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Overuse of 3 Common Tests in the Elderly: Primary Care Physician (PCP) Variation, Associated Physician Characteristics, and Correlation of Overuse of Tests Within Physicians

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Overuse of 3 Common Tests in the Elderly: Primary Care Physician (PCP) Variation, Associated Physician Characteristics, and Correlation of Overuse of Tests Within Physicians

by

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Dedication

I would like to dedicate this Thesis to God and to my parents (Danny and Doris). Without their help and support I could not have finished this Thesis.

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Overuse of 3 Common Tests in the Elderly: Primary Care Physician (PCP) Variation, Associated Physician Characteristics, and Correlation of Overuse of Tests Within Physicians

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Abstract: Overuse of tests in the elderly is a nationwide problem that leads to patient harm. Some of the most commonly ordered tests are overused even though specific guidelines have been published and appropriately disseminated. Previous work has evaluated national, regional, state, levels of overuse but little research has been done examining this problem at the physician level. This is important as physicians are the ones who are ordering the tests. While other levels may affect overtesting, physician factors, such as age, level of training, and personal beliefs, have been associated with overtesting. Determining which physician characteristics are associated with overtesting can help identify physicians with overtesting behaviors. These physicians can then be offered interventions to decrease this behavior. This retrospective study used cohorts from 100% Texas Medicare data to address the following three aims: 1) to determine the degree of between-physician variation in the overuse of screening PSA, screening mammography, and acute low back pain imaging tests, 2) to define the physician characteristics associated with overuse of these tests, and 3) to evaluate the correlation among these three tests at the PCP-level. The cohorts were analyzed using multilevel multivariate logistic regression and Pearson's correlation. The Intraclass Correlation Coefficient (ICC) score is a marker of how much of the total variation is attributable to certain characteristics. In this study the ICC scores were 0.27 for PSA screening, 0.15 for mammography screening, and 0.25 for acute low back pain. Factors associated with overtesting were Family Medicine specialty and not having U.S. training. There was a weak correlation between overuse of the two cancer screening tests and a very weak correlation between overuse between PSA screening and the use of x-rays for acute low back pain and between Mammography screening and the use of x-rays for acute low back pain.

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List of Abbreviations

AHRQ	Agency for Healthcare Research and Quality
AMA	American Medical Association
CPT	Current Procedural Terminology
GSBS	Graduate School of Biomedical Science
HCFA	Health Care Financing Administration
HMO	Health Maintenance Organization
ICC	Intraclass Correlation Coefficient
NPI	National Provider Identification
PCP	Primary Care Physician
PSA	Prostate Specific Antigen
TDC	Thesis and Dissertation Coordinator
U.S.	United States
USPSTF	United States Preventive Services Task Force
UTMB	University of Texas Medical Branch

Chapter 1: Overview

Importance of Overuse

Overuse of medical tests, or overtesting, is a significant problem in the United States healthcare system. It can harm patients and increase the direct and indirect medical costs for both the patient and the healthcare system. National organizations such as the Institute of Medicine and the American Board of Internal Medicine have raised concerns about overtesting. They have developed agencies and campaigns (such as Agency for Healthcare Research and Quality (AHRQ) and the Choosing Wisely campaign) to facilitate awareness of overtesting. The AHRQ was developed to help fund healthcare research in areas such as overuse. The Choosing Wisely campaign's mission is to educate physicians and their patients on commonly overused tests. Over 60 specialty associations have given their input to the Choosing Wisely campaign on commonly overused tests.

Importance of Physician Variation

Substantial variation among providers usually stems from a lack of scientific evidence. However, there are cases where there is a large amount of variation between providers despite sufficient evidence. Sometimes there are obvious explanations for these variations (patients of cardiologists having more stress tests ordered compared to patients of urologists) but other times the reason for the variability is not at all clear. Variation has been found to be associated with a number of factors including controversy, lack of knowledge of guidelines, lack of expert consensus, and physician characteristics. Determining which factors are associated with significant variation of specific tests can help us to determine why the overtesting is occurring. With further research it can also help us develop specific interventions to stop this behavior.

