ANESTHESIOLOGY

Antiemetic Administration and Its Association with Race: A Retrospective Cohort Study

Robert S. White, M.D., M.S.,
Michael H. Andreae, M.D., M.B.A. M.Sc., M.A.,
Briana Lui, B.S., Xiaoyue Ma, M.S.,
Virginia E. Tangel, M.A., M.Sc.,
Zachary A. Turnbull, M.D., M.B.A, M.S.,
Silis Y. Jiang, Ph.D., Anna S. Nachamie, M.B.A.,
Kane O. Pryor, M.D.; Multicenter Perioperative Outcomes Group Collaborators*

ANESTHESIOLOGY 2023; 138:587–601

EDITOR'S PERSPECTIVE

What We Already Know about This Topic

- Social determinants, such as race, may lead to disparities in health care
- Perioperative antiemetic administration has been found to differ with socioeconomic status

What This Article Tells Us That Is New

- Using data from the Multicenter Perioperative Outcomes Group registry and adjusting for Apfel postoperative nausea and vomiting risk factors, Black *versus* White patient race was associated with less antiemetic administration

ABSTRACT

Background: Anesthesiologists' contribution to perioperative healthcare disparities remains unclear because patient and surgeon preferences can influence care choices. Postoperative nausea and vomiting is a patient-centered outcome measure and a main driver of unplanned admissions. Antiemetic administration is under the sole domain of anesthesiologists. In a U.S. sample, Medicaid insured *versus* commercially insured patients and those with lower *versus* higher median income had reduced antiemetic administration, but not all risk factors were controlled for. This study examined whether a patient's race is associated with perioperative antiemetic administration and hypothesized that Black *versus* White race is associated with reduced receipt of antiemetics.

Methods: An analysis was performed of 2004 to 2018 Multicenter Perioperative Outcomes Group data. The primary outcome of interest was administration of either ondansetron or dexamethasone; secondary outcomes were administration of each drug individually or both drugs together. The confounder-adjusted analysis included relevant patient demographics (Apfel postoperative nausea and vomiting risk factors: sex, smoking history, postoperative nausea and vomiting or motion sickness history, and postoperative opioid use; as well as age) and included institutions as random effects.

Results: The Multicenter Perioperative Outcomes Group data contained 5.1 million anesthetic cases from 39 institutions located in the United States and The Netherlands. Multivariable regression demonstrates that Black patients were less likely to receive antiemetic administration with either ondansetron or dexamethasone than White patients (290,208 of 496,456 [58.5%] *vs.* 2.24 million of 3.49 million [64.1%]; adjusted odds ratio, 0.82; 95% CI, 0.81 to 0.82; $P < 0.001$). Black as compared to White patients were less likely to receive any dexamethasone (140,642 of 496,456 [28.3%] *vs.* 1.29 million of 3.49 million [37.0%]; adjusted odds ratio, 0.78; 95% CI, 0.77 to 0.78; $P < 0.001$), any ondansetron (262,086 of 496,456 [52.8%] *vs.* 1.96 million of 3.49 million [56.1%]; adjusted odds ratio, 0.84; 95% CI, 0.84 to 0.85; $P < 0.001$), and dexamethasone and ondansetron together (112,520 of 496,456 [22.7%] *vs.* 1.0 million of 3.49 million [28.9%]; adjusted odds ratio, 0.78; 95% CI, 0.77 to 0.79; $P < 0.001$).

Conclusions: In a perioperative registry data set, Black *versus* White patient race was associated with less antiemetic administration, after controlling for all accepted postoperative nausea and vomiting risk factors.

(ANESTHESIOLOGY 2023; 138:587–601)

Social determinants of health are the societal circumstances in which we are born and grow up, learn and mature, and work and age.[1,2] They can pertain to (1) identity

This article is featured in "This Month in Anesthesiology," page A1. This article is accompanied by an editorial on p. 581. Supplemental Digital Content is available for this article. Direct URL citations appear in the printed text and are available in both the HTML and PDF versions of this article. Links to the digital files are provided in the HTML text of this article on the Journal's Web site (www.anesthesiology.org). This article has an audio podcast. This article has a visual abstract available in the online version. This work was previously presented at the American Society of Anesthesiologists 2019 Annual Meeting in Orlando, Florida, October 19, 2019.

Submitted for publication May 4, 2022. Accepted for publication February 28, 2023.

Robert S. White, M.D., M.S.: Department of Anesthesiology, Weill Cornell Medicine, New York, New York.

Michael H. Andreae, M.D., MBA. M.Sc, M.A.: Department of Anesthesiology, University of Utah, Salt Lake City, Utah.

Briana Lui, B.S.: Department of Anesthesiology, Weill Cornell Medicine, New York, New York.

Xiaoyue Ma, M.S.: Department of Anesthesiology, Weill Cornell Medicine, New York, New York.

Virginia E. Tangel, M.A., M.Sc.: Department of Anesthesiology, Weill Cornell Medicine, New York, New York.

Zachary A. Turnbull, M.D., M.B.A, M.S.: Department of Anesthesiology, Weill Cornell Medicine, New York, New York.

 Anesthesiology 2023; 138:587–601. DOI: 10.1097/ALN.0000000000004549

<zdoi;10.1097/ALN.0000000000004549>

(race or ethnicity), (2) socioeconomic status (wealth, insurance status), or (3) geography (built environment; fig. 1).[1–3] Research has shown that social determinants of health drive health services disparities.[1,2] Health services disparities can be divided into (1) access to care (getting a surgical appointment), (2) care processes (receiving intraoperative antiemetics), and (3) outcomes (experiencing postoperative nausea and vomiting).[4–8] Intraoperative anesthesia healthcare disparities have not been thoroughly investigated, and the precise contribution of anesthesiologists to these disparities is questionable; disparities identified in anesthesia procedure times, blood transfusion use, and neuraxial or regional anesthesia use cannot be conclusively attributed to the anesthesiologist's practice patterns because patient, surgeon, and institutional preferences confound medical decision-making.[5,8–18] For instance, while previous research has found racial differences in anesthesia procedure times, these findings were attributed to interhospital and surgical duration differences.[9,10]

We previously demonstrated antiemetic administration disparities for postoperative nausea and vomiting by *socioeconomic* status with differences in administration by insurance status (Medicaid *vs.* commercially insured patients receiving less antiemetic) and by median income in patient ZIP code (lower *vs.* higher median income patients receiving less antiemetics).[5,8] Disparities in antiemetic administration matter, because postoperative nausea and vomiting is associated with increased length of postanesthesia care unit (PACU) stay, unplanned hospital admissions, and greater resource utilization.[5,19–23] Postoperative nausea and vomiting prophylaxis has widely accepted explicit consensus guidelines with easily elicited, specific, and measurable risk factors, for which attending anesthesiologists are solely accountable.[5,19–22] Our previous study was limited by missing data, lack of confounder adjustment for all major postoperative nausea and vomiting risk factors (the final model could only adjust for age and sex and did not contain variables for smoking status, history of postoperative nausea and vomiting or motion sickness, and intended postoperative administration of opioids), and concerns regarding generalizability.[5] In our current study, we address these limitations by being able to adjust for all important Apfel postoperative nausea and vomiting risk factors and complement previous work by examining *race*.[24]

Our primary objective was to test whether a patient's race is associated with the risk-adjusted administration of perioperative antiemetic *prophylaxis* (either ondansetron or dexamethasone) as documented on the anesthesia record in a 2004 to 2018 national representative data set,[25–27] but differentiating intraoperative (prophylactic) use in the operating room *versus* postoperative (rescue intervention or therapeutic) use in the PACU proved impossible in our data set, as our reviewers pointed out (we could only measure overall administration). However, we believe that the attending anesthesiologist's scope of patient care covers both domains, and it is the attending anesthesiologist's ultimate responsibility to ensure consensus guideline–compliant care throughout the entire perioperative period. We hypothesized that patients classified as Black race, as compared to White race, would have reduced receipt of antiemetics with confounder adjustment for potential patient-level (including all four chief Apfel postoperative nausea and vomiting risk factors: sex, smoking status, history of postoperative nausea and vomiting or motion sickness, and use of postoperative opioids; as well as age),[20,21] procedure-level, and institution-level effects, in a hierarchical mixed-effects regression model.

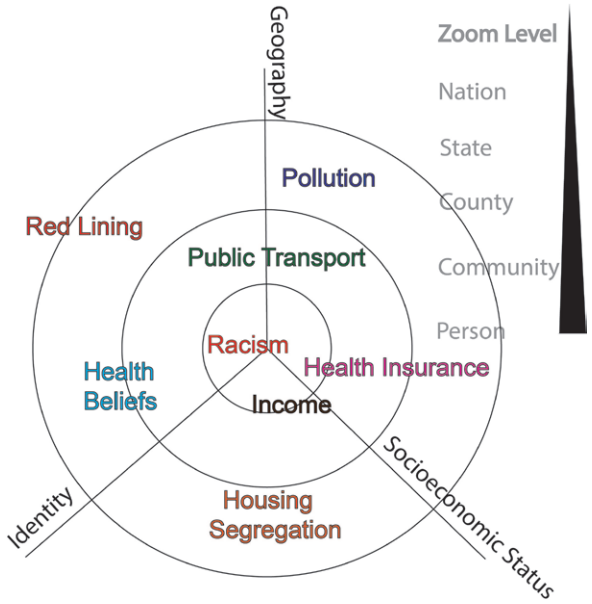


Fig. 1. Social determinants of health are the social circumstances in which we are born, live, grow, age, learn, and work. They can be attributes of individual patients, their community, neighborhood, census tract, or any larger spatial entity and typically fall on one of three axis, pertaining to (1) socioeconomic status, (2) identity, race, or ethnicity, or (3) geography. Health beliefs operate at the individual, family, or community level; spatial accessibility of providers would be an example of a census tract-level attribute.[3]

Silis Y. Jiang, Ph.D.: Department of Anesthesiology, Weill Cornell Medicine, New York, New York.

