

Unequal Distribution of Screening Mammography Services by Race/Ethnicity and Health Insurance

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Abstract

Background: Black and Hispanic women are diagnosed at a later stage of breast cancer than white women. Differential access to specialists, diffusion of technology, and affiliation with an academic medical center may be related to this stage disparity.

Methods: We analyzed data from a mammography facility survey for the metropolitan region of Chicago, Illinois, to assess in part whether quality breast imaging services were equally accessed by non-Hispanic white, non-Hispanic black, and Hispanic women and by women with and without private insurance. Of 49 screening facilities within the city of Chicago, 43 facilities completed the survey, and 40 facilities representing about 149,000 mammograms, including all major academic facilities, provided data on patient race/ethnicity.

Results: Among women receiving mammograms at the facilities we studied, white women were more likely than black or Hispanic women to have mammograms at academic facilities, at facilities that relied exclusively on breast imaging specialists to read mammograms, and at facilities where digital mammography was available ($p < 0.001$). Women with private insurance were similarly more likely than women without private insurance to have mammograms at facilities with these characteristics ($p < 0.001$).

Conclusions: Black and Hispanic women and women without private insurance are more likely than white women and women with private insurance to obtain mammography screening at facilities with less favorable characteristics. A disparity in use of high-quality mammography may be contributing to disparities in breast cancer mortality.

Introduction

SCREENING WITH MAMMOGRAPHY is generally recognized as effective in reducing morbidity and mortality from breast cancer.^{1,2} Despite reporting similar mammography use,³ black and Hispanic women continue to be diagnosed at a later stage of breast cancer compared to white women,⁴ and this later stage is at least partly responsible for the greater breast cancer mortality experienced by black women in the United States when compared to white women.

In Chicago, Illinois, there is a particularly wide racial disparity in breast cancer mortality that has been increasing since the early 1990s.^{5,6} During this period, breast cancer mortality rates for black women in Chicago have remained fairly stable while the rates for white women have decreased substantially.⁵ In 2005, the breast cancer mortality rate for black women was 43.2/100,000, and the rate for white women was 21.8/100,000 (age-adjusted rate ratio = 1.98). The breast cancer

mortality disparity for Hispanic vs. non-Hispanic whites is difficult to evaluate because breast cancer mortality in Hispanics is generally underestimated.

This pattern suggests that black women have not benefited as much as white women have from the technologic advancements made in breast imaging, diagnosis, and treatment over the last two decades. A recently published article suggests that this may be a pattern for several cancers.⁷ One set of risk factors for the widening disparity in breast cancer mortality might relate to differences in the effectiveness of mammography in the early detection of breast cancer. Factors related to advantages of an academic medical setting, quality of mammogram interpretation, and quality of imaging could impact the extent to which a woman with a screen-detectable breast cancer benefits from the screening process.

The Metropolitan Chicago Breast Cancer Task Force (MCBCTF) was formed in 2007 to respond to the growing breast cancer mortality disparity and consists of advocates,

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physicians, administrators, researchers, and epidemiologists concerned with improving breast health (www.sinai.org/urban/summit/docs/Task%20Force%20Rpt_Oct%202007_FINAL.pdf). Because of the growing and uniquely large racial breast cancer mortality disparity in Chicago, we undertook a survey of mammography facilities in part to determine if specific facility attributes generally associated with higher-quality mammography were equally available to non-Hispanic white, non-Hispanic black, and Hispanic women and to women with vs. without private health insurance. Based on the available literature on factors that may impact mammography screening quality, we decided to examine three measures demonstrated to impact the quality of mammography: access to academic medical centers, access to radiologists who specialize in breast imaging, and access to digital mammography. Examples of evidence include:

- Breast radiologists working in academic settings have more opportunities to advance or sustain their level of mammogram interpretation accuracy beyond what is available to their counterparts at nonacademic facilities.⁸
- Radiologists who specialize in breast imaging are more successful in detecting early stage cancers than are general radiologists.^{9,10}
- Research has found that digital mammography is better than analog (film screen) mammography at detecting cancerous lesions in younger women and women with dense breasts.^{11,12}

There are other mammography facility practice characteristics that could potentially influence the quality of imaging, interpretation, and timeliness but for which evidence is lacking, and these factors are not examined here.

