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Screening Mammography Need, Utilization and Capacity in Chicago: Can We Fulfill Our Mission and Our Promises?

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1. Introduction

There is a widening Black:White breast cancer mortality disparity in Chicago (Figure 1). In 1980 the mortality rates were equal; by 2005 Black women were nearly twice as likely to die from breast cancer (Ansell et al, 2009; Whitman et al, 2011). This disparity has been increasing since the early 1990's because the breast cancer mortality rates for Black women in Chicago have remained constant while the rates for White women have decreased substantially (Whitman et al, 2011). Additionally, this disparity in Chicago is unusually high. For example, in 2005 the breast cancer mortality rate for Black women in Chicago was 43.2 per 100,000 population and the rate for White women was 21.8 per 100,000 population (Whitman et al, 2011). This equates to a rate ratio of 1.98 (43.2/21.8) which is interpreted by stating that in 2005 Black women were 98% more likely to die from breast cancer than White women in Chicago. More recent data suggests that Black women in Chicago are 62% more likely to die from breast cancer using the 2005-2007 three-year average (38.3/23.6=1.62) (Figure 1). Disparities are seen in other cities as well. For example, in New York City the Black:White breast cancer disparity in 2005 was 37% (Whitman et al, 2011). These data suggest that Black women in Chicago are not benefiting from the technological advancements that have been made in early detection and treatment over the last two decades (Berry et al, 2005; Smith-Bindman et al, 2006; Tehranifar et al, 2009).

In response to such data, health care providers, researchers, community leaders, educators, administrators and breast cancer survivors joined efforts to devise a strategy to eliminate the breast cancer mortality disparity in the Chicago area. As a result of a call to action, 111 individuals from 74 local institutions formed three working groups focusing on access to mammography, quality of the diagnostic process, and access and quality of breast cancer treatment. These three groups formed the Metropolitan Chicago Breast Cancer Task Force and outlined a plan consisting of 37 actionable recommendations to decrease breast cancer mortality for the metropolitan area of Chicago (Ansell et al, 2009; Metropolitan Chicago Breast Cancer Task Force [Task Force], 2007).

One of the three main goals of the Task Force was to implement interventions to increase the number of age-eligible women in Chicago who obtain regular screening mammograms. At

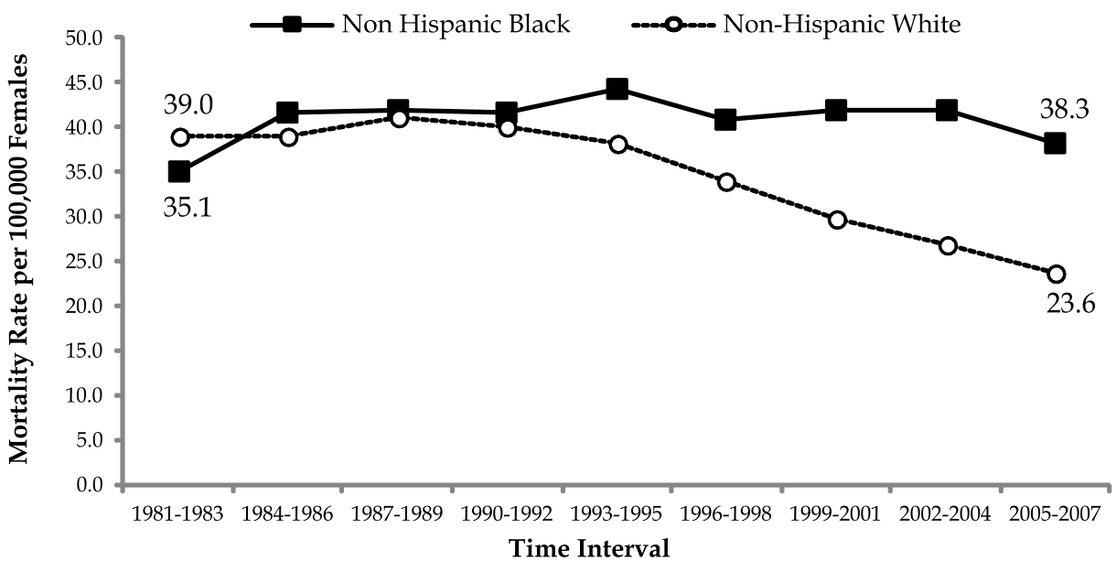

Fig. 1. Age Adjusted Female Breast Cancer Mortality Rates, Chicago, By Race, 1981-2007.

an early point we asked ourselves: If our efforts were successful in increasing the number of women who wanted to obtain mammograms, would there be adequate capacity? We thus began an inquiry to determine what this capacity was in Chicago. Researchers in the city did not know the answer to this question. Neither did advocacy groups. We were surprised that such a number was not even partially established for Chicago so we turned to other large cities. We were then more surprised that we were not able to find even one city that had an estimate of mammography capacity that might be useful in understanding the situation in Chicago.

