

## Research Article

# Standardized Breast Imaging with Centralized Interpretation Using Academic-Community Collaboration Helps Small Community Hospital(s) Improve Breast Cancer Disparity

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**Submitted:** 18 May 2022

**Accepted:** 16 June 2022

**Published:** 18 June 2022

**ISSN:** 2333-7095

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**OPEN ACCESS****Keywords**

- Breast Cancer Stage
- Breast Cancer Specific Survival
- Academic-Community Collaborative
- Mammography
- Screening
- Disparity Improvement

**Abstract**

We are a rural hospital with access to care barriers historically linked to geography. We see a disproportionate percentage of late stages of breast cancer, with correspondingly worse mortality rates. A decade ago, screening mammogram rates were low rurally compared to elsewhere, and particularly evident to us locally. We recognized this as a geographic barrier to care and collaborated with an academic institution to improve access to breast imaging rurally using a network hub-and-spoke wheel model. In 2016, we standardized breast imaging by offering identical screening and diagnostic radiology services at all our community hospitals (N=7: the "spokes"), while centralizing image interpretation at the "hub" with a team of imaging specialists. Utilizing fellowship specialty-trained breast radiologists for all central review, along with uniform imaging regionally, our hypothesis was we could improve our diagnostic results rurally and move the bar away from disparity. The Outer Banks Hospital is now the largest volume imager for breast care within the community hospital network and it has leveraged this collaborative model with East Carolina University Health to improve access and achieve American College of Radiology certification locally, as well as American College of Surgeons cancer accreditation (Commission on Cancer). This report reviews a favorable change in stage at presentation over time and other quality outcomes for breast cancer rurally as the result of this academic-community collaborative, which is feasible anywhere.

**ABBREVIATIONS**

MQSA: Mammogram Quality Standards Act; BC: Breast Cancer; NCDB: National Cancer Database; ACR: American College of Radiology

**INTRODUCTION**

We are a 21-bed hospital situated on a barrier island in the Atlantic Ocean, which links us to access to care and barrier concerns by the nature of our rural geography. In 2002, our small community hospital opened its doors with the intent to provide improved access to care for our beach community. We are one of 20 CMS-designated Critical Access Hospitals in rural North Carolina, and one of 1353 in the US that faces ongoing challenges in rural healthcare [1-3]. Remote in location, and small by size, we see barriers commonly faced by rural hospitals. Specialty care is often lacking, and consistency (and quality) of care is a continuous struggle. Resources are often lacking, and therefore small community hospitals are forced to become innovative to solve local problems.

Like most small community hospitals, we lack specialists. This creates challenges when dealing with complex diseases such as cancer and heart disease, historically our number one and two causes of mortality respectively. In 2002, when we opened our hospital doors to the community, cancer was the number one cause of mortality locally. Thirty-percent of deaths in our service region came from cancer, compared to 22.4% of mortalities linked to cancer elsewhere in the state. This represented a 34% higher relative rate when normalized to our small population [4]. We decided to begin to address this disparity by adding selected services to our hospital, beginning with radiology imaging and in particular screening mammography, since breast cancer is the most common cancer in our region. By the end of the first decade however, we still had fewer mammograms performed within our population regionally compared to other counties within our state and compared to national demographics [5]. We added various other services but care was disjointed and not lending itself to quality assessment and improvements.

Beginning in 2013, we discussed coordinating services by

leveraging a relationship with a nearby academic facility - East Carolina University (ECU). By collaborating with ECU, we hoped we could standardize primary evaluation and management for cancer services and improve some of the rural barriers to care that existed historically. Our first foray into this was our initiative to standardize breast imaging and interpretation at several of our outlying hospitals, providing similar equipment and radiological technologists at each. We centralized image interpretation at the "hub" in Greenville (ECU) by using breast specialists who are fellowship trained and board-certified in breast imaging to help standardize the quality of diagnostic interpretation. This collaborative model has since become an elegant hub-and-spoke wheel model that now includes other small community hospitals (N= 7) within eastern North Carolina (Figure 2) [6]. We anticipate this network model of collaboration will eventually improve access to care through shared resources, and favorably change geographic disparity in our 29-county service region of the state. We analyze the results from a critical access hospital using this collaborative model for breast imaging and cancer care, as this hospital has been the most proactive from the beginning in analyzing local data and is a relatively new hospital. Now that we have two decades of information locally to study the impact of these initiatives, we can measure the effects on our community over time.

