Racial differences in cancer screening with electronic health records and electronic preventive care reminders

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ABSTRACT

Background Health information technology (HIT) can increase preventive care. There are hopes and fears about the impact of HIT on racial disparities in cancer screening.

Objective To determine whether electronic health records (EHRs) or electronic preventive care reminders (e-reminders) modify racial differences in cancer screening order rates.

Design Using the 2006–2010 National Ambulatory and National Hospital Ambulatory Medical Care Surveys, we measured (1) visit-based differences in rates of age-appropriate breast, cervical and colon cancer screening orders between white and non-white subjects at primary care visits with and without EHRs, and, at visits with EHRs, with and without e-reminders, and (2) whether EHRs or e-reminders modified these differences.

Main outcomes Mammography (N=45 380); Pap smears (N=73 348); and sigmoidoscopy/colonoscopy (N=50 955) orders.

Results Among an estimated 2.4 billion US adult primary care visits, orders for screening for breast, cervical or colon cancer did not differ between clinics with and without EHRs or e-reminders. There was no difference in screening orders between non-white and white patients for breast (aOR=1.1; 95% CI 0.9 to 1.4) or cervical cancer (aOR=1.2; 95% CI 1.0 to 1.3). For colon cancer, non-white patients were more likely to receive screening orders than white patients overall (aOR=1.5; 95% CI 1.1 to 2.0), at visits with EHRs (aOR=1.8; 95% CI 1.1 to 2.8) and at visits with e-reminders (aOR=2.1; 95% CI 1.2 to 3.7). EHRs or e-reminders did not modify racial differences in cancer screening rates.

Conclusions In this visit-based analysis, non-white patients had higher colon cancer screening order rates than white patients. Despite hopes and fears about HIT, EHRs and e-reminders did not ameliorate or exacerbate racial differences in cancer screening order rates.

INTRODUCTION

Rates of screening for breast cancer, cervical cancer and colon cancer are all below national targets.[1] In addition, the prevalence of cancer screening varies across races, and the rates of screening for different cancers also varies. In 2010, screening rates for white and black patients were similar for breast cancer (72.8% vs 73.2%) and cervical cancer (83.4% vs 85%); however, white patients had higher rates of colon cancer screening than black patients (59.8% vs 55.0%).[1] To begin reducing racial disparities in the prevalence of completion of cancer screening, incidence of orders for screening examinations must increase for minority group patients.

The 2001 Institute of Medicine report, *Crossing the Quality Chasm*, made explicit the need to pursue equity in the provision of healthcare in order to improve quality overall.[2] Preventive care offers an opportunity to reduce racial disparities in diagnosis, treatment, and outcomes.

Health information technology (HIT), and electronic health records (EHRs) specifically, are becoming ubiquitous tools, implemented equally across racial and ethnic groups of patients.[3–6] Clinical decision support modules as a part of EHRs have been shown to improve rates of receipt of preventive care.[7] Cancer screening rates have increased as a result of non-visit-based HIT solutions[8–10] and visit-based reminders to providers.[11] Of note, many HIT solutions are directed at the physician, and thus more likely to affect the physician's behavior in ordering cancer screening examinations than the patient's behavior in completing the examinations.

There are both hopes and fears about whether EHRs will alleviate or exacerbate disparities. A small EHR-based quality improvement project that included point-of-care clinical decision support and performance feedback reduced racial disparities in colorectal cancer screening, although not in breast cancer or cervical cancer screening.[12]

We examined the rates of cancer screening orders by EHR and electronic reminder (e-reminder) status, the extent of racial disparities in these orders, and the degree to which EHRs or e-reminders affect those disparities, in order to determine if EHRs and e-reminders to physicians would improve cancer screening order rates and thus potentially reduce racial disparities in cancer screening.

METHODS

Data source

We analyzed the National Ambulatory Medical Care Survey (NAMCS) and the National Hospital Ambulatory Medical Care Survey (NHAMCS) from 2006 to 2010. Both surveys are administered by the Ambulatory Care Statistics Branch of the National Center for Health Statistics (NCHS) of the Centers for Disease Control and Prevention. These surveys collect information on outpatient visits to non-federally funded practices throughout the USA. The NCHS assigns weights to each visit to allow estimation of national figures from sample records. The NCHS institutional review board approves the protocols for both surveys, including a waiver of informed consent for participating patients.

