HHS Public Access

Author manuscript

Dis Colon Rectum. Author manuscript; available in PMC 2018 October 01.

Published in final edited form as:

Dis Colon Rectum. 2017 October ; 60(10): 1092–1101. doi:10.1097/DCR.0000000000000879.

Racial and Socioeconomic Differences Manifest in Process Measure Adherence for Enhanced Recovery After Surgery Pathway

Ira L. Leeds, M.D., M.B.A.[1,*], **Yewande Alimi, M.D., M.H.S.**[2,*], **Deborah R. Hobson, R.N.**[2], **Jonathan E. Efron, M.D.**[1], **Elizabeth C. Wick, M.D.**[1], **Elliott R. Haut, M.D., Ph.D.**[1], and **Fabian M. Johnston, M.D., M.H.S.**[1]

[1]Department of Surgery, Johns Hopkins University School of Medicine, Baltimore, MD

[2]The Johns Hopkins Hospital, Baltimore, MD

Abstract

BACKGROUND—Adherences to care processes and surgical outcomes vary by population subgroups for the same procedure. Enhanced Recovery After Surgery pathways are intended to standardize care but their effect on process adherence and outcomes for population subgroups is unknown.

OBJECTIVE—To demonstrate the association between recovery pathway implementation, process measures, and short-term surgical outcomes by population subgroup.

DESIGN—Pre- and post-quality improvement implementation cohort study.

SETTING—Tertiary academic medical center.

INTERVENTION—Implementation of a modified colorectal Enhanced Recovery After Surgery pathway.

Corresponding author: Fabian M. Johnston, MD MHS, The Johns Hopkins Hospital, Department of Surgery, Division of Surgical Oncology, 600 N Wolfe Street, Blalock 654, Baltimore, MD 21287, Phone: 410-502-2846, Fax: 443-451-8583.

*Ira L. Leeds, M.D., M.B.A., and Yewande Alimi, M.D., M.H.S., contributed equally to this manuscript.

Prior Presentation

This paper was an oral presentation at the Academic Surgical Congress in Las Vegas, Nevada, February 6–9, 2017.

Author Contributions

Study Design: I.L.L., Y.A., E.C.W., F.M.J.
Acquisition of Data: I.L.L., Y.A., D.R.H., E.C.W.
Analysis of Data: I.L.L., Y.A.
Interpretation of Data: I.L.L., Y.A., J.E.F., E.C.W., E.R.H., F.M.J.
Drafting Manuscript: I.L.L., Y.A.
Critical Revision: I.L.L., Y.A., D.R.J., J.E.F., E.C.W., E.R.H., F.M.J.
Final Approval: I.L.L., Y.A., D.R.J., J.E.F., E.C.W., E.R.H., F.M.J.

Conflicts of Interest and Source of Funding

I.L.L. and Y.A. received salary support while conducting this research from National Institutes of Health National Cancer Institute T32 training grant 5T32CA126607. I.L.L. received additional support for research expenses from American Society of Colon and Rectal Surgeons Research Foundation General Surgery Resident Research Initiation Grant GSSRIG-031. E.H. received salary support as the primary investigator of an Agency for Healthcare Research and Quality grant (1R01HS024547-01) and Patient Centered Outcomes Research Institute contract (CE-12-11-4489). F.J. received salary support as the primary investigator of an Agency for Healthcare Research and Quality grant (1K08HS024736-01) from the Agency for Healthcare Research and Quality. For the remaining authors, none were declared.

PATIENTS—Elective colon and rectal resections prior to (2013) and following (2014–2016) recovery pathway implementation.

MAIN OUTCOME MEASURE—30-day outcomes by race and socioeconomic status were analyzed using a difference-in-differences approach with correlation to process adherence.

RESULTS—We identified 639 cases (199 pre, 440 post). 75.2% were white and 91.7% were high socioeconomic status. Groups were similar in terms of other preoperative characteristics. Following pathway implementation, median lengths of stay improved in all subgroups (−1.0 days overall, p=<0.001), but with no statistical difference by race or socioeconomic status (p=0.89 and p=0.29, respectively). Complication rates in both racial and socioeconomic groups were no different (26.4% vs. 28.8%, p=0.73; 27.3% vs. 25.0%, p=0.86, respectively) and remained unchanged with implementation (p=0.93, p=0.84). By race, overall adherence was 31.7% in white patients and 26.5% in non-white patients (p=0.32). While stratification by socioeconomic status demonstrated decreased overall adherence in the low status group (31.8% vs 17.1%, p=0.05), white patients were more likely to have regional pain therapy (57.1% vs 44.1%. p=0.02) with a similar trend seen with socioeconomic status.

LIMITATIONS—Data collected primarily for quality improvement purposes.

CONCLUSIONS—Differences in outcomes by race and socioeconomic status did not arise following implementation of a enhanced recovery pathway. Differences in process measures by population subgroups highlight differences in care that requiring further investigation. See **Video Abstract** at http://links.lww.com/DCR/AXXX.

Keywords

Enhanced recovery after surgery; Health status disparities; Logistic regression; Minority health; Outcomes; Process measure

Introduction

Enhanced Recovery After Surgery (ERAS) pathways have proliferated over the last 20 years following the demonstration of markedly improved outcomes.[1,2] These pathway-driven programs focus on marshaling evidence-based principles into everyday clinical practice. Results have varied but most ERAS pathways have demonstrated a number of clinical successes including reduced length of stay, decreased complications, and increased patient satisfaction.[1,2]

Over a similar chronological period, there have been increasingly documented socioeconomic and racial disparities following surgery.[3–11] These differences in outcomes are thought to result from the broad population health inequalities observed in the United States where income level alone is associated with more than 10 years of decreased life expectancy.[12] Clinical pathways have been found to ameliorate disparities in care.[13,14] However, generic care pathways may not be appropriate for all patients.