Given this general lack of information the Task Force thus decided to undertake a study of mammography screening capacity in Chicago. The purpose of this chapter is to report the results from a survey of such mammography facilities in order to estimate and compare potential need for screening mammography, utilization, and current capacity for screening mammography in the third largest city in the United States. To our knowledge this is the first such analysis of capacity for a major urban area in the United States.

2. Methods

2.1 The survey instrument

The mammography capacity survey, which was conducted July – September 2007, contained 31 questions (Figure 2.), and was designed to take about 10 minutes to complete for someone familiar with the information. We asked facilities to provide information related to 2007 capacity, including the number of screening and diagnostic mammograms performed per month, hours of operation, number of machines, number of imaging technologists and radiologists interpreting mammograms, and the level of difficulty maintaining staffing.

2.2 Recruitment of mammography centers

In order to determine what mammography facilities existed in Chicago, we compiled a list of certified mammography facilities (U.S. Food and Drug Administration [FDA], 2007). We searched the FDA website by zip codes beginning with "606" which designates the city of Chicago. At the time of the survey there were no operating mobile mammography units, thus none were surveyed.

Each facility received a cover letter stating the purpose of the Task Force, the purpose of the survey and the expectation of confidentiality. We mailed the letter along with a copy of the survey and waited two weeks. As expected few centers responded to an unsolicited letter requesting information about their mammography facility. For facilities that did not respond within the 2 weeks, we recruited partners in the Task Force to distribute the survey to their contacts or colleagues in the radiology departments on the list. This round of efforts improved the response rate substantially but still not enough. We next solicited the help of three prominent health care leaders in the city who also serve as the co-chairs of the Task Force. They were able to stimulate several more institutions to complete the surveys.

In the end we identified and attempted to survey all 49 FDA certified mammography centers located in Chicago. The overall response rate was 88% (43 out of 49). Every major institution responded. There were 6 non-responding sites according to state inspection records obtained by the authors each of which operated a single licensed mammography machine.

2.3 Estimating potential need for screening mammography

We estimated potential need for screening mammography as a function of the estimated number of female residents of Chicago aged 40 or older according to the 2000 United States Census (http://factfinder.census.gov) (577,609) (Unites States Census Bureau, n.d.), and current guidelines which typically recommend a screening mammogram every year or every other year for women aged 40 and above (American Cancer Society, 2009; Lee et al, 2010; Humphrey et al, 2002; U.S. Preventive Services Task Force, 2009). Need according to the recommendation for annual mammography was simply the number of age-eligible women residing in Chicago, and need according to biennial recommendation was equal to the number of age-eligible women divided by two.

2.4 Estimating mammography utilization (volume)

Facilities were asked to report separately on the number of screening and diagnostic mammograms performed in an average month. For the six non-responding Chicago sites, we estimated the numbers of screening and diagnostic mammograms based on the mean values for participating facilities obtained after excluding the larger academic centers.

Mammography volume was calculated based on the responses to the question: "How many screening mammograms does this facility perform approximately per month?" This number was then divided by the site specific number of days open for mammograms. Consistent with previous reports, volume was then sub-divided into 3 categories: High, Medium and Low. High Volume was defined as 15 or more mammograms performed each day, Medium Volume was 5-14 mammograms per day and Low Volume included centers that performed 4 or fewer mammograms per day (Houn & Brown, 1994; Hendrick et al, 2005).

2.5 Estimating mammography maximum capacity

We estimated each facility's maximum capacity by using the 2006 Government Accountability Office (GAO) definition of maximum capacity that assumes that three mammograms can be performed per machine per operating hour (U.S. Government Accountability Office [GAO], 2006). We defined "maximum GAO screening capacity" as three times the number of mammography machines, times the number of hours open, multiplied by the proportion of all mammograms that were for screening. For non-responding facilities, we estimated the number of machines, number of hours open, and maximum capacity based on information available on participating non-academic facilities.

2.6 Staffing difficulties

Our survey also asked questions about difficulties in staffing open positions in imaging. Difficulty was categorized as such: much, moderate, none, and did not have to recruit new staff).

2.7 Classifying mammography centers

We asked the affiliation of every site filling out the survey. Sites were classified as academic if they reported a university affiliation with a medical school. Academic institutions in Chicago are larger and may have more resources than non-academic institutions due to grant opportunities, endowments, payer mix, etc. The survey also requested information on whether each facility made available a variety of breast screening and diagnostic procedures, imaging staff, the ability to interpret mammograms on site, the ability to offer same day results or procedures and general demographics of patients such as insurance status and race/ethnicity.

