1	44 (0.9)	41 (1.0)	2 (0.4)	1 (1.1)	0 (0.0)	
ASA 2	1,490 (30.6)	1,308 (31.0)	116 (24.5)	26 (29.9)	40 (46.5)	0.002
ASA 3	2,978 (61.2)	2,555 (60.5)	329 (69.4)	52 (59.8)	42 (48.8)	
ASA 4-5	357 (7.3)	318 (7.5)	27 (5.7)	8 (9.2)	4 (4.7)	
Body Mass Index Category						
Underweight	156 (3.2)	128 (3.0)	24 (5.1)	0 (0.0)	4 (4.7)	
Healthy weight	1,350 (27.7)	1,181 (28.0)	108 (22.8)	17 (19.5)	44 (51.2)	<0.001
Overweight	1,582 (32.5)	1,374 (32.5)	151 (31.9)	33 (37.9)	24 (27.9)	
Obese	1,781 (36.6)	1,539 (36.5)	191 (40.3)	37 (42.5)	14 (16.3)	
Disseminated cancer	440 (9.0)	385 (9.1)	47 (9.9)	2 (2.3)	6 (7.0)	0.095
Tobacco use	797 (16.4)	661 (15.7)	109 (23.0)	13 (14.9)	14 (16.3)	<0.001
Diabetes	1,021 (21.0)	859 (20.3)	116 (24.5)	31 (35.6)	15 (17.4)	<0.001
COPD	437 (9.0)	404 (9.6)	21 (4.4)	9 (10.3)	3 (3.5)	<0.001
CHF	57 (1.2)	51 (1.2)	4 (0.8)	1 (1.1)	1 (1.2)	0.840
Hypertension	2,814 (57.8)	2,398 (56.8)	319 (67.3)	53 (60.9)	44 (51.2)	<0.001
Chronic condition	229 (4.7)	203 (4.8)	19 (4.0)	5 (5.7)	2 (2.3)	0.630
Dialysis	44 (0.9)	29 (0.7)	12 (2.5)	0 (0.0)	3 (3.5)	<0.001
Ascites	66 (1.4)	52 (1.2)	11 (2.3)	3 (3.4)	0 (0.0)	0.050
Preoperative sepsis	107 (2.2)	95 (2.3)	10 (2.1)	2 (2.3)	0 (0.0)	0.670
Ventilator dependent	6 (0.1)	5 (0.1)	1 (0.2)	0 (0.0)	0 (0.0)	0.580
Metastatic colorectal cancer	584 (12.0)	508 (12.0)	62 (13.1)	5 (5.7)	9 (10.5)	0.270
Functional status independent	4,645 (95.4)	4,036 (95.6)	443 (93.5)	81 (93.1)	85 (98.8)	0.048
Preoperative Staging	N=809	N=723	N=55	N=17	N=14	
Documented	628 (77.6)	559 (77.3)	45 (81.8)	12 (70.6)	12 (85.2)	0.657

Preoperative CEA	N=4048	N=3508	N=402	N=74	N=64	
Documented	3022 (74.7)	2614 (74.5%)	307 (76.4%)	53 (71.6%)	48 (75.0%)	0.796
Preoperative Ostomy Consult	N=828	N=702	N=93	N=14	N=19	
Documented	464 (56.0)	398 (56.7%)	49 (52.7%)	6 (42.9%)	11 (57.9%)	0.668

Legend: Preoperative staging was assessed among a subgroup of 809 patients with a diagnosis of rectal cancer and included evaluation via transrectal endoscopic ultrasound (TEUS) or pelvic magnetic resonance imaging (MRI). CEA was assessed among a subgroup of 4048 patients from 1/1/2017 onward. Preoperative ostomy consultation was assessed among 828 patients with CPT codes for ostomy creation

.

Table 2 – Logistic regression for emergency surgery.

	Emergency (N=1,122)	Elective (N=3,747)	Odds ratio (95% CI)	P value
Race/ethnicity				
White, non-Hispanic	950 (84.7)	3,272 (87.3)	Ref.	N/A
Black, non-Hispanic	133 (11.9)	341 (9.1)	6.46 (1.89-22.08)	0.003
Hispanic	23 (2.0)	64 (1.7)	5.77 (0.46-71.79)	0.173
Other	16 (1.4)	70 (1.9)	18.17 (1.66-199.11)	0.018
Age	70.8 (14.8)	66.5 (13.0)	1.03 (1.02-1.04)	<.001
Race/ethnicity * Age				
White, non-Hispanic	---	---	Ref.	N/A
Black, non-Hispanic	---	---	0.98 (0.96-1.00)	0.028
Hispanic	---	---	0.98 (0.94-1.01)	0.189
Other	---	---	0.96 (0.92-0.99)	0.019
Male	532 (47.4)	1,933 (51.6)	0.91 (0.80-1.03)	0.138
SDI score	44.4 (27.8)	41.8 (26.1)	1.00 (1.00-1.01)	0.517
Payer type				
Private	244 (21.7)	1,179 (31.5)	Ref.	N/A
Medicare	662 (59.0)	1,994 (53.2)	0.81 (0.59-1.09)	0.168
Medicaid	94 (8.4)	280 (7.5)	1.28 (0.92-1.79)	0.146
Medicare and Medicaid	64 (5.7)	109 (2.9)	1.32 (0.73-2.40)	0.362
Uninsured	10 (0.9)	24 (0.6)	2.28 (0.91-5.71)	0.079
Other	21 (1.9)	49 (1.3)	1.96 (1.01-3.79)	0.047
Unknown	27 (2.4)	112 (3.0)	0.68 (0.47-0.98)	0.041
ASA class				
ASA 1	5 (0.4)	39 (1.0)	0.58 (0.22-1.55)	0.280
ASA 2	228 (20.3)	1,262 (33.7)	Ref.	N/A
ASA 3	711 (63.4)	2,267 (60.5)	1.43 (1.17-1.75)	<.001
ASA 4-5	178 (15.9)	179 (4.8)	3.20 (2.36-4.34)	<.001
Body Mass Index Category				
Underweight	54 (4.8)	102 (2.7)	0.97 (0.67-1.40)	0.881
Healthy	372 (33.2)	978 (26.1)	Ref.	N/A
Overweight	357 (31.8)	1,225 (32.7)	0.79 (0.66-0.93)	0.006
Obese	339 (30.2)	1,442	0.69 (0.55-0.85)	0.001