## MATERIALS AND METHODS

We examined several baseline metrics for breast care in our county. We examined NC state registry statistics [4], mammogram rates in 65-year and older women [5], and National Cancer Database (NCDB) measures of stage [7]. We examined the following baseline data as endpoints: 1) 5-year trends in breast cancer incidence and mortality rates prior to collaborative program changes; 2) stages of BC at presentation by periods; and 3) mammography screening rates.

Our academic-community hospital imaging collaborative is the intervention, although we could also simply say the addition of the community hospital in 2002 at Outer Banks is a huge part of access to care improvement. East Carolina Health represents the flagship for the 29-county region of eastern North Carolina. ECU health is a partnership owner of our community hospital. By leveraging resources from radiology with standardized diagnostic and screening imaging services available at each facility, we hoped to see better access to mammograms (and hence longitudinal growth), as well as improved earlier diagnosis of cancers, with correspondingly more early stages of BC. This might also lead to improved survivals as well. We offered 3-D breast imaging with central interpretation by breast-specialized radiologists at each rural hospital within the network beginning in 2016. The Outer Banks Hospital also became cancer accredited in 2016 by the American College of Surgeons Commission on Cancer (COC)[8] by similarly leveraging resources from this academic-community collaborative. It is the only critical access hospital that is cancer accredited in our state and has achieved this by leveraging collaboration through this very model of shared resources. As a member of the COC we report data to the National Cancer Database annually through our cancer registry.

Following intervention we measured outcomes to observe favorable changes including: 1) 5-year trends in breast cancer

incidence and mortality rates [4]; 2) mammogram screening rates [5]; 3) BC stages at presentation [6]; and 4) MQSA reports [9] to examine the effects of a standardized imaging program with respect to other hospitals within our network and compared to published national standards.

## RESULTS AND DISCUSSION

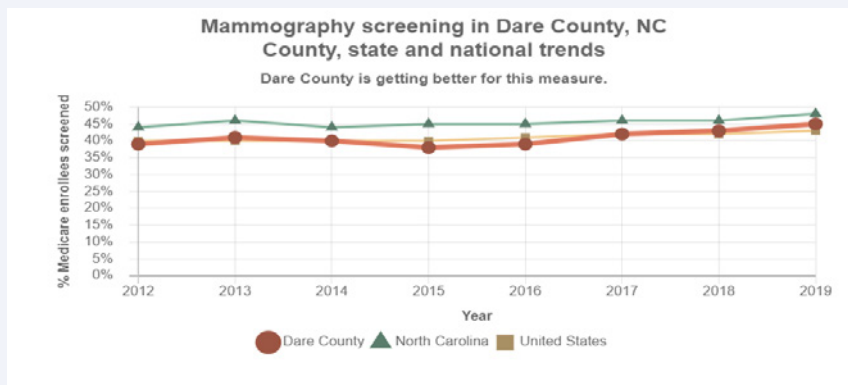
At baseline, cancer was the number one cause of mortality in our county at 30%, compared to the rest of the state at 22.4% [4]. Breast cancer was historically the number one cancer by volume in our region [4]. Mammograms per year averaged 2500 at our hospital prior to the intervention. Breast cancer specific mortality rates (5-year trends used) were 10% higher relatively than elsewhere in the state [4] and nearly all patients had to leave the area for some component of treatment. Stage at diagnosis was disproportionate compared to other areas in our state. We witnessed higher percentages of late stages for BC, and correspondingly lower early stages [7]. Mammogram utilization rates as a percent of the local population were lower in our area than elsewhere, even in the first decade after opening our hospital, highlighting the barrier imposed by rural geography (Figure 1, and Table 1).

Following intervention locally, emphasizing an academic-community hospital collaboration, mammography rates improved (Figure 1), stages at presentation improved (Figure 3), and cancer-specific survival improved (Table 1). Breast cancer remains the most common cancer regionally. As mammography rates increased, so did the number of analytic cases at our