2.8 Statistical analysis

Data were entered into a Microsoft Access database and then analyzed in SAS (v. 9.0).

3. Results

In most cases (77%) the surveys were completed by staff members who were directly involved with the day to day workings of the imaging departments. Of the n=43 completed surveys, 12% of the sites (n=5) had senior management, consisting of executive directors and department heads, complete the survey. Forty-seven percent were directors or managers of breast imaging or general imaging (n=20), 14% were either radiologists or nurse practitioners (n=6), 9% were lead technologists (n=4), 7% were non-lead technologists (n=3), and 12% were data analysts or clerks (n=5). (Data not Shown).

3.1 Potential need for screening mammography

According to the 2000 U.S. Census, there were approximately 578,000 female residents of Chicago aged 40 or older. In order for every age-eligible woman in Chicago to obtain annual screening mammography there would need to be 578,000 screening mammography slots or appointments available, and one half of that or 289,000 slots or appointments in order for every age-eligible woman in Chicago to obtain a mammogram every two years.

	Total For Chicago
Number of Centers	49 [a]
Annual Screening Mammographic Need [b]	577,609
Biennial Screening Mammographic Need [c]	288,805
Number of Screening Mammograms (Utilization/Volume)	176,214
Number of Total Mammograms (Utilization/Volume)	254,850
Maximum Capacity for Screening using GAO (2006) Estimation [d]	492,879

[a] 43 facilities responded to the survey; totals for the remaining 6 were estimated
[b] defined as female residents of Chicago aged 40 and over
[c] defined as female residents of Chicago aged 40 and over divided by 2
[d] Government Accountability Office

Table 1. Estimated Mammography Utilization, Capacity, and Need for Chicago, 2007.

3.2 Mammography utilization (volume) compared with potential need

Table 1 presents the screening mammography need, utilization, and capacity. In 2007, an estimated 176,214 screening mammograms were provided by Chicago facilities. If one assumes, consistent with several recommendations (American Cancer Society, 2009; Lee et al, 2010), that all women 40 years of age and older should have an annual mammogram then the estimated screening mammography volume (176,214) represents 31% of eligible women or "need" (577,609). If one instead assumes, consistent with other recommendations (Humphrey et al, 2002), that all women age 40 and over should have a mammogram every two years then the "need" is halved (288,805) and the estimated screening mammography volume represents 71% of eligible women or "need".

3.3 Mammography capacity compared with potential need

According to the GAO-defined maximum capacity based on their 2006 revised definition that assumes 3 mammograms can be performed on one machine in an hour (GAO, 2006), there are 492,879 available screening mammography slots or appointments in the City of Chicago. This represents roughly 85% the "need" or number of age-eligible for annual screening (women 40 and over) women in Chicago (approximately 578,000) and 170% of the "need" or age eligible women for biennial screening (all women 40 and over divided by 2).

3.4 Difficulty recruiting mammography staff

More than one third (37%) of all facilities reported some difficulty in recruiting mammography technologists or radiologists, corresponding to one third (32%) of screening mammograms performed across these facilities (Table 2). One quarter of facilities representing one of every five screening mammograms reported difficulty hiring technologists, while a fifth of all facilities representing one quarter of screening mammograms reported difficulty hiring radiologists. Most notably, while only 1 in 10 facilities reported difficulties recruiting breast imaging specialists, they accounted for nearly one of every 5 mammograms performed (Table 2).

A city wide task force was assembled in March of this year to address the unacceptable disparity in breast cancer mortality by race in Chicago. This task force is compiling a list of recommendations to be released on October 17, 2007 to address the issues related to Access to and Quality of Mammography as well as Access and Quality of Treatment for breast cancer. In order to ensure that our recommendations are in line with mammography capacity in Chicago we need your help. We are asking you or someone knowledgeable within your institution to complete this brief survey and return this form as soon as possible.

These data will be used to further guide our recommendations to improve breast health for all women in Chicago. We will not present or publish information from individual facilities or institutions either as part of the task force or elsewhere. Your name and the names of any colleagues will not be published in this report and will remain confidential. We will only use your name and contact information if we have further follow-up questions.

Thank you in advance for helping to fill in this important picture of access to mammography in Chicago.

Instructions: Please fill out ONE form for EACH mammography facility at your institution, for your convenience we have typed in the names of the facilities which we are interested in learning more about.

Facility name: _____
Address: _____
City:_____ ZIP: _____
Institution affiliation (if any): _____
Name of person(s) completing this questionnaire: _____
Position or title(s):_____

Capacity:

1. How many hours is this facility open Monday-Friday? _____
2. How many hours is this facility open on the weekend? _____
3. How many mammography machines do you have at this facility? _____
4. How many imaging techs do you have who are dedicated to mammography (>75% of time spent on mammograms)? _____
5. How many imaging techs does this facility have who spend <75% of their time on mammography? _____
6. How many radiologists who specialize in mammography (e.g. dedicated to mammography) does this facility have? _____
7. How many general radiologists who read mammograms does this facility have? _____
8. How many screening mammograms does this facility perform:
9. approximately _____ per month?
10. How many diagnostic mammograms does this facility perform:
    approximately _____ per month?

