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ORIGINAL ARTICLE

Disparities in colostomy reversal after Hartmann's procedure for diverticulitis

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Abstract

Background Hartmann's procedure for diverticulitis is a common procedure, with highly variable rates and timing of colostomy reversal. The aim of this study was to evaluate the impact of race and insurance coverage on reversal within 2 years of Hartmann's procedure for diverticulitis.

Methods The Healthcare Cost and Utilization Project (HCUP) State Inpatient Database of five states (2007–2010) was queried for patients who had Hartmann's procedure in the setting of diverticulitis. Patients were grouped by race and insurance status, and multivariable adjustment was performed to evaluate rate and timing of colostomy takedown at 2 years.

Results Among 11,019 patients who had Hartmann's procedure for diverticulitis, 6900 (69%) patients had colostomy reversal by 2 years, with a median time to reversal of 19 weeks. Compared to white patients with private insurance, combinations of black race and non-private insurance significantly reduced likelihood of colostomy reversal at 2 years across all combinations. Black patients without insurance had the lowest likelihood of reversal at 2 years (OR 0.27, 95% CI 0.14–0.51, $p < 0.001$). For patients who had colostomy reversal within 2 years, black patients without insurance had a significant delay in time to reversal (11 weeks, 95% CI 6–16, $p < 0.001$) compared to white patients with private insurance, and delays persisted across all other groups.

Conclusions Black patients and those without private insurance experienced significantly lower rates of, and delayed time to, colostomy reversal compared to white patients with private insurance. These disparities must be considered for allocation of resources in marginalized communities.

Keywords Hartmann's procedure · Diverticulitis · Population groups · Ethnic groups · Insurance · Health · Medically uninsured · Healthcare disparities · Colostomy

Introduction

Diverticulitis is a common disease in the United States and is increasing in incidence and affecting younger patients [1, 2]. While few patients ultimately progress to acute diverticulitis requiring operative intervention, the Hartmann procedure (HP) remains the standard treatment for perforated diverticulitis with feculent soilage [3], leaving patients with a temporary colostomy. Living with a colostomy has a substantial impact on quality of life for these patients [4–6]. The rate of colostomy reversal and timing to reversal are variable across indications for formation and patient populations [7, 8]. Timing of reversal is influenced by patient and primary operation characteristics including comorbidities, and postoperative complications [9, 10].

Black race and lack of insurance coverage have been implicated in disparate outcomes elsewhere in colorectal surgical care [7, 11–20]. Although black race and lack of insurance are associated with higher Hinchey scores at the time of presentation, no study has examined the rate and timing of reversal in this population [13]. We aimed to characterize the impact of race and insurance coverage on the

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Permissions: The HCUP SID databases were used following application and permission.

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rate and timing of colostomy reversal for patients following Hartmann's procedure for diverticulitis.

Materials and methods

Database

The State Inpatient Database (SID) was developed as a part of the Healthcare Cost and Utilization Project (HCUP) from the United States Agency for Healthcare Research and Quality (AHRQ), capturing 95% of all hospital discharges within a state [21]. A large, diverse, and broadly applicable patient sample was generated using the HCUP SID (2007–2010) for patients who had operative management of diverticulitis with Hartmann's procedure in California, Florida, North Carolina, New York, and Utah. These five states were selected given their diversity, population size and years of data available. This study was granted an exemption by the Duke University Institutional Review Board.

Cohort selection

Using International Classification of Diseases, 9th edition (ICD-9) codes, we identified all adults with a diagnosis of diverticulitis (ICD 9 diagnosis codes: 56211 and 56213) who had surgical intervention (ICD 9 Procedure codes: (1735, 1736, 1737, 1738, 1739, 4575, 4576, 4577, 4578, 4579, 4862, 4863) with colostomy formation (ICD 9 procedure codes 461X, 4610, 4611, 4612, 4613, 4862). Patients who died during the hospital stay for their index operation were excluded, as were patients who lived outside the state in which they had their initial operation. Included patients were stratified into two cohorts: those who had colostomy reversal (ICD9 procedure code: 4652) within 2 years and those who continued into the third postoperative year with a stoma. Patient encounters are linked across separate admissions via a unique pseudo-identifier provided by HCUP.