The NAMCS and NHAMCS collect patient records from community-based and hospital-based outpatient clinics, respectively. Annually, from 2006 to 2010, about 30 000 patient records from 1400 physician offices (representing 60% participation) were included in NAMCS and about 34 000 patient records from 375 hospitals (representing 90% participation) were included in NHAMCS.

In all years included in the analysis, both the NAMCS and NHAMCS included the following questions in their intake surveys: "Does your practice use electronic medical records or EHRs (not including billing records)?" and "Does your practice have a computerized system for reminders for guideline-based interventions and/or screening tests?"

The NAMCS and NHAMCS collect patient demographic information on race as categorized by the physician's office. The non-response rate for the variable race was 23.0–32.8% in NAMCS and 12.4–14.6% in NHAMCS for the years analyzed. Based on this non-response rate, we used the imputed race data from the NAMCS and NHAMCS. NCHS imputes race based on the patient's locality and the physician's office; if this is not possible, then imputation is based on physician specialty and primary diagnosis; failing that, it is based on a randomly selected record. According to NCHS, use of imputed race data is valid when true race data are missing.[13 14]

The NAMCS and NHAMCS collect information on screening examinations ordered or conducted during a participating visit. The survey form asks the respondent to indicate if any diagnostic or screening examinations were ordered or provided during the visit; mammography, Pap test, and scope procedures (a free text box is provided to indicate the type of scope, which is then categorized as sigmoidoscopy/colonoscopy by NCHS) are all possible responses. Fecal occult blood testing, although an acceptable screening method for colon cancer, is not a response option. The patient record forms also collect up to three reasons identified by the patient for the visit, three physician diagnoses for the visit, and ask whether the patient has a diagnosis of cancer.

Data analysis

We performed a retrospective, cross-sectional analysis of adult primary care ambulatory clinic visits in the NAMCS and NHAMCS from 2006 to 2010. The unit of analysis was the patient visit, representing incident, not prevalent, screening orders.

We calculated the availability of EHRs and e-reminders during visits to these practices. Responses of 'blank', 'unknown', or 'turned off' were considered to be equivalent to 'no', indicating the lack of an EHR or e-reminder.

We selected a parsimonious list of patient and practice characteristics to determine any differences in access to practices with EHRs and e-reminders based on prior work showing associations between these characteristics and EHR availability—namely, patient income category, region of the country, expected payment source, primary reason for the visit, and whether the patient had been seen previously by that practice.[3 15 16]

On the premise that most preventive care takes place through a primary care practice, we limited our sample to these practices. We defined primary care as physicians with internal medicine or family medicine specialty (NAMCS) or visits to general medicine practices (NHAMCS). We also included obstetrics-gynecology practices (both NAMCS and NHAMCS) as many women receive their primary care through their obstetrician-gynecologist.[17]

Our main outcomes of interest were orders for cancer screening examinations: mammograms, Pap smears, or sigmoidoscopy/colonoscopy. To limit our analysis to age-appropriate screening based on US Preventive Services Task Force recommendations,[18] we limited the sample population by age and medical history for each type of screening examination. We excluded patients with a history of the type of cancer the screening test would detect in order to limit our sample to screening, rather than surveillance, examinations. For breast cancer screening, we limited the sample to 40–75-year-old women without a history of breast carcinoma, abnormal mammogram, or current breast lump. For cervical cancer screening, we limited the sample to 21–65-year-old women without a history of genital tract carcinoma. For colon cancer screening, we limited the sample to 50–75–year-old men and women without a history of gastrointestinal tract cancers.

We used age as a continuous variable. We treated race as binary (white vs non-white which represents the aggregation of 'black' and 'other' race categories) because there were insufficient visit records for sound statistical analysis of black and other race as separate categories. We treated reason for visit as binary: general medical examination or other. We collapsed insurance type into four categories: private, Medicare, Medicaid, and other.