Fig. 2. Mammography Facility Survey.

11. Roughly what percentage of your patients have private insurance?
☐<25% ☐25-49% ☐50-75% ☐ >75%
12. Roughly what percentage of your patients are African American?
☐ <25% ☐25-49% ☐ 50-75% ☐ >75%
13. Roughly what percentage of your patients are Latina/Hispanic?
☐<25% ☐ 25-49% ☐ 50-75% ☐ >75%
14. Roughly what percentage capacity is your facility at now?
☐ <25% ☐ 25-49% ☐ 50-74% ☐ 75-89% ☐ 90-99% ☐100%

Does your facility routinely	Never	Rarely	Sometimes	Often	Always
15. Read mammograms on site at your facility?	☐	☐	☐	☐	☐
16. Read films on the same day so that the patient can leave with the results?	☐	☐	☐	☐	☐
17. Routinely double-read mammograms with suspicious findings?	☐	☐	☐	☐	☐
18. Routinely double-read all mammograms?	☐	☐	☐	☐	☐
19. Provide computer-aided detection (CAD) for suspicious mammograms findings?	☐	☐	☐	☐	☐
20. Provide computer-aided detection (CAD) for all screening mammograms?	☐	☐	☐	☐	☐

Does your facility offer:

21. Diagnostic mammography?	☐Yes	☐No
22. Breast ultrasound?	☐Yes	☐No
23. Digital mammography?	☐Yes	☐No
24. Breast magnetic resonance imaging?	☐Yes	☐No
25. Breast nuclear medicine scanning?	☐Yes	☐No
26. Biopsies after a diagnostic mammogram?	☐Yes	☐No
27. Biopsies carried out during the same visit?	☐Yes	☐No

Over the last year how much difficulty have you had staffing…	Much difficulty	Moderate Difficulty	No difficulty	Did not have to recruit new staff
28. Dedicated mammography technicians	☐	☐	☐	☐
29. X-ray technicians who perform some mammograms	☐	☐	☐	☐
30. Dedicated mammography radiologists	☐	☐	☐	☐
31. General Radiologists who read mammograms	☐	☐	☐	☐

If we need to ask follow-up questions, please provide the name and phone number of the person we should contact:

Name:_____Phone number:_____

Fig. 2. Mammography Facility Survey (continued).

Difficulty Hiring	% Facilities (N=43)	% Screening Mammograms (N=159,612)[b]
Mammography Technicians or Radiologists	37	32
Mammography Technicians	26	19
Dedicated Mammography Technicians	12	10
General Mammography Technicians	23	12
Breast Radiologists	19	26
Dedicated Breast Radiologists	10	19
General Breast Radiologists	14	13

[a] Difficulty defined as much/moderate difficulty vs. no difficulty/did not need to recruit staff.
[b] Does not include non-responding sites (n=6)

Table 2. Difficulty[a] Recruiting Mammography Staff for Chicago, 2007.

3.5 Characteristics of mammography centers

Table 3 presents the characteristics of the Chicago facilities with completed surveys and also demonstrates how these characteristics are distributed according to facility volume (Low, Medium, High; see Methods). Because the number of facilities in each category is small we omit tests of significance. However, several of the trends suggest strong relationships.

As Table 3 indicates, in 2007 the 43 responding Chicago facilities (out of a total of 49) performed about 160,000 screening mammograms. Sixty-eight percent of the mammograms performed by the 43 responding Chicago facilities were performed at High Volume facilities. On average the High Volume centers performed 8,400 screening mammograms per site, whereas the Medium Volume centers performed 2,704 and the Low Volume centers performed 785.

The facilities are open for an average of 45 hours per week (range = 4 hrs – 90 hrs) and more than half offer weekend hours. They reported employing a total of 160 radiologists who read screening mammograms, of whom 36% are dedicated mammography radiologists (interpreting mammograms or conducting breast procedures for >75% of working hours). The mean number of dedicated radiologists per institution (1.3 overall) was highest for High Volume facilities (2.6). These institutions reported the use of 84 mammography machines with the highest average per institution again being for High Volume facilities.

About 16% of these facilities reported an academic affiliation, more than half of them occurring at High Volume facilities. A majority of facilities offer diagnostic services (67%) and interpret mammograms on site (79%) while smaller proportions offer same day results (23%) or same day biopsies (30%).