Statistical analysis

The primary outcomes of interest were rate of colostomy reversal within 2 years and time to reversal which was evaluated in univariate analysis. To account for possible selection bias, a multivariable logistic regression model was developed, adjusting for demographic and clinical characteristics, defined a priori, specifically evaluating race and insurance coverage. The model included adjustment for the independent variables of patient age, sex, race, insurance status, year of operation, hospital state, emergency surgery status, and postoperative complications. Subgroup analyses were performed by race and insurance coverage, specifically black or white race by private insurance, medicare, medicaid, and uninsured. A p value of less than 0.05 was considered significant. All statistical analyses were performed using R 3.2.2 (R Foundation, Vienna, Austria).

Results

Of the 11,019 patients identified with colostomy formation following Hartmann's procedure for diverticulitis, 66% (7278) underwent colostomy takedown within 2 years. Of these patients, the median time to reversal was 19 weeks [interquartile range (IQR) 14–27 weeks]. In unadjusted analysis, patients who had colostomy reversal were younger (median 59 years, IQR 49–70 years) compared to those who were not reversed (median 72 years, IQR 59–81 years) ($p < 0.001$). Additionally, those patients who had reversal were more likely to be male, of white race, with private insurance coverage, and have had their index operation electively (all $p < 0.05$) (Table 1). Patients who did not have their colostomy reversed at 2 years had higher rates of postoperative complications including surgical site infection (SSI) abscess, sepsis, pneumonia, respiratory failure, venous thromboembolism, and bleeding (all $p < 0.05$) (Table 1). Patients who ultimately had reversal had a shorter index median length of stay of 10 days (IQR 7–14 days) compared to those who did not have reversal, with a length of stay of 13 days (IQR 9–20 days, $p < 0.001$) (Table 1).

Both black race and non-private insurance were independent risk factors for lack reversal ($p = 0.001$ and $p < 0.001$, respectively) when compared to white patient and patients with private insurance. The literature supports an independent role of both race and insurance status on rate and timing of ostomy takedown. Our study is unique because it explores the role of insurance status and race as interactive social determinants of health with regard to ostomy reversal, while adjusting for confounding factors [11–20]. Following adjustment with multivariable logistic regression analysis, patients who were black and without private insurance coverage had decreased rates of colostomy reversal and longer duration to takedown compared to white, privately insured counterparts when controlling for patient, demographic, facility and postoperative characteristics. Compared to privately insured white patients, black patients with private insurance had equal rates of colostomy reversal [odds ratio (OR): 0.75, 95% CI 0.5–1.12, $p = 0.162$]. However, all other subgroups of insurance coverage had significantly decreased rates of reversal at 2 years: black patients without insurance (OR: 0.27, 95% CI 0.14–0.51, $p < 0.001$), as do white patients with medicare (OR: 0.32, 95% CI 0.24–0.43, $p < 0.001$), white patients without insurance (OR: 0.32, 95% CI 0.25–0.39, $p < 0.001$), black patients with medicare (OR: 0.33, 95% CI 0.18–0.59, $p < 0.001$), black patients

Table 1 Characteristics of patients undergoing operative management of diverticulitis