The need for population-specific ERAS modifications are already well-recognized.[15,16] Yet, the effect of ERAS pathways as an additional quality adjunct for surgical disparities is not well understood. Given the beneficial effects that ERAS pathways have already

demonstrated, addressing variation in the effect based on racial and socioeconomic groups may be necessary. With the proliferation of ERAS pathways in the United States, understanding population-specific differences is an important gap in our current knowledge base.

The purpose of this study was to examine the effect of ERAS pathways on racial and socioeconomic disparities in a colorectal surgery population with attention to differences in processes of care. We hypothesized that ERAS would improve surgical disparities for these historically vulnerable subgroups.

Materials and Methods

A retrospective analysis of prospectively collected data was performed prior to and following colorectal ERAS pathway implementation at a single academic medical center. All adult patients undergoing elective, major colorectal surgery (CPT codes 44140–44160, 45110–45123, 44202–44213, 45395, 45397) between January 1, 2013 and June 30, 2016 were included with the exception of all cases in January 2014 due to a one-month lead-in to a comprehensive ERAS pathway beginning February 1, 2014. This institution's organizational approach and selection process for ERAS pathway components has been previously described.[17] All surgeons included in the study were colorectal board-certified.

Patient data was aggregated from two prospective databases. Demographics (e.g., age, gender), comorbidities (e.g., liver disease, renal failure), and outcomes (e.g., complications, length of stay, mortality) were obtained from the institution's National Surgical Quality Improvement Program (NSQIP) internal database which captured all major colorectal procedures performed during the time period except for six 8-day vacation cycles provided by NSQIP reporting policies.[18] Cases with missing outcome data were omitted from the respective univariable analysis.

Participation in ERAS and adherence to prospectively determined process measures were obtained from a quality improvement database maintained by the institution's Department of Surgery. Adherence was assessed using electronic medical record automated abstraction scripts of quantitative data captured during the patient's preoperative interview and inpatient stay. Each process measure was a dichotomous variable with errors of omission and commission treated similarly. Protocol adherence at the patient level was defined as achieving completion of the 75th percentile of binary process measures. Cases not found independently in each of the two databases were dropped from analysis. Each patient was also assigned an Agency for Healthcare Research and Quality Socioeconomic Status (SES) Index score based on home address zip code, the most segmented standardized SES data available.[19] "Low" SES was defined as an SES Index score less than 53 – corresponding to the lower half of a U.S. standard population – or those on Medicaid; "High" SES included all who were not Low SES.

Outcomes for white and non-white patients as well as low versus high SES index scores were analyzed using Chi-square and Wilcox-Mann-Whitney tests to compare pre- and post-implementation surgical outcomes within group. Out-group differences were compared

using a difference-in-difference approach.[20] ERAS pathway adherence was further compared to patients' surgical outcomes with respect to race and SES. To evaluate our findings, given the imbalance in sample size, we utilized propensity score near-neighbor matching after utilizing logistic regression analysis to create the propensity score and test the balance of covariates in our model.[21] This study was reviewed and approved by the Johns Hopkins School of Medicine Institutional Review Board with an informed consent waiver granted.

Results

A total of 639 colon and rectal resections were identified (199 pre-ERAS era, 440 ERAS era). Of the ERAS era cohort, 338 (76.8%) were white and 102 (23.2%) were non-white. 399 (90.7%) were High SES and 41 (9.3%) were Low SES. White patients were more likely to carry commercial health insurance ($p < 0.001$) in the pre-ERAS and ERAS eras. In the pre-ERAS era, white patients were more likely to undergo an open procedure ($p = 0.04$). In the ERAS era, white patients were less likely to be diabetic ($p = 0.03$); High SES index patients were less likely to smoke cigarettes and more likely to be employed than the low SES index cohort ($p < 0.001$ for both) (Tables 1 and 2).

Surgical outcomes prior to and following implementation of the ERAS pathway by race and SES Index are reported in Tables 3 and 4, respectively. Prior to ERAS implementation median lengths of stay, complication rate, and total number of complications were not statistically different between white and non-white patients. Following ERAS implementation, median lengths of stay improved in both whites (−1.5 days, $p<0.001$) and non-whites (−1.0 days, $p=<0.001$) as well as high SES (−1.0 days, $p<0.001$) and low SES (−2.0 days, $p = 0.003$). A difference-in-difference analysis of these length of stay changes demonstrated no statistical difference in the temporal change of the outcomes differences by race or socioeconomic status ($p = 0.89$ and $p = 0.28$, respectively). Initially, complication rates in both racial (26.4% versus 28.8%, $p = 0.73$) and socioeconomic (27.3% versus 25.0%, $p = 1.00$) groups were no different and remained unchanged after ERAS implementation ($p=1.00$). Also, the average number of complications per surgery were not statistically different pre- and post-ERAS implementation.

Following ERAS implementation, overall short-term surgical outcomes demonstrated no statistically significant associations with process measures (Data Supplement). Univariable analysis of process measure adherence demonstrated no statistically significant association to lengths of stay ($p =0.11$) or readmission rates ($p = 0.19$). The propensity score matching alternative approach described in the Methods yielded the same results.

