Decreasing mammography capacity in the southern United States, 2002-2008

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Introduction

- Mammography reduces mortality and incidence of late-stage breast cancer. Evidence is strongest for women over 50.
- Heavily promoted in the 1970s, leading to prolific adoption in the 1980s
- Supply outstripped demand by 1990, driving up costs

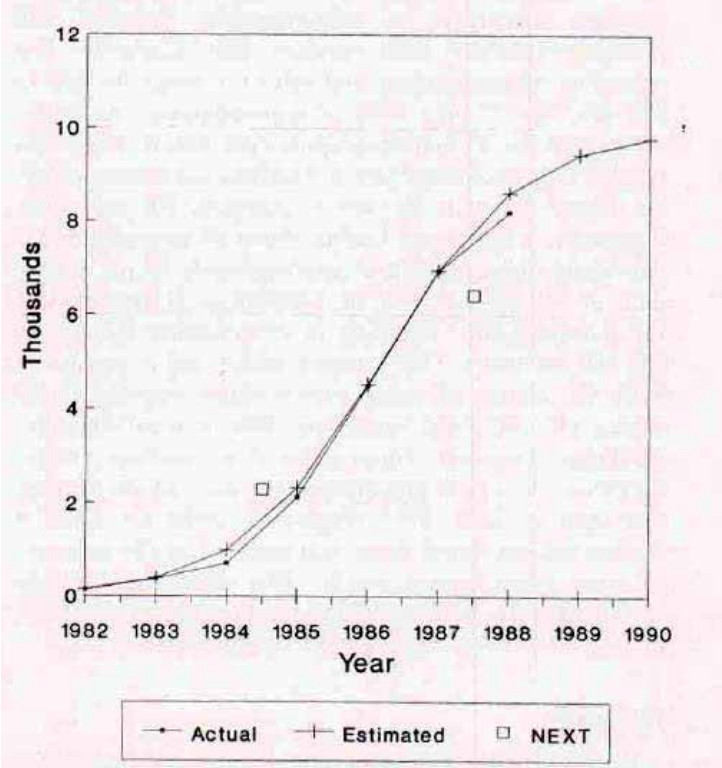


Figure 1. The number of mammography machines. NEXT = Nationwide Evaluation of X-Ray Trends.

Source: Brown et al, Ann Intern Med, 1990

Introduction

- Despite evidence of oversupply, complaints about access were prevalent.
- 2 GAO reports noted that while national capacity was adequate, some counties were losing machines.

Table 4: Counties Randomly Selected for Review from Those That Lost over 25 Percent of Their Mammography Machines from October 1, 2001, to October 1, 2004

Rural counties		Urban counties	
County	State	County	State
Navajo	Arizona	Houston	Alabama
Drew	Arkansas	Saint Johns	Florida
Putnam	Florida	Coweta	Georgia
Shiawassee	Michigan	Warren	Iowa
Newton	Mississippi	Butler	Kansas
Lewis and Clarke	Montana	Wayne	New York
Fulton	New York	Morton	North Dakota
Duplin	North Carolina	Pottawatomie	Oklahoma
Dickenson	Virginia	Lubbock	Texas

Source: GAO analysis, based on FDA's Mammography Program Reporting and Information System database.

Reasons for facility closures:

- Financial decision
- Relocation or merger
- Equipment problems
- Staffing problems
- Change in ownership
- Bankruptcy

Source: GAO-06-724, 2006

Introduction

- County-level capacity studies have been done in recent years.
  - Masks within-county variation and does not account for travel across counties
  - Most are focused on the epidemiologic association between capacity and screening utilization or late-stage diagnosis.

Marchick & Henson, Cancer, 2005
Elkin et al, Medical Care, 2010
Elting et al, American Journal of Preventive Medicine, 2009
Wang et al, Professional Geographer, 2008
Gumpertz et al, Cancer Causes & Control, 2006
Rahman et al, International Journal of Cancer Prevention, 2009

Introduction

- A small area assessment of capacity would help determine where pockets of over/under supply of mammography exist.
- Investigating supply and demand at the small area level considers:
  - Distance to, not just presence of, facilities
  - Crossing boundaries to seek mammography
  - Choice of facilities, not just the nearest one

Purpose

- Our goal was to determine the locations and extent of over/under supply relative to the demand for services in the south.
  - Longitudinal (2002-2008)
  - Multiple states
  - Spatially specific
- This information can assist in business planning and resource allocation.
  - Where should we send mobile units?
  - What areas should receive public funding?
  - What areas can support a for-profit facility?