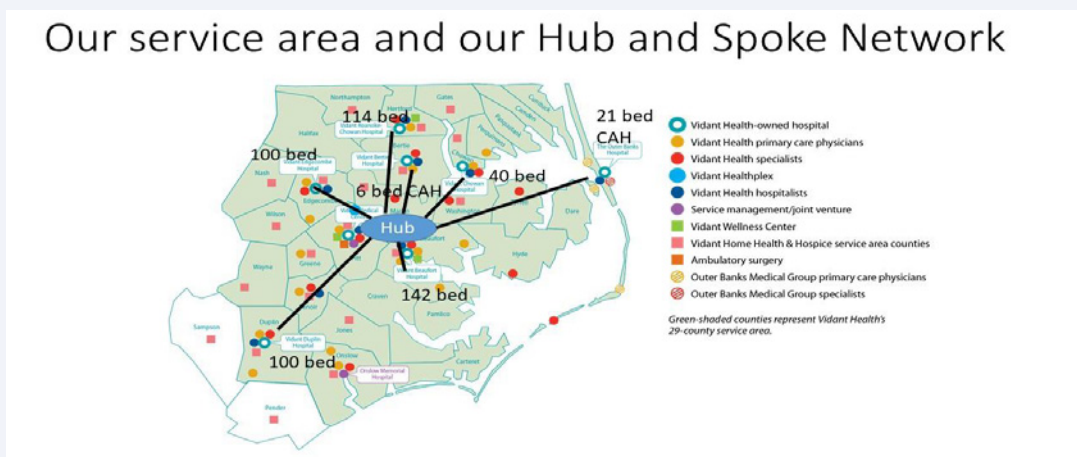
**Table 1:** Summary of results from quality collaboration and increased access to care.

Metric:	Pre-Intervention	Post-Intervention (CI)	Relative Change	Comments
Mammogram rate age 65-74, Medicare	39%	45%	1.15	15% improvement
BC mortality rates per 100K population (5-yr.)	30.9	16.8 (10.4, 26.2)	0.54	46% reduction in mortality
Number of Mammograms/yr.	2500	5000	2	Double the number of mammograms
Early-stage BC (stage 0 and I)	49%	72%	1.47	47% improvement in early detection
Stage 4 BC	7%	3%	0.43	57% reduction in stage 4
Number of analytic BC local in 1 year	20	60	3	Triple the number of cases treated locally
Incidence of BC per 100K (5-yr.)	190.6	162.5	0.85	incidence down by 15%
Raw numbers BC	215	228	1.06	Increased raw numbers 6%

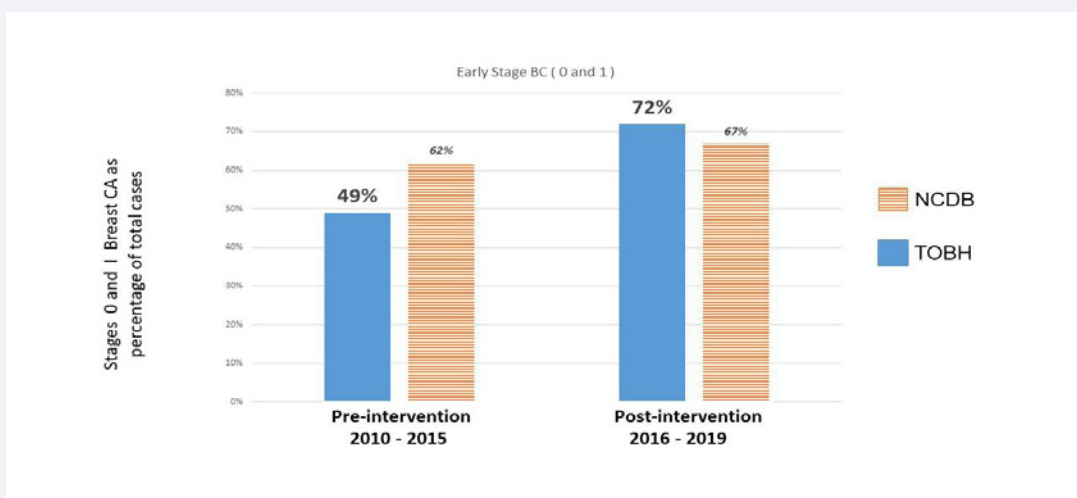
Abbreviations: BC: Breast Cancer; yr: year; CI: Confidence Intervals (included on most recent mortality data); 100K: 100,000



**Figure 1** Use of screening mammography in our region compared to rest of the state and US over time. Note the uptick beginning in 2016, post intervention. Abbreviations: NC= North Carolina



**Figure 2** We use an Academic-Community collaborative model in eastern North Carolina with the Academic facility (East Carolina University) as the "hub", and the community hospitals representing "spokes" on the wheel. By sharing resources centrally, we can offer more uniformity of care to our rural communities. Abbreviations: CAH= critical access hospital



**Figure 3** Stage at diagnosis for Breast Cancer has changed significantly over time, and now compares favorably to the National Cancer Database (N=1351 hospitals). Abbreviations: BC: Breast Cancer; TOBH: The Outer Banks Hospital; NCDB: National Cancer Database

hospital as well, although the overall BC incidence dropped 15% over the analytic period according to state/county data after normalizing for the population and adjusting for age (Table 1). We were not surprised that the volume of mammography increased locally, although a doubling in annual numbers to over 5000 was more than we anticipated. We attribute that increase to a loss of competition from other providers who were initially in our county, but later withdrew imaging in our service area after we became more established and we had garnered a reputation for quality thanks to this collaboration. Now we still see some patients who insist on obtaining their imaging elsewhere, but this is clearly a minority.