Materials and Methods

Recruitment of mammography centers

In order to determine what mammography facilities in 2007 existed in the metropolitan area that served Chicago residents, we compiled a list of mammography facilities certified by the Food and Drug Administration (FDA) from the website: www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfMQSA/mqsa.cfm. In order to maximize the probability of getting responses back from facilities, the survey was designed to be brief; it contained 35 questions and fit onto a single double-sided sheet of paper. We recruited our partners in the MCBCF to distribute the survey to their contacts in the radiology departments on the list. Once that method was exhausted, we asked the co-chairs of our Task Force to contact the chief executive officers of the medical centers for which we did not have any other access.

The survey, which was conducted in July–September 2007, took about 10 minutes to complete for someone familiar with the information. We asked facilities to provide information related to 2007 capacity and services, including the number of screening (bilateral mammograms performed on asymptomatic women) and diagnostic mammograms (mammograms performed on symptomatic women), whether digital mammography was offered, and the number of general radiologists and breast imaging specialists who read mammograms. The surveys were generally completed by staff members who were directly involved with the day-to-day workings of the

imaging departments. Mammography facility staff are generally able to provide raw numbers of screening and diagnostic mammogram volume by a simple query to a radiology or related database.

The survey included facilities throughout metropolitan Chicago; however, this article focuses on facilities within the city of Chicago, and, thus, suburban facilities have been excluded from the analysis. We identified and attempted to survey 49 mammography centers located geographically in the city of Chicago. One facility performed only diagnostic mammograms and was excluded from these analyses. Of the 48 facilities that provided screening mammograms, 40 facilities representing about 149,000 screening mammograms completed the survey and provided data on patient race/ethnicity. There were 6 nonresponding facilities that (according to state inspection records obtained by the authors) each operated a single licensed mammography machine. Two additional smaller (one mammography machine each), non-academic facilities were excluded because they did not provide data on race/ethnicity. Every major facility, including all academic (defined here as university-based) mammography centers and all city and county sites (located within city limits), are included in these analyses.

Mammography facility characteristics

Facilities were grouped into three categories: public; private, nonuniversity-based; and private, university-based. Facilities reported the number of general radiologists and breast imaging specialists interpreting mammographic studies. A breast imaging specialist was defined as a radiologist who dedicated at least 75% of his or her working time on breast imaging regardless of fellowship training. We also asked if facilities offered digital mammography in place of or in addition to conventional film screen mammography. In addition, facilities reported the percentage of patients who were black, who were Hispanic, and who had private health insurance in categories of <25%, 25%–49%, 50%–74%, and ≥75%.

Statistical analysis

We estimated polychoric correlations between variables pertaining to patient mix (race/ethnicity and private insurance), between variables pertaining to facility characteristics (facility type, reliance on specialists, and availability of digital mammography), and between patient mix and facility characteristics. Correlations were weighted by each facility's contribution to the total annual volume of screening mammograms across all facilities.

In order to estimate the number of screening mammograms performed separately in non-Hispanic black, Hispanic, and white patients at each facility, we used the midpoint of the racial/ethnic category reported by each facility (12.5%, 37.5%, 62.5%, and 87.5%). We assumed that the remaining proportion of patients who were not black or Hispanic were predominantly white, a reasonable approximation given that more than 95% of individuals in Chicago self-identify as either non-Hispanic black, non-Hispanic white, or Hispanic.¹³ We then multiplied each facility's annual number of screening mammograms by the estimated percentage of patients within each racial/ethnic subgroup. We used a similar process to estimate the number of screening mammograms performed

separately for patients with and without private health insurance.

We tabulated the number and percentage of facilities with specific facility service characteristics and the corresponding number and percentage of screening mammograms by facility service characteristic. In order to determine if the distribution of screening mammograms by facility service characteristic varied by patient race/ethnicity, we compared the number and percentage of screening mammograms performed in the three racial/ethnic groups stratified on facility characteristics. We performed similar analyses separately for women with and without private health insurance. We conducted chi-square tests of homogeneity in the distribution of facility characteristics by subgroup. Because all p values were highly significant because of the large number of mammograms performed, additional interpretation is based on the magnitude of the differences shown.