Anna S. Nachamie, M.B.A.: Department of Anesthesiology, Weill Cornell Medicine, New York, New York.

Kane O. Pryor, M.D.: Department of Anesthesiology, Weill Cornell Medicine, New York, New York.

*The Multicenter Perioperative Outcomes Group Collaborators are listed in Appendix 1.

Materials and Methods

Study Database and Population

We performed a multicenter retrospective observational study using data from the Multicenter Perioperative Outcomes Group (https://mpog.org; founded 2008), a perioperative registry of anesthesia care electronic health records from institutions located in the United States and The Netherlands for surgical and diagnostic procedures.[25,28] Comprehensive methodology and database policies, procedures, software, and technical infrastructure for data entry, process, validation, and storage have been previously detailed.[25,28] Briefly, data validation and case accuracy occurs at the institution level through monthly case review that must satisfy an assortment of quality diagnostics.[25] The Multicenter Perioperative Outcomes Group registry has received Institutional Review Board approval from the University of Michigan (Ann Arbor, Michigan). The Weill Cornell Medicine Institutional Review Board (New York, New York) deemed that neither local institutional review board approval nor a notice of exemption was needed for our project because the patient records contained in the database are not identifiable, and we did not have the ability to reidentify the data. No additional local institutional review board approval was sought from other institutions. For patients included in the registry, there is a waiver of written informed consent. The clinical investigation protocol, which included study outcomes, data collection, methodologies, and statistical analysis, was established *a priori* and presented and registered on March 12, 2018, and approved with revisions on March 17, 2018, by the Perioperative Clinical Research Committee (Appendix 2: Perioperative Clinical Research Committee 0056 Approved Proposal, https://links.lww.com/ALN/D102), a multicenter peer-review forum, before data access and data analysis. Outlined below are deviations or additions to the original Perioperative Clinical Research Committee proposal. Statistical power calculation, conducted as part of the Perioperative Clinical Research Committee process (Appendix 2, https://links.lww.com/ALN/D102), showed that a sample size of 5,885 was required to detect a significant association at an α level of 0.01, 80% power, with assumption that Black patients were 30% less likely to receive antiemetic administration as compared to White patients, while our *a priori* cohort identification predicted a sample size several orders of magnitude larger.[5]

Data Extraction, Cleaning, and Coding

We queried retrospective anesthetic procedure records from all adult patients (age 18 yr or older) who underwent an anesthetic procedure from 39 participating Multicenter Perioperative Outcomes Group consortium institutions using quarter 1 2004 to January 2018 data. Procedures included in our analysis were those with current procedural terminology codes included in the Anesthesiology Performance Improvement and Reporting Exchange postoperative nausea and vomiting 1 Merit Based Incentive Program 430: Prevention of Post-Operative Nausea and Vomiting – Combination Therapy measure guideline.[27] The Anesthesiology Performance Improvement and Reporting Exchange postoperative nausea and vomiting 1 guidelines exclude patients younger than 18 yr, labor epidurals, obstetric nonoperative procedure rooms (labor and delivery), and certain current procedural terminology codes.[27] Exclusion criteria for our analysis included missing demographic data (age, sex, or race), pediatric patients (age younger than 18 yr), patients with missing antiemetic administration data, and missing American Society of Anesthesiologists (ASA) Physical Status score or ASA Physical Status 6 patients. In our Perioperative Clinical Research Committee protocol proposal, we had planned *a priori* to exclude trauma and cardiac surgery, anesthesia for labor and delivery, and endoscopic procedures. Instead, we opted to include all procedure types for the Anesthesiology Performance Improvement and Reporting Exchange postoperative nausea and vomiting 1 quality metric, with indicator variables provided by Multicenter Perioperative Outcomes Group for the procedure types of case emergency status, cardiac surgery, anesthesia for cesarean delivery with inhalational general anesthesia only, and endoscopic (gastrointestinal) procedures.[27] For each logistic regression model, additional cases were dropped from the analysis if they were missing data on the included independent or dependent variables (complete case analysis).

The data are coded so that each individual record corresponds to one anesthetic case; therefore, patients could be included in the sample more than once if they underwent multiple procedures during our study period. Patient-level variables abstracted for each admission include demographic information (age; sex; race; ASA Physical Status classification system scores 1 to 6; all Apfel postoperative nausea and vomiting risk factors: sex, smoking status, history of postoperative nausea and vomiting, and history of motion sickness; intended administration of opioids for postoperative analgesia; and calculated Apfel simplified postoperative nausea and vomiting risk score) and International Classification of Diseases, Ninth and Tenth Revision, Clinical Modification diagnosis codes for *a priori* selected comorbidities that can affect clinical decisions regarding postoperative nausea and vomiting medication administration (long QT syndrome, diabetes). Patient race were categorized (unordered) as either White, Black, other, or unknown. Hospital-level variables included American Hospital Association size: 100 to 199 beds, 200 to 299 beds, 300 to 399 beds, 400 to 499 beds, or 500 or more beds; American Hospital Association teaching status; and Multicenter Perioperative Outcomes Group academic center. Procedure-level variables included surgical information

(current procedural terminology codes specific notifier if procedure was endoscopic [gastrointestinal], cardiac, or the anesthesia for cesarean delivery with inhalational general anesthesia only; case emergency status; and year of surgery), anesthetic information (anesthetic administration length; anesthesia provider details: attending anesthesiologist present, resident present, fellow present, or certified registered nurse anesthetist present; and anesthetic technique: general, neuraxial, or regional), and information regarding medications administered during the procedure (antiemetics, inhalational general anesthetic gases, or propofol infusion). Additionally, a variable was created indicating the presence of inclusion into the Anesthesiology Performance Improvement and Reporting Exchange postoperative nausea and vomiting guideline: age 18 yr or older, undergoing a procedure with an inhalational general anesthetic, and who have three or more risk factors for postoperative nausea and vomiting (female sex, history of postoperative nausea and vomiting, history of motion sickness, nonsmoker, and intended administration of opioids for postoperative analgesia).[27]

Study Outcomes

The primary outcome was perioperative administration of either ondansetron or dexamethasone. Secondary outcomes were administration of each drug individually or both drugs together.

Statistical Analysis

Patient-level (demographic; postoperative nausea and vomiting risk factors individually and as a summed Apfel simplified postoperative nausea and vomiting risk scores; and selected comorbidities), procedure-level, and institution-level characteristics were compared for all patients by our variable of interest: recorded patient race. Unadjusted rates of antiemetic administration for all patients were compared by Multicenter Perioperative Outcomes Group racial categories. Continuous variables were compared using ANOVA, reporting means and standard deviations; nonparametric equivalents were used for variables that violated assumptions of normality, reporting medians and interquartile ranges. Categorical variables were compared using the chi-squared test, reporting frequencies, and percentages. We calculated standardized mean differences for our patient and hospital characteristics; we defined a meaningful difference between characteristic groups as a standardized difference of 10% or more.

To examine the effect of a patient's race on antiemetic administration while adjusting for patient-, procedure-, and institution-related covariates and other potential confounders, mixed-effects general linear models (with individual hospital coded as the random-effect intercept) were fit to the data. Multivariable models and covariates to be included into the models were specified *a priori* based on our objective to investigate racial disparities in guidance-concordant risk-adjusted antiemetic administration; models were prespecified before the data were accessed (including all variables and risk factors that had reliably coded Multicenter Perioperative Outcomes Group phenotypes and were available for analysis). Race (unordered categories: White, Black, other, or unknown) was the primary exposure variable of interest. The models included the following confounding variables: individual Apfel postoperative nausea and vomiting risk factors (sex [male or female], smoking status [never, former, or current smoker], history of postoperative nausea and vomiting or motion sickness, and intended postoperative administration of opioids), patient ASA physical status, patient comorbidities with theoretical contraindications to postoperative nausea and vomiting medications (defined and selected *a priori*: history of diabetes or history of long QT syndrome), procedure emergency status case, presence of attending anesthesiologists, case presence of resident, case presence of fellow, case presence of a certified registered nurse anesthetist, year of procedure (reference: 2004), anesthesia technique used for procedure (regional, general, or neuraxial), case administration of propofol, case administration of volatile gases, indicator variable for cardiac case, indicator variable for endoscopic (gastrointestinal) case, indicator variable for cesarean delivery with inhalational general anesthesia only case, indicator variable for presence of patient inclusion into the Anesthesiology Performance Improvement and Reporting Exchange postoperative nausea and vomiting guidelines as described above, American Hospital Association size (coded as 100 to 199 beds, 200 to 299 beds, 300 to 399 beds, 400 to 499 beds, or 500 or more beds), American Hospital Association teaching status, and Multicenter Perioperative Outcomes Group academic center status. We report adjusted odds ratios for our outcomes with 95% CI. Individual hospital was included as a level 2 covariate (random effect) in our mixed-effects general linear models; random intercepts in mixed-effects models consider the fact that clustering occurs due to interhospital practice pattern variations when individual hospitals contribute repeated observations to the overall analysis. No variables were analyzed as effect modifiers. In our initial Perioperative Clinical Research Committee proposal, we had planned to fit hierarchical Bayesian models; we were concerned that frequentist model specifications would not converge or might not be computationally effective, given our large data set. However, our final models presented in this article are frequentist models with random effects, made possible by advances in computational efficiency in frequentist statistics. Frequentist approaches, also known as classical Fisher or Neyman–Pearson statistics, are more widely accepted and familiar to our target audiences.

We developed separate models for perioperative administration of either ondansetron or dexamethasone (primary outcome) and for perioperative administration of each drug individually or both drugs together (secondary outcomes).