Methods: Study region

- Capacity was measured for 14 southern states.
- To accurately measure capacity, we also used information from neighboring states.

Methods:
What is the supply?

- Data obtained from a FDA Freedom of Information Act Request
  - Facilities geocoded to address where possible; otherwise, zip code centroid
- Over 3,500 facilities were located in the study region or within a 1 hour drive into a neighboring state.
- Facilities were certified all or part of 2002-2008.

Methods:
What is the demand?

- Women aged 40+ represent potential mammography users.
  - Annual population estimates were obtained from *Geolytics Inc.*
  - Because we do not have the physical addresses of women 40+, we used the estimated population of women 40+ at the block group (BG) level. Weighted, BG centroids signified the locations of potential users.
  - We looked at a variety of potential utilization rates and screening intervals.

Methods: Geographic analyses

Determine spatial accessibility to services

(Two-step floating catchment area method; 2SFCA)

Categorize into levels of capacity (4 levels)

Methods: Determining spatial accessibility

- Constructed 60 minute catchment areas around facilities within the study region and its neighboring states using road network data.
- Step 1 of the 2SFCA: calculate a supply-demand ratio for each facility(F_i):

$$\frac{\text{Number of machines}}{\text{Number of women 40+}/x}$$

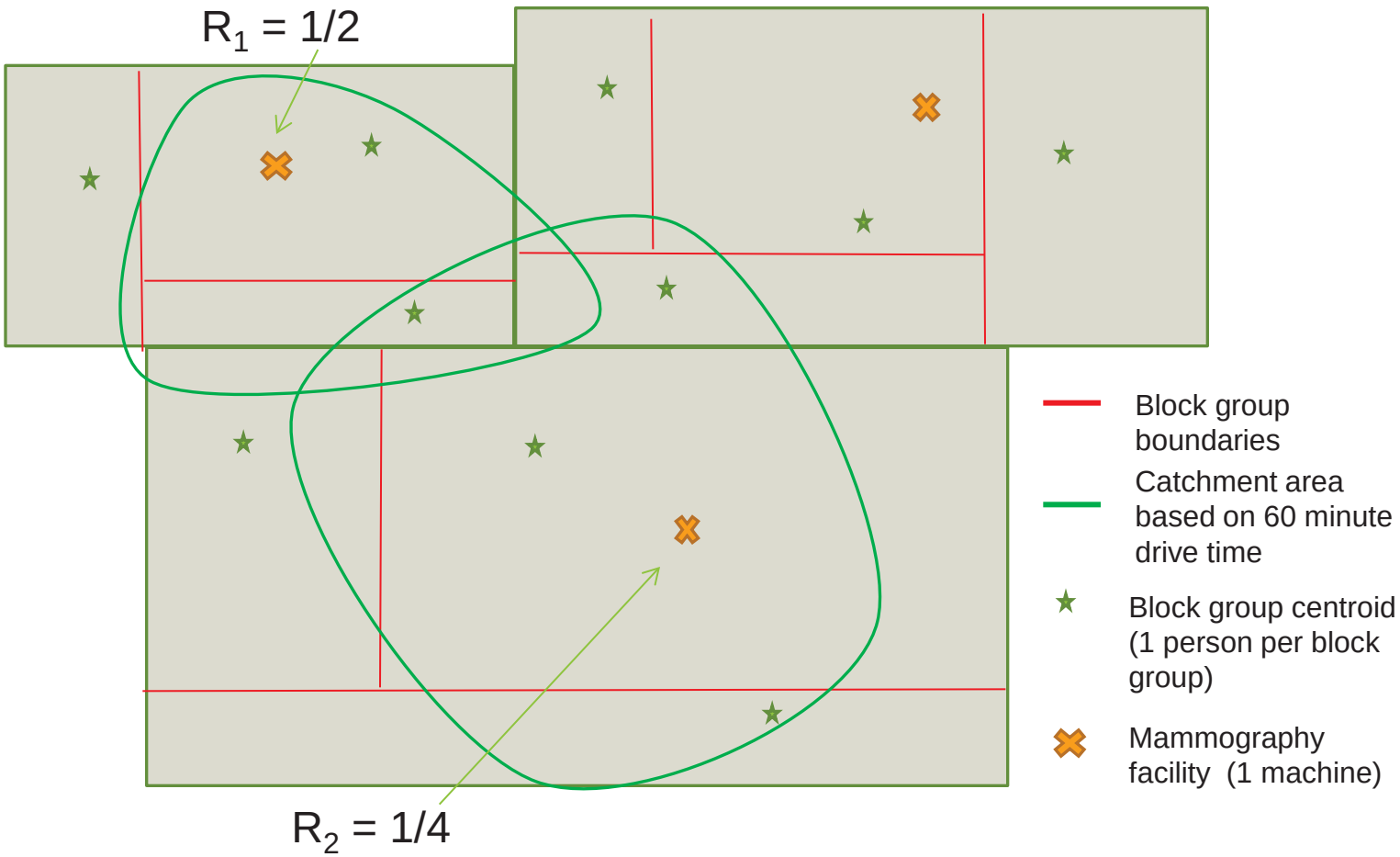
where x = 1 for annual screening or 2 for biennial screening

