

The Impact of Hospital-Level Factors on Clostridioides difficile Infections Among Colorectal Surgical Patients: A National Database Analysis

Amy VanderStoep MD MPH, Rebecca Kowalski MD, Diego Mora BS, Elizabeth Summers BS, Annalise B Penikis MD, Brian R Englum MD MHS, Kerri Lopez MD

Department of Surgery, University of Maryland

INTRODUCTION:

Clostridioides difficile infection (CDI) is a common cause of nosocomial diarrhea and a known cause of increased morbidity and mortality among hospitalized patients. There are several commonly recognized individual- or patient-level factors associated with CDI, including age, certain comorbidities, proton pump inhibitor (PPI) use, and previous hospitalizations [1,2,3].

A study of national safety indicators showed that certain hospital-level factors are associated with higher rates of hospital-associated infections, citing urban setting and non-private status [4]. Similar patterns of hospital-level associations have been shown among other populations such as cardiac and orthopedic surgery patients [5,6].

Among general surgical patients, the Northeast region, large hospital size, urban setting, and teaching status were associated with higher risk of CDI [7]. Similar analyses have been done in single-state colorectal surgical (CRS) populations, highlighting urban setting and teaching status as factors increasing CDI odds [8]. However, to the best of our knowledge, no national analysis of hospital-level factor association with CDI has been performed on CRS patients. We aimed to evaluate these associations in a national sample.

METHODS:

This is a retrospective analysis of the National Inpatient Sample (NIS) database, including United States adults who underwent colorectal surgical procedures requiring hospital admission between 2017 – 2022, ad defined by ICD-10-PCS codes. Descriptive univariate statistics were generated. Bivariate associations between hospital region, urbanicity & teaching status, size, and ownership (e.g. private vs public) with CDI were evaluated with chi-squared tests. Multivariable logistic regression (MVR) models were created for each hospital level factor. Covariates included patient sex, age, race, insurance status, mortality risk on admission, and admission type (elective vs emergent). Statistics were performed using SAS 9.4.

REFERENCES:

- 1.Mada et al. *Clostridioides difficile Infection*. StatPearls Publishing LLC; 2024.
- 2.Aukes L, et al. *Open Forum Infect Dis*. 2021.
- 3.Puro N, et al. *Journal for Healthcare Quality*. 2020.
- 4.Thomlow DK, et al. *Med Care*. 2006.
- 5.Flagg A, et al. *Journal of Thoracic and Cardiovascular Surgery*. 2014.
- 6.Gwam CU, et al. *Eur J Orthop Surg Traumatol*. 2019.
- 7.Zerey M, et al. *Surg Infect (Larchmt)*. 2007.
- 8.Aquina CT, et al. *Dis Colon Rectum*. 2016.

RESULTS:

Population descriptive univariate statistics:

Total population: 413,954

Mean age: 62.5 years

Sex: 51.6% female

Race: 72.5% White, 11.9% Black, 9.7% Hispanic, 5.9% Other

Mean length of stay: 6.6 days

Overall C. diff infection rate: 1.71%

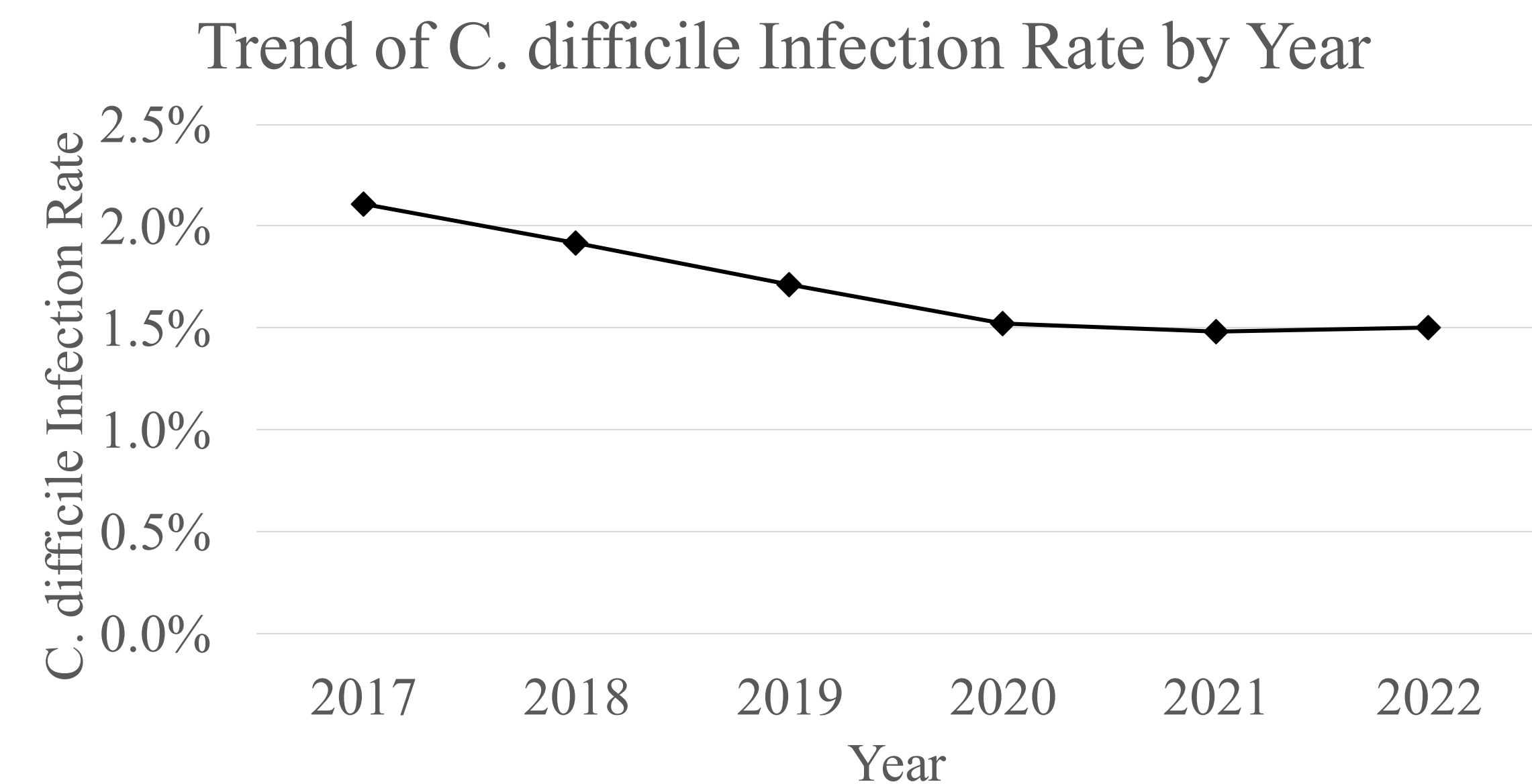


Figure 1. Rates of CDI in the CRS population, over time, as defined by NIS C. diff variables. Trend noted to be statistically significant with a decrease of 0.13% annually (p=0.006).

Sample Characteristics		Number of patients (%)
Hospital Size	Small	77,780 (18.8)
	Medium	118,434 (28.6)
	Large	217,740 (52.6)
Hospital Region	Northeast	77,803 (18.8)
	Midwest	91,895 (22.2)
	South	162,526 (39.3)
	West	81,730 (19.7)
Hospital Location / Teaching Status	Rural	27,604 (6.7)
	Urban, Teaching	312,480 (75.5)
	Urban, Non-Teaching	73,870 (17.8)
	Public	44,426 (10.7)
Hospital Ownership	Private, Not-For-Profit	322,077 (77.8)
	Private, Investor-Owned	47,451 (11.5)

Table 1. Breakdown of CRS population by hospital-level factor. All four factors demonstrated statistically significant (p<0.05) difference in CDI rates in unadjusted bivariate analysis.