For vulnerable patient groups, process measure adherence following ERAS implementation is described in Table 5. Adherence to the protocol was defined as completion of at least 10 process measures (75^{th} percentile). Overall adherence was 31.7% in white patients and 26.5% in non-white patients ($p=0.32$). Stratifying by SES, High SES index patients were more likely to be adherent than Low SES index patients (31.8% versus 17.1%, $p = 0.05$). Notably, white patients were more likely to have TAP blocks or epidurals initiated and subsequently maintained than their non-white counterparts (initiation: 57.1% versus 44.1%.

p = 0.02; maintenance: 47.3% versus 34.3%, p = 0.02). A similar trend was seen in High SES patients (55.4% versus 41.5%, p = 0.09). Those with higher SES trended towards increased rates of being placed on ERAS pathway during scheduling (p = 0.14) and adhered to at-home preoperative carbohydrate drink loading almost twice as often as their Low SES counterparts (47.6 versus 26.8, p = 0.01). Similarly, High SES patients were more likely to be mobilize and be ambulating at goal on their second post-operative day than Low SES patients (53.6 versus 39.0, p = 0.08).

Due to asymmetric variation noted in process measures (e.g., TAP blocks), further analysis was performed with process measures stratified by phase of care (e.g., perioperative, postoperative) (Table 5). All phases of care demonstrated meaningful – while not all significant – differences between groups. Most notably, adherence to preoperative process measures was 36.6% in white patients versus 24.2% in non-white patients (p <0.01). Stratification by SES also demonstrated a similar trend (34.3% in high SES versus 24.5% in low SES, p = 0.15).

Discussion

This study was designed to assess any effect of ERAS pathway implementation on short-term surgical disparities using one of the largest patient series of ERAS patients from a diverse population (~30% historically non-white). Using a database that began as part of a process-based quality improvement program, outcomes were examined within the context of both ERAS implementation and the adherence of each patient to individual ERAS process measures. Our findings suggest that short-term disparities appear to be mitigated by quality monitoring. Additionally, there were significant differences in process adherence suggestive of shared decision-making dissonance.

These findings are important for the field's current emphasis on eliminating surgical disparities. Practice innovation within colorectal surgery has specifically been found to discriminate by underlying patient demographics.[22] Surgical disparities have been shown to diminish when surgery is conducted in quality-oriented environments.[23,24] Some of these disparities in short-term surgical outcomes may be reduced for surgery performed at quality-driven and high-volume centers.[23,24]. Conventional wisdom holds that disparities are due in part to care variation[25–27] and bundled pathways may reduce the latter and thereby eliminate disparities. However, one could argue the opposite that standardized pathways have the potential to worsen disparities due to the lack of individualized adjustment to a patient's unique needs.[28] Of course, a final possibility is that quality-driven centers have already mitigated short-term surgical disparities and the association of quality-driven institutions as those most likely to implemented bundled pathways as well may lead to their having no effect on the symmetry of outcomes in different population groups. Given that the existing literature already suggests that experienced centers have reduced many surgical disparities,[23,24] the implementation of further quality efforts such as an ERAS pathway may have no effect. This study was designed with these different possible scenarios in mind and with the urgency that any unforeseen surgical pathway-inducing disparities be addressed expeditiously.

The population reported here represents a diverse and large number of colorectal surgery patients treated under an ERAS pathway. 30.2% of our study population was non-white whereas most of the large European studies on ERAS and outcomes have not reported race presumably due to the racial homogeneity of the general population.[29–31] As has been previously reported by a number of centers with similar pathways,[1,2] patients undergoing elective colorectal surgery on an ERAS pathway had improved lengths of stay compared to historical controls without any worsening of readmission rates. As has been shown previously with high volume centers that take a quality-driven approach to patient care,[23] colorectal surgery patients at our institution have had similar short-term surgical outcomes regardless of race and socioeconomic status for years prior to ERAS implementation. Reassuringly, enrollment in an ERAS pathway did not produce short-term surgical disparities in this population.

This study also links ERAS process measures to post-operative outcomes in a manner previously done by European institutions prior to the widespread deployment in the United States.[30] Our reported adherence here was significantly worse than the 50–70% reported in seminal studies.[29–31] We attribute this difference to our use of a real-world quality improvement database rather than a heavily regulated prospective research protocol. The automated abstraction scripts that were used to obtain process data likely under-estimated adherence due to missing data but this loss of data is assumed to occur in a non-differential manner and may pose little material effect on results. Outside of a formal research protocol, we would expect a considerable drop in process adherence.[29–31] The adherence findings demonstrate an association between increasing process measure adherence and High SES status. Process measure adherence stratified by groups and phase of care favored white and High SES index patients. Adherence to ERAS process measures was not correlated with length of stay or complication rates in this study, but this inconsistency with previously published literature may be due to limited power. Alternatively, the lack of association may be indicative of previous findings that simply measuring quality improvement efforts also reduces these disparities.[23]

Given the lack of pre-existing racial disparities in our institution’s surgical population, an unanswered question for further study is how an ERAS implementation may perform in a more disparate setting. Combined with others’ findings,[23] our data supports that ERAS pathways may be a useful component of a quality improvement program to reduces differences in surgical care as well as serve as an early warning monitoring system through the liberal use of detailed process measures. The granularity of these process measures also support continuous improvement approaches where relative underperformers are targeted even if overall performance appears adequate.[32]

Of concern, specific important components of the ERAS pathway were underutilized in historically underserved populations. The rate of epidural use was markedly less in non-white patients (44.1% versus 57.1%, $p = 0.02$) and near-significant in Low SES patients (55.4% versus 41.5%, $p = 0.09$). Two possible interpretations that require further investigation include: 1) non-white patients are declining epidural blocks at higher rates due to inadequate counseling on the benefits; or 2) providers may be carrying implicit biases that

lead to them not offering epidural blocks due to presumed historical preferences of a racial group.[33,34]

