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Patterns of chronic disease management and health outcomes in a population-based cohort of Black women with breast cancer

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Abstract

Purpose: Diabetes and hypertension are two common comorbidities that affect breast cancer patients, particularly Black women. Disruption of chronic disease management during cancer treatment has been speculated. Therefore, this study examined the implementation of clinical

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practice guidelines and health outcomes for these comorbidities before and during cancer treatment.

Methods: We used a population-based, prospective cohort of Black women diagnosed with breast cancer (2012–2016) in New Jersey (N=563). Chronic disease management for diabetes and hypertension were examined 12-months before and after breast cancer diagnosis and compared using McNemar's test for matched paired and paired t-tests.

Results: Among this cohort, 18.1% had a co-diagnosis of diabetes and 47.2% had a co-diagnosis of hypertension. Implementation of clinical practice guidelines and health outcomes that differed in the 12-months before and after cancer diagnosis included: lipid screening (64.5% before versus 50.0% after diagnosis; p=0.004), glucose screening (72.7% versus 90.7%; p<0.001), and blood pressure control <140/90 mmHg (57.6% versus 71.5%; p=0.004) among patients with hypertension-only. For patients with diabetes, eye and foot care were low (<35%) and optimal HbA1c <8.0% was achieved for less than 50% of patients in both time periods.

Conclusion: Chronic disease management continued during cancer treatment; however, eye and foot exams for patients with diabetes and lipid screening for patients with hypertension only were inadequate. Given that comorbidities may account for half of the Black-White breast cancer survival disparity, strategies are needed to improve chronic disease management during cancer, especially for Black women who bear a disproportionate burden of chronic diseases.

Keywords

Breast cancer; diabetes; hypertension; practice guidelines; care coordination; cancer health disparities

INTRODUCTION

Cancer, type 2 diabetes mellitus, and hypertension are important public health issues for women in the United States given their significant disease burden and impact on mortality [1, 2]. Breast cancer is the most common cancer diagnosis and second leading cause of cancer death for women [3]. Chronic diseases are prevalent among 32% of the Medicare population at breast cancer diagnosis [4]. Comorbidity is defined as another chronic disease or prolonged health-related illness, which is not a health status, symptom, or functional ability, in addition to the primary disease of interest (i.e., cancer) [5–7]. Two of the most common chronic diseases affecting breast cancer survivors are diabetes (affecting 16–20% of women with breast cancer) and hypertension (32%) [8–11].

Comprehensive chronic disease management can lead to better health outcomes and reduce avoidable healthcare utilization and costs [13, 14]. For example, testing, managing, and improving glycemic control among patients with diabetes can prevent peripheral neuropathy and subsequent lower limb amputations, which may involve additional medical visits, medications, hospital stay, and care coordination with rehabilitation and pain specialists [15, 16]. Chronic disease management is defined as "an organized, proactive, multi-component, patient-centered approach to healthcare delivery" that includes the implementation of clinical practice guidelines and the assessment and management of health outcomes among a defined population with a specific disease [12]. Management involves a sequence of care

processes that is both clinician- and patient-directed and includes the interaction between the two where the patient is informed and engaged with their care and the clinician/healthcare team are prepared and proactive with clinical care management [17]. Research to date is sparse in understanding chronic disease management during cancer treatment, especially among racial/ethnic minorities [18]. This is particularly salient for African American/Black women (referred to hereafter as Black) who historically have received less clinical care and treatment for chronic diseases and disproportionally bear the burden of chronic diseases, including diabetes, hypertension, and breast cancer [19–22, 4, 23].

These common comorbidities (i.e., diabetes and hypertension) may also account for half of the Black-White breast cancer survival disparity [9]. A co-diagnosis of diabetes during breast cancer, which is more prevalent among Black women, increases the risk for adverse clinical events and mortality [24, 8, 25–27]. Adherence to diabetes management guidelines among the general population is associated with improved patient outcomes and preventable complications (e.g., retinopathy, cardiovascular disease (CVD), microvascular events, mortality) [28]. A co-diagnosis of hypertension during breast cancer, which is more prevalent among Black women, increases the risk for cardiac events and related deaths in addition to treatment toxicities associated with chemotherapy, radiation, and monoclonal therapy [29, 30]. Black patients with breast cancer also have a higher risk of developing CVD within one year of cancer diagnosis and higher risk of death from CVD or renal disease within 1–5 years of diagnosis [31].