Sensitivity analyses. Using data collected on race/ethnicity and insurance status from the Illinois Annual Hospital Questionnaire (AHQ) (www.idph.state.il.us/about/hfcpb.htm), we estimated the percentage of non-Hispanic white patients vs. the percentage of Hispanic and nonwhite patients as a group. We also estimated the percentage of patients without private health insurance vs. the percentage of pa-

tients with private health insurance. Of the 49 Chicago mammography facilities surveyed, 32 were situated within hospitals, and another 6 facilities were affiliated with 1 of the 32 hospitals. Affiliates were assigned the information on ethnicity and insurance to be that of the referral hospital. There were 11 additional mammography facilities that were neither a hospital nor affiliated with a referral hospital and for which no data from the hospital questionnaire were available and used.

Data management and analyses were performed in SAS software version 9.1.3 (SAS Institute, Cary, NC) and Stata version 11 (StataCorp, College Station, TX).

Results

The distribution of facility characteristics ($n=40$), mammography machines ($n=75$), and screening mammograms (approximately 149,000) by facility characteristics are presented in Table 1. Whereas 23% of facilities in the city of Chicago were public facilities and 10% were private university-based facilities, 9% of screening mammograms were performed in public facilities, and 32% were performed in private university-based facilities. The three facility characteristics generally associated with higher quality were strongly correlated (Table 2): private university-based

TABLE 1. DISTRIBUTION OF SCREENING MAMMOGRAMS BY PATIENT MIX AND FACILITY CHARACTERISTICS FOR MAMMOGRAPHY FACILITIES LOCATED IN THE CITY OF CHICAGO ($N=40$ FACILITIES)

	Number of facilities (n=40)		Number of machines (n=75)		Number of screening mammograms (n~149,300)	
	n	%	n	%	n	%
patient mix						
% black						
<25	11	27.5	19	25	59,700	40
25-49	10	25	19	25	39,200	26
50-75	10	25	24	32	29,600	20
>75	9	22.5	13	17	20,800	14
% Hispanic						
<25	16	40	27	36	68,200	46
25-49	16	40	38	51	59,700	40
50-75	6	15	8	11	19,600	13
>75	2	5	2	3	1,900	1
% privately insured						
<25	20	51	28	38	39,700	27
25-49	5	13	10	14	13,100	9
50-75	5	13	10	14	27,400	18
>75	9	23	26	35	68,300	46
Missing	1		1			
Facility characteristics						
Facility type						
Public	9	22.5	13	17	14,000	9
Private, nonacademic	27	67.5	44	59	88,100	59
Private, academic	4	10	18	24	47,200	32
Dedicated mammographers						
None	12	30	18	24	35,400	24
Some	23	57.5	34	45	53,900	36
All	5	12.5	23	31	60,000	40
Digital mammography						
Yes	34	85	57	76	99,200	66
No	6	15	18	24	50,100	33.56

facilities relied to a greater extent on specialists and were more likely to offer digital mammography than other facilities (polychoric correlations=0.96, 0.83, respectively), and facilities offering digital mammography relied to a greater extent on specialists (polychoric correlations=0.70). Facilities that served a greater proportion of black patients were less likely to be academic, relied less on specialists, and were less likely to offer digital mammography (polychoric correlations = -0.41, -0.34, and -0.56, respectively) (Table 2). Correlations between proportion Hispanic and these same facility characteristics were in the same direction but were more modest (Table 2). Facilities that served a greater proportion of not privately insured patients were also less likely to be private university-based facilities, to rely on specialists, and to offer digital mammography (Table 2).

The distribution of screening mammograms by race/ethnicity is shown in Table 3. Mammograms performed on white women were considerably more likely than those performed on black or Hispanic women to occur at private university-based facilities (47% vs. 23% and 26%, respectively, $p < 0.001$); facilities that relied solely on breast imaging specialists (64% vs. 26% and 33%, respectively, $p < 0.001$); and facilities with digital mammography (52% vs. 22% and 29%, respectively, $p < 0.001$) (Table 3). Mammograms performed on privately insured patients (vs. uninsured or publicly insured patients) were more than four times more likely to occur at private university-based facilities (48% vs. 10%); four times more likely to occur at facilities that relied solely on breast imaging specialists (58% vs. 15%), and four times more likely to occur at facilities with digital mammography (49% vs. 13%) (all $p < 0.001$) (Table 4).