Post hoc, for our primary outcome model, we calculated an E value and a confidence limit to show the minimum strength of an unmeasured confounder's association with our variable of interest (Black race) and outcome (perioperative antiemetic administration) that would suffice to undercut our inferences based on the observed but potentially spurious, association of interest.[29] We calculated our E value two ways: using the original formula presented by VanderWeele and Ding[29] (table 1 of reference) and an approximate E value adjusted for common outcomes (outcome prevalence greater than 15%). For context, we additionally calculated E values and confidence limits for individual Apfel postoperative nausea and vomiting risk factors (sex [male or female], smoking status [never, former, or current smoker], history of postoperative nausea and vomiting or motion sickness, and intended postoperative administration of opioids).

Because of potential intrahospital practice pattern differences and temporal differences that could affect perioperative antiemetic administration, we subsequently fit a series of additional exploratory stratified multivariable models by individual hospital and individual year for our primary outcome. *Post hoc*, at the request of the peer reviewers, we fit a series of stratified multivariable regression models for our *a priori* selected comorbidities that might possibly affect clinical decisions regarding postoperative nausea and vomiting medication administration (diabetes with dexamethasone or long QT Syndrome with ondansetron). Patients undergoing multiple anesthetics could be a source of bias; about 30% of our sample had more than one case encounter. *Post hoc*, at the request of the peer reviewers, we examined the sensitivity of our results to models specification with individual patient included as a level 2 covariate (random effect) in our mixed-effects general linear models.

Model assumptions of normality and linearity were assessed graphically and statistically. The *P* values are two sided, with statistical significance evaluated at an α level of less than 0.01. Statistical tests and analysis were performed using SAS version 9.4 (SAS Institute, USA), and R version 3.5.3/ Rstudio version 1.1.456 (R Foundation for Statistical Computing, Vienna, Austria). The study was conducted and reported in adherence to the Strengthening the Reporting of Observational studies in Epidemiology guidelines for observational research (Appendix 3, https://links.lww.com/ALN/D103).[30]

Results

A total of 5,105,123 adult anesthetic records from 39 hospitals in the United States and The Netherlands during the study period 2004 to 2018 met our inclusion criteria and were included in our Multicenter Perioperative Outcomes Group data file. After application of our exclusion criteria for missing sex, missing ASA status, or ASA Physical Status 6, a total of 5,000,136 anesthetic records (representing 3,234,312 unique patients) were included in our statistical analysis (104,987 excluded cases; 2.1% reduction; supplemental figure 1, https://links.lww.com/ALN/D99). Of the 3,234,312 unique patients in the database, the majority (71% of patients n = 2,298,671) have only one record in the data set, 18% of patients have two records listed (n = 1,152,152), 6% have three records listed (n = 565,620), and the remaining 5% of records represent patients with four or more anesthesia records in the database. The anesthetic characteristics and patient demographics are described in table 1.

Our analysis and interpretation of standardized mean differences revealed Black–White differences in our outcome measures (dexamethasone or ondansetron administration, any dexamethasone administration, dexamethasone and ondansetron administration) and patient demographic factors. Of the 5,000,136 anesthetic records included in our cohort, 3,491,904 were White (69.8%), 496,456 were Black (9.9%), 787,621 were of unknown race (15.8%), and 224,155 were of other races (4.5%). The average age of the sample population was 54.8 yr (SD, 17.0) with Black patients significantly younger at 51.9 yr (SD, 16.5) compared to White patients at 56.1 yr (SD, 16.8). Our sample population was composed of 55.1% females, including 60.7% of Black patients and 54.3% of White patients. ASA 2 patients made up 43.1% of the cohort (including 37.5% of Black patients and 42.6% of White patients), and 42.4% of the cohort were classified as ASA 3 (including 47.2% of Black patients and 43.7% of White patients). General anesthesia was utilized in 66.2% of cases (61.4% for Blacks and 65.9% for Whites). Considering hospital characteristics, 78.6% of the hospitals were academic centers (comprising 74.3% of Black patient cases and 76.8% of White patient cases), 89.4% were teaching hospitals (comprising 87.8% of Black patient cases and 88.1% of White patient cases), and 72.4% of cases were performed at a hospital with more than 500 hospital beds (comprising 78.3% of Black patient cases and 69.8% of White patient cases). An attending anesthesiologist was present in 99.8% of total cases, a resident in 28.8% of total cases, a certified registered nurse anesthetist in 68.2% of total cases, and a fellow in 0.3% of total cases. Anesthesia duration was on average 102 min (interquartile range, 55.0 to 177), and procedure duration was 53.0 min (interquartile range, 23.0 to 109). The cases captured by the Multicenter Perioperative Outcomes Group database increased from 2004 (24,497 cases; 0.5% of included cases) to 2017 (979,905 cases; 19.6% of included cases); 2018 data was only available until January.

Dexamethasone or ondansetron was given in 63.7% of cases (58.5% for Blacks and 64.1% for Whites), any dexamethasone in 35.9% of cases (28.3% for Blacks and 37.0% for Whites), and any ondansetron in 56.3% of cases (52.8% in Blacks and 56.1% in Whites). Concerning traditional postoperative nausea and vomiting risk factors, 33.7% of patients were current smokers (48.9% of Blacks and 32.2% of Whites), 28.0% were former smokers (20.3% of Blacks and 30.5% of Whites), and 38.4% were never smokers (30.8% of Blacks and 37.3% of Whites). In addition, 7.7%

Table 1. Characteristics of Patient Demographics and Anesthetics Delivered

Characteristics	All Patients (*N* = 5,000,136)	Black Race (*N* = 496,456)	Other Race (*N* = 224,155)	Unknown Race (*N* = 787,621)	White Race (*N* = 3,491,904)	*P* Value	N (Nonmissing)	Standardized Difference between Black and White Patients
Anesthetics								
Dexamethasone or ondansetron	3,186,315 (63.7%)	290,208 (58.5%)	138,366 (61.7%)	517,989 (65.8%)	2,239,752 (64.1%)	< 0.001	5,000,136	0.117
Dexamethasone and ondansetron	1,424,571 (28.5%)	112,520 (22.7%)	68,849 (30.7%)	234,002 (29.7%)	1,009,200 (28.9%)	< 0.001	5,000,136	0.143
Any dexamethasone	1,797,501 (35.9%)	140,642 (28.3%)	80,926 (36.1%)	285,062 (36.2%)	1,290,871 (37.0%)	< 0.001	5,000,136	0.185
Any ondansetron	2,813,385 (56.3%)	262,086 (52.8%)	126,289 (56.3%)	466,929 (59.3%)	1,958,081 (56.1%)	< 0.001	5,000,136	0.066
Dexamethasone alone	372,930 (7.46%)	28,122 (5.66%)	12,077 (5.39%)	51,060 (6.48%)	281,671 (8.07%)	< 0.001	5,000,136	0.095
Ondansetron alone	1,388,814 (27.8%)	149,566 (30.1%)	57,400 (25.6%)	232,927 (29.6%)	948,881 (27.2%)	< 0.001	5,000,136	-0.065
No dexamethasone and no ondansetron (no therapy)	1,813,821 (36.3%)	206,248 (41.5%)	85,789 (38.3%)	269,632 (34.2%)	1,252,152 (35.9%)	< 0.001	5,000,136	-0.117
Demographics								
Age	54.8 ± 17.0	51.9 ± 16.5	51.1 ± 17.2	52.2 ± 17.7	56.1 ± 16.8	< 0.001	5,000,136	0.256
Sex						< 0.001	5,000,136	-0.128
Female	2,756,152 (55.1%)	301,232 (60.7%)	131,962 (58.9%)	425,524 (54.0%)	1,897,434 (54.3%)			
Male	2,243,984 (44.9%)	195,224 (39.3%)	92,193 (41.1%)	362,097 (46.0%)	1,594,470 (45.7%)			
Apfel simplified risk score	1 [0, 2]	1 [1, 2]	1 [0, 2]	1 [0, 2]	1 [0, 2]	< 0.001	5,000,136	-0.054
Emergency status	279,022 (5.62%)	38,480 (7.92%)	14,258 (6.40%)	58,463 (7.47%)	167,821 (4.84%)	< 0.001	4,960,586	-0.122
ASA Physical Status						< 0.001	5,000,136	-0.150
1	365,335 (7.31%)	25,745 (5.19%)	26,522 (11.8%)	84,228 (10.7%)	228,840 (6.55%)			
2	2,156,809 (43.1%)	186,196 (37.5%)	101,804 (45.4%)	379,713 (48.2%)	1,489,096 (42.6%)			
3	2,120,107 (42.4%)	234,199 (47.2%)	82,039 (36.6%)	276,338 (35.1%)	1,527,531 (43.7%)			
4	346,167 (6.92%)	48,742 (9.82%)	13,268 (5.92%)	44,814 (5.69%)	239,343 (6.85%)			
5	11,718 (0.23%)	1,574 (0.32%)	522 (0.23%)	2,528 (0.32%)	7,094 (0.20%)			
Anesthesia technique								
Regional	378,114 (7.56%)	43,181 (8.70%)	15,985 (7.13%)	57,050 (7.24%)	261,898 (7.50%)	< 0.001	5,000,136	-0.044
General	3,311,364 (66.2%)	304,794 (61.4%)	140,300 (62.6%)	564,885 (71.7%)	2,301,385 (65.9%)	< 0.001	5,000,136	0.094
Neuraxial	502,518 (10.1%)	49,602 (9.99%)	22,654 (10.1%)	83,007 (10.5%)	347,255 (9.94%)	< 0.001	5,000,136	-0.002
Location								
Academic center	3,930,784 (78.6%)	368,946 (74.3%)	182,474 (81.4%)	698,938 (88.7%)	2,680,426 (76.8%)	< 0.001	5,000,136	0.057
Teaching hospital	4,407,381 (89.4%)	425,177 (87.8%)	195,203 (92.0%)	750,487 (95.4%)	3,036,514 (88.1%)	< 0.001	4,931,002	0.0382
Hospital size						< 0.001	4,931,002	-0.080
500 or more beds	3,567,754 (72.4%)	379,030 (78.3%)	125,334 (59.1%)	655,946 (83.4%)	2,407,444 (69.8%)			
100 to 199 beds	175,696 (3.56%)	15,918 (3.29%)	7,869 (3.71%)	7,484 (0.95%)	144,425 (4.19%)			
200 to 299 beds	35,197 (0.71%)	8,313 (1.72%)	536 (0.25%)	4,421 (0.56%)	21,927 (0.64%)			
300 to 399 beds	91,667 (1.86%)	17,778 (3.67%)	2,014 (0.95%)	4,141 (0.53%)	67,734 (1.96%)			
400 to 499 beds	1,060,688 (21.5%)	63,260 (13.1%)	76,448 (36.0%)	114,748 (14.6%)	806,232 (23.4%)			
Anesthesia provider								
Presence of attending anesthesiologist	4,991,798 (99.8%)	495,395 (99.8%)	224,008 (99.9%)	786,893 (99.9%)	3,485,502 (99.8%)	< 0.001	5,000,136	0.007
Presence of resident	1,438,623 (28.8%)	126,574 (25.5%)	62,479 (27.9%)	349,436 (44.4%)	900,134 (25.8%)	< 0.001	5,000,136	0.006
Presence of certified registered nurse anesthetist in case	3,408,139 (68.2%)	368,955 (74.3%)	147,002 (65.6%)	422,738 (53.7%)	2,469,444 (70.7%)	< 0.001	5,000,136	-0.081
Presence of fellow in case	14,941 (0.30%)	1,501 (0.30%)	789 (0.35%)	2,793 (0.35%)	9,858 (0.28%)	< 0.001	5,000,136	-0.004
Anesthesia duration	102 [55.0;177]	97.0 [54.0;167]	95.0 [52.0;168]	114 [67.0;191]	100 [53.0;176]	< 0.001	4,999,578	0.004
Procedure duration	53.0 [23.0;109]	45.0 [19.0;95.0]	49.0 [22.0;104]	63.0 [30.0;123]	53.0 [22.0;109]	< 0.001	3,708,354	0.094
Year						< 0.001	5,000,136	
2004	24,497 (0.49%)	796 (0.16%)	294 (0.13%)	13,634 (1.73%)	9,773 (0.28%)			-0.103