Given the imperative to understand and address the mechanisms of cancer health disparities, we examined the implementation of clinical practice guidelines and the measurement of health outcomes for diabetes and hypertension among Black women with breast cancer, using data from the Women's Circle of Health Follow-up Study (WCHFS). We hypothesized that chronic disease management (both clinical practice guidelines and health outcomes) were worse for the 12-months *after* breast cancer diagnosis compared with the 12-months *before* breast cancer diagnosis given the competing care demands of the breast cancer diagnosis.

METHODS

Data Source and Study Cohort

The WCHFS is a prospective population-based cohort study of lifestyle, obesity, obesity-related comorbidities, and breast cancer outcomes among Black breast cancer survivors in ten counties in New Jersey [32]. Eligible cases are first identified within two months of breast cancer diagnosis and then recruited by the New Jersey State Cancer Registry. Data collection takes place during an in-person interview within 9–12 months of breast cancer diagnosis. During the interview, informed consent, medical and pharmacy records releases, and questionnaires are collected. Standardized anthropometric measurements (e.g., weight, height, and measures of body fat distribution and body composition) are also obtained [33]. Blood pressure is also measured during home visits in a seated position after at least five minutes of rest using a clinically validated automated blood pressure monitor (Omron HEM-907XL). A set of two blood pressure readings are averaged and recorded. Upon receipt of all requested medical records from inpatient hospital stays, emergency department

use, ambulatory surgery and outpatient physician visits, and pharmacy records from all pharmacies used to fill prescriptions, trained abstractors abstract breast cancer information including medical history, diagnostic work up, breast cancer treatment, and comorbidity types, severity, and date of onset. Additional information related to diabetes and hypertension clinical care management and health outcomes are also abstracted.

The WCHFS study is ongoing. Inclusion criteria for the WCHFS: primary, histologically confirmed non-invasive ductal carcinoma in situ (DCIS) or invasive breast cancer; self-identified as African American/Black; and 20–75 years old. DCIS cases were included in this analysis since breast cancer treatment guidelines indicate treatments such a lumpectomy/mastectomy, radiation, and/or endocrine therapy that also require optimal chronic disease management. Potentially eligible women for this study included 563 patients whose medical records were received and abstracted for breast cancer information through July 2018. Patients who had medical documentation of a clinical diagnosis of type 2 diabetes mellitus or hypertension at least 12-months prior to their cancer diagnosis (2012–2016) were eligible for this analysis (see Figure 1). Exclusion criteria for this analysis: metastatic breast cancer, death within 12-months of cancer diagnosis, or medical provider refused to send medical records. This study was approved by the Institutional Review Boards of all participating institutions and written informed consent was obtained from all study participants.

Outcome Measures

Data abstractors specifically looked for the documentation of chronic disease management 12-months prior to the breast cancer diagnosis through 12-months following diagnosis in the medical and pharmacy records. Data at the visit level were abstracted, including date of visit, test, or prescription ordered, name and type of clinician who ordered the test, facility name and location, and type/result of test or medication ordered. Two sets of outcome measures were constructed: 1) implementation of clinical practice guidelines and 2) health outcomes for diabetes and hypertension.

Implementation of clinical practice guidelines for diabetes and hypertension

The diabetes and hypertension clinical practice guidelines and definitions selected for this study are listed in Table 1. For patients with diabetes and hypertension, clinical practice guidelines included: hemoglobin A1C (HbA1c) test, low-density lipoprotein-cholesterol (LDL-C) test, eye and foot exams, medical attention for nephropathy, and prescription for hypertension medication. For patients with hypertension-only, clinical practice guidelines included: lipid, glucose, and nephropathy screening and prescription for hypertension medication. The implementation of clinical practice guidelines was considered met if there was at least one order, test result, or prescription documented in the medical or pharmacy records. Prior studies using administrative claims data have examined medical encounter data and services (i.e., clinician ordered the test and the patient completed test) [34, 35]. This study using medical and pharmacy records determined if a clinician ordered the test regardless if the patient completed the test or not.

Health outcomes for diabetes and hypertension

All available health outcomes for HbA1c, LDL-C, and glucose measures were obtained from medical records and averaged per patient for each target time period. Blood pressure was collected at one time before diagnosis (i.e., last blood pressure measurement available in the medical record before primary surgery) and one time after diagnosis (i.e., average blood pressure readings at home interview). Health outcomes were considered not optimal when the test result was abnormal, a test was not ordered, or a test was ordered by the clinician but was not completed by the patient. This calculation is based on quality measure specifications from the Centers for Medicare & Medicaid Services' Quality Payment Program [36].