POSSIBILITY OF OVERTESTING SCORE AND APPLICATION

An overtesting score can be used to evaluate physician overuse. An overtesting score would incorporate multiple quality measures into one score. For example, a physician may not have very many patient visits in a time period for a specific reason, such as cancer screening. However, by combining more than one quality measure (such as routine Hemoglobin A1c tests and routine monofilament tests) the score becomes more reliable. The problem in the past when using single quality measures was small sample size. However, the sample size increases when using multiple quality measures. An increase in sample size also increases reliability. It is important for these scores to be reliable. The goal would be to have a reliability of at least 0.80.

Application of a reliable overtesting score would allow physicians, and others, to see where they stand on overuse. Physicians would be able to track their progress in decreasing overuse. The overtesting score could also become an outcome measures for quality improvement programs aimed at decreasing overuse in the outpatient setting.

Chapter 2: Background and Introduction

OVERUSE

Overuse Defined

Overuse is defined by the AHRQ as providing a process of care in circumstances where the potential for harm exceeds the potential for benefit[1]. Although overuse is common, physicians are usually unaware they are overtesting.

Overuse Causes Harm

Overuse can lead to physical harm. For example, blood pressure control is important to prevent sequelae from hypertension. However, in elderly patients tight blood pressure control can be associated with orthostatic hypotension[2]. When a patient stands up too quickly he can become very dizzy and fall down[3]. Falls in the elderly often lead to hip fractures[4]. About 20% of elderly patients are dead one year after sustaining a hip fracture[5]. As patients age and develop multiple comorbidities it becomes more important to focus on quality of life rather than prolongation of life.

Estimating Life Expectancy

Cancer screening guidelines often take overuse into account. They will usually include a statement similar to "men with less than ten years life expectancy should not be screened." However, physicians have not been taught to estimate life expectancy. Estimating life expectancy based on population data can be helpful but does not take into account individual patient characteristics. Although some physicians are wary of using population data for this reason, it can still be helpful in initiating a conversation on appropriate use between the patient and physician.

Researchers at the University of California, San Francisco, have developed a tool for clinicians called ePrognosis. Although it is based on population data it also takes into account individual information, such as functional status, when estimating five and ten

year life expectancy. Teaching physicians to use this tool can potentially decrease overuse.

Prostate Cancer in the Elderly

Using the Prostate Specific Antigen (PSA) test as a screening tool for prostate cancer has been controversial since its inception in the 1980s. In studies over the last two decades have shown little or no mortality benefit but rather evidence of an increase in harm[6]. Prostate cancer in the elderly is common but is usually so slow growing that men will die from other causes before having symptoms of prostate cancer[7]. In addition, older men also have benign prostatic hypertrophy which can increase PSA levels. Positive PSA tests usually lead to biopsies which expose these men to adverse events including bleeding, infection, pain, erectile dysfunction, and difficulty urinating[7]. Overdiagnosis, diagnosis of men who should never have had the test in the first place, causes men to be exposed to the risk of these complications. In 2008, after an exhaustive systematic review, the United States Preventive Services Task Force (USPSTF) recommended against PSA screening in men over 75 years old[8]. Since then, other societies such as the American Urological Association and American Cancer Association still recommended PSA screening in men with life expectancy greater than ten years[9,10].

Breast Cancer in the Elderly

By definition, a screening mammogram is performed before any symptoms of cancer are found. It takes 7-10 years from the time a cancer is initially detected on mammograms for survival benefits to actually occur[11]. Older women with multiple comorbidities, such as dementia, advanced nonresectable cancer, or heart failure, do not tend to live as long as their health counterparts. Screening these women will lead to overdiagnosis. Overdiagnosis, diagnosis of women who should never had been screened, provides little or no benefit but exposes these women to significant harms. Research has shown screening mammograms are overused in women with limited life expectancy[11]. In one study, 32.5 % of women with less than 7 years life expectancy received a screening

mammogram[12]. Harms related to overdiagnosis include complications from treatment, short term cognitive decline, and fatigue, breast pain, and edema[13]. These preventable harms could have been avoided had the women not been screened.