Odds of CDI

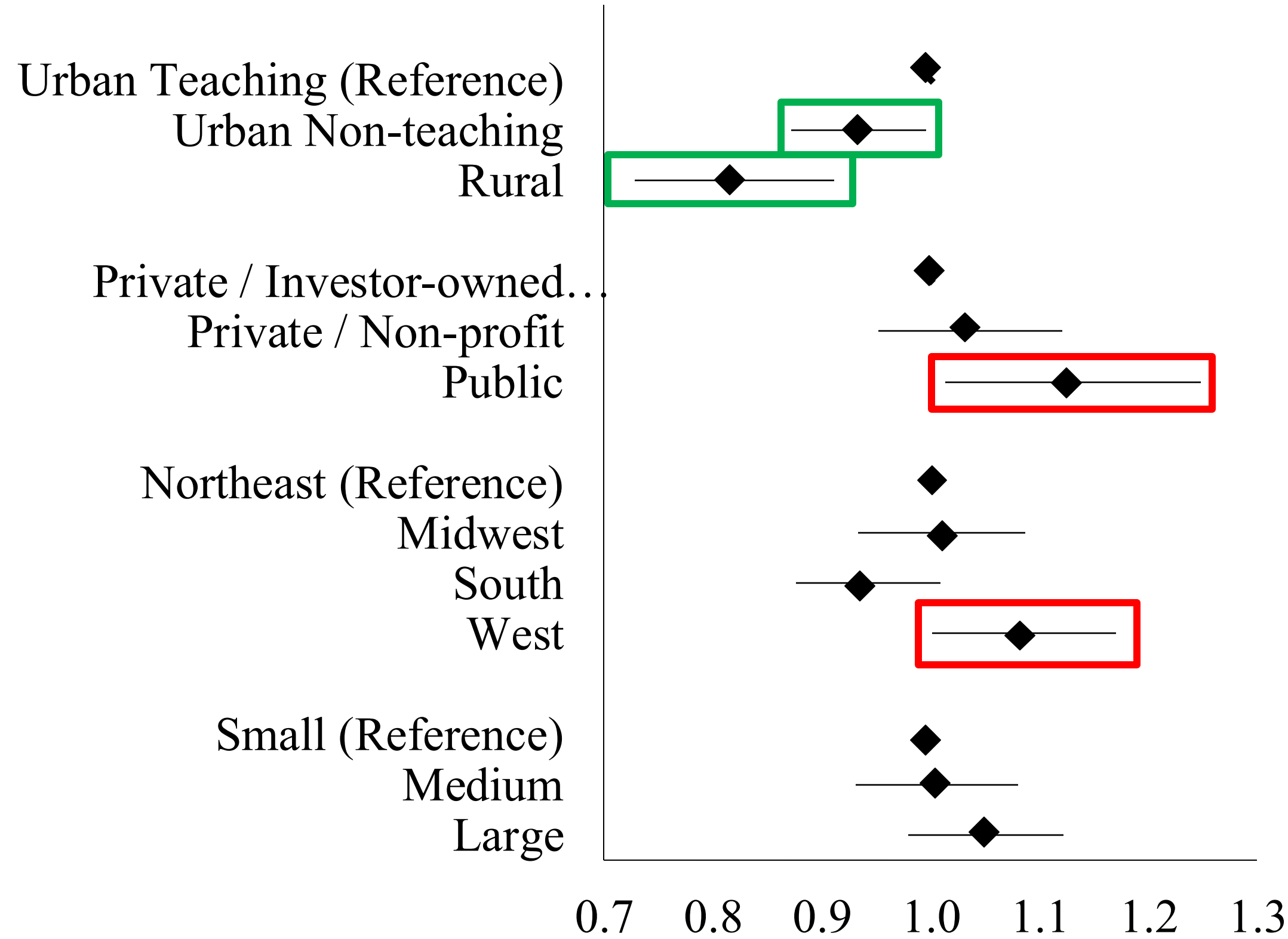


Figure 2. Results from multivariable logistic regression model noting associations between the various hospital-level factors and CDI, after adjusting for several covariates including age, sex, surgical indication, etc. Statistical significance (p<0.05) designated with green (lower odds CDI) and red (higher odds CDI) boxes.