Statistical analysis

The unit of analysis was the patient visit. We followed NCHS guidelines based on the complex, clustered sampling design. All tests were done on data with a <30% relative SE (ie, the SE is <30% of the estimate) and more than 30 sample records. All proportions are weighted as required by NCHS.

We evaluated categorical variables with the χ^2 test and continuous variables with the t test. We performed multivariable logistic regression modeling for each cancer screening test separately, including variables previously shown to be associated with EHR use or hypothesized to be associated with cancer screening (patient income category, region of the country, expected payment source, primary reason for the visit, and whether the patient had been seen previously by that practice) to obtain adjusted ORs (aORs). The main predictors of interest were race and EHR or e-reminder status. We also evaluated the interaction term between race and EHR or e-reminder status to determine whether there was any effect modification of the presence of the EHR or e-reminders on racial differences in cancer screening orders. We considered p values <0.05 to be significant. We used SAS statistical software (V.9.3; SAS Institute, Cary, North Carolina) for all analyses.

RESULTS

Visit characteristics

We analyzed 132 276 sample records from 2006 to 2010, representing 2.4 (95% CI 2.2 to 2.6) billion adult primary care visits in the USA. Of all adult primary care visits, 47% were to practices with EHRs, and of visits to practices with EHRs, 60% had e-reminders. Of all visits, 7.8% included an order for at least one type of cancer screening of interest. There was no significant difference in the proportion of visits to clinics with or without EHRs by race (white patients: 48% with EHRs vs 52% without EHRs; non-white patients: 45% with EHRs vs 55% without EHRs; p=0.09). Visits to clinics with EHRs were more likely to be paid for by private insurance or Medicare and less likely to be paid for by Medicaid or other type of insurance (p<0.0001); and less likely to be by patients in the lowest income category (p=0.007) than visits to clinics without EHRs (table 1). Visits to clinics with e-reminders were made by younger patients (p<0.0001); were more likely to be paid for by private insurance and less likely to be paid for by Medicare,

Table 1 Adult primary care visits with and without electronic health records and electronic preventive care reminders, 2006–2010

	No EHR (N=71 295 sample records*) %	EHR (N=60 981 sample records†) %	p Value	No e-reminder (N=28 411 sample records‡) %	e-Reminder (N=32 570 sample records§) %	p Value
Age (mean)	52.5±0.4	53.2±0.4	0.12	54.6±0.6	52.4±0.5	**<0.0001**
Race			0.09			0.30
White	74	76		75	77	
Non-white	26	24		25	23	
Reason for visit			0.31			0.14
General medical examination	29	28		29	27	
Other	71	72		71	73	
Patient seen previously?			0.22			0.73
Yes	87	86		86	86	
Expected payment source			**<0.0001**			**0.0005**
Private insurance	37	40		37	42	
Medicare	21	23		24	22	
Medicaid	22	20		21	19	
Other	16	12		14	11	
Income category			**0.007**			**0.03**
≤$32 793	29	27		29	25	
$32 794–40 626	25	24		23	24	
$40 627–52 387	22	21		21	21	
≥$52 388	20	20		21	24	
Region			0.06			0.74
Northeast	25	26		24	29	
Mid-west	27	25		30	21	
South	31	27		29	26	
West	18	21		18	24	

*Represents 1.3 billion estimated visits without an EHR.
†Represents 1.1 billion estimated visits with an EHR.
‡Represents 460 million estimated visits without an e-reminder.
§Represents 680 million estimated visits with an e-reminder.
EHR, electronic health record.

Medicaid or other insurance type (p=0.0005); and were less likely to be by patients in the lowest income category and more likely to be by patients in the highest income category (p=0.03) than visits to clinics without e-reminders.