	N	No (*N* = 3741)	Yes (*N* = 7278)	*p* value
Weeks to colostomy reversal	7278		14.14/18.86/27.71 (Q1, median, Q3)	
Age at diagnosis (years)	11,011	59.00/72.00/81.00 (Q1, median, Q3)	49.00/59.00/70.00 (Q1, median, Q3)	< 0.001
Sex	10,997			< 0.001
Male		39.9% (1491)	52.4% (3806)	
Female		60.1% (2245)	47.6% (3455)	
Race	11,019			0.001
White		76.7% (2870)	75.0% (5455)	
Black		5.2% (194)	4.3% (316)	
Other		18.1% (677)	20.7% (1507)	
Insurance	11,019			< 0.001
Private		22.8% (854)	48.6% (3537)	
Government		67.9% (2541)	42.5% (3092)	
None		9.2% (346)	8.9% (649)	
Year of index admission	11,019			0.025
2007		32.0% (1197)	34.0% (2478)	
2008		33.2% (1241)	33.5% (2438)	
2009		34.8% (1303)	32.5% (2362)	
State	11,019			< 0.001
California		25.1% (938)	28.8% (2096)	
Florida		38.7% (1447)	35.7% (2601)	
North Carolina		9.4% (353)	9.3% (677)	
New York		25.2% (941)	23.9% (1740)	
Utah		1.7% (62)	2.3% (164)	
Emergency surgery	7973			0.004
Elective		10.9% (304)	8.9% (460)	
Emergent/urgent		89.1% (2496)	91.1% (4713)	
Surgical site infection	11,019			0.002
No		91.0% (3406)	92.7% (6750)	
Yes		9.0% (335)	7.3% (528)	
Abscess	11,019			< 0.001
No		58.8% (2201)	54.0% (3931)	
Yes		41.2% (1540)	46.0% (3347)	
Anastomotic leak	11,019			0.365
No		87.6% (3278)	87.0% (6333)	
Yes		12.4% (463)	13.0% (945)	
Sepsis	11,019			< 0.001
No		82.5% (3086)	90.3% (6573)	
Yes		17.5% (655)	9.7% (705)	
Pneumonia	11,019			< 0.001
No		99.5% (3722)	99.9% (7272)	
Yes		0.5% (19)	0.1% (6)	
Respiratory failure	11,019			< 0.001
No		89.8% (3358)	96.1% (6993)	
Yes		10.2% (383)	3.9% (285)	
Myocardial infarction	11,019			
No		100% (3741)	100% (7278)	
Venous thromboembolism	11,019			< 0.001
No		97.7% (3654)	98.7% (7182)	
Yes		2.3% (87)	1.3% (96)	

Table 1 (continued)

	N	No (*N* = 3741)	Yes (*N* = 7278)	*p* value
Renal failure	11,019			< 0.001
No		85.4% (3195)	93.7% (6819)	
Yes		14.6% (546)	6.3% (459)	
Bleeding	11,019			< 0.001
No		98.5% (3685)	99.3% (7229)	
Yes		1.5% (56)	0.7% (49)	
Index hospital length of stay (days)	11,019	9.00/13.00/20.00 (Q1, median, Q3)	7.00/10.00/14.00 (Q1, median, Q3)	< 0.001

Table 2 Odds ratios for rate of colostomy reversal at 2 years: white patients with private insurance as reference

Odds ratio for reversal: white and private insurance as reference	Odds ratio	Confidence interval	*p* value
Black and no insurance	0.27	0.14–0.51	< 0.001
White and medicare	0.32	0.24–0.43	< 0.001
White and no insurance	0.32	0.25–0.39	< 0.001
Black and medicare	0.33	0.18–0.59	< 0.001
Black and medicaid	0.67	0.47–0.96	0.03
Black and private insurance	0.75	0.5–1.12	0.162
White and medicaid	0.79	0.67–0.93	0.005

OR < 1 is less likely to undergo reversal

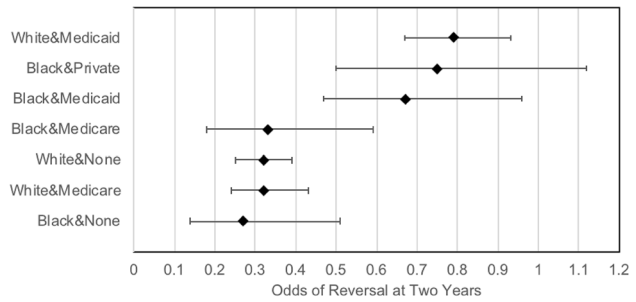

Fig. 1 Odds ratios for rate of colostomy reversal at 2 years: white patients with private insurance as reference. Error bars represent 95% CI

with medicaid (OR: 0.67, 95% CI 0.47–0.96, $p = 0.03$), and white patients with medicaid (OR: 0.79, 95% CI 0.67–0.93, $p = 0.005$) (Table 2; Fig. 1).