Methods: Determining spatial accessibility

- Step 2 of the 2SFCA: calculate a supply-demand ratio for each block group, $A_g = \sum F_i$
  - Constructed 60 minute catchment areas around population locations using road network data.
  - Sum up the ratios from Step 1 for all facilities that fall within the population's catchment area
  - Larger values of A_g represent better access

Methods

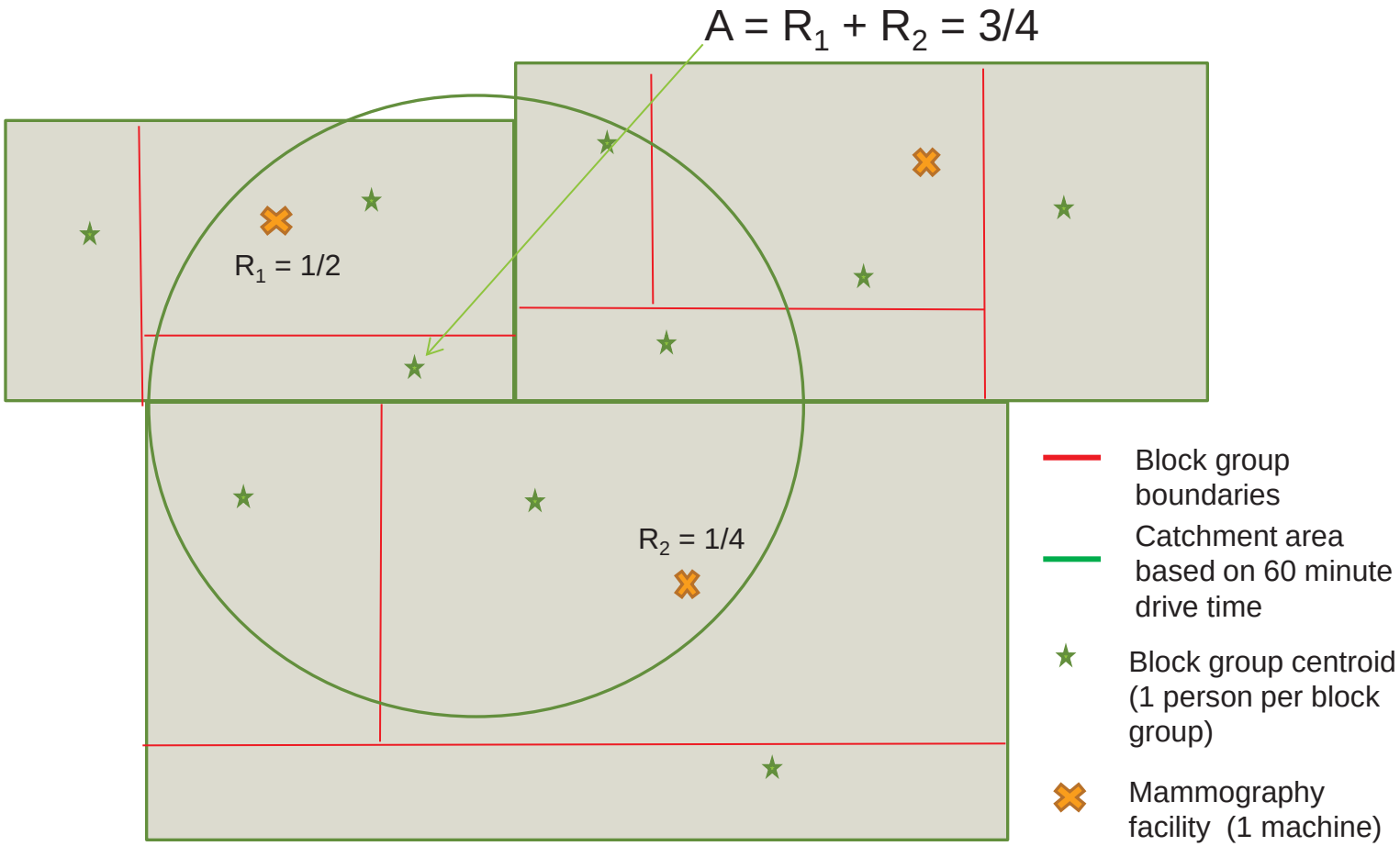
The 2SFCA approach simplified:



Adapted from Luo & Wang, Environment and Planning B: Planning & Design, 2003

Methods

The 2SFCA approach simplified:



Adapted from Luo & Wang, Environment and Planning B: Planning & Design, 2003

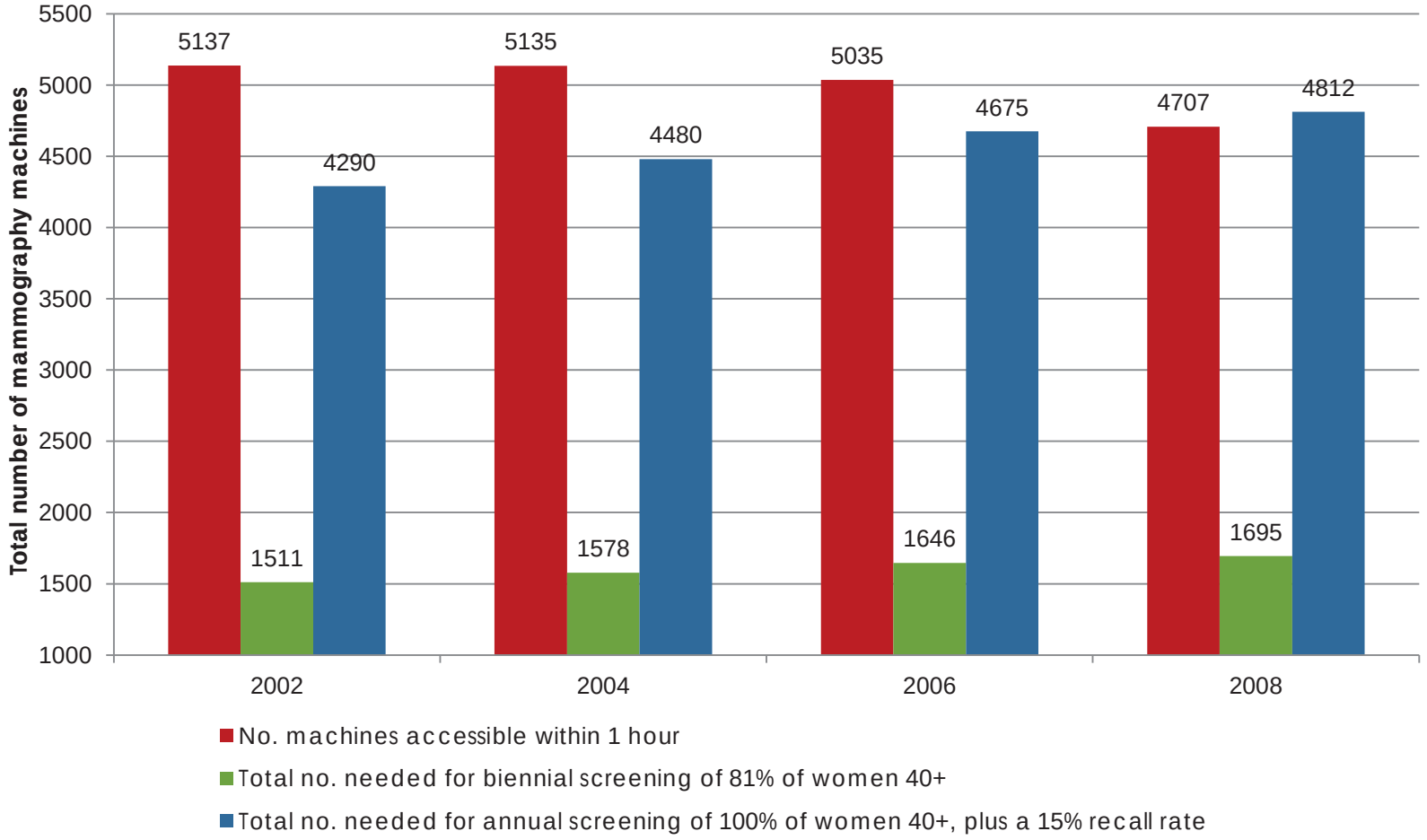
Methods:
How is capacity categorized?