Breast cancer screening

We considered mammogram orders to be for breast cancer screening for women of 40–75 years of age without a history of breast cancer, abnormal mammogram, or current breast lump. Mammograms were ordered in 3900 sample records representing 77 million estimated visits (9.0% of all eligible visits) overall (table 2). There was no difference in breast cancer screening order rates between clinics with EHRs and clinics without EHRs (8.9% vs 9.2%; adjusted OR (aOR) 0.96; 95% CI 0.8 to 1.2). There was no difference in breast cancer screening orders between non-white and white patients overall (9.7% vs 8.9%; aOR=1.1; 95% CI 0.9 to 1.4). There were 42 million (9.2% of all eligible visits) mammography orders at visits to clinics without EHRs and 35 million (8.9% of all eligible visits) mammography orders at visits to clinics with EHRs. There was no difference in odds of breast cancer screening orders between non-white and white patients at clinics without EHRs (9.7% vs 9.0%; aOR=1.2; 95% CI 0.9 to 1.5) or with EHRs (9.7% vs 8.7%; aOR=1.1; 95% CI 0.8 to 1.4). The presence of an EHR did not modify the difference in breast cancer screening orders between white and non-white patients (p=0.63).

There were 14 million (8.7% of all eligible visits) mammography orders at visits to clinics without e-reminders and 21 million (9.0% of all eligible visits) mammography orders at visits to clinics with e-reminders. There was no difference in the odds of breast cancer screening orders between non-white and white patients at clinics with (8.9% vs 9.0%; aOR=0.98; 95% CI 0.7 to 1.3) or without (11.0% vs 8.3%; aOR=1.3; 95% CI 0.8 to 2.2) e-reminders. The presence of an e-reminder did not modify the difference in breast cancer screening orders between white and non-white patients (p=0.39).

Cervical cancer screening

We considered Pap smear orders to be for cervical cancer screening for women of 21–65 years of age without a history of genital tract cancer. Pap smears were ordered in 8600 sample records representing 142 million estimated visits overall (12.1% of all eligible visits) (table 2). There were 79 million (12.6% of all eligible visits) Pap smear orders at visits to clinics without EHRs and 63 million (11.5% of all eligible visits) Pap smear orders at visits to clinics with EHRs. Overall, there was no difference in the odds of non-white patients receiving cervical cancer screening orders versus white patients (13.3% vs 11.8%; aOR=1.2; 95% CI 0.99 to 1.3). There was no difference in odds of cervical cancer screening orders between non-white and white patients at clinics without EHRs (13.4% vs 12.4%; aOR=1.1; 95% CI 0.95 to 1.4) or with EHRs (13.1% vs

Table 2 Odds* of cancer screening for primary care patients by electronic health record and e-reminder, stratified by race

	Overall		No EHR		EHR		No E-reminder		E-reminder	
	% Screened	**aOR* (95% CI)**	**% Screened**	**aOR* (95% CI)**	**% Screened**	**aOR* (95% CI)**	**% Screened**	**aOR* (95% CI)**	**% Screened**	**aOR* (95% CI)**
Breast cancer†										
All	9.0		9.2	Ref	8.9	0.96 (0.8 to 1.2)	8.7	Ref	9.0	1.1 (0.8 to 1.4)
White	8.9	Ref‡	9.0	Ref	8.7	Ref	8.3	Ref	9.0	Ref
Non-white	9.7	1.1 (0.9 to 1.4)	9.7	1.2 (0.9 to 1.5)	9.7	1.1 (0.8 to 1.4)	11.0	1.3 (0.8 to 2.2)	8.9	0.98 (0.7 to 1.3)
Interaction§					0.63				0.39	
Cervical cancer¶										
All	12.1		12.6	Ref	11.5	1.1 (0.9 to 1.3)	10.3	Ref	12.3	0.9 (0.7 to 1.1)
White	11.8	Ref	12.4	Ref	11.1	Ref	9.9	Ref	11.9	Ref
Non-white	13.3	1.2 (0.99 to 1.3)	13.4	1.1 (0.95 to 1.4)	13.1	1.2 (0.9 to 1.5)	11.9	1.2 (0.7 to 1.9)	13.8	1.2 (0.9 to 1.5)
Interaction§					0.75				0.98	
Colon cancer**										
All	2.3		2.2	Ref	2.5	0.9 (0.7 to 1.1)	2.4	Ref	2.6	0.98 (0.7 to 1.4)
White	2.2	Ref	2.2	Ref	2.2	Ref	2.2	Ref	2.2	Ref
Non-white	3.0	**1.5 (1.1 to 2.0)**	2.3	1.2 (0.8 to 1.7)	3.8	**1.8 (1.1 to 2.8)**	3.3	1.5 (0.9 to 2.7)	4.1	**2.1 (1.2 to 3.7)**
Interaction§					0.17				0.46	