Sensitivity analyses. Using AHQ data on race/ethnicity and health insurance in place of mammography facility survey data when available, differences were attenuated but qualitatively similar. Mammograms performed on nonwhite women were considerably less likely than those performed on white women to occur at private university-based facilities (31% vs. 42%, respectively); facilities that relied solely on breast imaging specialists (38% vs. 65%); and facilities with digital mammography (36% vs. 61%, respectively) (p value from Pearson's chi-square test = 0.000 for each). Using AHQ data on health insurance in place of mammography facility survey data when available, differences were again attenuated but qualitatively similar. Mammograms performed on women without private health insurance were less likely than those performed on women with private health insurance to occur at private university-based facilities (18% vs. 44%, respectively); facilities that relied solely on breast imaging

specialists (40% vs. 31%); and facilities with digital mammography (26% vs. 60%, respectively) (p value from Pearson's chi-square test = 0.000 for each).

Discussion

We found that there were differences in features of screening mammography associated with better quality that favor white women and women with private insurance in Chicago. These features included access to academic (defined here as private university-based) facilities, breast imaging specialists, and digital mammography. It is important to note that our study was not designed to examine differences in interpretive performance, usually measured in terms of sensitivity and specificity of screening mammography in ruling in or ruling out breast cancer. Much of the prior research regarding variation in interpretive performance has come from two analyses of data from the Breast Cancer Surveillance Consortium (BCSC).^{14,15} One analysis found that facilities serving more vulnerable populations (defined as lower income, lower education, rural, and minority) performed screening mammography with slightly better specificity and equivalent sensitivity when compared to other facilities.¹⁴

The BCSC findings may not be generalizable to Chicago because of either differences in population structure or structure of healthcare for vulnerable populations. Chicago has a large and highly segregated urban black population and a large and growing urban Hispanic population. The city's combined proportion of non-Hispanic black (35%) and Hispanic (29%) residents far exceeds the proportion of minority individuals included in the BCSC sample, which includes both rural and urban populations from diverse regions of the United States. In addition, economic differences exist among black, white, and Hispanic households within the city of Chicago. In 2005, 32% of non-Hispanic blacks and 22% of Hispanics were below the federal poverty level compared to only 9% of whites.¹³ Consistent with these percentages, we found that black and Hispanic women in Chicago were more likely than their white counterparts to rely on publicly funded facilities for mammography. These facilities are likely to have fewer resources available to ensure high-quality breast imaging, interpretation, and tracking of patients to ensure timely diagnostic follow-up.

Digital mammography may be better at detecting cancerous lesions in younger women and women with heterogeneously or extremely dense breasts.¹² The observed disparity in access to digital mammography in Chicago may play a part in disparities in stage at diagnosis, especially because black and Hispanic women tend to be diagnosed at an earlier age

TABLE 2. POLYCHORIC CORRELATIONS BETWEEN FOUR-CATEGORY, ORDINAL PATIENT MIX VARIABLES WITH ORDINAL AND BINARY FACILITY CHARACTERISTIC VARIABLES

	% Black	% Hispanic	% Privately insured	Academic facility	Reliance on specialists
% Hispanic	-0.06				
% Privately insured	-0.21	-0.52			
Academic facility	-0.41	-0.28	NC		
Reliance on specialists	-0.34	-0.17	0.71	0.96	
Digital mammography	-0.56	-0.25	0.86	0.83	0.70

NC, estimation did not converge, Pearson correlation = 0.63.

TABLE 3. DISTRIBUTION OF SCREENING MAMMOGRAMS ($n \sim 149,000$) BY RACE/ETHNICITY AND FACILITY CHARACTERISTICS IN CHICAGO, ILLINOIS

	<i>White</i>		<i>Black</i>		<i>Hispanic</i>	
	n	%	n	%	n	%
Facility type***						
Public	1,500	3	7,200	12	5,300	12
Private, nonacademic	23,400	50	37,500	64	27,200	62
Private, academic	22,000	47	13,600	23	11,700	26
Dedicated mammographers***						
None	11,700	25	13,300	23	10,400	23
Some	5,000	11	29,800	51	19,100	43
All	30,200	64	15,200	26	14,700	33
Digital mammography***						
No	22,300	48	45,500	78	31,400	71
Yes	24,600	52	12,700	22	12,800	29