Odds of CDI: Patient-Level

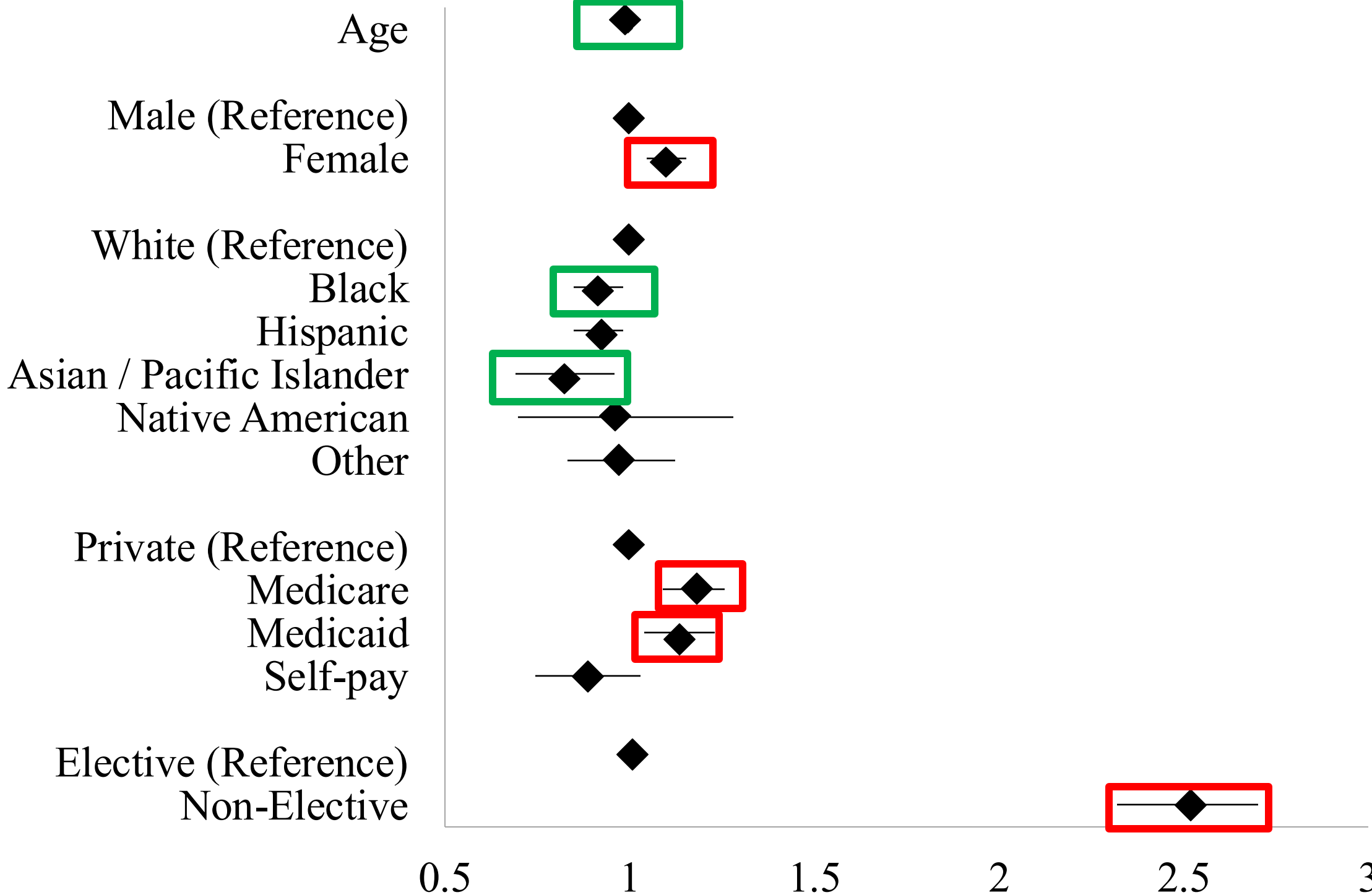


Figure 3. Patient-level covariates included in multivariable logistic regression model. Statistical significance (p<0.05) designated with green (lower odds CDI) and red (higher odds CDI) boxes. Preoperative mortality risk and surgical indication were also found to be statistically significant.

DISCUSSION:

CDI remains a problem in hospitalized patients, including CRS patients. Evidence exists supporting several patient-level factors that increase CDI risk. This study now provides evidence of additional associations between hospital-level factors and CDI risk. This aligns with the literature on other nosocomial infections and populations, that it is not just a patient's history or hospital course that influences their risk, but also where they are treated.

This study has limitations. Due to the nature of this study as a database analysis, we were unable to obtain more granular clinical detail, such as medications. Additionally, as a claims-based database, NIS is subject to potential coding errors like all claims databases.

In addition to limitations built into the study type, there are a few specific areas that raise questions. In general, CDI rates have been reported to be on the rise. However, this study demonstrated a steady decrease in the rates. This could be a result of changed coding patterns or a true decrease in this specific population. Either way, a more robust analysis is needed.

Finally, it is important to fully investigate these potential relationships as both hospitals and surgeons are held to standards when it comes to post-operative complications, including CDI. It cannot be fully determined from this analysis whether patients are more likely to develop CDI due to institution in which they are treated or if there are patients with different risk factors that are more likely to seek care at these institutions, risk factors we could not account for in our MVR. Or perhaps the colonization rates of areas or populations vary. These questions must be answered in order to correctly identify high risk patients and institutions.

CONCLUSIONS:

- 1.In addition to patient-level variables, hospital-level variables may be associated with higher risk of CDI in CRS patients;
- 2.These variables include urban areas, public ownership, and the Western US region.
- 3.More work is needed to fully elucidate the extent of and cause of these associations in order to identify high risk patients and institutions