About a quarter of these facilities serve a high proportion (>75%) of patients with private insurance, including almost half of the High Volume facilities. Forty-two percent of the

facilities serve a majority Black population and this proportion is highest at Low Volume facilities. Nineteen percent of the facilities serve a majority Hispanic population and this proportion is highest at Medium Volume facilities.

4. Discussion

The results of this unique survey show that the current available capacity for screening mammography in Chicago, as measured in terms of available mammography machines, is not adequate to meet the need of screening all Chicago residents (Table 1). In addition, there appear to be substantial issues pertaining to recruitment of staff needed to perform activities necessary to achieve this capacity (Table 2).

The other important set of observations (Table 3) revolves around the many differences in the characteristics of Low, Medium and High Volume facilities. High Volume facilities (those doing $\geq$ 15 screening mammograms/day) were different in many ways from Low ($\leq$4/day) and Medium (5-14/day) Volume facilities (Table 2). High Volume facilities are open more hours, have a greater proportion of radiologists who are dedicated to mammography, more often have academic affiliations and serve a greater proportion of patients with private insurance. They are also less likely to serve patient populations who are majority Black or Hispanic. These differences are most stark when comparing High Volume facilities with Low Volume ($\leq$ 4/day) facilities. Literature suggests that both volume and academic affiliation may be associated with higher quality (Esserman et al, 2002; Barlow et al, 2004; Woodward et al, 2002; Sickels et al, 2002; Miglioretti et al, 2007).

There is some confusion in vocabulary in the few existing capacity studies and we would thus like to spell out some concepts and terminology before proceeding with a contextualization of our findings. *Need* for screening mammography is both a function of the number of women aged 40 or over (which is a function of the size of the population and its age structure), the screening rate and the accepted recommendation for the frequency of screening mammography (e.g., every year or every two years). *Utilization (Volume)* is in turn a function of capacity, education and outreach, geographic distribution of machines, financial barriers and opportunities, etc. (Etling et al, 2009; Elkin et al, 2010; Schueler et al, 2008; Masi et al, 2008). Finally, *Capacity* refers to the potential supply of screening mammography and is a function of the number of available machines, the technology of the machines (e.g., analog or digital), and the numbers of available technologists and interpreters. Curiously, the number of mammography facilities is a frequently studied topic (Etling et al, 2009) but this is irrelevant to capacity and would be subsumed by consideration of the available number of machines.

Given this terminology let us examine in greater detail the screening mammography situation in Chicago. In 2007, 206,000 women received (utilized) screening mammograms. Depending upon which screening frequency recommendation one employs, this number may be compared with a potential annual need of 578,000 mammograms or 289,000 mammograms (Table 1). We see that the utilization of screening mammography in Chicago is far less than what is theoretically possible given that Chicago facilities can perform approximately 493,000 mammograms at full capacity.

We have been able to locate only a few peer-reviewed journal articles on the topic of capacity and utilization of screening mammography. Brown and colleagues published an

economic analysis which was conducted in 1990 (Brown et al, 1990). This study concluded that there was an excess supply of mammograms for the utilization at that time. However, two major events occurred since this publication that affect capacity. First, the Mammography Quality Standards Act (MQSA) was enacted in 1993 creating an infrastructure for quality (FDA, 2002). After the enactment of MQSA several facilities closed due to not being able to keep up with the standards (Eastern Research Group, 2001). Second, insurance companies began covering screening mammograms as part of routine care. Thus, mammography became available to more women (Institute of Medicine, 2005). The conclusion of this study is now 20 years old and has only decreasing relevance to the field.

The most prominent studies of capacity data revolve around the two main reports on this topic which are authored by the Government Accountability Office (GAO) in formats prepared for Congress. In 2002 the GAO (GAO-2002) prepared a report that evaluated capacity for the U.S. as a whole between 1998 and 2001 following the enactment of the Mammography Quality Standards Act (MQSA) (FDA, 2002).

The GAO-2002 report noted that even while the number of mammography facilities had decreased during this interval the number of technologists and machines had increased (GAO, 2002). At the same time the GAO cited signs that these increases were coming to a halt. The GAO also noted, "Although mammography services are generally available, women have problems obtaining timely mammography services in some locations. Most of the availability problems are in certain metropolitan areas . . ." (GAO, 2002, pp. 3). Chicago may be one of these areas but that remains unknown since the GAO did not present any estimates for cities.

The GAO issued the second report in 2006 (GAO-2006) to evaluate the potential capacity issues with possible facility closures related to MQSA that may have occurred between 2001 and 2004 and found that capacity was adequate in most places (GAO, 2006). In the GAO-2006 report facilities performing mammography, machines, and staff had all decreased since 2001 yet capacity remained sufficient (GAO, 2006). In addition, the GAO-2006 report noted that Illinois, and Cook County (which contains Chicago) in particular, was one of the areas which had significant facility closures. The reports conclude that low-income women may be most affected by these closures.