*** $p < 0.0001$.

and with more aggressive breast cancer than their white counterparts.¹⁶

In our survey, academic facilities were more likely than nonacademic facilities to have digital mammography and to rely solely on breast imaging specialists when interpreting mammograms. Radiologists who specialize in breast imaging are more successful in detecting early stage cancers than are general radiologists.^{9,10} We believe that access to breast imaging specialists is probably the single most important contributor to effective mammography screening. In addition, breast imaging specialists working in academic settings have more opportunities to advance or sustain their level of mammogram interpretation accuracy beyond what is available to their counterparts at nonacademic facilities.⁸

Limitations

There are several limitations to these analyses. We structured the survey to be short and easy to complete and in the process sacrificed some precision in our questions, particularly with respect to the distribution of race/ethnicity and health insurance status. Data on race/ethnicity and private health insurance were requested in broad categories and were based on facility self-reports that were completed by individuals with a range of responsibilities within clinics. When we inserted data on race/ethnicity and health insurance from the AHQ in place of the same data collected from the mammography facility survey, differences were attenuated, but our conclusions remained unchanged: mammograms performed on minority women and women without private health insurance were less likely than those performed on white women and women with private health insurance to occur at academic facilities, at facilities that relied solely on breast imaging specialists, and at facilities with digital mammography. Neither source of information is completely accurate. In both instances, we would expect misclassification of patient mix to be nondifferential with respect to facility characteristics, which would tend to attenuate true differences. Despite this likely tendency toward attenuation, we still found substantial differences in access to facility service characteristics between white and minority patients and women with and without private insurance.

With regard to digital mammography, many facilities are in the process of converting from analog to digital mammography, and these facilities often have both analog and digital mammography in use. For these facilities, we attached the attribute of access to digital mammography to all mammograms done at these facilities. Therefore, the percentage of mammograms that were performed as digital mammogram will be less than the reported percentage of mammograms obtained in facilities with digital mammography.

To keep the survey brief and to maximize response rates, we did not attempt to measure individual attributes of reading radiologists. Greater mammography reading volume by radiologists may be associated with higher reading sensitivity, although this has not been shown consistently.^{9,17-20} On the other hand, greater number of years of experience in interpreting mammograms has been associated with more false negative interpretations.^{8,9,21} Radiologists who spend a greater proportion of their time in breast imaging, who are more recently trained, and who perform breast biopsies tend

TABLE 4. DISTRIBUTION OF SCREENING MAMMOGRAMS ($n \sim 149,000$) BY HEALTH INSURANCE STATUS AND FACILITY CHARACTERISTICS IN CHICAGO, ILLINOIS

	<i>Private insurance</i>		<i>No private insurance</i>	
	n	%	n	%
Facility type***				
Public	3,400	4	10,600	17.1
Private, nonacademic	42,000	48.4	45,300	73.3
Private, academic	41,300	48	5,900	10
Dedicated mammographers***				
None	14,800	17.1	19,800	32.1
Some	21,200	24.5	32,700	52.9
All	50,700	58	9,300	15
Digital mammography***				
No	44,600	51.4	53,900	87.2
Yes	42,200	49	7,900	13

*** $p < 0.0001$.

to read mammograms with greater accuracy and higher sensitivity.⁸ Nonetheless, specialization in breast imaging, which was measured, is perhaps the most important single radiologist characteristic influencing mammogram interpretation accuracy.

Black and Hispanic patients are more likely than white patients to be diagnosed with more aggressive tumor subtypes that are higher grade and that lack expression of estrogen and progesterone receptors, including basal-like tumors.^{16,22–27} These aggressive tumors, in turn, are less likely to be detected on routine screening mammography and more likely to arise as so-called interval cancers between scheduled screens.²⁸ As a result, even if access to high-quality mammography screening were uniform, black and Hispanic patients might still be less likely to have their cancer detected through screening.

There are other potential explanations for the breast cancer mortality disparity. Mammography screening tends to be lower in black and Hispanic compared to white women.²⁹ Racial/ethnic disparities in access to timely and high-quality treatment could also contribute to mortality disparities. In addition, black and Hispanic patients are more likely than white women to be diagnosed with more aggressive tumors that are less responsive to treatment.^{16,22–27} The pattern of mammography facility characteristics in Chicago suggests that black and Hispanic patients do not have the same level of access to the standard of care with regard to mammography screening, and this disparity in access to high-quality mammography may be worsening disparities in breast cancer mortality in the city.

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Disclosure Statement

The authors have no conflicts of interest to report.

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