		(38.5)		
Disseminated cancer	160 (14.3)	280 (7.5)	1.07 (0.72-1.59)	0.731
Tobacco use	197 (17.6)	600 (16.0)	1.07 (0.84-1.36)	0.585
Diabetes	246 (21.9)	775 (20.7)	1.00 (0.83-1.21)	0.990
COPD	132 (11.8)	305 (8.1)	1.00 (0.82-1.23)	0.996
CHF	38 (3.4)	19 (0.5)	3.89 (1.97-7.68)	<.001
Hypertension	682 (60.8)	2,132 (56.9)	0.87 (0.74-1.03)	0.098
Chronic condition	51 (4.5)	178 (4.8)	0.69 (0.44-1.07)	0.101
Dialysis	19 (1.7)	25 (0.7)	2.09 (0.84-5.21)	0.114
Ascites	49 (4.4)	17 (0.5)	7.12 (4.60-11.02)	<.001
Preoperative sepsis	102 (9.1)	5 (0.1)	73.99 (34.54-158.51)	<.001
Ventilator dependent	6 (0.5)	0 (0.0)	---	---
Metastatic colorectal cancer	223 (19.9)	361 (9.6)	2.43 (1.78-3.32)	<.001
Functional status independent	976 (87.0)	3,669 (97.9)	0.21 (0.15-0.29)	<.001
Hospital Bed Size				
<300 beds	397 (35.4)	1,126 (30.1)	Ref.	N/A
300-499 beds	464 (41.4)	1,293 (34.5)	0.90 (0.62-1.32)	0.598
≥500 beds	261 (23.3)	1,328 (35.4)	0.49 (0.26-0.93)	0.028
Year of Surgery	---	---	0.97 (0.90-1.04)	0.416

Table 2 Legend: Ventilator dependence omitted due to collinearity.

Table 3 – Outcomes for patients who underwent emergency versus elective surgery.

	Total	Emergency/Urgent	Elective	P value
	N=4,869	N=1,122	N=3,747	
Postoperative Outcomes				
Positive Surgical Margin	310 (6.4)	125 (11.1)	185 (4.9)	<0.001
30-Day Clinical Outcomes				
Mortality	99 (2.0)	62 (5.5)	37 (1.0)	<0.001
Complications	926 (19.0)	328 (29.2)	598 (16.0)	<0.001
ED visit	381 (7.8)	87 (7.8)	294 (7.8)	0.92
Readmission	499 (10.2)	140 (12.5)	359 (9.6)	0.005
Reoperation	443 (9.1)	137 (12.2)	306 (8.2)	<0.001
Length of Stay	5.0 (3.0-8.0)	10.0 (7.0-14.0)	4.0 (3.0-6.0)	<0.001
Discharge destination				<0.001
Discharged home	2,908 (59.7)	439 (39.1)	2,469 (65.9)	
SNF	513 (10.5)	264 (23.5)	249 (6.6)	
Transferred	105 (2.2)	54 (4.8)	51 (1.4)	
LTC hospital	19 (0.4)	14 (1.2)	5 (0.1)	
Hospice	36 (0.7)	31 (2.8)	5 (0.1)	
Home health	1,205 (24.7)	276 (24.6)	929 (24.8)	
Left AMA	6 (0.1)	2 (0.2)	4 (0.1)	
Expired	59 (1.2)	38 (3.4)	21 (0.6)	
Still in hospital	18 (0.4)	4 (0.4)	14 (0.4)	
Preoperative Evaluation				
Preoperative Staging Documented	628 (77.6)	5 (29.4)	623 (78.7)	<0.001
Preoperative CEA Documented	3022 (74.7)	651 (70.8)	2371 (75.8)	0.002
Preoperative Ostomy Consult Documented	464 (56.0)	62 (27.7)	402 (66.6)	<0.001

Table 3 Legend: Preoperative staging was assessed among a subgroup of 809 patients with a diagnosis of rectal cancer and included evaluation via transrectal endoscopic ultrasound (TEUS) or pelvic magnetic resonance imaging (MRI). CEA was assessed among a subgroup of 4048 patients from 1/1/2017 onward. Preoperative ostomy consultation was assessed among 828 patients with CPT codes for ostomy creation