X-rays for Acute Low Back Pain in the Elderly

Another example of overuse is x-rays for acute low back pain. Acute low back pain is a very common diagnosis. The vast majority of patients will have complete resolution of pain within 4-6 weeks[14,15]. 90% of patients do not have red flag signs (such as trauma) or symptoms (such as neurologic impairment) and do not require imaging[16]. Despite much literature showing the futility of routinely ordering x-rays for acute low back pain, these tests are ordered often[14,17]. Imaging has not been shown to be clinically helpful in the first few weeks[16]. Incidental findings can also lead to procedures which place elderly patients at higher risk for complications[18,19]. 90% of older adults have incidental findings on spine imaging[19]. It also causes harm by exposing patients to unnecessary radiation[14,17]. In addition, The American College of Physicians, the American Pain Society, the American Association of Orthopedic Surgeons, and the American Chronic Pain Association recommend against x-rays for acute low back pain if no red flags are present[20,21].

PHYSICIAN VARIATION

Importance of Using Physician Level Data

Research has identified associations of overtesting at the regional and institutional levels. However, very little research has been done at the physician level. Examining physician level data can identify common physician characteristics associated with overtesting. Once identified, these characteristics can help determine why certain physicians are overtesting. This can lead to development of interventions specific to that population.

Multilevel analysis has been used in the past to evaluate physician level data[22,23]. The advantages of using multilevel analysis compared to other statistical analyses include not requiring independence of observations, avoiding aggregation bias, decreased error rates, and elimination of the need to run separate multiple regression analyses in extremely large data sets. It is also readily available in major statistical software packages. This type of analysis can be used to determine between-physician variation in overuse of tests and to define the physician characteristics associated with overtesting[23].

Physicians vary among themselves. A small amount of variation among a group of people, or physicians, is normal. However, a large amount of variation is not. Factors usually associated with larger variations among physicians include controversial subject, lack of scientific evidence and guidelines, lack of consensus among experts, personal beliefs, physician regret, and financial gain impact. These factors impact physicians differently which can lead to very large variations. For example, there was a 27% variance due to physician characteristics among PCPs who ordered a screening PSA for older men compared to 3.7% explained only by patient characteristics[22]. This meant that which PCP he saw explained approximately seven times the amount of variance in PSA screening than the patient characteristics.

The Intraclass Correlation Coefficient (ICC) is a marker of variation. Specifically, it is a marker of how much of the total variation is due to a certain factor. In the cited study above the ICC was 0.27, or 27%. So 27% of the total variance between physicians was due to physician characteristics alone. In this study, ICC is also marker of how much of the total variation is due to physician characteristics alone.

Importance of Determining Physician Factors Related to Overtesting

Variation between physicians has been documented in overtesting behaviors[11,22,24]. Variation between physicians has been associated with factors such as age, gender, specialty, and geographic regions[25]. Other more modifiable factors, such as experience, knowledge, belief system, regret, and financial incentives, have also been associated with overtesting behaviors[25]. These behaviors have been found to persist over time and can be difficult to change[26].

Not knowing which physicians have persistent overtesting tendencies limits improvement of this problem. Also, different tests may be associated with different physician factors. It is essential to determine which physician factors are associated with overuse of different tests. Once these factors have been identified further research can be done to explain why physicians are overtesting and to develop interventions to stop the behavior.

2.5 Aims

Aim #1: to Estimate the overtesting rates of individual primary care physicians (PCPs) and to evaluate the between-PCP variation in overuse of screening PSA, screening mammography, and imaging for acute low back pain in older patients.

Aim #2: to determine the physician characteristics associated with overuse of these tests. Physician characteristics associated with overuse of these tests will be useful in determining which physicians would benefit the most from educational interventions to decrease overtesting behaviors.

Aim #3: to evaluate the correlation of these 3 tests at the PCP level. It is possible that physicians who overuse one test will overuse another. To evaluate the likelihood of this event, possibility the correlation of overuse between the three tests will be tested.

Chapter 3: Methods

SAMPLE

The analysis of all three tests used the same data sources, patient characteristics, and physician characteristics.

Data Sources

Medicare enrollment files were used to identify the patients in all three cohorts. Physician age, gender, graduation year, and receipt of U.S. training were obtained from the American Medical Association (AMA) Masterfile and linked to the Medicare claims by the physicians National Provider Identification (NPI) number. Specialty was identified using the Health Care Financing Administration (HCFA) specialty field in the carrier file. Comorbidity assessment was based on the Medicare Carrier file (claims for physician services), Outpatient Statistical Analysis Files (claims for hospital outpatient services), and Medicare Provider Analysis and Review files (claims for inpatient stays) in 2009. Race/ethnicity was used from the Medicare part D denominator file. This study was approved by the UTMB Institutional Review Board.