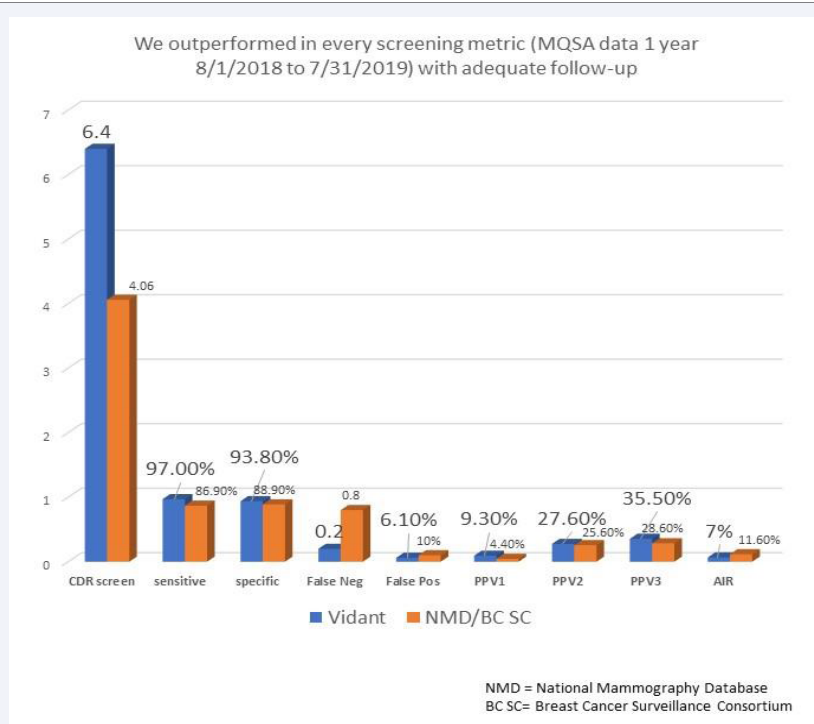
As the volume of mammography increased, it is also no surprise that the number of analytic cases at our hospital increased locally, as did the cancer detection rates locally. Currently we image over 5000 women a year locally, and we are the leader in the community network despite being a small critical access hospital on a barrier island. We do have a higher median age population as we are a beach retirement community, and we have experienced some population growth since COVID-19, which may each help explain this growth in small part.

What is also not surprising is the improvement in staging, albeit more than we anticipated. As rates of screening increase, we would expect to see *similar* rates of cancers by stage compared to other hospitals of our size, assuming no other differences in the demographics. We did a comparison to the entire NCDB (all 1351 hospitals) to show how well we performed in this metric, as we think this quality intervention represents a very high standard and should be compared to all hospitals, not just those of similar