*aOR=adjusted OR. Adjusted for patient age, patient income, reason for visit, new/established patient, expected payment source, and region of the country. Note that percentages are unadjusted.
†Breast cancer—N=45 380 sample records (represents 851 million estimated visits). Included women, age 40–75 years, without a history of breast carcinoma, abnormal mammogram, or current breast lump.
‡Ref=reference group.
§Interaction p value is for the difference in ORs between white and non-white patients, when either EHRs or e-reminders were used.
¶Cervical cancer—N=73 348 sample records (represents 1.2 billion estimated visits). Included women, age 21–65 years, without a history of genital tract carcinoma.
**Colon cancer—N=50 955 sample records (represents 1 billion estimated visits). Included women and men, age 50–75 years, without a history of gastrointestinal tract cancers.
EHR, electronic health record.

11.1%; aOR=1.2; 95% CI 0.9 to 1.5). The presence of an EHR did not modify the difference in cervical cancer screening orders between white and non-white patients (p=0.75).

There were 21 million (10.3% of all eligible visits) Pap smear orders at visits to clinics without e-reminders and 42 million (12.3% of all eligible visits) Pap smear orders at visits to clinics with e-reminders. There was no difference in the odds of cervical cancer screening orders between non-white and white patients at clinics with (13.8% vs 11.9%; aOR=1.2; 95% CI 0.9 to 1.5) or without (11.9% vs 9.9%; aOR=1.2; 95% CI 0.7 to 1.9) e-reminders. The presence of an e-reminder did not modify the difference in cervical cancer screening orders between white and non-white patients (p=0.98).

Colon cancer screening

We considered sigmoidoscopy and colonoscopy orders to be for colorectal cancer screening for patients aged 50–75 years without a history of gastrointestinal tract cancer. Sigmoidoscopy or colonoscopy was ordered in 1400 sample records representing 24 million estimated visits overall (2.3% of all eligible visits) (table 2). There were 12 million (2.2% of all eligible visits) sigmoidoscopy/colonoscopy orders at visits to clinics without EHRs and 12 million (2.5% of all eligible visits) orders at visits to clinics with EHRs. Overall, non-white (3.0% of all eligible visits) patients had 1.5 (95% CI 1.1 to 2.0) times the odds of having colon cancer screening orders placed than white (2.2% of all eligible visits) patients. There was no difference in odds of having colon cancer screening orders between non-white and white patients at clinics without EHRs (2.3% vs 2.2%; aOR=1.2; 95% CI 0.8 to 1.7). However, non-white patients had 1.8 (95% CI 1.1 to 2.8) times the odds of having colon cancer screening orders placed than white patients at visits to clinics with EHRs (3.8% vs 2.2%). The presence of an EHR did not modify the difference in colon cancer screening orders between white and non-white patients (p=0.17).

There were five million (2.4% of all eligible visits) sigmoidoscopy/colonoscopy orders at visits to clinics without e-reminders and seven million (2.6% of all eligible visits) orders at visits to clinics with e-reminders. There was no difference in odds of colon cancer screening orders between non-white and white patients at clinics without e-reminders (3.3% vs 2.2%; aOR=1.5; 95% CI 0.9 to 2.7). However, non-white patients had 2.1 (95% CI 1.2 to 3.7) times the odds of having colon cancer screening orders placed than white patients at visits to clinics with e-reminders (4.1% vs 2.2%). The presence of an e-reminder did not modify the difference in colon cancer screening orders between white and non-white patients (p=0.46).

DISCUSSION

To address the hope and fear of the impact of EHRs on racial disparities, we analyzed national cancer screening orders by race and the extent to which EHRs or e-reminders were associated with differences. We found small, potentially clinically insignificant differences in EHR and e-reminder availability by age, payment source, and income; we adjusted for these in the multivariable model. Non-white patients are just as likely as (for breast and cervical cancer), or are more likely (for colon cancer) than, white patients to have orders placed for cancer screening tests. For colon cancer, non-white patients were more likely to have screening orders placed than white patients at visits to clinics with EHRs or with e-reminders. For none of the screening modalities did the presence of EHRs or e-reminders modify the differences in screening orders between white and non-white patients.