(*Continued*)

Table 1. (Continued)

Characteristics	All Patients (*N* = 5,000,136)	Black Race (*N* = 496,456)	Other Race (*N* = 224,155)	Unknown Race (*N* = 787,621)	White Race (*N* = 3,491,904)	*P* Value	N (Nonmissing)	Standardized Difference between Black and White Patients
2005	40,556 (0.81%)	2,851 (0.57%)	531 (0.24%)	15,025 (1.91%)	22,149 (0.63%)			
2006	58,568 (1.17%)	5,228 (1.05%)	681 (0.30%)	15,725 (2.00%)	36,934 (1.06%)			
2007	47,460 (0.95%)	3,591 (0.72%)	713 (0.32%)	16,829 (2.14%)	26,327 (0.75%)			
2008	96,713 (1.93%)	5,771 (1.16%)	1,538 (0.69%)	33,503 (4.25%)	55,901 (1.60%)			
2009	164,758 (3.30%)	11,686 (2.35%)	2,451 (1.09%)	44,965 (5.71%)	105,656 (3.03%)			
2010	217,893 (4.36%)	15,849 (3.19%)	5,299 (2.36%)	46,953 (5.96%)	149,792 (4.29%)			
2011	267,988 (5.36%)	19,633 (3.95%)	6,724 (3.00%)	64,455 (8.18%)	177,176 (5.07%)			
2012	317,247 (6.34%)	25,338 (5.10%)	8,907 (3.97%)	72,508 (9.21%)	210,494 (6.03%)			
2013	379,735 (7.59%)	39,270 (7.91%)	17,747 (7.92%)	62,088 (7.88%)	260,630 (7.46%)			
2014	495,201 (9.90%)	54,263 (10.9%)	24,757 (11.0%)	47,784 (6.07%)	368,397 (10.6%)			
2015	833,497 (16.7%)	81,370 (16.4%)	45,022 (20.1%)	108,381 (13.8%)	598,724 (17.1%)			
2016	963,580 (19.3%)	105,682 (21.3%)	53,732 (24.0%)	125,341 (15.9%)	678,825 (19.4%)			
2017	979,905 (19.6%)	111,878 (22.5%)	50,971 (22.7%)	113,628 (14.4%)	703,428 (20.1%)			
2018	112,538 (2.25%)	13,250 (2.67%)	4,788 (2.14%)	6,802 (0.86%)	87,698 (2.51%)			
Smoking status						< 0.001	1,656,928	0.117
Current smoker	557,584 (33.7%)	73,015 (48.9%)	14,406 (29.7%)	81,688 (32.5%)	388,475 (32.2%)			
Former smoker	463,828 (28.0%)	30,272 (20.3%)	6,091 (12.6%)	58,494 (23.3%)	368,971 (30.5%)			
Never smoking	635,516 (38.4%)	45,913 (30.8%)	27,955 (57.7%)	110,904 (44.2%)	450,744 (37.3%)			
History of postoperative nausea and vomiting	366,001 (7.66%)	18,678 (3.95%)	13,048 (6.31%)	40,153 (5.24%)	294,122 (8.82%)	< 0.001	4,780,024	0.196
History of motion sickness	55,038 (1.10%)	2,169 (0.44%)	1,740 (0.78%)	4,376 (0.56%)	46,753 (1.34%)	< 0.001	4,999,033	0.096
Postoperative administration of opioids	1,620,764 (33.2%)	193,700 (40.0%)	50,233 (22.6%)	257,621 (34.0%)	1,119,210 (32.7%)	< 0.001	4,887,502	-0.146
Diabetes	847,243 (18.6%)	111,548 (24.4%)	47,814 (23.4%)	109,633 (15.4%)	578,248 (18.2%)	< 0.001	4,553,453	-0.150
Long QT syndrome	8,126 (0.18%)	881 (0.19%)	583 (0.29%)	963 (0.14%)	5,699 (0.18%)	< 0.001	4,553,453	-0.003
Administration of volatile gases	2,814,856 (56.3%)	274,121 (55.2%)	106,904 (47.7%)	483,824 (61.4%)	1,950,007 (55.8%)	< 0.001	5,000,136	0.013
Administration of Propofol	4,418,587 (88.4%)	440,972 (88.8%)	193,391 (86.3%)	673,943 (85.6%)	3,110,281 (89.1%)	< 0.001	5,000,136	0.008
Endoscopic (gastrointestinal) case	165,289 (3.31%)	13,659 (2.75%)	7,085 (3.16%)	34,072 (4.33%)	110,473 (3.16%)	< 0.001	5,000,136	0.024
Cardiac case	51,390 (1.03%)	3,452 (0.70%)	1,894 (0.85%)	7,190 (0.91%)	38,854 (1.11%)	< 0.001	4,997,558	0.044
Cesarean delivery with inhalational general anesthesia only case	392,954 (7.88%)	48,271 (9.74%)	26,383 (11.8%)	80,578 (10.2%)	237,722 (6.82%)	< 0.001	4,988,927	-0.106

The data are n, mean SD, or n (%) values, unless otherwise specified. The *P* values refer to comparisons between race cohorts. The continuous variables were analyzed using analysis of variance; the categorical variables were analyzed using the chi-square test. Percentages may not sum to 100 due to rounding and missing values. Calculated standardized mean differences compare Black and White patients for our patient and hospital characteristics; we define a meaningful difference between characteristic groups as a standardized difference of 10% or more.

ASA, American Society of Anesthesiologists.

of patients reported a history of postoperative nausea and vomiting (4.0% of Blacks and 8.8% of Whites), and 1.1% of patients reported a history of motion sickness (0.4% of Blacks and 1.3% of Whites). Approximately a third of patient cases were scheduled for postoperative administration of opioids, including 40.0% of Black patients and 32.7% of White patients, and 56.3% of cases received volatile anesthetics. Black patients were more likely to have diabetes (24.4%) as compared to White patients (18.2%). Overall Apfel simplified postoperative nausea and vomiting risk scores were similar between Black and White patients.

Our primary analysis compared the odds of receiving either of the antiemetic medications ondansetron or dexamethasone, after controlling for generally accepted risk factors for postoperative nausea and vomiting in Black *versus* White patients in a mixed model with random effects for institutions. The results of our regression analysis (table 2) demonstrate that Black patients were less likely to receive antiemetic administration with either ondansetron or dexamethasone (adjusted odds ratio, 0.82; 95% CI, 0.81 to 0.82) after adjusting for patient postoperative nausea and vomiting risk factors-, procedure-, anesthetic-, and institution-level variables with clustering on individual hospitals to account for interhospital differences or practice patterns. The E value estimate adjusted for common occurrence for the primary outcome was 1.44 (lower limit of the 95% CI, 1.44). Therefore, an unmeasured confounder would have to be associated with both Black race and antiemetic administration with either ondansetron or dexamethasone with a risk ratio of 1.44 or greater for the observed association between Black race and antiemetic administration with either ondansetron or dexamethasone to be fully explained away. To contextualize the E value, we calculated additional E values for the individual Apfel postoperative nausea and vomiting risk factors (supplemental table 1, https://links.lww.com/ALN/D100). Black patients were also less likely to receive any dexamethasone (adjusted odds ratio, 0.78; 95% CI, 0.77 to 0.78), any ondansetron (adjusted odds ratio, 0.84; 95% CI, 0.84 to 0.85), and both dexamethasone and ondansetron together (adjusted odds ratio, 0.78; 95% CI, 0.77 to 0.79).

Stratified multivariable models by individual hospital showed that Black patients were significantly less likely than White patients to receive either ondansetron or dexamethasone in 32 of 39 hospitals (82.1%; fig. 2). Black patients continued to have lower odds of receiving either antiemetic medications when stratified subgroup analysis were performed by year, with statistical significance observed throughout 2004 to 2009 and 2011 to 2018 (fig. 3). Additionally, Black patients continued to have lower odds of receiving either antiemetic medications for most subgroups when stratified subgroup analysis were performed by diabetes or long QT syndrome (table 3).