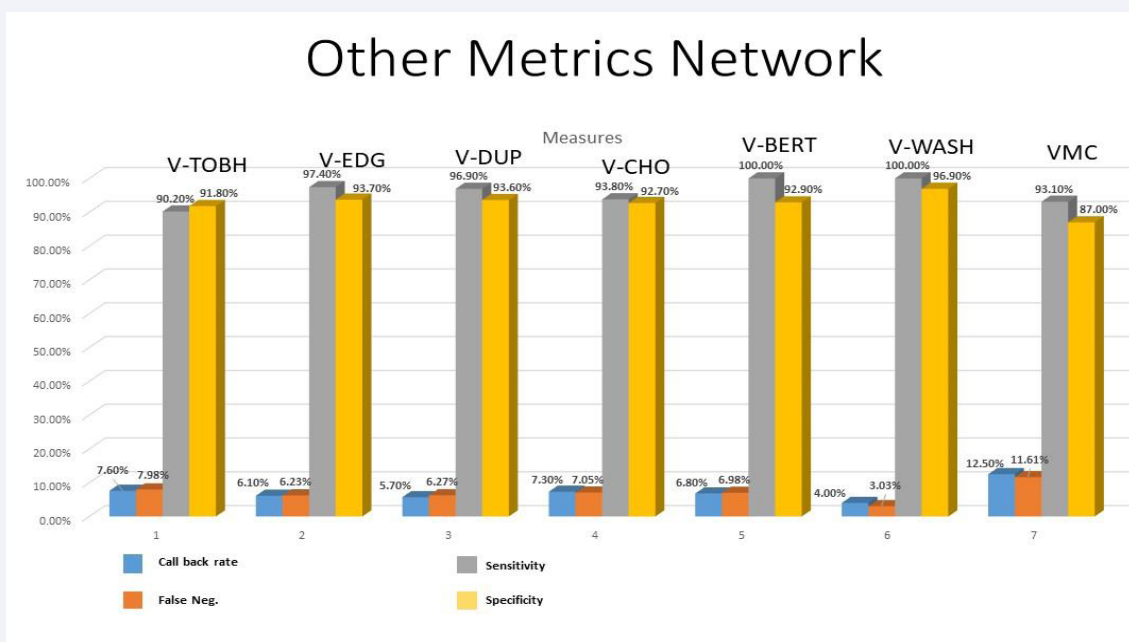
type. As seen in Table 1, we improved early detection by 47% over our own baseline, and we are in line with the National Cancer Database for early stages of BC at presentation at 72% over the last 4 years (vs 67% early stage 0 and stage 1 BC seen in all 1351 hospitals within the NCDB, Figure 3).

Finally, as an American College of Radiology certified site for mammography, MQSA reports were examined to see how we scored in the various metrics relevant to quality programmatic breast imaging/diagnosis [9]. These are not the only quality metrics to advocate [10], but we include them in accompanying Figure(s) 4 to show we exceeded every metric. Comparative values from reference national data are also included (Figure 4a) [11-13]. MQSA metrics were included in this analysis for obvious reasons. If we are to hold ourselves accountable to a higher assumed standard with centralized specialty-trained radiologists, we need to examine this data to hold ourselves accountable within the network. We examine these reports annually, and they remain consistent with time and with regard the quality outcomes we have come to expect and consistent between hospitals (Figure 4b). One might hypothesize using breast-specialized radiologists may bias our data towards better outcomes, so that is one factor to consider in the interpretation and reproducibility of these results.

Lastly, we were unsurprised by an improvement in BC-specific mortality over time. We had a sharper decline in BC mortality rates in our region than in NC as a whole, mainly due we believe to the change in stage at presentation (Figure 5, and Figure 3). With a much larger percentage of early-stage BC, we would expect better survivals in our population. We also cannot

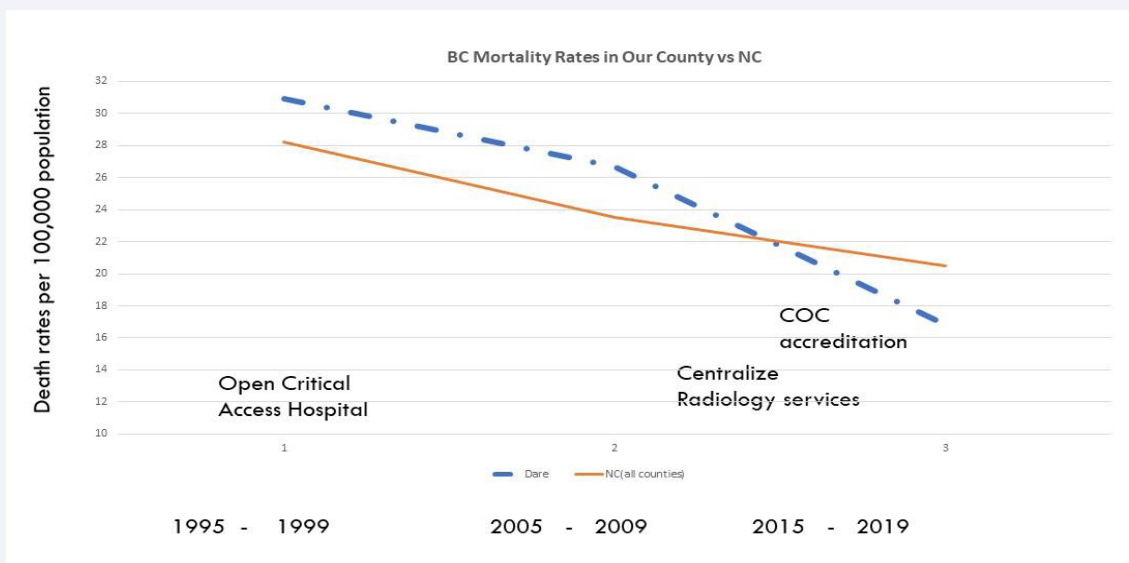


**Figure 4a** We performed well in all metrics compared to expected standards as a system. Abbreviations: MQSA: Mammogram Quality Standards Act; CDR: Cancer Detection Rate; PPV: positive predictive value(s); AIR: abnormal interpretation rate; NMD: National Mammography Database; BCSC: Breast Cancer Surveillance Consortium