It is important that we consider the potential role of implicit bias in our study.[35] Implicit bias from health care professionals represents unrecognized bias against members of a social group affecting the quality of care provided.[36] This has been increasingly recognized to contribute to healthcare disparities. Implicit bias operates in an unintentional or unconscious manner. It can be activated quickly through social interactions (e.g., skin color, accent, or wardrobe) and unnoticeably exert its influence on perception, memory, and behavior.[37] Because implicit bias can operate without a person's intent or awareness, it is reasonable to consider this as an etiology of the disparate use of components of the ERAS pathway observed in this study. The rate of preoperative assignment to the ERAS pathway was only 58.5% in Low SES patients while High SES patients were correctly assigned 69.7% of the time ($p = 0.14$). At our institution, patients were assigned to the ERAS pathway if they met criteria and are then were designated to the ERAS pathway as part of surgical case scheduling by the operating surgeon. That Low SES patients were less likely to be assigned to the pathway suggests that some stimulus was leading scheduling surgeons to not do so. ERAS home medications and infection prevention bundle supplies were provided free-of-charge to all patients as part of their clinic appointment; therefore, it is unlikely that surgeons were omitting Low SES patients from the pathway for lack of financial support or resources.

While our evidence does not prove implicit biases as the cause of these process measure differences, it does heighten concern for its existence. Specifically, concern may be raised with the approach and effectiveness of patient counseling as well as how our providers engage with patients toward a shared goal of comprehensive and equitable care. This finding has resulted in a renewed attention to identify and address implicit biases in care processes at our institution. For example, an ongoing quality improvement process is currently systematically analyzing why rates of regional anesthesia use were markedly lower among non-white patients. Future work could focus on reducing disparities by determining the degree of implicit bias in our institution and attempt to understand it relationship with clinical outcomes.

An important corollary of these findings is that an ERAS pathway is likely protective of short-term surgical disparities. We believe that ERAS pathways may intrinsically improve quality through its use of process measures. Some evidence already exists that performance improvement efforts (e.g., NSQIP registry use) correlate with reductions in disparities.[38] In this study we observed, ERAS pathway process measures as a quality improvement tool as well as a means of conveying granular quality data to change agents.[39] Given that prior studies have shown that surgeons under-utilize quality improvement as a means of addressing surgical disparities, we believe that ERAS pathway process measures may be an important and accessible quality assessment tool and act as a sentinel indicator for surgical disparities.[40]

A limitation of this study is that data was analyzed from a single institution with a modified ERAS pathway. It is possible that the lack of short-term disparities in our surgical

population and the supportive effect of our institution's ERAS pathway on disparities are unique features of this institution's care environment. Furthermore, each ERAS pathway is unique and the specific process measures of concern are not generalizable to other institutions. The ERAS experience in the United States is currently lacking robust, multi-institutional studies but such organizing efforts are just starting to be underway. Even without direct generalizability the quality monitoring methods described here offer a framework for further examining subgroup effects of ERAS implementation in other settings. A second limitation is that data was drawn from two distinct quality datasets that were not intentionally designed to be merged for chronological analysis. In addition, prior quality improvement and faculty additions limited pre-ERAS historical data collection to only one year to limit the effect of temporal trends. Such a limitation affected our ability to capture and merge every case performed at the institution thereby limiting our sample size and limiting cases to one year prior to ERAS implementation. Although these findings are currently the best available evidence of the ERAS experience in historically vulnerable populations, efforts are underway to further explore the negative results of this study as the post-implementation group continues to accrue. A related limitation is the accuracy of subgroup assignment, specifically national SES indexing. Being able to assign SES accurately is central to further investigation of differences in care, but small-area SES variation is typically not statistically discriminatory using these national metrics.[41] Methods for small-area SES classification such as geocoding have been proposed but their effective use is limited to a few highly studied geographic areas.[42] However, for both race and SES, absolute differences do not appear to be clinically meaningful effects but a larger sample size may confirm these early findings. A final limitation of many healthcare quality studies is the debated causal relationship between process measure and outcomes.[43] However, data continues to mount that process measure adherence is associated with improved outcomes presuming high-quality and appropriate measurement design.[44–46]

Conclusion

This study's findings are consistent to prior published literature with regards to the lack of short-term surgical outcomes disparities at high-quality centers and improvements reported with other ERAS pathway implementations. ERAS pathway implementation appears to have no overall benefit or harm on surgical disparities. However, differences in process adherence by racial and socioeconomic group may represent important themes for enhanced quality monitoring. While these differences are unlikely to be identical at other institutions, the experience described here provides a framework for further work.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

The authors thank Sam Sokolinsky for his role in helping to coordinate data management for this project.