Regarding timing to colostomy reversal, black patients without insurance had an 11 week longer wait to reversal compared to white patients with private insurance ($p < 0.001$). The delay in colostomy reversal was also seen in white patients without insurance at 7 weeks (CI 5–8, $p < 0.001$), black patients with medicare at 6 weeks (CI 1–10, $p = 0.016$), white patients with medicare at 6 weeks (CI 4–9, $p < 0.001$), black patients with medicaid at 5 weeks (CI 2–8, $p = 0.001$), black patients with private insurance at 4 weeks (CI 1–7, $p < 0.001$), and white patients with medicaid at 2 weeks (CI 0–3, $p = 0.01$) (Table 3; Fig. 2).

Table 3 Adjusted additional weeks to colostomy reversal at 2 years: white patients with private insurance as reference

Additional weeks elapsed for reversal: white and private insurance as reference	Weeks	Confidence interval	*p* value
Black and no insurance	11	6–16	< 0.001
White and no insurance	7	5–8	< 0.001
Black and medicare	6	1–10	0.016
White and medicare	6	4–9	< 0.001
Black and medicaid	5	2–8	0.001
Black and private insurance	4	1–7	0.003
White and medicaid	2	0–3	0.01

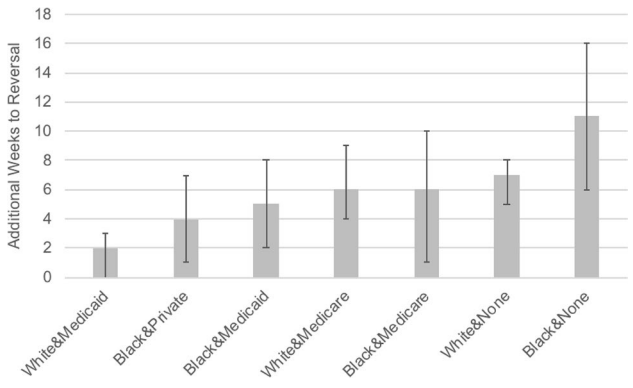

Fig. 2 Adjusted additional weeks to colostomy reversal at 2 years: white patients with private insurance as reference. Bar graph, error bars represent 95% CI

Discussion

Patient race and insurance coverage play a complex and significant role in disparities associated with surgical management of diverticulitis. Our results demonstrate the negative impact of non-white race and lack of private insurance coverage on the rates and timing of colostomy reversal following Hartmann's procedure for diverticulitis within 2 years. Zafar and colleagues [7] explored the impact of race and insurance on colostomy takedown among Californian patients who had colostomy creation for any cause. Their findings included higher colostomy reversal rates over 5 years for white patients than for black patients (67% vs. 56%, $p < 0.001$), and higher reversal rates for privately insured patients than for uninsured patients (88% vs 63%, $p < 0.001$). Furthermore, when sub-grouped by insurance status, insured middle-aged white patients had higher colostomy reversal rates at 1 year than insured middle-aged black patients (96% vs 82%, $p < 0.001$) [3] and this has been substantiated in other studies [22, 23]. While Zafar and colleagues showed that colostomy reversal rates at 1 year were lower for black or uninsured patients than for their white or insured counterparts, this analysis was performed without adjustment for patient characteristics, hospital factors, and postoperative complications. A key difference in methodology is our study limited the analysis to patients with a diagnosis of diverticulitis with a presentation severe enough to require colostomy formation and performed an adjusted analysis to address confounders and selection bias. While other studies have shown black patients are as likely as white patients to receive a colostomy for the treatment of diverticulitis, black race is associated with more complicated presentation and mortality and this can affect timing to colostomy takedown requiring adjustment as seen in our analysis [13, 24]. While both studies describe average colostomy reversal rates by race and insurance coverage, our study provides further insight into disparities of surgical diverticulitis management including time to colostomy reversal.