Main Predictor - Time Periods

Chronic disease management measures were compared at two target time periods: 1) 12-months prior to the date of breast cancer diagnosis (i.e., date of biopsy), and 2) 12-months from the date of breast cancer diagnosis.

Statistical Analysis

We generated summary statistics to describe patient-level characteristics by chronic disease: 1) patients with diabetes and hypertension; and 2) patients with hypertension-only. We chose not to create a separate category for patients with diabetes-only since there were only eight patients. Chronic disease management measures and health outcomes (including means and standard deviations for continuous data and counts and proportions for categorical data) were reported by target time period. We used McNemar's tests for matched pairs for categorical variables and paired t-test for continuous variables to determine if chronic disease management measures and health outcomes for each patient differed by time period. Associations with p-values less than 0.05 were considered statistically significant. All analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC).

RESULTS

This study used data from the first 563 women enrolled in the WCHFS, of which 274 women were eligible for inclusion in the analysis (Figure 1). Among this cohort of Black women diagnosed with breast cancer between 2012 and 2016, 18.1% (n=102) had a co-diagnosis of diabetes and 47.2% (n=266) had a co-diagnosis of hypertension for at least 12-months prior to their breast cancer diagnosis. Among the patients with diabetes and hypertension, the mean age at breast cancer diagnosis was 61 years and 37.3% had private health insurance at diagnosis (Table 2). The mean duration of having diabetes was 11 years and hypertension was 16 years; 30% were insulin-dependent; and 68.6% had no complications from their diabetes. Among patients with hypertension-only, the mean age at breast cancer diagnosis was 57 years and 56.4% had private health insurance at diagnosis. The mean duration of having hypertension was 13 years, and 91.3% of patients had category I hypertension.

Implementation of clinical practice guidelines for diabetes and hypertension

Table 3 shows the implementation of clinical practice guidelines for diabetes and hypertension for the 12-months prior to and the 12-months following breast cancer

diagnosis. For patients with diabetes and hypertension, the measures did not statistically differ by time period. The majority of patients with diabetes had an order for an HbA1c test (80.4% versus 83.3%), LDL-C test (81.4% versus 78.4%), medical attention for nephropathy (90.2% versus 94.1%), or hypertension medications (88.3% versus 87.2%) before and after breast cancer diagnosis. Many patients had at least one HbA1c test (68.6%) and LDL-C test (62.7%) ordered in both time periods. However, the proportion of patients receiving an order or referral for an eye exam (35.3% versus 31.4%; p=0.505) and a foot exam (22.5% versus 30.4%; p=0.103) before and after cancer diagnosis was low. There was an 8% increase in foot exams after the breast cancer diagnosis, although not statistically significant (p=0.103). Most (61.8%) of the foot exams were ordered for the same patients in both time periods.

For patients with hypertension-only, lipid screening decreased significantly in the 12-months following breast cancer diagnosis (64.5% versus 50.0%; p=0.004) with 20.9% of patients receiving no order in either time period. Screening for blood glucose increased significantly (72.7% versus 90.7%; p<0.001). There was no change by time period in nephropathy screening (11.6% versus 10.5%; p=0.655) and for being prescribed hypertension medications (83.1% versus 82.6%; p>0.999).

Health outcomes for diabetes and hypertension

Patients with diabetes and hypertension did not differ in their health outcomes before or after breast cancer diagnosis (Table 4). Mean HbA1c levels (among patients who completed the HbA1c test) for each time period was 7.7% and 7.5%. The proportion of patients who completed an HbA1c test ordered by their clinician was 86.5% before and 87.1% after cancer diagnosis. Overall less than half of all patients with diabetes and hypertension had optimal HbA1c <8.0% in either time period (49.0% versus 46.1%). Mean LDL-C levels (among patients who completed the lipid/LDL-C test) before diagnosis were 104 mg/dL and 99 mg/dL after diagnosis. The proportion of patients who completed an LDL-C test ordered by their clinician was 85.5% before and 83.8% after cancer diagnosis. More than a third of all patients had optimal LDL-C < 100 mg/dL in either time period (34.3% versus 37.3%). For eye exams, 16 of the 24 patients who received an eye exam in either time period, but not both, all had normal exams. For foot exams, the same 11 patients received a foot exam before and after their breast cancer diagnosis; 9 of these 11 had normal results and 2 were abnormal. Optimal blood pressure levels <140/90 mmHg, which there were results for all patients, was achieved for 56.9% of the patients before and 59.8% after cancer diagnosis (p=0.647).