References

1. Nicholson A, Lowe MC, Parker J, Lewis SR, Alderson P, Smith AF. Systematic review and meta-analysis of enhanced recovery programmes in surgical patients. Br J Surg. 2014; 101:172–188. [PubMed: 24469618]
2. Zhuang CL, Ye XZ, Zhang XD, Chen BC, Yu Z. Enhanced recovery after surgery programs versus traditional care for colorectal surgery: a meta-analysis of randomized controlled trials. Dis Colon Rectum. 2013; 56:667–678. [PubMed: 23575408]
3. Sukumar S, Ravi P, Sood A, et al. Racial disparities in operative outcomes after major cancer surgery in the United States. World J Surg. 2015; 39:634–643. [PubMed: 25409836]
4. Ravi P, Sood A, Schmid M, et al. Racial/Ethnic Disparities in Perioperative Outcomes of Major Procedures: Results From the National Surgical Quality Improvement Program. Ann Surg. 2015; 262:955–964. [PubMed: 26501490]
5. Esnaola NF, Ford ME. Racial Differences and Disparities in Cancer Care and Outcomes. Where's the Rub? Surg Oncol Clin N Am. 2012; 21:417–437. [PubMed: 22583991]
6. Shavers VL, Brown ML. Racial and ethnic disparities in the receipt of cancer treatment. J Natl Cancer Inst. 2002; 94:334–357. [PubMed: 11880473]
7. 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; 216:482–92. e12. [PubMed: 23318117]
8. Osborne NH, Upchurch GR, Mathur AK, Dimick JB. Explaining racial disparities in mortality after abdominal aortic aneurysm repair. J Vasc Surg. 2009; 50:709–713. [PubMed: 19703760]
9. Bennett KM, Scarborough JE, Pappas TN, Kepler TB. Patient socioeconomic status is an independent predictor of operative mortality. Ann Surg. 2010; 252:552–557. 558. [PubMed: 20739856]
10. Anderson JE, Li Z, Romano PS, Parker J, Chang DC. Should Risk Adjustment for Surgical Outcomes Reporting Include Sociodemographic Status? A Study of Coronary Artery Bypass Grafting in California. J Am Coll Surg. 2016; 223:221–230. [PubMed: 27216572]
11. Torain MJ, Maragh-Bass AC, Dankwa-Mullen I, et al. Surgical Disparities: A Comprehensive Review and New Conceptual Framework. J Am Coll Surg. 2016; 223:408–418. [PubMed: 27296524]
12. Adler NE, Glymour MM, Fielding J. Addressing Social Determinants of Health and Health Inequalities. JAMA. 2016; 316:1641. [PubMed: 27669456]
13. Misky GJ, Carlson T, Thompson E, Trujillo T, Nordenholz K. Implementation of an acute venous thromboembolism clinical pathway reduces healthcare utilization and mitigates health disparities. J Hosp Med. 2014; 9:430–435. [PubMed: 24639293]
14. Cabana MD, Flores G. The role of clinical practice guidelines in enhancing quality and reducing racial/ethnic disparities in paediatrics. Paediatr Respir Rev. 2002; 3:52–58. [PubMed: 12065183]
15. Kennedy EP, Rosato EL, Sauter PK, et al. Initiation of a Critical Pathway for Pancreaticoduodenectomy at an Academic Institution-the First Step in Multidisciplinary Team Building. J Am Coll Surg. 2007; 204:917–923. [PubMed: 17481510]
16. Leeds IL, Boss EF, George JA, Strockbine V, Wick EC, Jelin EB. Preparing enhanced recovery after surgery for implementation in pediatric populations. J Pediatr Surg. 2016; 51:2126–2129. [PubMed: 27663124]
17. Wick EC, Galante DJ, Hobson DB, et al. Organizational Culture Changes Result in Improvement in Patient-Centered Outcomes: Implementation of an Integrated Recovery Pathway for Surgical Patients. J Am Coll Surg. 2015; 221:669–677. [PubMed: 26228010]
18. American College of Surgeons National Surgical Quality Improvement Program. User Guide for the 2014 ACS NSQIP Participant Use Data File. Chicago, IL: 2015.
19. Bonito, AJ., Bahn, C., Eicheldinger, C., Carpenter, L. Creation of New Race-Ethnicity Codes and Socioeconomic Status (SES) Indicators for Medicare Beneficiaries. Research Triangle Park, NC: 2006.
20. Dimick JB, Ryan AM. Methods for evaluating changes in health care policy: the difference-in-differences approach. JAMA. 2014; 312:2401–2402. [PubMed: 25490331]

21. Austin PC. An Introduction to Propensity Score Methods for Reducing the Effects of Confounding in Observational Studies. Multivariate Behav Res. 2011; 46:399–424. [PubMed: 21818162]
22. Damle RN, Flahive JM, Davids JS, Maykel JA, Sturrock PR, Alavi K. Examination of Racial Disparities in the Receipt of Minimally Invasive Surgery Among a National Cohort of Adult Patients Undergoing Colorectal Surgery. Dis Colon Rectum. 2016; 59:1055–1062. [PubMed: 27749481]
23. Parsons HM, Habermann EB, Stain SC, Vickers SM, Al-Refaie WB. What happens to racial and ethnic minorities after cancer surgery at american college of surgeons national surgical quality improvement program hospitals? J Am Coll Surg. 2012; 214:539–547. [PubMed: 22321524]
24. Robinson CN, Balentine CJ, Sansgiry S, Berger DH. Disparities in the use of minimally invasive surgery for colorectal disease. J Gastrointest Surg. 2012; 16:897–903. 4. [PubMed: 22411487]
25. Rangrass G, Ghaferi AA, Dimick JB. Explaining racial disparities in outcomes after cardiac surgery: the role of hospital quality. JAMA Surg. 2014; 149:223–227. [PubMed: 24402245]
26. Institute of Medicine. Unequal Treatment: Confronting Racial and Ethnic Disparities in Healthcare. Washington, DC: National Academies Press; 2003.
27. Ladin K, Rodrigue JR, Hanto DW. Framing disparities along the continuum of care from chronic kidney disease to transplantation: Barriers and interventions. Am J Transplant. 2009; 9:669–674. [PubMed: 19344460]
28. Basu A, Jena AB, Philipson TJ. The impact of comparative effectiveness research on health and health care spending. J Health Econ. 2011; 30:695–706. [PubMed: 21696840]
29. ERAS Compliance Group. The Impact of Enhanced Recovery Protocol Compliance on Elective Colorectal Cancer Resection: Results From an International Registry. Ann Surg. 2015; 261:1153–1159. [PubMed: 25671587]
30. Gustafsson UO, Hausel J, Thorell A, Ljungqvist O, Soop M, Nygren J. Adherence to the enhanced recovery after surgery protocol and outcomes after colorectal cancer surgery. Arch Surg. 2011; 146:571–577. [PubMed: 21242424]
31. Gonzalez-Ayora S, Pastor C, Guadalajara H, et al. Enhanced recovery care after colorectal surgery in elderly patients: compliance and outcomes of a multicenter study from the Spanish working group on ERAS. Int J Colorectal Dis. 2016; 31:1625–1631. [PubMed: 27378580]
32. Berwick DM. Developing and testing changes in delivery of care. Ann Intern Med. 1998; 128:651–656. [PubMed: 9537939]
33. Glance LG, Wissler R, Glantz C, Osler TM, Mukamel DB, Dick AW. Racial differences in the use of epidural analgesia for labor. Anesthesiology. 2007; 106:18–19.
34. Morris T, Schulman M. Race inequality in epidural use and regional anesthesia failure in labor and birth: An examination of women's experience. Sex Reprod Healthc. 2014; 5:188–194. [PubMed: 25433830]
35. Haider AH, Schneider EB, Sriram N, et al. Unconscious race and social class bias among acute care surgical clinicians and clinical treatment decisions. JAMA Surg. 2015; 150:457–464. [PubMed: 25786199]
36. Smedley, BD.Stith, AY., Nelson, AR., editors. Institute of Medicine. Unequal Treatment: Confronting Racial and Ethnic Disparities in Healthcare. Washington, DC: Institute of Medicine; 2003.
37. Blair IV, Steiner JF, Havranek EP. Unconscious (implicit) bias and health disparities: where do we go from here? Perm J. 2011; 15:71–78.
38. Trivedi AN, Zaslavsky AM, Schneider EC, Ayanian JZ. Trends in the Quality of Care and Racial Disparities in Medicare Managed Care. N Engl J Med. 2005; 353:692–700. [PubMed: 16107622]
39. Lilford RJ, Brown CA, Nicholl J. Use of process measures to monitor the quality of clinical practice. BMJ. 2007; 335:648–650. [PubMed: 17901516]
40. Britton BV, Nagarajan N, Zogg CK, et al. Awareness of racial/ethnic disparities in surgical outcomes and care: factors affecting acknowledgment and action. Am J Surg. 2016; 212:102–108. e2. [PubMed: 26522774]
41. Blum AB, Egorova NN, Sosunov EA, et al. Impact of socioeconomic status measures on hospital profiling in new york city. Circ Cardiovasc Qual Outcomes. 2014; 7:391–397. [PubMed: 24823956]