Variable	Definition	Assumptions
No access within 1 hour	No mammography machines within a 1 hour drive from population-weighted block group centroid	N/A
Inadequate capacity	≤0.674 machines/10,000 women *	Biennial screening of 81% of women aged 40+
Poor capacity	No access within 1 hour + Inadequate capacity	Same as above
Adequate capacity	≥0.675 machines/10,000 women	Same as above
Excess capacity	≥1.917 machines/10,000 women	Annual screening of 100% of women aged 40+, plus 15% called back for follow-up

* Based on the estimated 6000 mammograms per year that 1 machine can perform working 8 hours/day, 5 days/week, 50 weeks/year

Results

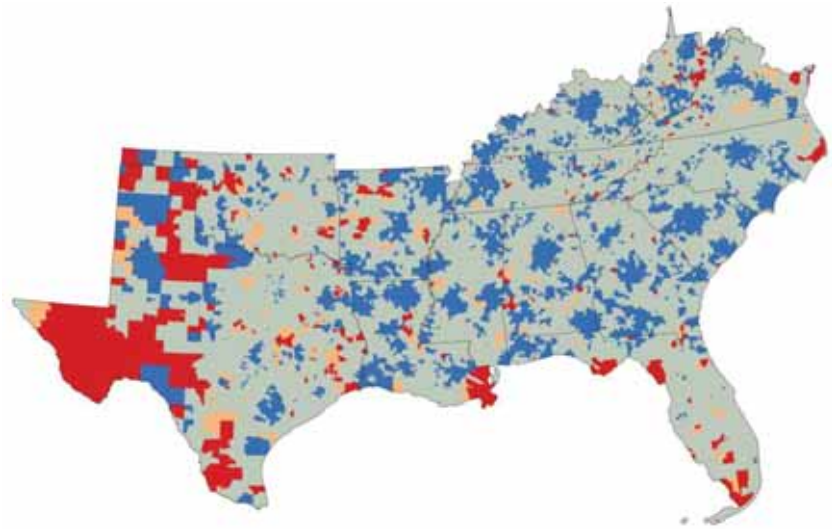
Extent of oversupply in the south over time