For patients with hypertension-only, health outcomes did not statistically differ by time period except for blood pressure control. Blood pressure measurements were available for all patients. After cancer diagnosis, 71.5% of patients had normal blood pressure (<140/90 mmHg) compared to 57.6% before diagnosis (p=0.004); an increase of 13.9%. Mean LDL-C levels (among patients who completed the lipid screening) before diagnosis were 117 mg/dL and 109 mg/dL after diagnosis. The proportion of patients who completed an LDL-C test ordered by their clinician was 91.9% before and 84.9% after cancer diagnosis. Optimal LDL-C < 100 mg/dL in both time periods were achieved for 20% of all patients. Mean

glucose levels (among patients who completed the glucose screening) for each time period was 98 mg/dL and 104 mg/dL.

DISCUSSION

This population-based cohort study of Black breast cancer survivors is among the first to examine chronic disease management before and after breast cancer diagnosis including the implementation of clinical practice guidelines for diabetes and hypertension management and the measurement of these health outcomes. Among the 563 women in this cohort, we found a significant proportion had diabetes and/or hypertension at breast cancer diagnosis. We observed suboptimal implementation of some of the clinical practice guidelines and measurements of health outcomes among patients.

Implementation of clinical practice guidelines for diabetes and hypertension

We did not find a statistically significant decrease in diabetes management after cancer diagnosis, which contrasts with two studies. Yao et al.'s study among colorectal cancer (CRC) and breast cancer patients used Medicare claims data linked with a central cancer registry in the Appalachia region [35]. Pinheiro et al.'s study among older breast, CRC, and prostate cancer patients used national SEER-Medicare claims data [34]. The difference in findings may be due to multiple factors including: study design or data source (i.e., claims data instead of medical records), racial/ethnic differences given that prior studies were majority non-Hispanic White, sex and cancer site differences in that women with breast cancer may be more engaged in their care compared with men and women with other cancer types, regional differences in the delivery of cancer and comorbid care, and/or disease severity. These two prior studies using claims data used different chronic disease reference time periods from date of diagnosis (12-months and 24-months) and they identified diabetes diagnosis codes from one inpatient stay or two outpatient claims using the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnoses codes. This study, however, identified eligible cases from any medical documentation of diabetes and hypertension in any inpatient or outpatient medical records. Even with the differing data sources, the implementation of diabetes clinical practice guidelines was consistent across studies. The proportion of HbA1c orders for patients with diabetes after breast cancer diagnosis was 83% in our study, which is on par or better than results from other studies using claims data: 82% among SEER-Medicare patients, 58% among Medicare patients with breast cancer or CRC, 84% among CRC patients in a single health system, and 66% among cancer survivors in a single health system [34, 35, 37, 38]. Also, LDL-C test being ordered after breast cancer diagnosis was 78%, which is also similar to these studies' findings (77%, 70%, 84%, and 84%, respectively) [34, 35, 37, 38]. Eye exam orders or referrals to an ophthalmologist/ optometrist was low in our study (31%) compared with other studies, which ranged from 55% to 84% [35, 37, 34].

Hypertension clinical care management among breast cancer patients has been less studied in the literature. We found that lipid screening decreased in the year after breast cancer diagnosis, while blood glucose screening increased. The increase in blood glucose screening is not surprising, as glucose screening is part of the comprehensive metabolic panel usually

done as part of cancer care. We also observed that nephropathy screening was not part of the usual care for patients with hypertension, although it can be used as a marker for CVD and renal disease for which Black women are more likely to die from within 5 years of breast cancer diagnosis [39, 31].