42. Krieger N, Chen JT, Waterman PD, Rehkopf DH, Subramanian SV. Painting a truer picture of US socioeconomic and racial/ethnic health inequalities: The public health disparities geocoding project. Am J Public Health. 2005; 95:312–323. [PubMed: 15671470]

43. Donabedian A. The quality of care. How can it be assessed? JAMA. 260:1743–1748.

44. Kahn KL, Rogers WH, Rubenstein LV, et al. Measuring quality of care with explicit process criteria before and after implementation of the DRG-based prospective payment system. JAMA. 1990; 264:1969–1973. [PubMed: 2120476]

45. Liu SW, Singer SJ, Sun BC, Camargo CA. A Conceptual Model for Assessing Quality of Care for Patients Boarding in the Emergency Department: Structure-Process-Outcome. Acad Emerg Med. 2011; 18:430–435. [PubMed: 21496148]

46. Mant J. Process versus outcome indicators in the assessment of quality of health care. Int J Qual Heal care J Int Soc Qual Heal Care. 2001; 13:475–480.

Table 1

Patient demographics and clinical characteristics by race (reported as % except where indicated)

	Pre-ERAS		p	Post-ERAS		p
	White (n =140)	Non-White (n =59)		White (n =338)	Non-White (n =102)	
Gender(%)			0.63			0.93
Male	47.1	50.8		54.4	54.9	
Female	52.9	49.2		45.6	45.1	
Age (%)			0.95			0.32
< 65	72.9	76.3		70.1	79.4	
65–74	18.6	15.3		18.6	13.7	
75–84	6.4	6.8		9.2	5.9	
> 84	2.1	1.7		2.1	1.0	
Race, N(%)						
White	140 (100)			338 (100)		
Black		39 (66.1)			59 (57.8)	
Asian		6 (10.2)			16 (15.7)	
Other		12 (20.3)			27 (26.5)	
Missing	0 (0.0)	2 (3.4)			0 (0.0)	
Employment Status			0.80			0.24
Employed	47.9	47.5		53.3	53.9	
Unemployed/Disabled	15.7	20.3		13.6	15.7	
Retired	30.7	28.9		31.4	25.5	
Other	5.7	3.4		1.8	4.9	
Insurance Status			<0.001			<0.001
Commercial	76.4	61.0		65.7	59.8	
Medicare	22.9	23.7		27.2	18.6	
Medicaid	0.0	10.1		3.6	15.7	
Other	0.7	5.1		3.5	5.9	
Comorbidities						

	Pre-ERAS		p	Post-ERAS		p
	White (n =140)	Non-White (n =59)		White (n =338)	Non-White (n =102)	
Overweight/Obese	58.6	64.4	0.48	60.9	55.9	0.36
Smoker	7.9	10.2	0.59	11.5	18.6	0.06
Diabetes	10.7	15.3	0.37	7.7	14.7	0.03
Wound Class			0.42			0.42
Clean/Contaminated	89.3	94.9		90.2	85.3	
Clean	0.0	0.0		1.5	1.0	
Contaminated	10.0	5.1		5.0	7.8	
Dirty/Infected	0.7	0.0		3.3	5.9	
Disseminated Cancer	5.0	1.7	0.28	6.8	3.9	0.29
ASA Class			0.63			0.12
No Disturbance	1.4	0.0		1.2	1.0	
Mild disturbance	47.1	45.8		54.1	41.2	
Severe Disturbance	51.4	51.2		43.2	56.9	
Life Threatening	0.0	0.0		1.2	1.0	
Missing	0.0	0.0		0.3	0.0	
> 10% Weight Loss	2.1	1.7		2.7	2.9	0.88
Median Income(IQR)($)	75,742.5 (58,643–106,640)	74,308 (53,666–99,547)	0.24	76,799 (57,226–100,172)	63,717.5 (49,162–95,807)	0.008
Approach			0.04			0.76
Open	59.5	48.0		62.1	64.4	
Laparoscopic	40.5	52.0		37.9	35.6	
Procedure Type			0.45			0.7
Colectomy	40.0	45.8		52.1	50.0	
Proctectomy	60.0	54.2		47.9	50.0	