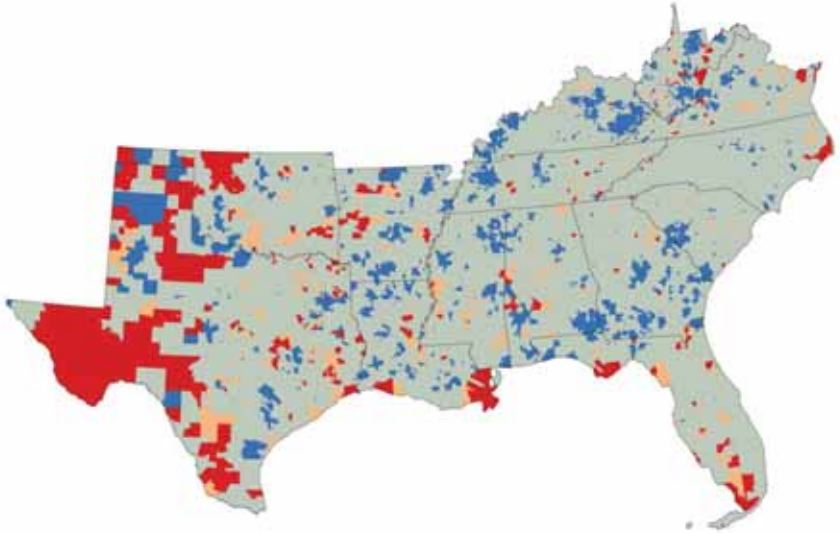
Results

Geographic variation in capacity in the south over time

2002



2008



Legend

- No access within 1 hour
- Inadequate capacity
- Adequate capacity
- Excess capacity

Results

Number and proportion of women living in areas with poor or excess capacity over time

	2002		2004		2006		2008	
	Poor	Excess	Poor	Excess	Poor	Excess	Poor	Excess
	N(% Pop)	N(% Pop)	N(% Pop)	N(% Pop)	N(% Pop)	N(% Pop)	N(% Pop)	N(% Pop)
14 states combined	260,947 (1.17)	7,493,756 (33.49)	267,116 (1.14)	6,139,331 (26.27)	279,637 (1.15)	4,605,372 (18.89)	323,895 (1.29)	2,411,942 (9.61)

- The proportion of women living in areas with poor capacity rose by 10% from 2002-2008.
- The proportion of women living in areas with excess capacity dropped by 68% from 2002-2008.

Results

- Poor capacity:
  - Range in 2002: 0.06 (SC) – 2.53% (TX)
  - Range in 2008: 0.24 (NC) – 3.20% (OK)
  - Texas contributed almost half of all the women aged 40+ living in poor capacity areas.
- Excess capacity:
  - Range in 2002: 10.09% (FL) – 65.22% (LA)
  - Range in 2008: 1.53% (FL) – 32.47% (WV)

Results

Sensitivity analysis of mammography capacity across different age groups, 2002 and 2008

		2002		2008	
		Poor	Excess	Poor	Excess
	Age Group	N (% Pop)	N (% Pop)	(N % Pop)	N (% Pop)
14 States	40+	260,947 (1.17)	7,493,756 (33.49)	323,895 (1.29)	2,411,942 (9.61)
	50+	122,035 (0.81)	11,691,776 (77.88)	147,850 (0.85)	10,482,529 (60.25)
	50-74	81,771 (0.71)	10,251,194 (89.50)	88,339 (0.66)	11,009,551 (82.00)

Conclusions

- The number of available mammography machine decreased over time. Reductions occurred primarily in areas with an oversupply of machines.
- The % of women living in areas with poor capacity increased and the % living in areas with excess capacity decreased.
- Poor capacity areas were overwhelmingly rural (82%). Texas had the largest land mass affected, as well as the most women.

Conclusions

- There was significant geographic variation in capacity across and within-states.
- Although there was less oversupply over time, the **maldistribution** of resources was not remedied.
  - The loss of machines was largely in areas that already had too many.
  - 90% of areas with poor capacity in 2002 remained as such in 2008.

Limitations

- We are using proxy information for patient's likely travel pattern.
- We don't have patient-level address data. We are using geographic centroids.
- We know all facilities are not equally available (i.e., out-of-network, not accepting new patients, etc…), but data are not available to measure this currently.
- Choice of catchment area size will affect measure.

Discussion

- Why do differences in mammography capacity matter?
  - Poor capacity has been linked to lower mammography screening rates.
  - Better capacity has been linked to earlier stage at breast cancer diagnosis.
  - Excess capacity may create unnecessary demand for services, resulting in more false-positive tests and breast biopsies.
  - Equal access to health care is a priority for the public health community.

Elting et al, Am J Preventive Med, 2009
Elkin et al, Medicare Care, 2010
Marchick et al, Cancer, 2005
Mushlin A, Ann Intern Med, 1990

Discussion

- Practical uses of these findings:
  - Offer routing information for facilities with existing mobile units
  - Provide tax incentives for starting new businesses in areas with poor capacity
  - Assist grant-making organizations in allocating research and programmatic funds
  - Include results in “breast cancer awareness” fund-raising materials and presentations

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