Timeframe of Study

For the screening PSA cohort we used Medicare parts A and B data for years 2007-2010 to estimate the 2010 screening rates and ICC. This timeframe was used as the 2008 USPSTF guidelines recommended no PSA screening for men over 75 years old. Using 2010 data should have allowed enough time for the guidelines to disseminate among physicians. Medicare data for years 2008-2011 were used for the screening mammography cohort to estimate screening rates and the ICC score from the same time period as the PSA cohort but with the most recent years of Medicare data. Medicare data for 5 years, 2007-2011, was used for the Acute Low Back Pain cohort. As back pain is an

episodic diagnosis a larger range of years was required to improve reliability. The most recent 5 years of available Medicare data were used.

Cohort Selection

PSA Screening in Men > 75 year old

Texas Medicare part A and B data were used for years 2009-2010. Exclusions included having Health Maintenance Organization (HMO) enrollment at any time in 2010, history of prostate cancer or prostatectomy in the previous 3 years, and symptoms suggestive of prostate cancer in the previous 3 months. The diagnosis codes are listed in Table 1. PCPs were identified using an algorithm developed by Walter et al.[27].

Screening Mammography in Older Women with Limited Life Expectancy < 7 years

Tan et al.[12] previously published the methods used to determine this cohort. Briefly, Texas Medicare part A and B data were used for years 2010-2011. Exclusions included having HMO enrollment at any time in 2011 and history of breast cancer or breast mass in the previous 3 years. The diagnosis codes are listed in Table 1. PCPs were identified as the physician who saw the patient on two or more occasions in 2010 and who cared for at least 20 women in 2010. Life expectancy was estimated using the model developed by Tan *et al*[28]. This model takes was specifically developed and validated to estimate life expectancy for the elderly using Medicare claims data.

Imaging for Acute Low Back Pain in Older Patients

This cohort was defined using Medicare data 2007-2011. Men and women at least 66 years old as of 1/1/2007 were identified. Excluded patients had a prior diagnosis of lower back pain claims or history of trauma, cancer, intravenous drug use, or neurologic impairment in the past year. Patients who received an x-ray within 4 weeks of an initial diagnosis of low back pain ordered by a general practice physician were identified. A general practice physician was defined as a physician with a specialty in family medicine, general internal medicine, or geriatric medicine. HCFA specialty codes were used to identify these physicians.

Exclusion Criteria	Diagnosis Codes
Enrolled in Health Maintenance Organization at any time in 2010	
PSA Screening Cohort	
Men with history in the previous 3 years that would warrant ordering of PSA for non-screening use	Prostate Cancer *ICD-9* 185, V1046, 222.2, 233.4, 236.5 Prostatectomy *ICD-9* 60.21, 60.29, 60.3-60.6 *CPT* 55810 55812, 55815, 55801, 55821, 55831, 55842, 55845
Symptoms suggestive of prostate cancer in previous 3 months	Urinary Obstruction *ICD-9* 599.6 Hematuria *ICD-9* 599.7 Prostatitis *ICD-9* 601-601.9 Other Disorders of the Prostate *ICD-9* 602-602.9 Unexplained Weight Loss *ICD-9* 783.21 Back Pain *ICD-9* 724.5
Screening Mammography Cohort	
Breast cancer or mass in past 3 years	*ICD-9* 174.xx, 233.0, or 611.72
Imaging for Acute Low Back Pain Cohort	
Patients with history suggestive of a legitimate reason for imaging	Low back pain *ICD-9* 721.3, 722.10, 722.52, 722.93, 724.02, 724.2, 724.3, 724.5, 724.6, 724.70, 724.71, 724.79, 738.5, 739.3, 739.4, 846.x, 847.2 Cancer *ICD-9* 140-208, 230-239 Trauma *ICD-9* 830-839, 850-854, 860-869, 905-909, 926.11, 926.12, 929, 952, 958-959 Intravenous drug use *ICD-9* 304.0, 304.1x, 304.2x, 304.4x, 305.4x-305.7x Neurologic impairment *ICD-9* 344.60, 729.2

Table 1: Exclusion Criteria and Diagnosis Codes for the PSA Screening test in men >75, Screening Mammography Test in Women with Life Expectancy < 7 years, and Imaging for Acute Low Back Pain Cohorts.