Dis Colon Rectum. Author manuscript; available in PMC 2018 October 01.

Table 2

Patient demographics and clinical characteristics by socioeconomic status (reported as % except where indicated)

	Pre-ERAS		p	Post-ERAS		p
	High SES (n =187)	**Low SES (n =12)**		**High SES (n =399)**	**Low SES (n =41)**	
Gender(%)			0.53			0.87
Male	47.6	58.3		54.4	56.1	
Female	52.4	41.7		45.6	43.9	
Age (%)			0.44			0.02
< 65	73.8	75.0		70.2	92.7	
65–74	18.2	8.3		18.5	7.3	
75–84	5.9	16.7		9.3	0.0	
> 84	2.1	0.0		2.0	0.0	
Race, N(%)			0.01			<0.001
White	72.7	33.3		80.5	41.5	
Black	17.6	50.0		10.3	43.9	
Asian	2.7	8.3		3.3	7.3	
Other	5.9	8.3		6.0	7.3	
Missing	1.2	0				
Employment Status			0.04			<0.001
Employed	49.2	25.0		55.6	31.7	
Unemployed/Disabled	14.9	50.0		10.5	48.8	
Retired	30.5	25.0		31.6	14.6	
Other	5.4	0.0		2.3	4.9	
Insurance Status			<0.001			<0.001
Commercial	74.3	33.3		68.7	22.0	
Medicare	24.1	8.3		26.8	9.8	
Medicaid	0.0	50.0		0.0	68.3	
Other	1.6	8.3		4.5	0.0	
Comorbidities						

	Pre-ERAS		p	Post-ERAS		p
	High SES (n =187)	**Low SES (n =12)**		**High SES (n =399)**	**Low SES (n =41)**	
Overweight/Obese	62.0	33.3	0.07	59.6	61.0	0.86
Smoker	7.5	25.0	0.07	10.8	36.6	<0.001
Diabetes	11.8	16.7	0.64	9.8	4.9	0.41
Wound Class			0.32			0.72
Clean/Contaminated	91.4	83.3		89.2	87.8	
Clean	0.0	0.0		1.3	2.4	
Contaminated	8.0	16.7		5.8	4.9	
Dirty/Infected	0.5	0.0		3.8	4.9	
Disseminated Cancer	4.3	0.0	1.00	6.3	4.9	1.00
ASA Class			0.45			1.00
No Disturbance	1.1	0.0		1.3	0.0	
Mild disturbance	47.6	33.3		50.9	53.7	
Severe Disturbance	51.3	66.7		46.4	46.3	
Life Threatening	0.0	0.0		1.3	0.0	
Missing	0.0	0.0		0.3	0.0	
> 10% Weight Loss	1.6	8.3	0.11	2.5	4.9	0.37
Median Income(IQR)($)	78,705 (58,643–106,640)	36,724 (35,060–48,993)	<0.001	77,021 (58,019–100,336)	38,043 (33,768–65,526)	<0.001
Approach			1.00			0.41
Open	62.6	66.7		56.1	63.4	
Laparoscopic	37.4	33.3		43.9	36.6	
Procedure Type			0.54			0.17
Colectomy	42.3	33.3		52.6	41.5	
Proctectomy	57.8	66.7		47.4	58.5	

Dis Colon Rectum. Author manuscript; available in PMC 2018 October 01.

Table 3

Postoperative outcomes by race (reported as % except where indicated)

	Pre-ERAS			Post-ERAS			
	White (n =140)	**Non-White (n =59)**	**p**	**White (n =338)**	**Non-White (n =102)**	**p**	**Pre/Post p value***
LOS (Median)	5.5 (4.0,7.0)	5.0 (4.0,9.0)	0.81	4 (3.0, 6.0)	4 (3.0, 7.0)	0.97	0.89
Death	0.0	0.0	--	0.0	0.0	--	--
Morbidity (%)							
Any Complication	26.4	28.8	0.73	25.4	28.4	0.55	0.94
Superficial SSI	5.7	6.8	0.75	4.4	4.9	0.79	0.89
Deep SSI	0.7	0.0	1.00	1.5	0.0	0.59	0.68
Organ Space SSI	6.4	6.8	1.00	4.1	3.9	1.00	0.89
Wound dehiscence	0.7	0.0	1.00	0.9	0.0	1.00	0.91
Pneumonia	0.0	0.0	--	0.9	0.0	1.00	0.50
Reintubation	0.7	0.0	1.00	0.0	0.0	--	0.35
Pulmonary Embolism	0.7	0.0	1.00	0.9	0.0	1.00	0.91
Prolonged Mechanical Ventilation (> 48 hours)	1.4	1.7	1.00	0.9	0.0	1.00	0.53
Progressive RF	0.7	0.0	1.00	0.3	1.0	0.41	0.29
ARF	0.0	0.0	--	0.0	0.0	--	--
UTI	2.1	1.7	1.00	0.9	1.0	1.00	0.80
CVA	0.0	0.0	--	0.0	0.0	--	--
Cardiac arrest	0.0	0.0	--	0.0	0.0	--	--
Myocardial infarction	1.4	0.0	1.00	0.0	1.0	0.23	0.07
Bleeding transfusions	3.6	6.8	0.46	6.2	7.8	0.56	0.73
DVT	0.0	0.0	--	0.9	1.0	1.00	0.95
Sepsis	0.0	1.7	0.30	0.6	2.0	0.23	0.85
Septic Shock	0.7	1.7	0.51	0.6	1.0	0.55	0.73
Total # Complications (Mean)	0.4 (0.8)	0.4 (0.7)	0.94	0.4 (0.8)	0.4 (0.6)	0.76	0.82
Readmission within 30 days	16.4	15.3	0.84	16.6	13.7	0.49	0.82