Secondary findings from our main statistical model predicting administration of dexamethasone or ondansetron (table 2) showed that males compared to females (adjusted odds ratio, 0.66; 95% CI, 0.66 to 0.67), emergency surgery compared to elective surgery, current and former smokers compared to never smokers, and diabetic patients compared to nondiabetic patients were associated with decreased odds of receiving either medication. Patients with history of individual postoperative nausea and vomiting or motion sickness and planned administration of postoperative opioids had increased odds of receiving either medication. The presence of a resident was associated with increased odds of administration; the presence of an attending anesthesiologist, certified registered nurse anesthetist, or fellow was associated with reduced odds of administration. There was a temporal trend of increased administration of either postoperative nausea and vomiting medication (adjusted odds ratio for 2018 compared to 2004, 44.4; 95% CI, 42.6 to 46.2).

Due to technical limitations, hierarchical models clustering on the individual patient were not able to be fit for any outcome. However, there were not substantial differences between racial groups in terms of the number of anesthetic records per patient present in the database (supplemental table 2, https://links.lww.com/ALN/D101).

Discussion

Our analysis of 5.1 million adult anesthetic records from across the United States and The Netherlands for greater than 15 consecutive years found that Black patients with similar Apfel postoperative nausea and vomiting risk scores to White patients received less antiemetic medications (ondansetron and dexamethasone) with consistent confounder-adjusted estimates across diverse modeling approaches.[25–27] The wide range of academic and community hospitals, procedures, and patients included in our analysis contributed to our findings' generalizability. The demonstrated disparity is disconcerting given that our model contained all accepted Apfel postoperative nausea and vomiting risk factors.[20,21] Our findings were present throughout models stratified by individual year, demonstrating the longstanding and stable presence of this disparity, despite the initial postoperative nausea and vomiting consensus guidelines published in 2003 with recurrent updates.[20,21,26,27]

Discrimination is not an atypical behavior of a few but best understood in the context of institutional policies, unconscious bias, and negative stereotypes.[31,32] Process variability invites bias and can result in disparity.[4] Macario *et al.*[33] found wide variation in practitioners' postoperative nausea and vomiting clinical judgment and beliefs. Gillmann *et al.*[34] studied 10,000 German university hospital patients and found that only 54% of patients received correct guideline prophylaxis. Kooij *et al.*[35] reported similar poor postoperative nausea and vomiting guideline adherence; the main reasons for not administering prophylaxis were "unintended nonadherence" and "failure to document."[35,36] Racial variation in antiemetic use have been

Table 2. Analysis of Ondansetron or Dexamethasone Administration

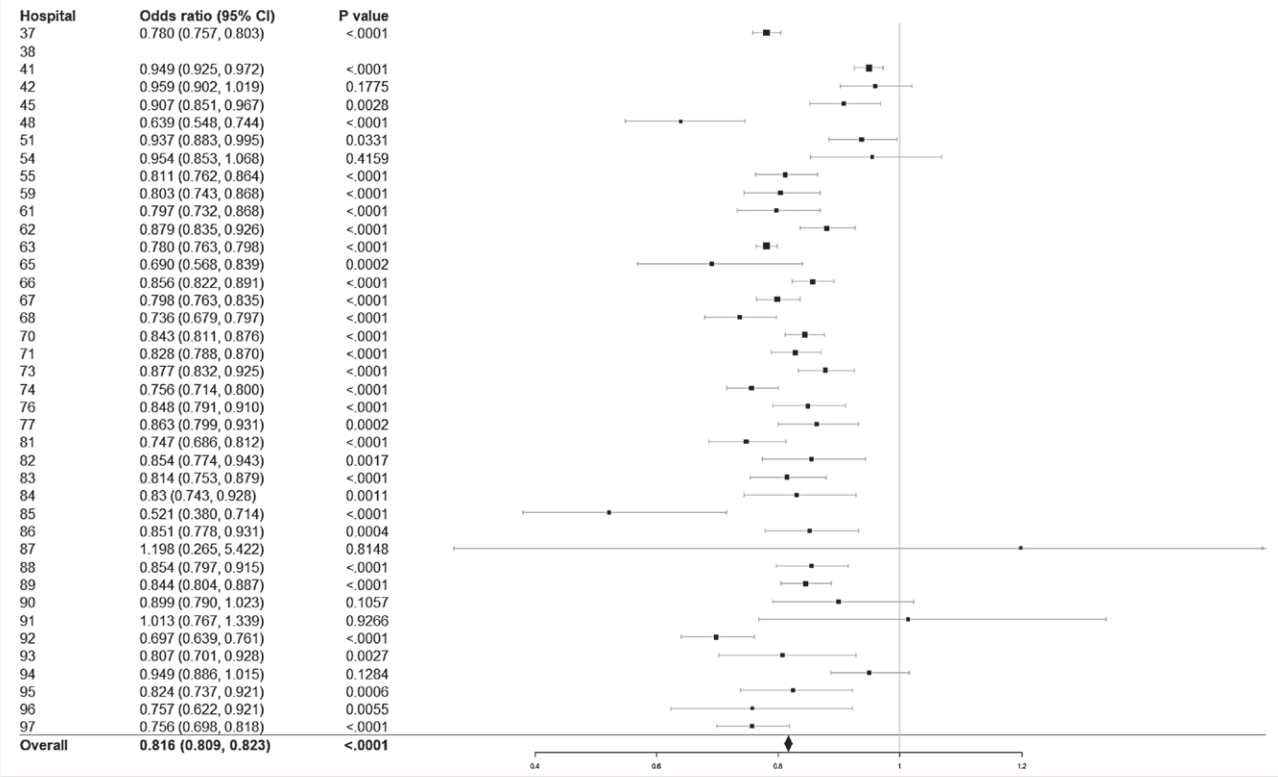
Characteristics	Adjusted Odds Ratio (95% CI)	*P* Value
Race/ethnicity		
White	1.00 (reference)	
Black	0.82 (0.81 to 0.82)	< 0.0001
Other	0.87 (0.86 to 0.88)	< 0.0001
Unknown	0.99 (0.98 to 1.00)	0.0043
Sex		
Female	1.00 (reference)	
Male	0.66 (0.66 to 0.67)	< 0.0001
Emergency status		
No	1.00 (reference)	
Yes	0.45 (0.44 to 0.45)	< 0.0001
ASA Physical Status		
1	1.00 (reference)	
2	0.90 (0.89 to 0.91)	< 0.0001
3	0.63 (0.63 to 0.64)	< 0.0001
4	0.175 (0.173 to 0.178)	< 0.0001
5	0.027 (0.026 to 0.029)	< 0.0001
Smoking status		
Never smoker	1.00 (reference)	
Current smoker	0.93 (0.92 to 0.94)	< 0.0001
Former smoker	0.79 (0.78 to 0.80)	< 0.0001
History of diabetes		
No	1.00 (reference)	
Yes	0.88 (0.87 to 0.88)	< 0.0001
History of postoperative nausea and vomiting		
No	1.00 (reference)	
Yes	2.21 (2.19 to 2.24)	< 0.0001
History of motion sickness		
No	1.00 (reference)	
Yes	1.26 (1.23 to 1.29)	< 0.0001
Postoperative administration of opioids		
No	1.00 (reference)	
Yes	1.63 (1.61 to 1.64)	< 0.0001
Presence of resident		
No	1.00 (reference)	
Yes	1.03 (1.02 to 1.04)	< 0.0001
Presence of attending anesthesiologist		
Yes	1.00 (reference)	
No	0.278 (0.263 to 0.294)	< 0.0001
Presence of certified registered nurse anesthetist		
Yes	1.00 (reference)	
No	0.95 (0.95 to 0.96)	< 0.0001
Presence of fellow		
No	1.00 (reference)	
Yes	0.48 (0.46 to 0.50)	< 0.0001
Year		
2004	1.00 (reference)	
2005	0.93 (0.89 to 0.97)	0.0017
2006	1.54 (1.48 to 1.61)	< 0.0001
2007	14.5 (13.9 to 15.1)	< 0.0001
2008	21.6 (20.7 to 22.5)	< 0.0001
2009	25.7 (24.7 to 26.7)	< 0.0001
2010	29.9 (28.8 to 31.1)	< 0.0001
2011	29.3 (28.2 to 30.5)	< 0.0001
2012	22.6 (21.8 to 23.5)	< 0.0001
2013	28.1 (27.1 to 29.2)	< 0.0001
2014	25.5 (24.6 to 26.5)	< 0.0001
2015	30.9 (29.8 to 32.1)	< 0.0001
2016	34.4 (33.1 to 35.7)	< 0.0001
2017	37.5 (36.2 to 39.0)	< 0.0001
2018	44.4 (42.6 to 46.2)	< 0.0001
Anesthesia technique: regional		
No	1.00 (reference)	
Yes	1.50 (1.49 to 1.52)	< 0.0001
Anesthesia technique: general		
Yes	1.00 (reference)	
No	0.140 (0.139 to 0.141)	< 0.0001
Anesthesia technique: neuraxial		
No	1.00 (reference)	
Yes	1.82 (1.80 to 1.84)	< 0.0001
Administration of propofol		
Yes	1.00 (reference)	
No	0.52 (0.52 to 0.53)	< 0.0001
Administration of volatile gases		
Yes	1.00 (reference)	
No	0.208 (0.206 to 0.210)	< 0.0001

The table shows the results of the mixed-effects model regression analysis for the primary outcome of intraoperative administration of either ondansetron or dexamethasone (including cases where patients received either medication or both medications). These results are only for the primary exposure variable of interest (race) and statistically significant model confounders. Covariates included (see text for full details): race, individual Apfel postoperative nausea and vomiting risk factors (sex, smoking status, history of postoperative nausea and vomiting or motion sickness, and intended postoperative administration of opioids), patient ASA physical status, patient comorbidities with theoretical contraindications to postoperative nausea and vomiting medications (history of diabetes, history of long QT syndrome), procedure emergency status case, presence of attending anesthesiologists, case presence of resident, case presence of fellow, case presence of a certified registered nurse anesthetist, year of procedure (reference: 2004), anesthesia technique used for procedure, case administration of propofol, case administration of volatile gases, indicator variable for cardiac case, indicator variable for endoscopic (gastrointestinal) case, indicator variable for cesarean delivery with inhalational general anesthesia only case, indicator variable for presence of patient inclusion into the Anesthesiology Performance Improvement and Reporting Exchange postoperative nausea and vomiting guidelines, American Hospital Association bed size, American Hospital Association teaching status, and Multicenter Perioperative Outcomes Group academic center status.