Although the interaction between racial differences and the use of EHRs in cancer screening has not previously been examined, many previous studies have noted the variability in rates of cancer screening by race. The findings of these studies have been inconsistent, with some noting no difference and others noting disparities only for certain screening modalities (eg, white patients complete more colorectal cancer screening than non-white patients). Of note, these studies were mostly of screening prevalence, based on surveys of completion of appropriate cancer screening tests by patients. In our study, we analyzed the incidence of screening examination orders placed by physicians. For colon cancer, where white patients are more likely to complete screening examinations, we show that non-white patients are more likely to have screening orders placed, thus creating the potential for non-white patients to increase their rates of screening completion.

The origin of racial disparities in healthcare is multifactorial —systems, physicians, and patients are all responsible.[19] Providers' roles in these disparities result from multiple cognitive processes, including unconscious behaviors due to time constraints, information overload, and fatigue.[20] This may result in lower rates of screening recommendations to minorities; low rates of colorectal cancer screening are seen among black patients owing to lack of recommendation from primary care providers,[21] and among Latino patients owing to lack of awareness and inadequate counseling by their providers.[22]

There was a lack of consistency in EHRs and e-reminders in our results. This may reflect the complexity of the systems for cancer screening. For instance, many practices have established easy to navigate processes for breast cancer screening, and Pap smears are often ordered and completed during the same visit, not requiring complex systems for ordering or completion. However, endoscopies for colorectal cancer screening are often ordered during a routine clinic visit and are followed by a complex system in which the order translates to a completed examination. For colon cancer screening, despite having orders placed more often for non-white patients, white patients are more likely to complete an examination.[23] This reflects a breakdown in the system after the placement of the order by the physician. Racial disparities in completion of screening colonoscopies have been successfully reduced using non-HIT interventions, such as patient navigators.[24]

Given our findings, it may be that EHRs and e-reminders compel the physician to re-order incomplete screening examinations; this may be through such mechanisms as better organization of records, greater transparency of data, or active reminder systems. Interventions such as patient navigation have been shown to increase the rate of minority completion of these examinations, but are not available universally.[10 11 25] Given that EHRs are soon to be universally available, we should build systems that support equality in orders and also equality in examination completion.

There are limitations to our study. We use data that are the visit-based incidence of screening examination orders. While we attempt to exclude those orders that are not screening-related, we cannot judge whether orders are appropriate beyond age, gender, and medical history indications. There are many determinants of health that contribute to disparities in cancer screening; we have limited our analysis to the effect of race on the incidence of screening orders, given prior data showing disparities in prevalence of screening completion by race. There were high rates of non-reporting of race, which required using the NCHS imputed race variable, which has been validated for 'white', 'black' and 'other' racial categories.[26] We performed multiple comparisons with these data; however, the sample size is large. We note low overall screening order rates. Data are self-reported by the physician practice; however, more than half of the data are collected by trained US Bureau of the Census field agents, and NCHS does field audits for accuracy and clerical edits for quality control of the data.[26 27] Additionally, we do not have data on the way in which EHRs or preventive care reminders were used, just whether the practice had such functionality.

In conclusion, racial differences in orders for age-appropriate cancer screening examinations exist, but are inconsistent across screening examinations and whether the clinic has EHRs or e-reminders. Non-white patients are more likely to have orders placed for sigmoidoscopy or colonoscopy. For colon cancer screening, non-white patients visiting clinics with EHRs or e-reminders are more likely to have orders placed than white patients. The presence of EHRs or e-reminders did not modify the racial differences in screening orders for any of the screening modalities. Racial differences seen in the prevalence of completion of cancer screening are not a result of disparities in orders placed by physicians for these screening examinations. For those who hold hope for HIT, we found no evidence that EHRs and e-reminders ameliorate racial differences in cancer screening orders. On the other hand, our results provide reassurance to those who fear that EHRs and e-reminders might exacerbate racial disparities in cancer screening orders. Advances in the use of HIT, together with patient involvement and care management, have the potential to improve the quality of care and outcomes for all patients.

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