Women in the WCHFS were at increased risk for CVD given their comorbidities and may be at additional increased risk for CVD due to their breast cancer treatment [29, 34, 30]. Given this additional risk along with the increased healthcare interaction during cancer care, we did not see an overall increase in chronic disease management. This may be due to the competing cancer care demands or the lack of role clarity between healthcare providers on who should be managing the comorbidity. In addition, there remains a paucity of research and clinical guidelines recommending optimal surveillance of CVD and cardiotoxicity from breast cancer treatment [40, 41]. Hypertension and hyperlipidemia, which are more prevalent among Black individuals, are known risk factors for anthracycline cardiotoxicity [42, 43, 41]. The gold standard to prevent CVD and to treat hypertension remains pharmacological intervention, as well as maintaining optimal LDL-C levels [44, 45]. Clinical guidelines identify the optimal LDL-C level as 100 mg/dL, especially for women at higher CVD risk, but the optimal interval of testing remains uncertain [46, 47]. Although no specific guidelines for hypertension management during breast cancer exist, there are clinical guidelines for the management of hypertension for the general population [48, 44]. The U.S. Preventive Services Task Force (USPSTF) and the Canadian Cardiovascular Society recommend lipid disorder screening in adults older than 20 as part of a cardiovascular risk assessment [49–51]. Breast cancer survivorship care guidelines recommend the monitoring of lipid levels and cardiovascular health post-treatment [52].

Health outcomes for diabetes and hypertension

The health outcomes for patients with diabetes and hypertension in our study were similar to other studies among the general Black population but were worse compared to other racial/ethnic populations. In a prior study of optimal diabetes care among cancer survivors, optimal HbA1c < 8% was achieved for 73% of patients with diabetes and cancer in a single health system [38]. This study's finding is much higher than the 46% of women in our study. Future interventions, especially for racial/ethnic minority cancer survivors, are needed to promote glycemic control, which is associated with better breast cancer prognosis [53, 54]. Our finding that only 37% of breast cancer patients with diabetes had an LDL-C level < 100 mg/dL was similar to two other studies. Keating et al. found that 41% of cancer survivors with diabetes and Bulger et al. found that 39% of Black individuals without cancer had optimal LDL-C levels [38, 55].

The health outcomes for patients with hypertension-only aligned with prior studies among Black breast cancer survivors. We observed a mean LDL-C value of 109 mg/dL after breast cancer diagnosis, which is similar to the levels found in two studies among Black women with breast cancer (119 mg/dL and 110mg/dL) [56, 57]. Yet, overall optimal LDL-C < 100 mg/dL for this study population was dismal at 20%. The proportion of women in this cohort with optimal blood pressure (< 140/90 mmHg) did improve from 58% before breast cancer

diagnosis to 72% after, which is higher than the national average among Black women in the general population (49%) [58].

We also found that not all patients who were ordered a test completed it. This may be due to several reasons. Patients may face barriers to completing it such as additional time to go to a lab, lab not co-located in the office with clinician who ordered test, costs (e.g., co-payments), fear, and/or mistrust going to a new lab or another medical center. Social determinants of health can impact the processes of care for chronic disease management, including patient receiving services ordered by their clinician. This warrants further investigation to identify moderators and mediators (e.g., health insurance, health system/facility type) along the care pathway for chronic disease management. In the context of cancer care delivery, the patient care team should also consider how optimal chronic disease management including appropriate referrals (e.g., cardio-oncology) are necessary to address cancer health disparities for Black breast cancer patients [59].

Strengths and limitations

A major strength of the study, which contributes to its generalizability, is it being a population-based cohort study of Black breast cancer survivors, designed to assess the impact of obesity-related comorbidities and their management based on robust data from medical and pharmacy records and patient interviews. Potential limitations include sample size, inclusion of DCIS, exclusion of metastatic breast cancer, and information bias of outcome measures. The sample size could have limited the power to detect a statistical difference. DCIS cases were included in this sample; however, guidelines indicate treatments such a lumpectomy/mastectomy, radiation, and/or endocrine therapy that also require optimal chronic disease management. Misclassification of implementation of clinical practice guidelines or health outcomes was possible if a patient did not disclose all medical providers seen and we could therefore not request nor abstract those medical records. Clinicians also document clinical care management differently; however, measures selected are nationally recognized quality indicators. Not all patients with an ordered test completed it and therefore the interpretation of health outcomes should be made cautiously due to potential selection bias. This may be due to documentation issues or patients not completing the orders, which should be further explored. Additionally, only one blood pressure measurement before diagnosis was used, which may not be a true representation of the patient's overall blood pressure. However, national guidelines and studies use single measurements.