METHODS

Patient Characteristics

The patient characteristics chosen for use in this study were chosen due to previous studies in order to help detect bias (age, race/ethnicity, and socioeconomic) and to estimate life expectancy (number of comorbidities, number of physicians visited in one year). All of the characteristics chosen for use in this study may influence a patient's participation in healthcare and/or receipt of PSA screening, mammogram screening, or imaging for acute low back pain. The patient characteristics used were age, race/ethnicity, number of comorbidities, Medicaid eligibility, type of county residence, number of high school graduates in the zip code area, and number of physicians visited in one year. The number of comorbidities was classified as none, 1, 2, 3, or ≥ 4. Medicaid eligibility was used as a marker for poverty. It was measured using the state buy-in fields in the Medicare Enrollment file. The county of residence was identified as rural, nonrural, or urban based on definitions from the US Department of Agriculture. The percentage of high school graduates in the patient's zip code was obtained from the US Census Data and was used as a marker for level of education.

Physician Characteristics

Physician characteristics influencing physician ordering patterns have been studied in the past. The physician characteristics used were physician age, race/ethnicity, gender, specialty (Family Medicine or Internal Medicine), board certification status, if the physician received residency training in the United States, and the number of years in practice. Race/ethnicity was divided into four categories (White, Black, Hispanic/Latino, or Other/Unknown). The physicians were placed into two specialty categories: Family Medicine (including Family Medicine and General Practice) and Internal Medicine (General Internal Medicine and Geriatrics).

SCREENING PSA IN MEN OVER 75 YEARS OLD

In 2008 the USPSTF released prostate cancer screening guidelines recommending against PSA screening in men over 75. Data from 2010 was used to see if those guidelines impacted PSA testing rates. This occurs 2 years after guideline release which should be sufficient time for the guidelines to reach most physicians.

Using 100% Medicare A and B data in Texas for 2007-2010 a cohort of men at least 75 years old as of 1/1/2010 was identified. Any patients with claims in the previous 3 years suggestive of prostate symptoms (such as hematuria, weight loss, and urinary obstruction) most likely received a diagnostic PSA test and were excluded. Although Texas Medicare data was used it is possible the men may have moved. Men who did not live in Texas during 2007-2010 were excluded as we would have incomplete information. Also, men with claims related to prostate cancer were excluded. Patients enrolled in health maintenance organizations in the previous 3 years were excluded due to incomplete data on testing and diagnoses. See table 1 for Current Procedural Terminology (CPT) codes.

Patients with an identifiable PCP were identified. A PCP as defined by Shah et al.[29] is a physician who saw a man on two or more occasions in an outpatient setting for evaluation and management and has a HFCA specialty code in family medicine, general practice, internal medicine, or geriatrics. The NPI was used to identify individual physicians. If more than one PCP was identified the one who saw the patient most often was assigned as PCP. In case of a tie the physician who had seen him last was identified as the PCP. The sample was limited to patients whose physicians had at least 20 patients in their panel for a reliability of at least 0.8. An algorithm was used to assess PSA tests ordered by the patient's PCP[30].

SCREENING MAMMOGRAM IN OLDER WOMEN WITH LIMITED LIFE EXPECTANCY OF LESS THAN SEVEN YEARS

Using 100% Medicare A and B data in Texas for 2008-2011 a cohort of women at least 67 years old as of 1/1/2010 were identified. Any patient with a mammogram in the previous 11 months was excluded as were patients with any diagnosis of breast cancer or breast mass in the previous 2 years. Women who did not have both Medicare Part A and

Part B or who were enrolled in health maintenance organizations in the previous 3 years were excluded due to incomplete data on testing and diagnoses. See table 1 for exclusion diagnosis codes.

Patients with an identifiable PCP were identified. A PCP was identified as a generalist physician who saw a woman on 3 or more occasions in 2010. PCPs whose patient panels included at least 20 women 67 years or older whose life expectancy was less than 7 years without a prior diagnosis of breast cancer or breast mass were selected. The analysis was restricted to mammogram screening tests ordered by the patient's PCP.

Life expectancy was estimated based on the model developed by Tan *et al*.[31] This model was specifically developed and validated to estimate life expectancy for the elderly using Medicare claims data.