*Comparisons not made in cohorts with empty cells

Table 4

Postoperative outcomes by SES (reported as % except where indicated)

	Pre-ERAS			Post-ERAS			
	High SES (n =187)	**Low SES (n =12)**	**p**	**High SES (n =399)**	**Low SES (n = 41)**	**p**	**Pre/Post p value***
LOS, Median (IQR)	5 (4–7)	6 (5–11.5)	0.20	4 (3.0, 6.0)	4 (3.0,6.0)	0.37	0.28
Death	0.0	0.0	--	0.0	0.0	--	--
Morbidity (%)							
Any Complication	27.3	25.0	1.00	26.1	26.8	0.92	0.84
Superficial SSI	6.4	0.0	1.00	4.8	2.4	1.00	0.58
Deep SSI	0.5	0.0	1.00	1.3	0.0	1.00	0.83
Organ Space SSI	5.9	16.7	0.18	4.0	4.9	0.68	0.18
Wound dehiscence	0.5	0.0	1.00	0.8	0.0	1.00	0.94
Pneumonia	0.0	0.0	--	0.8	0.0	1.00	0.75
Re-intubation	0.5	0.0	1.00	0.0	0.0	--	0.69
Pulmonary Embolism	0.5	0.0	1.00	0.8	0.0	1.00	0.94
Prolonged Mechanical Ventilation (> 48 hours)	1.1	8.3	0.17	0.5	2.4	0.26	0.10
Progressive RF	0.5	0.0	1.00	0.3	2.4	0.18	0.24
ARF	0.0	0.0	--	0.0	0.0	--	--
UTI	2.1	0.0	1.00	1.0	0.0	1.00	0.76
CVA	0.0	0.0	--	0.0	0.0	--	--
Cardiac arrest	0.0	0.0	--	0.0	0.0	--	--
Myocardial infarction	1.1	0.0	1.00	0.3	0.0	1.00	0.73
Bleeding transfusions	4.3	8.3	0.44	6.5	7.3	0.74	0.69
DVT	0.0	0.0	--	1.0	0.0	1.00	0.71
Sepsis	0.0	8.3	0.06	0.8	2.4	0.33	0.03
Septic Shock	1.1	0.0	1.00	0.8	0.0	1.00	0.92
Total # Complications (Mean)	0.4 (0.8)	0.5 (1.0)	0.71	0.4 (0.7)	0.4 (0.8)	0.83	0.81
Readmission within 30 days	16.6	8.3	0.70	15.5	19.5	0.51	0.33

* Comparisons not made in cohorts with empty cells

Table 5

ERAS process measure adherence by race and socioeconomic status(as percentage adherent)

Metric	White (n = 338)	Non-White (n =102)	p	High SES (n=399)	Low SES (n=41)	P
Assigned to ERAS pathway during scheduling	69.5	65.7	0.46	69.7	58.5	0.14
Carbohydrate-rich fluid intake immediately preoperatively	46.2	44.1	0.72	47.6	26.8	0.01
Received preoperative ERAS medications	65.1	64.7	0.94	64.4	70.7	0.42
Used TAP block or epidural	57.1	44.1	0.02	55.4	41.5	0.09
All Pre-operative Measures Adherent	**36.6**	**24.2**	**0.01**	**34.3**	**24.5**	**0.15**
Avoided blood product administration during surgery	95.9	93.1	0.26	95.5	92.7	0.42
Received no more than 3 L of crystalloid during surgery	73.4	74.5	0.82	72.9	80.5	0.30
Didn’t receive colloid during surgery	42.6	52.0	0.10	44.1	51.2	0.38
All Intraoperative Measures Adherent	**23.2**	**24.8**	**0.68**	**22.7**	**34.0**	**0.06**
Ambulated at goal, POD 2	52.7	51.0	0.77	53.6	39.0	0.08
Received acetaminophen, POD 1	66.9	64.7	0.69	66.7	63.4	0.68
Received ibuprofen, POD 2	18.9	13.7	0.23	17.5	19.5	0.75
Received tramadol as first-line narcotic, POD 1	10.1	5.9	0.20	9.5	4.9	0.57
Received ketorolac, PODs 0–3	40.5	43.1	0.64	40.4	48.8	0.30
Did not receive PCA, PODs 0–3	61.2	58.8	0.66	61.9	48.8	0.10
Received gum, POD 1	63.9	61.8	0.69	63.7	60.9	0.73
Maintained epidural, PODs 0–3	47.3	34.3	0.02	45.4	34.2	0.17
All Post-operative Measures Adherent	**24.3**	**18.6**	**0.15**	**23.3**	**16.9**	**0.08**
“Total Adherence” (≥ than 10 of 15 process measures)	**31.7**	**26.5**	**0.32**	**31.8**	**17.1**	**0.05**

POD = post-operative day

Dis Colon Rectum. Author manuscript; available in PMC 2018 October 01.