The picture painted in this report was more pessimistic than its predecessor. It noted that, "The numbers of mammography facilities, machines, radiologic technologists, and interpreting physicians decreased from 2001 to 2004" (GAO, 2006, pp. 4) even as the number of women seeking and receiving mammograms increased. The declines were 4% for machines, 3% for technologists, and 5% for physician mammogram interpreters, "usually radiologists." The report thus notes: "Although experts believe the nation's current overall capacity to provide mammography services is adequate, they are concerned that the numbers of radiologic technologists and radiologists entering the field might not be sufficient to serve the increasing population that will need mammography services" (GAO, 2006, pp. 21).

Indeed, other research has shown evidence of a shortage of radiologists who interpret mammograms and mammography technicians (D'Orsi et al, 2005; Lewis et al, 2006; D'Orsi, 2004). Our survey indicates that there was substantial difficulty filling open positions in breast imaging. For instance, nearly 20% of the responding facilities had difficulty filling open positions for any type of radiologist, 10% had some difficulty hiring dedicated

radiologists and 14% had difficulty hiring general radiologists. In addition, nearly 30% of the sites had difficulty filling open positions for dedicated mammography technicians or x-ray technicians (Table 2).

Although there are few studies in this field some have recently emerged in the literature indicating a potential growing interest in the topic. For instance Etling and colleagues conducted a study in Texas. This group researched mammography facility proximity by county and the correlates of self-reported mammography utilization and reported that there was unequal distribution of mammography facilities in Texas counties which impacted utilization of screening mammography in some areas (Etling et al, 2009). In Texas, the rural counties had fewer facilities within them and this in turn was correlated with higher late-stage breast cancers (Etling et al, 2009). The main limitations to this study are that the researchers did not analyze machine availability, just facilities, and the results are mainly applicable to a more rural population. Although the methods are different this study does illuminate a potential capacity issue locally.

Another way to examine Chicago's capacity for screening mammograms comes from a study by Elkin and colleagues. This study concludes that in order to have adequate capacity to meet the recommendation of annual screenings there needs to be more than 1.7 mammography machines for every 10,000 age-eligible women. The study further estimated that if the screening rate of 70% of the target population is the goal (per Healthy People 2010) then 1.2 machines per 10,000 age eligible women would be needed (Elkin et al, 2010; U.S. Department of Health and Human Services, 2001). As Table 3 indicates, there are 84 mammography machines serving Chicago. In addition, there are approximately 578,000 age eligible women in Chicago equating to 58 groups of 10,000 women (578,000/10,000=57.8). In order to provide mammograms to 100% of the age eligible women Chicago would need 99 machines (58*1.7 machines). If Chicago were to accomplish screening 70% of age eligible women (which is recommended by the U.S. Healthy People 2010) then 70 machines (58*1.2) would be needed according to Elkin and colleagues' calculations (U.S. Department of Health and Human Services, 2001; Elkin et al, 2010). If one assumes that all age eligible women should receive mammograms annually, then it seems clear that the current capacity in Chicago is not adequate. If however, one assumes biennial mammography for age eligible women, then capacity in Chicago is adequate.

Of course in this chapter we have only been analyzing the issue of capacity. Even if there were adequate capacity to screen all women in Chicago, and our findings suggest that there is not, many other questions arise with respect to utilization. These include issues of health insurance, outreach, education, etc. All in all the breast cancer screening capabilities seem hardly up to the task of accommodating all women for screening, which is the goal of many advocates and physicians in the city.

The question must then be posed whether we will soon be doing a disservice to women by urging them to obtain a mammogram only to be turned away because there are no appointments available for several months. The problem is already at hand in some cases in Chicago. For example, the waiting time for a screening mammogram appointment at one of the most prominent academic medical centers in the city is between 7-10 months (Deardorff, 2008a, 2008b). At the same time the city's only public hospital has stopped doing screening mammograms altogether, a loss of about 10,000 mammograms per year which were obtained by the most vulnerable women in the city. Access is thus being challenged at both ends of the socioeconomic spectrum.

Table 3. Distribution of Indicators by Capacity Category, n=43.