**Figure 4b** We also performed consistently between 7 community hospitals for screening metrics.

**Abbreviations:** V-TOBH: Vidant/East Carolina University Health The Outer Banks Hospital; V-EDG: Vidant/East Carolina University Health Edgecombe Hospital; V-Dup: Vidant/East Carolina University Health Duplin Hospital; V-CHO: Vidant/East Carolina University Roanoke Chowan Hospital; V-BERT: Vidant/East Carolina University Health Bertie Hospital; V-WASH: Vidant/East Carolina University Health Washington Hospital; VMC: Vidant Medical Center/East Carolina University Health



**Figure 5** BC-specific mortality rates dropped more precipitously in our service area over time (dotted line) compared to the state (solid line) reflecting the addition of these services.

**Abbreviations:** BC: Breast Cancer; NC: North Carolina (all counties); COC: Commission on Cancer

discount the effect this model of collaboration had on local care. It is this same academic-community hospital collaborative model that allowed us to become the only Commission on Cancer-accredited critical access hospital in the state, something that cannot be discounted in these outcomes. Commission on Cancer-accredited programs focus on quality initiatives and improvement projects, and by nature the very coordination of

cancer care from prevention and screening to primary evaluation and management, to survivorship. This programmatic approach to the spectrum of cancer care may also therefore favorably bias our results.

One weakness of this study is the small size of the population. Although we perform more imaging than any other community



hospital, it would be more interesting to examine the effects of this model from the regional standpoint by including other hospital outcomes in the future, once this data is available.

## CONCLUSION

By collaborative networking using an academic-community hub-and-spoke model for breast imaging, we were able to improve several outcomes within our rural service area. First and foremost, we increased access to breast cancer imaging at a small critical access hospital. We increased mammogram volumes (2-fold) over time, and our increased the percentage of annual mammogram use relative to our population and relative to the US (Figure 1, most recent years).

Second, we provided a quality model of breast imaging that not only meets national standards in mammography but also exceeds them in several ways. For example, our desired quality metrics (sensitivity and specificity, incidence of false positives, and Positive Predictive Values, cancer detection rates) exceeded national industry standards.

Third, we changed the existing paradigm of barriers to care that are often linked to rural geography negatively affecting cancer stage. We now see higher rates of early-stage BC comparatively speaking than at baseline *and* compared to the rest of hospitals (as an average) in the NCDB (Figure 3), which we believe reflects the excellence of this model. Interestingly we have a higher cancer detection rate rurally, meaning we find more cancers per episode of imaging, which may reflect the quality of our radiologists (since they are specialty trained breast imagers) but may also suggest an inherently higher risk that is indeed "rural". This may also suggest we are still not screening enough rurally, which is something we see in other sites as well (e.g., low dose CT for lung cancer where we see one cancer per 90 scans instead of the rate seen nationally at one per 250 scans).

Finally, we have moved the bar in cancer-specific mortality, which is an outcome that excites us greatly. Now, not only is cancer as a whole second in cause-related mortality in our service region behind cardiac disease, but we are also at parity with the state in cancer specific deaths rather than adding to the disparities that plagued us historically. Breast cancer is an excellent example of this favorable return to parity geographically, and we would like to examine this collaborative model in aggregate within a larger region that includes our entire network in the 29-county region as future collaborative project.

## ACKNOWLEDGEMENTS

This collaboration would not be possible without the cooperation of many departments at East Carolina University and Vidant Health. Additionally, Chesapeake Hospital providers have more recently joined our collaborative in breast care by improving our access to pathology, radiology, breast surgeons, and plastic/reconstructive surgery.

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### Cite this article

Shelton CH, Griffin E, Crawford T, Ballestero J, Ward R, et al. (2022) Standardized Breast Imaging with Centralized Interpretation Using Academic-Community Collaboration Helps Small Community Hospital(s) Improve Breast Cancer Disparity. *J Radiol Radiat Ther* 10(1): 1091.