ASA, American Society of Anesthesiologists.

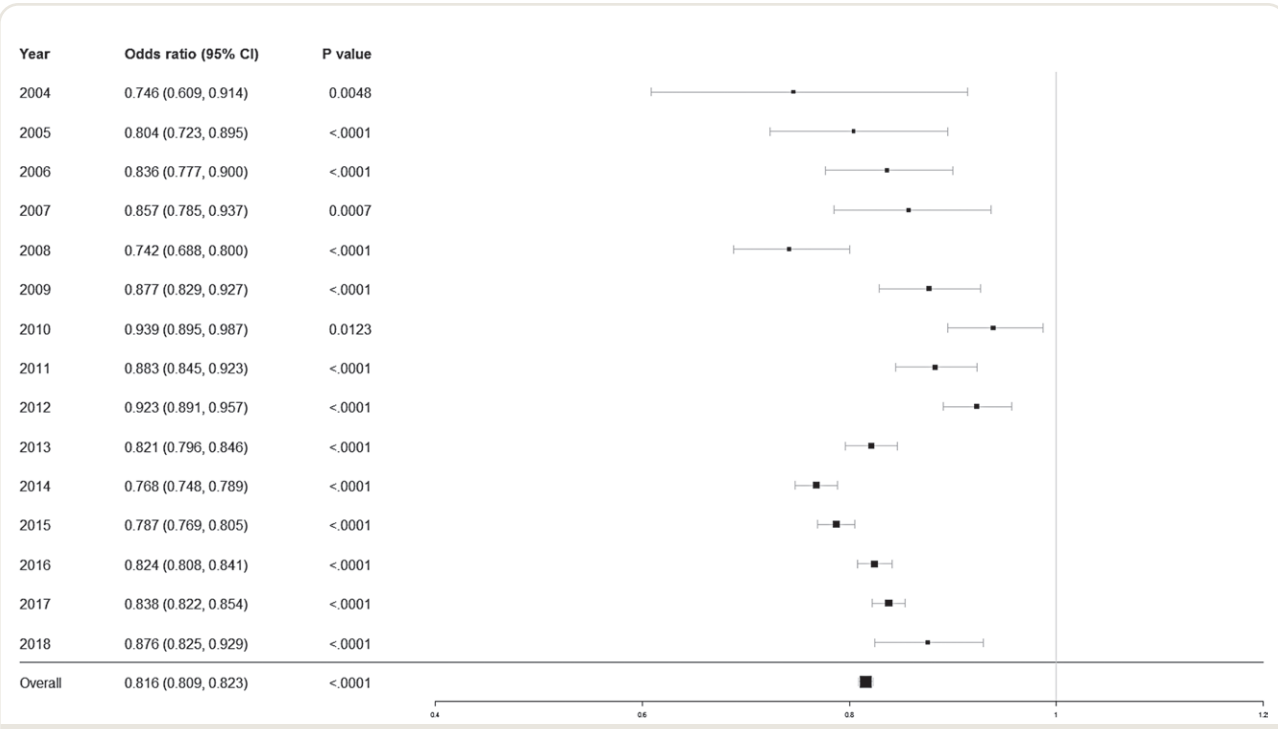
studied for chemotherapy-induced nausea and vomiting, with Black patients more likely to experience suboptimal guideline recommendation use.[37,38] Suggested explanations included differential symptom reporting and physicians' awareness of symptoms, economic barriers, or access to care.[37–39]

Clinicians could have administered less antiemetic medication in the belief that their Black patients were less prone to postoperative nausea and vomiting. Framing race as a biologic construct, previous observational studies have examined postoperative nausea and vomiting in South African populations comparing Black South African to non-Black South African patients and suggested intrinsic variation between the races in postoperative nausea and vomiting incidence, with non-Black race as an independent



Hospital	Odds ratio (95% CI)	P value
37	0.780 (0.757, 0.803)	<.0001
38		
41	0.949 (0.925, 0.972)	<.0001
42	0.959 (0.902, 1.019)	0.1775
45	0.907 (0.851, 0.967)	0.0028
48	0.639 (0.548, 0.744)	<.0001
51	0.937 (0.883, 0.995)	0.0331
54	0.954 (0.853, 1.068)	0.4159
55	0.811 (0.762, 0.864)	<.0001
59	0.803 (0.743, 0.868)	<.0001
61	0.797 (0.732, 0.868)	<.0001
62	0.879 (0.835, 0.926)	<.0001
63	0.780 (0.763, 0.798)	<.0001
65	0.690 (0.568, 0.839)	0.0002
66	0.856 (0.822, 0.891)	<.0001
67	0.798 (0.763, 0.835)	<.0001
68	0.736 (0.679, 0.797)	<.0001
70	0.843 (0.811, 0.876)	<.0001
71	0.828 (0.788, 0.870)	<.0001
73	0.877 (0.832, 0.925)	<.0001
74	0.756 (0.714, 0.800)	<.0001
76	0.848 (0.791, 0.910)	<.0001
77	0.863 (0.799, 0.931)	0.0002
81	0.747 (0.686, 0.812)	<.0001
82	0.854 (0.774, 0.943)	0.0017
83	0.814 (0.753, 0.879)	<.0001
84	0.83 (0.743, 0.928)	0.0011
85	0.521 (0.380, 0.714)	<.0001
86	0.851 (0.778, 0.931)	0.0004
87	1.198 (0.265, 5.422)	0.8148
88	0.854 (0.797, 0.915)	<.0001
89	0.844 (0.804, 0.887)	<.0001
90	0.899 (0.790, 1.023)	0.1057
91	1.013 (0.767, 1.339)	0.9266
92	0.697 (0.639, 0.761)	<.0001
93	0.807 (0.701, 0.928)	0.0027
94	0.949 (0.886, 1.015)	0.1284
95	0.824 (0.737, 0.921)	0.0006
96	0.757 (0.622, 0.921)	0.0055
97	0.756 (0.698, 0.818)	<.0001
Overall	**0.816 (0.809, 0.823)**	**<.0001**

Fig. 2. The *x*-axis scale represents coefficient point estimates for adjusted odds ratio and 95% CI for each corresponding hospital. The sizes of the squares of the odds ratios are proportional to the sample size contributed for each model compared to overall sample size.



Year	Odds ratio (95% CI)	P value
2004	0.746 (0.609, 0.914)	0.0048
2005	0.804 (0.723, 0.895)	<.0001
2006	0.836 (0.777, 0.900)	<.0001
2007	0.857 (0.785, 0.937)	0.0007
2008	0.742 (0.688, 0.800)	<.0001
2009	0.877 (0.829, 0.927)	<.0001
2010	0.939 (0.895, 0.987)	0.0123
2011	0.883 (0.845, 0.923)	<.0001
2012	0.923 (0.891, 0.957)	<.0001
2013	0.821 (0.796, 0.846)	<.0001
2014	0.768 (0.748, 0.789)	<.0001
2015	0.787 (0.769, 0.805)	<.0001
2016	0.824 (0.808, 0.841)	<.0001
2017	0.838 (0.822, 0.854)	<.0001
2018	0.876 (0.825, 0.929)	<.0001
Overall	0.816 (0.809, 0.823)	<.0001

Fig. 3. The *x*-axis scale represents coefficient point estimate for adjusted odds ratio and 95% CI for each corresponding year. The sizes of the squares of the odds ratios are proportional to the sample size contributed for each model compared to overall sample size.

Table 3. Postoperative Nausea and Vomiting Medication Administration Stratified by Diabetes and Long QT Syndrome Status

Population	Multivariable Model N Used	Adjusted Odds Ratio (95% CI) for Black *vs.* White Patients: Outcome: Received Dexamethasone or Ondansetron	Outcome: Received Any Dexamethasone	Outcome: Received Any Ondansetron
With diabetes	859,931	0.82 (0.80 to 0.84)*	0.66 (0.65 to 0.67)*	1.01 (0.99 to 1.03)
Without diabetes	3,787,603	0.73 (0.72 to 0.74)*	0.69 (0.68 to 0.69)*	0.88 (0.88 to 0.89)*
With long QT syndrome	8,249	0.91 (0.77 to 1.09)	0.76 (0.61 to 0.93)†	1.03 (0.87 to 1.22)
Without long QT syndrome	4,639,285	0.76 (0.81 to 0.83)*	0.68 (0.68 to 0.69)*	0.92 (0.91 to 0.92)*

*$p < 0.001$. †$p < 0.10$.

postoperative nausea and vomiting risk factor.[40–42] Regardless of the internal validity of these studies, even disregarding the misconception of Black race as a biologic construct, at a minimum these studies lack external validity and generalizability to the U.S. surgical population in general and to our study cohort.[40,41] The cytochrome P450 system used for volatile gas and opioid metabolism and genetic ancestry in general are too heterogeneous in the African American population; people of African descent living in the United States have average proportions of about 25% European and 1% Native American ancestry, and these proportions vary significantly by state, sex, African origin, and other social circumstances.[43] Generalizations about African Americans are biased by the ecological fallacy (inferences about individuals based on characteristics of the *social* group to which they belong) and hinge on the *biologic* construct of race.[44,45] Black race has a controversial and charged history in medicine and medical research, frequently abused to legitimize racism.[46] Modern biomedical research has provided considerable evidence and countless scientific arguments that invalidate race as a *biologic* construct and instead recognized race as a purely *social* construct.[47] Widely accepted guidelines and research do not recognize race as a risk factor for antiemetic prophylaxis; clinicians who administered fewer antiemetics to their Black patients must at least accept that they are not delivering guidance-congruent care.