	Low ≤4/day	**Medium** 5-14/day	**High** ≥15/day	**Total**
Facilities, n	16	14	13	43
Screening mammograms provided*, n (mean)	12,552 (785)	37,860 (2,704)	109,200 (8,400)	159,612 (3,712)
Screening mammograms provided to Chicago residents, %	7.9%	23.7%	68.4%	100.0%
Maximum capacity for screening using GAO (2006), sum (mean)	5,379 (5,355)	113,573 (8,112)	231,684 (17,822)	431,319 (10,031)
Screenings per machine, mean (median)	761 (720)	1,992 (1,800)	2,980 (2,400)	1,833 (1,578)
Hours open per week, mean	36.8 hrs	44.4 hrs	56.5 hrs	45.4 hrs
Sites with weekend hours, n	4 (25.0%)	9 (64.3%)	10 (77.0%)	23 (53.5%)
Dedicated radiologists, n (mean)	9.0 (0.6)	15.0 (1.1)	33.5 (2.6)	57.5 (1.3)
General radiologists who read mammograms, n (mean)	27.0 (1.7)	47.5 (3.4)	28.0 (2.2)	102.5 (2.4)
Dedicated mammography technologists, n (mean)	17.0 (1.1)	26.0 (1.9)	101.5 (7.8)	144.5 (3.4)
X-Ray technologists who perform mammograms, n (mean)	18.0 (1.3)	19.5 (1.4)	62.0 (4.8)	99.5 (2.3)
Machines, n (mean)	17.0 (1.1)	20.0 (1.4)	47.0 (3.6)	84 (2.0)
Academic affiliation, n (%)	0 (0%)	3 (21.4%)	4 (30.8%)	7 (16.3%)
Offers diagnostic breast services (e.g.) diagnostic mammograms, Ultrasounds, MRI or Image Guided biopsy	7 (43.8%)	11 (78.6%)	11 (84.6%)	29 (67.4%)
Reads/interprets mammograms on site	8 (50%)	13 (92.9%)	13 (100%)	34 (79.1%)
Offers same day results (often or always)	2 (12.5%)	2 (14.3%)	6 (46.2%)	10 (23.3%)
Offers same day biopsy, n (%)	2 (12.5%)	0 (0%)	6 (46.2%)	8 (18.6%)
Patients with >75% with private insurance [a]	1 (6.7%)	3 (21.4%)	6 (46.2%)	10 (23.3%)
50% or more African American/Black patients [a]	9 (56.3%)	4 (28.6%)	5 (38.5%)	18 (41.9%)
50% or more Hispanic/Latino patients [a]	3 (18.8%)	4 (28.6%)	1 (7.7%)	8 (18.6%)

[a] Some responses were missing, thus not included in the denominator

4.1 Limitations

There are some methodological limitations to consider. First, we had to estimate important measures for non-responders such as mammography volume and capacity indicators (e.g., machines and hours of operation). However, the non-response accounted for only 9% of the Chicago screening volume. In addition, all non-responding sites were smaller community based hospitals (e.g., none were larger academic institutions). Thus, our estimation techniques could not have affected the contours of our analysis.

Second, all surveys were self-reported by facility representatives. There was thus a chance that some of the questions may have been interpreted in an idiosyncratic manner but it is not obvious how the summation of these interpretations would have influenced our results.

4.2 Recommendations for further consideration

It has been suggested that with looming staff shortages in the field of mammography, one may need to begin looking for ways to improve quality or efficiency. Some possible areas to explore are as follows:

- The Metropolitan Chicago Breast Cancer Task Force recommends that the state of Illinois offer some tuition reimbursement for the medical training of physicians willing to practice radiology, and specifically mammography, in underserved communities, where fellowship trained radiologists are lacking. Perhaps an incentive for repaying medical school loans for physicians choosing to practice in underserved areas in mammography may increase the dwindling mammography workforce (Bärnighausen & Bloom, 2009).
- Literature notes that independent double reading of mammograms improves the performance of a screening mammography program (Harvey et al, 2001). However, in the United States, it has been suggested that there is a radiologist shortage willing to interpret screening mammograms (D'Orsi et al, 2005; D'Orsi, 2004). One way to increase the workforce in mammography and improve quality is to increase the use of physician assistants, trained breast cancer nurses or highly skilled mammography technologists into a mammography practice. The literature suggests that these staff could be used as second readers or to complete administrative work such as communicating results with primary care clinics or following up with patients who have abnormal findings under the supervision of a radiologist (IOM, 2005; Duijum, 2007; Tonita, 1999). These staff may be able to increase the time a radiologist has to interpret mammograms and perform breast procedures, thus allowing each site to provide more mammograms.
- Centralizing or regionalizing either interpreting radiologists and/or a film library may begin to solve some of the bottlenecks in Chicago, thus freeing up machine space for more mammograms. Having radiologists interpreting mammograms in a centralized location allows sites that do not have access to a fellowship trained radiologist to have their mammograms interpreted by the best possible radiologist. In addition, having a universal film library will allow sites to gain access to their patients' prior films. Having prior films available for comparison to current films could prevent unneeded additional imaging (Burnside et al, 2002).
- Some facilities have reputations for high quality care and thus have high demand for all services they provide, including mammograms. This can lead to long wait times at

facilities to obtain a simple screening mammogram. In Chicago those wait times have been as high as 10 months for a screening mammogram appointment. A way to combat this problem is to have a centralized scheduling database that allows referring physicians to find open appointments for mammograms across the city. Although it is not ideal to have women obtain mammograms at multiple sites, coupled with centralized interpretations and storage this should make it easier on both physicians and patients. In addition, mammograms can be distributed throughout the city rather than clustered at a few facilities, thus utilizing all available capacity throughout Chicago.