While there is no seminal article addressing disparities in colostomy reversal by insurance status, several studies have indicated the presence of such a disparity in the care of patients with diverticulitis [12–15, 25]. In a retrospective analysis of a Nationwide Inpatient Sample file from 1999 to 2003, Lidor and colleagues [13] established that uninsured and underinsured patients are more likely to receive a colostomy for the treatment of diverticulitis compared to their insured counterparts (OR: 2.11, 95% CI 1.89–2.36, $p < 0.001$), and that uninsured or underinsured status is associated with more complicated presentation and mortality (OR: 2.74, 95% CI 1.84–4.09, $p < 0.001$). There is little information that addresses the interaction that exists between race and insurance status in the surgical management of diverticulitis. While Lidor et al. note that they explored the impact of race and insurance status for independent variables of symptomatic presentation, colostomy creation and inpatient mortality, no interaction was found between the three variables [13]. While the scope of our study does not include rates of colostomy creation between groups, we establish a significant association between decreased rates of colostomy reversal and longer duration to takedown among a cohort of patients whose diverticulitis presented severely enough for colostomy formation.

Results from several studies have confirmed the presence of disparities by race and insurance coverage status in the medical and surgical management of colorectal disease [7, 11–20]. Despite recognizing the demand to elucidate mechanisms leading to these disparities and explore methods to provide equitable care, the literature has largely failed to address this need. Novel approaches to combat health care disparities must address multiple predictors of access to and quality of care received by patients across demographics. Explicit racism and classism are not thought to play a role in these disparities, rather, implicit biases, and institutional policy may drive these differences. While this study and others describe the correlations among race, insurance and care of diverticulitis, it is beyond the capacity of the study design to propose a mechanism for this phenomenon. However, we propose several theoretical approaches that may facilitate efforts toward equitable care. On an institutional level, establishing a default timeline for colostomy reversal with procedural scheduling integrated into the postoperative wound check visit, could reduce disparities in rates and timing on an institutional level. Furthermore, assessments of whether hospital characteristics, state-specific insurance plans, patient education, and/or implicit bias amongst healthcare providers contribute to the existing disparities and are barriers to implementing targeted interventions should be performed. National policy must also be implemented alongside standardized institutional practices to address other societal factors contributing to disparities in colorectal disease care [26].

Similar to other studies of population-level administrative data as reported in the HCUP SID, our study is limited by the accuracy of data collection including coding errors, incompleteness of some data, and a lack of data granularity. However, this dataset is carefully audited and has been validated for use in descriptive research [27]. While the included states are representative of several regions and demographics, caution should be exercised in extrapolation to the national population. Given the constraints of the database we are unable to include takedown procedures performed outside of the state of index operation although those patients who lived out-of-state where the operation occurred were excluded from analysis. Additionally, our results are limited to 2 years of follow-up, however, our captured reversal rates corroborate those in the current

literature. Variables not included in the dataset may confound our findings regarding rates and timing of reversal. Hinchey classification is not available for these patients, however, as all patients required a HP, their presentation would be uniformly severe. While specific comorbidity scores are not available for this cohort our adjustment for age, sex, urgency and postoperative complications provides adjustment for the different comorbidity profiles between patients. Given its retrospective nature, this study can only propose correlation not causation which limits proposals for mitigating these disparities. Despite these limitations, the use of a large representative dataset with 2 years of longitudinal follow-up is an improvement upon prior literature which largely neglects determination of risk factors adjusted for common confounders for colostomy reversal.

Conclusions

Race and insurance coverage have complex and significant interactions with rate and timing of colostomy reversal following Hartmann's procedure for diverticulitis. Black patients and those without private insurance receive suboptimal surgical management compared to white patients with private insurance regarding the reversal of their temporary colostomies. These disparities are important to consider for allocation of surgical resources in marginalized communities.

Author contributions Dr. MCT, Ms. MDT, Dr. CR, Dr. ZS, Dr. MLC, Dr. BE, Dr. KLS, Dr. CRM and Dr. JM each participated in the completion of this paper, with each author contributing significantly to (1) study conception, design, analysis and interpretation of data, (2) active manuscript drafting and review (3) final approval of the manuscript submitted and (4) a shared accountability for the accuracy and integrity of this work.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval This article does not contain studies with human participants or animals performed by any of the authors. This project received IRB exemption through the Duke IRB.

Informed consent Informed consent was not required as the dataset used is comprised of de-identified data.

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