While the provocative association of Black race with less risk-adjusted antiemetic administration is disconcerting, we did not investigate concrete mechanisms or key drivers. We could not differentiate prophylactic intraoperative use or postoperative therapeutic PACU rescue use. Therefore, the difference in antiemetic administration could be explained by disparities in postoperative nausea and vomiting *prophylaxis* or in *treatment* of postoperative nausea and vomiting in the PACU. Disparities in treatment of postoperative nausea and vomiting manifesting in the PACU would be as troubling. We rebutted the argument that Black patients are less prone to postoperative nausea and vomiting (leading to less treatment observed in the PACU potentially confounding our inferences) with our discussion on race as a social construct.

Our study has limitations, including its retrospective observational nature that can only report associations. Our data set lacked other social determinants of health at the individual patient, community, or state level; Black race could be serving as a proxy for other social determinants and associated social constructs driving perioperative disparities.[1–3,48] The calculated E value estimate of 1.44 demonstrates that an unmeasured confounder variable could remove the observed relationship between Black race and perioperative antiemetic utilization.[29] There are numerous potentially known unmeasured confounders that could bias our analysis.[49] We were unable to examine the impact of socioeconomic status, educational attainment, insurance status, wealth or income, or its interaction with race.[1–3,24] Given the demonstrated association between median income and patient insurance status, we concede that these factors could attenuate (or increase) the strength of the observed association between race and risk-adjusted antiemetic administration.[5] Further research is needed to explore these different factors to determine the relative contribution of race, social circumstances, and lived experience (fig. 1).[1–3,24,48]

We recognize that explicit or implicit bias exists among healthcare professionals and could influence decisions leading to disparities in antiemetic administration.[31,32] Individual or care team bias might cause predominantly White physicians or teams to feel more affinity toward White patients, leading to more efforts to prevent or treat postoperative nausea and vomiting. We considered the hypothesis that antiemetic medication being more easily accessible in some hospitals or anesthesia locations catering to more affluent populations could explain the observed disparity.[13] Care teams catering to affluent and likely predominantly White populations may attend with more diligence to postoperative nausea and vomiting administration because well insured patients can seek care elsewhere, as opposed to poorer, uninsured, minority patients who more often receive care in public hospitals with no choice. However, our stratified analysis by individual hospital detracts from this hypothesis, as the disparity was prevalent across most institutions. We need to examine which

clinician or institutional characteristics drive perioperative process disparities to identify an actionable mechanism to improve perioperative process equity. Anesthesiology provider demographic characteristics, which might influence behavior, were unavailable. The variability of equitable administration of postoperative nausea and vomiting medications among individual clinicians or teams in the same or in different institutions needs to be contextualized and may help to narrow down mechanisms and interventions to mitigate perioperative healthcare disparities.

Our models did not account for all known and possible patient (such as obesity and conditions predisposing to delayed gastric emptying), preoperative (fasting status or hydration status), and intraoperative factors (individual surgical types, surgical duration, and all anesthetics administered) that could influence postoperative nausea and vomiting. We only examined care processes (antiemetic administration) but not perioperative outcomes (postoperative nausea and vomiting incidence or length of stay). We believe that focus on disparities in care *processes* allows for the study of mechanisms and interventions to counter disparities.[19] Our analysis did not explore medical or surgical ward postoperative use of postoperative nausea and vomiting medications. The Multicenter Perioperative Outcomes Group anesthesia central registry is dependent upon on accuracy and completeness of member institution electronic medical record systems and data collection.[25,28] Despite data validation, the potential for error and misclassified or missing data remains. Our findings may be subject to selection bias, only reflecting practice patterns of the Multicenter Perioperative Outcomes Group member institutions sampled and may not be generalizable to other hospitals or institutions. Our sample population as compared to the 2020 U.S. Census included higher percentages of White and Black patients, which possibly reflects a geographical distribution skew of Multicenter Perioperative Outcomes Group participating sites to the U.S. Northeast and South (and less so the West). and therefore our sample may not be generalizable to the entire United States (or the international community). Hospital collection of racial data is still being standardized across the United States, leading to potential misclassification; it is likely that our race data are missing not at random because of this nonuniformity. We believe that missing race data would most likely serve to bias toward that null, showing no disparity. We only examined Black–White disparities and did not explore other race-based (or ethnicity-based) disparities (such as for Hispanic or Asian patients). *A priori*, our analysis was modeled after the Multicenter Perioperative Outcomes Group Anesthesiology Performance Improvement and Reporting Exchange postoperative nausea and vomiting guidelines that only pertain to the adult population (age greater than 18 years), and we did not explore disparities in the pediatric population.[27] In contrast to our findings, Rosenbloom *et al.*[12] examined pediatric anesthesia medication administration during emergency appendectomy and found no differences in medications administered, including ondansetron, between White and Black children at a *single* large academic children's hospital. We believe that the adult and pediatric populations are different, that the care teams and care processes differ substantially, and that the anesthetic technique and medications routinely used in pediatric populations may confound findings for adults. Future multicenter research that can account for different pediatric anesthesia practice patterns is needed.

Conclusions

Using perioperative data from 5.1 million representative samples of anesthetic cases, we found that Black patients as compared to White patients had lower odds of receiving antiemetic medications after adjusting for accepted postoperative nausea and vomiting risk factors. Our logistic regression models adjusted for important patient-specific (all four individual Apfel postoperative nausea and vomiting risk factors and other demographic variables), procedure-specific, and institution-specific variables; they were robust to sensitivity analysis and stratification by hospital or year. More work is needed to delineate the mechanisms that are driving these and other perioperative disparities with a view to develop, test, and implement targeted effective countermeasures, at the system, departmental, and individual provider levels.[19,48]

Acknowledgments

The authors express their gratitude and appreciation to the staff of the Center for Perioperative Outcomes at Weill Cornell Medicine, New York, New York.

Research Support

Supported by Foundation for Anesthesia Education and Research (FAER; Schaumburg, Illinois) grant No. MRTG-08-15-2021 (to Dr. White) and by departmental and institutional resources at each contributing site. In addition, partial funding to support underlying electronic health record data collection into the Multicenter Perioperative Outcomes Group registry was provided by Blue Cross Blue Shield of Michigan/Blue Care Network (Detroit, Michigan) as part of the Blue Cross Blue Shield of Michigan/Blue Care Network Value Partnerships program. Although Blue Cross Blue Shield of Michigan/Blue Care Network and Multicenter Perioperative Outcomes Group work collaboratively, the opinions, beliefs and viewpoints expressed by the authors do not necessarily reflect the opinions, beliefs, and viewpoints of Blue Cross Blue Shield of Michigan/Blue Care Network or any of its employees.

Competing Interests

The authors declare no competing interests.

Correspondence

Address correspondence to Dr. White: Weill Cornell Medicine, Department of Anesthesiology, 565 East 68th Street, New York, New York 10065. rsw9006@med.cornell.edu. This article may be accessed for personal use at no charge through the Journal Web site, www.anesthesiology.org.

Supplemental Digital Content

Supplemental Figure 1. Patient Flowchart, https://links.lww.com/ALN/D99

Supplemental Table 1. E values for categories of race or ethnicity and individual Apfel postoperative nausea and vomiting risk factors, https://links.lww.com/ALN/D100

Supplemental Table 2. Number of anesthetic procedures per individual patient by racial or ethnic group, https://links.lww.com/ALN/D101

Appendix 2. Perioperative Clinical Research Committee 0056 Approved Proposal, https://links.lww.com/ALN/D102

Appendix 3. Strengthening the Reporting of Observational studies in Epidemiology (STROBE) Statement, https://links.lww.com/ALN/D103