- The only public hospital system in the Cook County area no longer provides screening mammograms due to budget cuts. This leaves about 10,000 uninsured and underinsured women without a mammogram. In addition, public clinics operated by the city of Chicago are not nearing capacity. If they do operate at capacity an additional 25,000 mammograms could become available to the most underserved women in Chicago and Cook County. Safety-net providers have stepped up to absorb the uninsured women into their routine screening population. However this places a large financial burden on these facilities, rather than spreading the burden to other area facilities. We propose that the Cook County public hospital system reopen screening mammograms for its patients and that other public facilities begin to operate at capacity. In addition, other area facilities must also begin managing these patients for breast and other services.
- Finally, insurance carriers reimburse at various rates, and most hover around the cost of the image. Public insurances also differ in how they reimburse for mammograms. Medicare, the insurance plan that older Americans use, reimburses slightly below the cost of a mammogram, whereas Medicaid, the insurance provided to the poorest Americans, reimburses at about half to three-quarters of the cost. For those who have no insurance, either the facility must enroll them in a state program which reimburses at the Medicaid rate or the facility must absorb the total cost. Most mammography facilities operate in a deficit or break even, thus leaving little room for upgrades or departmental improvements including upgrading equipment, elective training for staff or hiring assistants (Chen et al, 2004). All insurance carriers (including government insurance plans) must reimburse for the costs of these services so that these departments can be profitable enough to improve care and efficiency. Once mammography facilities become more fiscally sustainable, they may be able to absorb more patients without health insurance and thus provide more mammograms.

Without testing or implementing some of these strategies, we will constantly run up against limited capacity as a barrier to receiving mammograms.

5. Conclusions

The findings in this chapter suggest that there is currently inadequate screening mammography capacity in Chicago to screen all age eligible women annually. However there is adequate capacity to screen all age eligible women biennially. Given the existence of programs to increase access and the work of the Metropolitan Chicago Breast Cancer Task Force and other advocacy organizations seeking to increase education and outreach, women may continue to confront barriers when scheduling their annual mammograms.

This brings us back to the motivation for this survey – the large and growing racial disparity in breast cancer mortality in the city. There may be two driving forces with respect to screening mammography that are perpetuating this disparity. First, women may be delaying care for various reasons (usually financial or lack of insurance) leading to larger tumors being discovered at screening mammography (Rauscher et al, 2010). Not having insurance may also lead to women waiting for diagnostic services because they have no other choice. The second is that facilities may not have enough appointments available for the demand. As noted above, we know that two major institutions are already experiencing such problems. Community-based organizations and other agencies spend a lot of time and money navigating women to screening and working towards women receiving routine breast services. There are things facilities can do to promote regular screening and some facilities employ these tactics. However, these efforts will fail unless there are enough appointments available for women to get timely mammography services.

The chicken and egg relationship between supply and demand must be understood in this context. Is utilization as low as it is because women do not yet desire screening mammograms or is it because they have pursued them and been turned away because of insurance difficulties? Or is it because of very long waits? Are we indeed inadvertently limiting utilization by limiting capacity? These are questions that require answers. More generally, this is a problem that demands a solution.

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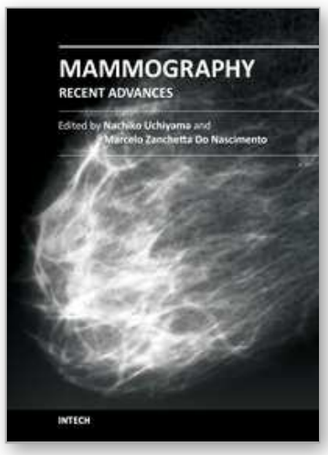

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In this volume, the topics are constructed from a variety of contents: the bases of mammography systems, optimization of screening mammography with reference to evidence-based research, new technologies of image acquisition and its surrounding systems, and case reports with reference to up-to-date multimodality images of breast cancer. Mammography has been lagged in the transition to digital imaging systems because of the necessity of high resolution for diagnosis. However, in the past ten years, technical improvement has resolved the difficulties and boosted new diagnostic systems. We hope that the reader will learn the essentials of mammography and will be forward-looking for the new technologies. We want to express our sincere gratitude and appreciation?to all the co-authors who have contributed their work to this volume.

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