IMAGING FOR ACUTE LOW BACK PAIN

Because acute low back pain is episodic there may not be enough episodes in one year to do a statistical analysis. Five of the most recent years of Medicare data (2007-2011) were used to perform a reliable analysis.

Using 100% Medicare A and B data in Texas for 2007-2011 a cohort of men and women at least 66 years old as of 1/1/2007 were identified. Patients with any of the following were excluded: a prior diagnosis of lower back pain claims, no history of trauma, cancer, intravenous drug use, or neurologic impairment in the past year, and patients who did not live in Texas. Patients without both Part A and Part B Medicare or enrolled in health maintenance organizations in the previous year were excluded due to incomplete data on testing and diagnoses. See table 1 for exclusion diagnosis codes.

Patients who received an x-ray within 4 weeks of an initial diagnosis of low back pain ordered by a general practice, family medicine, general internal medicine, or geriatric medicine physician were identified.

ANALYSIS

All three tests were analyzed using multilevel multivariate logistic regression, controlled for patient characteristics. The screening rates and ICC score were calculated. The physician characteristics associated with overtesting were found for each test. They were compared to determine if the characteristics associated with overuse varied between tests. Pearson's correlation was used to compare the three tests to determine if a physician who overuses one test was more likely to overuse one of the other tests.

The outcome measure for aim 1 was the rate of screening for each PCP, adjusted for patient characteristics, for aim 2 it was a list of physician characteristics with a significant association with overtesting, and for aim 3 it was binary (yes/no): is there a correlation between the three ICC scores (PSA screening, mammogram screening, Imaging for Acute Low Back Pain)?

Chapter 4: Results

SCREENING PSA

This cohort included 61,351 men and 1963 physicians who cared for them. 28.8% of the men received PSA screening ordered by their own PCP. Figure 1 presents a cumulative distribution of estimated PSA screening rates for each of the 1963 PCPs and adjusted for all patient and PCP characteristics in the multilevel model. There were 474 PCPs (24.2%) who had rates significantly greater than the average mean and 314 PCPs (16.0%) had rates significantly lower than the average mean. The ICC was 0.27.

Table 2 presents patient characteristics significantly associated with receipt of cancer screening or x-rays for acute low back pain. The characteristics associated with receiving PSA screening were age (age 80-84 0.706 (95% CI, 0.671-0.744), age >85 0.412 (95% CI, 0.389-0.437)) and increasing number of comorbidities (1 comorbidity 0.860 (95% CI, 0.0813-0.910), 2 comorbidities 0.700 (95% CI, 0.654-0.748), 3 comorbidities 0.541 (95% CI, 0.506-0.578)).

Table 3 presents PCP characteristics significantly associated with receipt of cancer screening or x-rays for acute low back pain. The characteristics associated with receiving PSA screening were a specialty in Family Medicine 0.800 (95% CI, 0.708-0.903) or Geriatrics 0.387 (95% CI, 0.160-0.934) and not having U.S. training 1.161 (95% CI, 1.005-1.341).