References

1. Healthy People 2030, U.S. Department of Health and Human Services, Office of Disease Prevention and Health Promotion. Available at: https://health.gov/healthypeople/objectives-and-data/social-determinants-health. Accessed April 20, 2022.
2. Solar O, Irwin A: A conceptual framework for action on the social determinants of health. 2010. World Health Organization, Geneva, Switzerland
3. Pearson J, Ugochukwu N, Kan K, Page N, Han J, Wan N, Schonberger RB, Andreae MH: Geospatial analysis of patients' social determinants of health for health systems science and disparity research. Int Anesthesiol Clin 2023; 61:49–62
4. Institute of Medicine Committee on Understanding and Eliminating Racial and Ethnic Disparities in Health Care: Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care. Edited by Smedley BD, Stith AY, Nelson AR. Washington, D.C., National Academy of Sciences. 2003
5. Andreae MH, Gabry JS, Goodrich B, White RS, Hall C: Antiemetic prophylaxis as a marker of health care disparities in the National Anesthesia Clinical Outcomes Registry. Anesth Analg 2018; 126:588–99
6. LaPar DJ, Bhamidipati CM, Mery CM, Stukenborg GJ, Jones DR, Schirmer BD, Kron IL, Ailawadi G: Primary payer status affects mortality for major surgical operations. Ann Surg 2010; 252:544–50
7. Andreae MH, White RS, Chen KY, Nair S, Hall C, Shaparin N: The effect of initiatives to overcome language barriers and improve attendance: A cross-sectional analysis of adherence in an inner city chronic pain clinic. Pain Med 2016; 18:265–74
8. Dutton RP: Disparities in anesthesia care. Anesth Analg 2018; 126:395–6
9. Silber JH, Rosenbaum PR, Zhang X, Even-Shoshan O: Influence of patient and hospital characteristics on anesthesia time in Medicare patients undergoing general and orthopedic surgery. Anesthesiology 2007; 106:356–64
10. Silber JH, Rosenbaum PR, Ross RN, Even-Shoshan O, Kelz RR, Neuman MD, Reinke CE, Ludwig JM, Kyle FA, Bratzler DW, Fleisher LA: Racial disparities in operative procedure time: The influence of obesity. Anesthesiology 2013; 119:43–51
11. Memtsoudis S, Stundner O: Disparities in care, public health and the role of the anesthesiologist. Reg Anesth Pain Med 2019; rapm-2019-100748
12. Rosenbloom JM, Senthil K, Long AS, Robinson WR, Peeples KN, Fiadjoe JE, Litman RS: A limited evaluation of the association of race and anesthetic medication administration: A single-center experience with appendectomies. Paediatr Anaesth 2017; 27:1142–7
13. La M, Tangel V, Gupta S, Tedore T, White RS: Hospital safety net burden is associated with increased inpatient mortality and postoperative morbidity after total hip arthroplasty: A retrospective multistate review, 2007–2014. Reg Anesth Pain Med 2019:rapm-2018-100305
14. White RS, Aaronson JA: Obstetric and perinatal racial and ethnic disparities. Curr Opin Anaesthesiol 2022; 35:260–6
15. Memtsoudis SG, Besculides MC, Swamidoss CP: Do race, gender, and source of payment impact on anesthetic technique for inguinal hernia repair? J Clin Anesth 2006; 18:328–33
16. Memtsoudis SG, Poeran J, Zubizarreta N, Rasul R, Opperer M, Mazumdar M: Anesthetic care for orthopedic patients: Is there a potential for differences in care? Anesthesiology 2016; 124:608–23
17. Cozowicz C, Poeran J, Memtsoudis SG: Epidemiology, trends, and disparities in regional anaesthesia for orthopaedic surgery. Br J Anaesth 2015; 115:ii57–67
18. Qian F, Eaton MP, Lustik SJ, Hohmann SF, Diachun CB, Pasternak R, Wissler RN, Glance LG: Racial disparities in the use of blood transfusion in major surgery. BMC Health Serv Res 2014; 14:121
19. Andreae MH, Maman SR, Behnam AJ: An electronic medical record-derived individualized performance metric to measure risk-adjusted adherence with perioperative prophylactic bundles for health care disparity research and implementation science. Appl Clin Inform 2020; 11:497–514
20. Apfel CC, Korttila K, Abdalla M, Kerger H, Turan A, Vedder I, Zernak C, Danner K, Jokela R, Pocock SJ, Trenkler S, Kredel M, Biedler A, Sessler DI, Roewer N; IMPACT Investigators: A factorial trial of six

interventions for the prevention of postoperative nausea and vomiting. N Engl J Med 2004; 350:2441–51
21. Gan TJ, Belani KG, Bergese S, Chung F, Diemunsch P, Habib AS, Jin Z, Kovac AL, Meyer TA, Urman RD, Apfel CC, Ayad S, Beagley L, Candiotti K, Englesakis M, Hedrick TL, Kranke P, Lee S, Lipman D, Minkowitz HS, Morton J, Philip BK: Fourth consensus guidelines for the management of postoperative nausea and vomiting. Anesth Analg 2020; 131:411–48
22. Wender RH: Do current antiemetic practices result in positive patient outcomes? Results of a new study. Am J Health Syst Pharm 2009; 66:S3–10
23. Diemunsch P, Diemunsch AM: Economics of antiemetics. Curr Opin Anaesthesiol 2002; 15:233–7
24. Kawachi I, Daniels N, Robinson DE: Health disparities by race and class: Why both matter. Health Aff (Millwood) 2005; 24:343–52
25. Colquhoun DA, Shanks AM, Kapeles SR, Shah N, Saager L, Vaughn MT, Buehler K, Burns ML, Tremper KK, Freundlich RE, Aziz M, Kheterpal S, Mathis MR: Considerations for integration of perioperative electronic health records across institutions for research and quality improvement: The approach taken by the Multicenter Perioperative Outcomes Group. Anesth Analg 2020; 130:1133–46
26. Multicenter Perioperative Outcomes Group: Quality measures exchange. Available at: https://spec.mpog.org/Measures/Public. Accessed April 20, 2022.
27. Anesthesiology Performance Improvement and Reporting Exchange (ASPIRE). PONV 01 Guidelines. Available at: https://www.aspirecqi.org/sites/default/files/PONV%2001%20Spec.pdf. Accessed April 20, 2022.
28. Kheterpal S: Clinical research using an information system: The multicenter perioperative outcomes group. Anesthesiol Clin 2011; 29:377–88
29. VanderWeele TJ, Ding P: Sensitivity analysis in observational research: Introducing the E-value. Ann Intern Med 2017; 167:268–74
30. Von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP; STROBE Initiative: The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: Guidelines for reporting observational studies. Ann Intern Med 2007; 147:573–7
31. Haider AH, Schneider EB, Sriram N, Dossick DS, Scott VK, Swoboda SM, Losonczy L, Haut ER, Efron DT, Pronovost PJ, Lipsett PA, Cornwell EE 3rd, MacKenzie EJ, Cooper LA, Freischlag JA: Unconscious race and social class bias among acute care surgical clinicians and clinical treatment decisions. JAMA Surg 2015; 150:457–64
32. FitzGerald C, Hurst S: Implicit bias in healthcare professionals: A systematic review. BMC Med Ethics 2017; 18:19
33. Macario A, Chung A, Weinger MB: Variation in practice patterns of anesthesiologists in California for prophylaxis of postoperative nausea and vomiting. J Clin Anesth 2001; 13:353–60
34. Gillmann H-J, Wasilenko S, Züger J, Petersen A, Klemann A, Leffler A, Stueber T: Standardised electronic algorithms for monitoring prophylaxis of postoperative nausea and vomiting. Arch Med Sci 2019; 15:408–15
35. Kooij FO, Klok T, Preckel B, Hollmann MW, Kal JE: The effect of requesting a reason for non-adherence to a guideline in a long running automated reminder system for PONV prophylaxis. Appl Clin Inform 2017; 8:313–21
36. Kooij FO, Klok T, de Haan P, Kal JE: Poor guideline adherence in prescribing PONV prophylaxis disclosed by anaesthesia information system: A-42. Eur J Anaesthesiol 2006; 23:11
37. Check DK, Reeder-Hayes KE, Zullig LL, Weinberger M, Basch EM, Dusetzina SB: Examining racial variation in antiemetic use and post-chemotherapy health care utilization for nausea and vomiting among breast cancer patients. Support Care Cancer 2016; 24:4839–47
38. Samuel CA, Landrum MB, McNeil BJ, Bozeman SR, Williams CD, Keating NL: Racial disparities in cancer care in the Veterans Affairs health care system and the role of site of care. Am J Public Health 2014; 104:S562–71
39. Gomez DR, Liao KP, Giordano S, Nguyen H, Smith BD, Elting LS: Adherence to national guidelines for antiemesis prophylaxis in patients undergoing chemotherapy for lung cancer: A population-based study. Cancer 2013; 119:1428–36
40. Rodseth RN, Gopalan PD, Cassimjee HM, Goga S: Reduced incidence of postoperative nausea and vomiting in black South Africans and its utility for a modified risk scoring system. Anesth Analg 2010; 110:1591–4
41. Alli A, Omar S, Tsang S, Naik BI: The effect of ethnicity on the incidence of postoperative nausea and vomiting in moderate to high risk patients undergoing general anesthesia in South Africa: A controlled observational study. Middle East J Anaesthesiol 2017; 24:119–29
42. Ugochukwu O, Adaobi A, Ewah R, Obioma O: Postoperative nausea and vomiting in a gynecological and obstetrical population in South Eastern Nigeria. Pan Afr Med J 2010; 7:6
43. Bryc K, Durand EY, Macpherson JM, Reich D, Mountain JL: The genetic ancestry of African Americans, Latinos, and European Americans across the United States. Am J Hum Genet 2015; 96:37–53
44. Schwartz S: The fallacy of the ecological fallacy: The potential misuse of a concept and the consequences. Am J Public Health 1994; 84:819–24
45. Kaufman JS, Merckx J, Cooper RS: Use of racial and ethnic categories in medical testing and diagnosis: Primum non nocere. Clin Chem 2021; 67:1456–65

46. Bailey ZD, Feldman JM, Bassett MT: How structural racism works—Racist policies as a root cause of U.S. racial health inequities. N Engl J Med 2021; 384:768–73
47. Borrell LN, Elhawary JR, Fuentes-Afflick E, Witonsky J, Bhakta N, Wu AHB, Bibbins-Domingo K, Rodríguez-Santana JR, Lenoir MA, Gavin JR 3rd, Kittles RA, Zaitlen NA, Wilkes DS, Powe NR, Ziv E, Burchard EG: Race and genetic ancestry in medicine—A time for reckoning with racism. N Engl J Med 2021; 384:474–80
48. Glymour MM, Spiegelman D: Evaluating public health interventions: 5. Causal inference in public health research—Do sex, race, And biological factors cause health outcomes? Am J Public Health 2017; 107:81–5
49. VanderWeele TJ, Mathur MB: Developing best-practice guidelines for the reporting of E-values. Int J Epidemiol 2020; 49:1495–7

Appendix 1. Multicenter Perioperative Outcomes Group Collaborators

The following Multicenter Perioperative Outcomes Group study group members are collaborators: Germaine Cuff, B.S.N., Ph.D., New York University Langone Health, New York, New York; Patrick McCormick, M.D., M.Eng., Memorial Sloan Kettering Cancer Center, New York, New York; Richard D. Urman, M.D., M.B.A., Brigham and Women's Hospital, Boston, Massachusetts; Nathan L. Pace, M.D., M.Stat., University of Utah, Salt Lake City, Utah.