Conclusion

We found overall that adherence to chronic disease management were in line with most clinical practice guidelines; however, eye and foot exams for patients with diabetes and lipid screening for patients with hypertension without diabetes were inadequate for Black breast cancer survivors. Given the growing population of cancer patients with comorbidities, strategies are needed to improve care coordination, comprehensive healthcare, and clinical patient outcomes, especially for underserved cancer patients. These findings can be used to inform the development of multilevel interventions, especially for Black women who bear a

disproportionate burden of chronic diseases, that improve the entire sequence of chronic disease management during cancer care from the patient, healthcare provider/team, health system level, and policy level.

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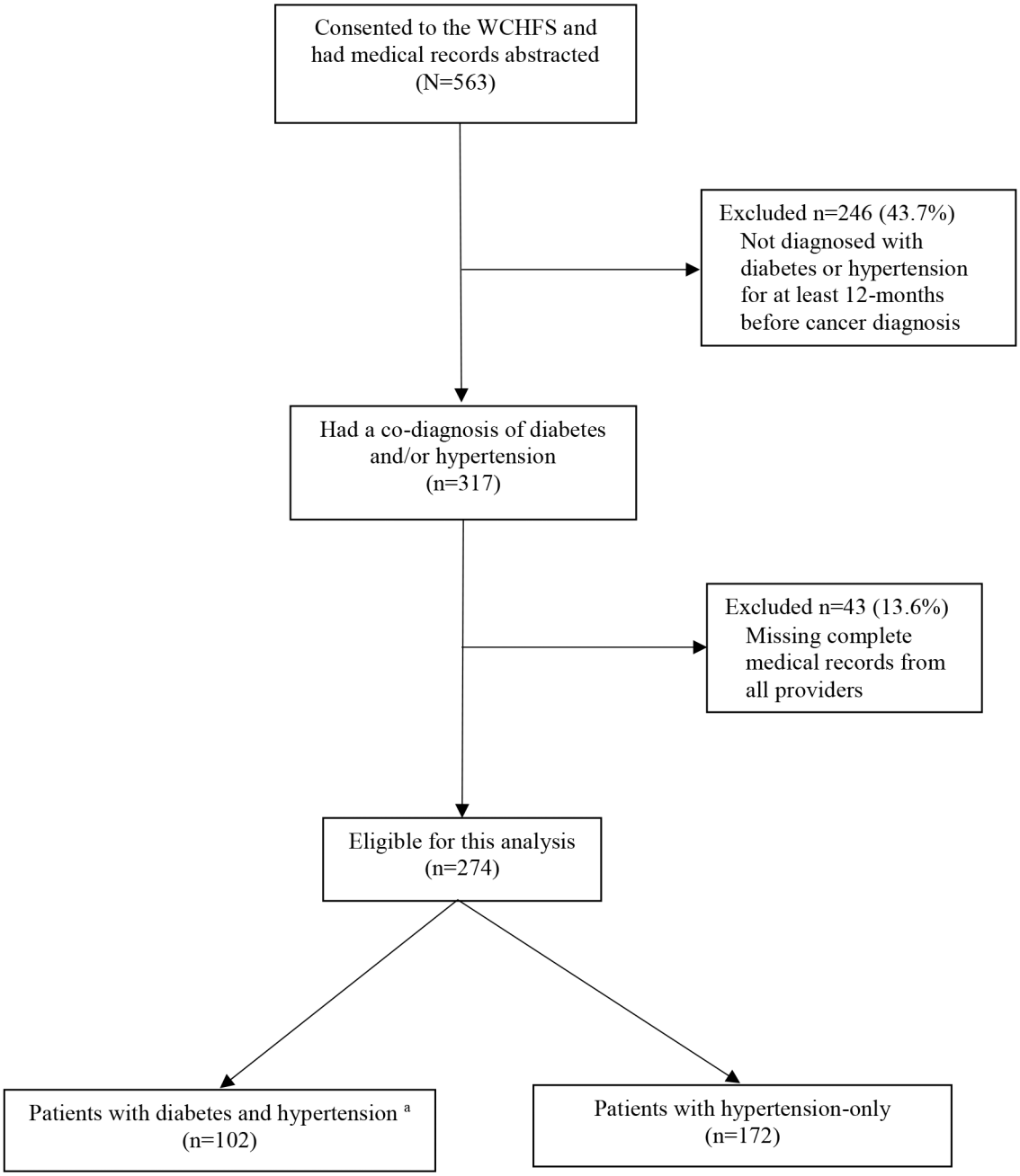

Figure 1.
Consort Diagram
[a] Includes eight patients with diabetes-only.