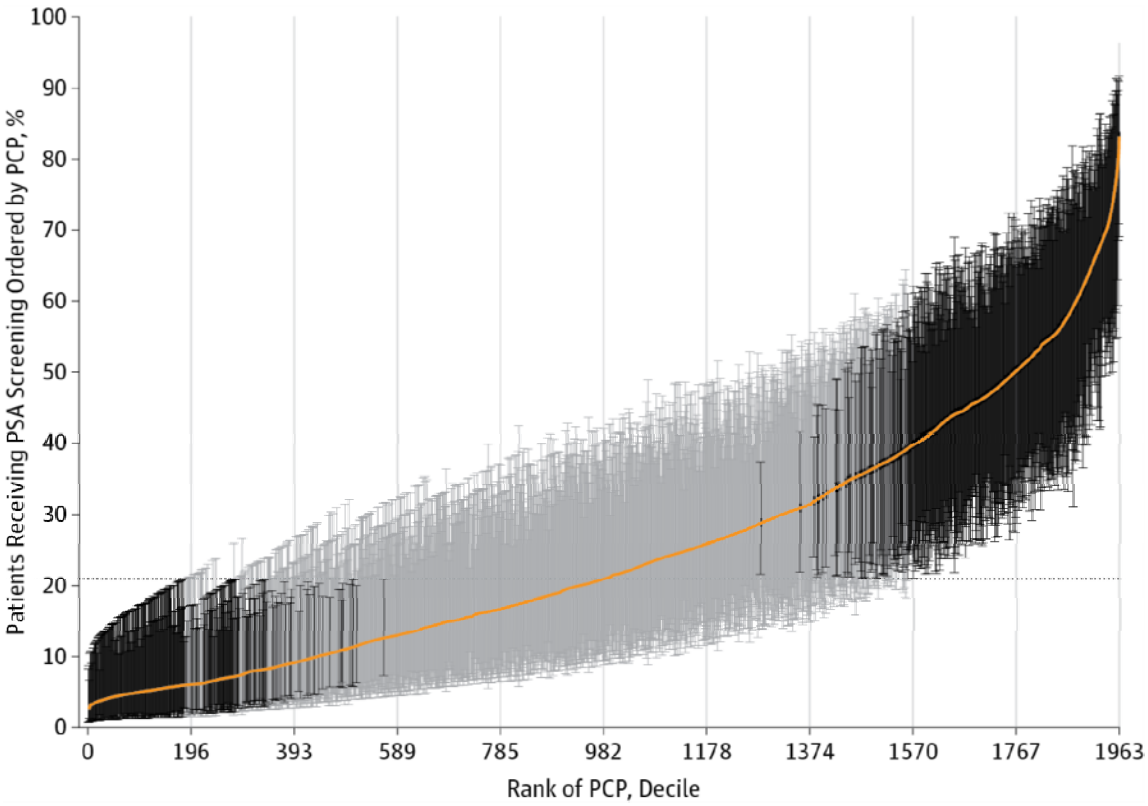

Figure 1: Cumulative distribution of 1963 Texas Primary Care Physicians by adjusted percentage of their patients who underwent Prostate-Specific Antigen (PSA) screening ordered by their own Primary Care Physician.

Patient characteristics	OR for Screening PSA in men ≥ 75 years old (95% CI)	OR for Screening Mammography < 7 years life expectancy (95% CI)	OR for Acute Low Back Pain, adjusted for patient gender (95% CI)
Age, years			
66-69	NA	Reference	Reference
70-74	NA	1.139 (0.986-1.315)	1.071 (1.032-1.112)
75-79	Reference	1.173 (1.022-1.347)	1.191 (1.146-1.238)
80-84	0.706 (0.671-0.744)	0.896 (0.782-1.027)	1.297 (1.244-1.353)
>=85	0.412 (0.389-0.437)	0.544 (0.475-0.624)	1.350 (1.291-1.413)
Race/ethnicity			
Non-Hispanic White	Reference	Reference	Reference
Non-Hispanic Black	0.882 (0.725-1.072)	0.955 (0.794-1.148)	0.875 (0.826-0.927)
Hispanic	1.000 (0.871-1.148)	1.279 (1.183-1.384)	0.908 (0.870-0.948)
Number of comorbidities			
0	Reference	NA	Reference
1	0.860 (0.813-0.910)	NA	1.021 (0.989-1.055)
2	0.700 (0.654-0.748)	NA	1.023 (0.975-1.073)
3 (3+ for ALBP)	0.541 (0.506-0.578)	NA	0.957 (0.908-1.010)
Medicaid eligible			
Yes	Reference	Reference	Reference
No	1.035 (0.938-1.142)	2.043 (1.213-3.442)	1.195 (1.146-1.247)
Location			
Metro	0.946 (0.776-1.155)	1.228 (1.006-1.499)	1.148 (1.029-1.280)
Nonmetro	0.942 (0.773-1.147)	1.195 (0.977-1.461)	1.108 (0.991-1.239)
Rural	Reference	Reference	Reference
High school graduates in zip code area, %			
Q1 (low)	Reference	Reference	Reference
Q2	0.935 (0.865-1.012)	1.014 (0.950-1.083)	0.988 (0.950-1.028)
Q3	0.956 (0.884-1.034)	1.106 (1.039-1.177)	0.985 (0.945-1.025)
Q4 (high)	1.027 (0.950-1.111)	1.110 (1.042-1.183)	0.969 (0.929-1.010)
Number of physicians visited in the previous year			
0	NA	NA	Reference
1	NA	NA	0.931 (0.889-0.976)
2	NA	NA	0.916 (0.875-0.958)
3 (3+ for ALBP)	NA	NA	0.839 (0.810-0.869)

OR: Odds Ratio, PSA: Prostate Specific Antigen, CI: Confidence Interval

Table 2: Patient Characteristics associated with overuse of PSA screening, Mammography screening, and X-rays for acute low back pain in the elderly.