Table 1.

Clinical practice guidelines for diabetes and hypertension

Guidelines	Operationalized definition of guideline
For patients with diabetes and hypertension	
1. HbA1c test	An HbA1c test ordered or completed during the measurement period. [60–64]
2. LDL-C test	A low-density lipoprotein cholesterol (LDL-C) test ordered or completed during the measurement period. [60, 62]
3. Eye exam	A retinal or dilated eye exam ordered, performed, or referral to an optometrist or ophthalmologist during the measurement period. [61, 62, 64]
4. Foot exam	A visual inspection, sensory exam with monofilament and pulse exam ordered or performed during the measurement period.[62, 65]
5. Medical attention for nephropathy	Microalbuminuria test (i.e., urinary test for albumin) ordered or completed, documentation of treatment for nephropathy (i.e., referral to nephrologist), or prescription for angiotensin converting enzyme (ACE) inhibitor or angiotensin receptor blocker (ARB) therapy during the measurement period. [60–62, 66]
6. Prescription for hypertension medication	Prescription documented in the medical or pharmacy records for thiazide-type diuretic, calcium channel blocker, ACE inhibitor, ARB therapy, vasodilator (e.g., hydralazine), and others (e.g., aliskiren, minoxidil) during the measurement period.[44, 48, 61,45,67, 51]
For patients with hypertension-only	
1. Lipid screening	A complete lipid panel (i.e., high-density lipoprotein cholesterol (HDL-C), LDL-C, total cholesterol, and triglycerides) ordered or completed during the measurement period.[50, 51]
2. Glucose screening	A glucose or HbA1c test ordered or completed during the measurement period. [49]
3. Nephropathy screening	A microalbuminuria test ordered or completed or referral to nephrologist during the measurement period.[39]
4. Prescription for hypertension medication	Prescription documented in the medical or pharmacy records for thiazide-type diuretic, calcium channel blocker, ACE inhibitor, ARB therapy, vasodilator (e.g., hydralazine), and others (e.g., aliskiren, minoxidil). [44, 48, 61, 45, 67, 51]

Table 2.

Characteristics of breast cancer patients enrolled in the WCHFS with a co-diagnosis of diabetes and/or hypertension (N=274)

	Patients with diabetes and hypertension (n=102) No. (%)	Patients with hypertension-only (n=172) No. (%)
Sociodemographics		
Age at diagnosis, mean (SD), years	60.9 (8.2)	57.0 (9.1)
Marital status		
Married	34 (33.3)	63 (36.6)
Not Married	68 (66.7)	109 (63.4)
Education		
≤ High school	44 (43.1)	69 (40.1)
> High school	58 (56.9)	103 (59.9)
Annual household income		
Less than $70,000/ unknown	83 (81.4)	118 (68.6)
$70,000 or more	19 (18.6)	54 (31.4)
Health insurance at breast diagnosis		
Medicaid	23 (22.5)	25 (14.5)
Medicare	39 (38.2)	38 (22.1)
Private	38 (37.3)	97 (56.4)
None/charity/unknown	2 (2.0)	12 (7.0)
Tumor and Comorbid Characteristics		
AJCC stage		
0 (DCIS)	27 (26.5)	41 (23.8)
I	34 (33.3)	53 (30.8)
II	32 (31.4)	60 (34.9)
III	9 (8.8)	18 (10.5)
Duration of diabetes, mean (SD), years	11.4 (8.7)	-
Insulin-dependent		
Yes	30 (29.4)	-
No	72 (70.6)	-
Not applicable	-	-
Diabetes disease severity		
Category I (No complications)	70 (68.6)	-
Category II (Eye or foot disease)	8 (7.8)	-
Category III (Diabetic heart or kidney disease)	19 (18.6)	-
Category IV (Diabetic heart and kidney disease)	5 (4.9)	-
Not applicable	-	172 (100.0)
Duration of hypertension, mean (SD), years	16.1 (12.7)	13.0 (11.8)
Hypertension disease severity		
Category I (DBP < 100 or SBP < 160mm Hg)	82 (80.4)	157 (91.3)

	Patients with diabetes and hypertension (n=102) No. (%)	Patients with hypertension-only (n=172) No. (%)
Category II (DBP ≥ 100 or SBP ≥ 160 mm Hg)	8 (7.8)	13 (7.6)
Category III (CHF and DBP ≥ 100 or SBP ≥ 160 mm Hg)	4 (3.9)	2 (1.2)
Not applicable	8 (7.8)	-
Count of comorbidity[a]		
1	4 (3.9)	96 (55.8)
2	40 (39.2)	51 (29.7)
≥3	58 (56.9)	25 (14.5)
Types of chronic conditions present at cancer diagnosis		
Hypertension	94 (92.2)	172 (100.0)
Diabetes	102 (100.0)	0 (0.00)
Chronic kidney disease	6 (5.9)	6 (3.5)
Cardiovascular disease[b]	22 (21.6)	9 (5.2)
Hyperlipidemia	42 (41.2)	34 (19.8)
Smoking status		
Never	55 (53.9)	87 (50.6)
Former	32 (31.4)	53 (30.8)
Current	15 (14.7)	32 (18.6)
Body mass index, mean (SD), kg/m^2	34.0 (6.9)	32.8 (6.9)

Abbreviations: SD, standard deviation; AJCC, American Joint Committee on Cancer; DBP, diastolic blood pressure; SBP, systolic blood pressure; CHF, congestive heart failure.

[a]Comorbidity count does not include breast cancer diagnosis.

[b]Cardiovascular disease includes congestive heart failure, myocardial infarction, angina, stroke, and coronary artery disease (not including hypertension).

Table 3.

Implementation of clinical practice guidelines for diabetes and hypertension in the 12-months before and 12-months after breast cancer diagnosis (N=274)

	Before Cancer Diagnosis		After Cancer Diagnosis		
	n	**%**	**n**	**%**	**P-value[a]**
Patients with diabetes and hypertension (n=102)					
HbA1c test	82	80.4	85	83.3	0.564
LDL-C test	83	81.4	80	78.4	0.736
Eye exam	36	35.3	32	31.4	0.505
Foot exam	23	22.5	31	30.4	0.103
Medical attention for nephropathy	92	90.2	96	94.1	0.344
Prescribed hypertension medications[b]	83	88.3	82	87.2	>0.999
Patients with hypertension-only (n=172)					
Lipid screening	111	64.5	86	50.0	**0.004**
Screening for abnormal blood glucose	125	72.7	156	90.7	**<0.001**
Nephropathy screening	20	11.6	18	10.5	0.655
Prescribed hypertension medications	143	83.1	142	82.6	>0.999

Abbreviations: HbA1c, hemoglobin A1c; LDL, low-density lipoproteins.

[a]P-value from McNemar's test for matched pairs comparing clinical care management measures met before and after diagnosis.

[b]Patients with diabetes-only (without hypertension) (n=8) are not eligible for this measure.

Table 4.

Health outcomes for diabetes and hypertension in the 12-months before and 12-months after breast cancer diagnosis (N=274)

	Before Cancer Diagnosis		After Cancer Diagnosis		
	Test Result		Test Result		P-value[a]
Patients with diabetes and hypertension (n=102)					
	Mean Value	*±SD*	*Mean Value*	*±SD*	
HbA1c (%)	7.71	± 1.93	7.48	± 1.57	0.745
LDL-cholesterol level (mg/dL)	103.63	± 28.89	99.28	± 31.02	0.615
	n	*%*	*n*	*%*	
Normal eye exam	14	13.73	10	9.80	0.455
Normal foot exam	9	8.82	9	8.82	>0.999
Normal albumin	20	19.61	27	26.47	0.178
Blood pressure control < 140/90 mmHg	58	56.86	61	59.80	0.647
Patients with hypertension-only (n=172)					
	Mean Value	*±SD*	*Mean Value*	*±SD*	
LDL-cholesterol level (mg/dL)	117.05	± 34.91	109.12	± 38.24	0.099
Blood glucose (mg/dL)	98.26	± 25.88	104.47	± 23.51	0.104
	n	*%*	*n*	*%*	
Normal albumin	8	4.65	7	4.07	>0.999
Blood pressure control < 140/90 mmHg	99	57.56	123	71.51	**0.004**

Abbreviations: SD, standard deviation; HbA1c, hemoglobin A1c; LDL, low-density lipoproteins.

[a]P-value from McNemar's test for matched pairs or paired t-test comparing health outcome measures before and after diagnosis among patients who completed the test.