PCP characteristics	OR for Screening PSA in men ≥ 75 years old (95% CI)	OR for Screening Mammography < 7 years life expectancy (95% CI)	OR for Acute Low Back Pain, adjusted for patient gender (95% CI)
Age, years			
<50	0.939 (0.682-1.292)	0.87 (0.81-0.93)	
51-60	1.012 (0.791-1.294)	Reference	
>60	Reference		
Sex			
Male	Reference	Reference	Reference
Female	0.822 (0.651-1.038)	1.40 (1.30-1.51)	1.006 (0.968-1.046)
Years in Practice			
Q1	Reference	Reference	Reference
Q2	0.873 (0.714-1.067)	1.082 (1.025-1.129)	1.164 (1.120-1.209)
Q3	0.872(0.679-1.120)	1.004 (0.094-1.102)	1.078 (1.038-1.121)
Q4	0.929 (0.664-1.300)	1.132 (1.04-1.201)	1.173 (1.129-1.219)
Specialty			
GP (01)	0.904 (0.660-1.238)	0.73 (0.58-0.91)	
FM (08)	0.800 (0.708-0.903)	0.80 (0.75-0.85)	1.140 (1.108-1.173)
IM (11)	Reference	Reference	Reference
GE (38)	0.387 (0.160-0.934)	0.73 (0.52-1.02)	
Board certified			
Yes	1.118 (0.976-1.280)	1.16 (1.07-1.23)	1.097 (0.881-0.942)
no	Reference	Reference	Reference
U.S. trained			
Yes	Reference	Reference	Reference
No	1.161 (1.005-1.341)	1.32 (1.22-1.43)	0.836 (0.810-0.864)

OR: Odds Ratio, PSA: Prostate Specific Antigen, CI: Confidence Interval, U.S.: United States

Table 3: Primary Care Physician (PCP) Characteristics associated associated with overuse of PSA screening, Mammography screening, and X-rays for acute low back pain in the elderly.

SCREENING MAMMOGRAPHY

This cohort included 83,766 women and 3,961 PCPs. 28.2% women with less than 7 years life expectancy received screening mammography ordered by their PCP. Figure 2 presents a cumulative distribution of estimated PSA screening rates for each of the 3,961 PCPs and adjusted for all patient and PCP characteristics in the multilevel model. There were 283 PCPs (7.1%) who had rates significantly greater than the average mean and 122 PCPs (3.1%) had rates significantly lower than the average mean. The ICC was 0.1454.

Table 2 presents patient characteristics significantly associated with receipt of cancer screening or x-rays for acute low back pain. The characteristics associated with receiving screening mammography were age 75-79 1.173 (95% CI, 1.022-1.347), age ≥ 85 0.544 (95% CI, 0.475-0.624), Hispanic ethnicity 1.279 (95% CI, 1.183-1.384), Medicaid ineligibility 2.043 (95% CI, 1.213-3.422), metro location 1.228 (95% CI, 1.006-1.499), and high school graduation 3rd quartile 1.106 (95% CI, 1.039-1.177) and 4th quartile 1.110 (95% CI, 1.042-1.183).

Table 3 presents PCP characteristics significantly associated with receipt of cancer screening or x-rays for acute low back pain. The characteristics associated with receiving screening mammography were female gender 1.40 (95% CI, 0.30-1.51), years in practice 2nd quartile 1.082 (95% CI, 1.025-1.129) and 4th quartile 1.132 (95% CI, 1.04-1.201) for years in practice, no US training 1.32 (95% CI, 1.22-1.43), having board certification status 1.16 (95% CI, 1.07-1.23), age less than 50 years old 0.87 (95% CI, 0.81-0.93), and General Practice 0.73 (95% CI 0.58-0.91) or Family Practice specialty 0.80 (95% CI, 0.75-0.85). Specialty in Geriatric Medicine had no significant association with receipt of screening mammography.

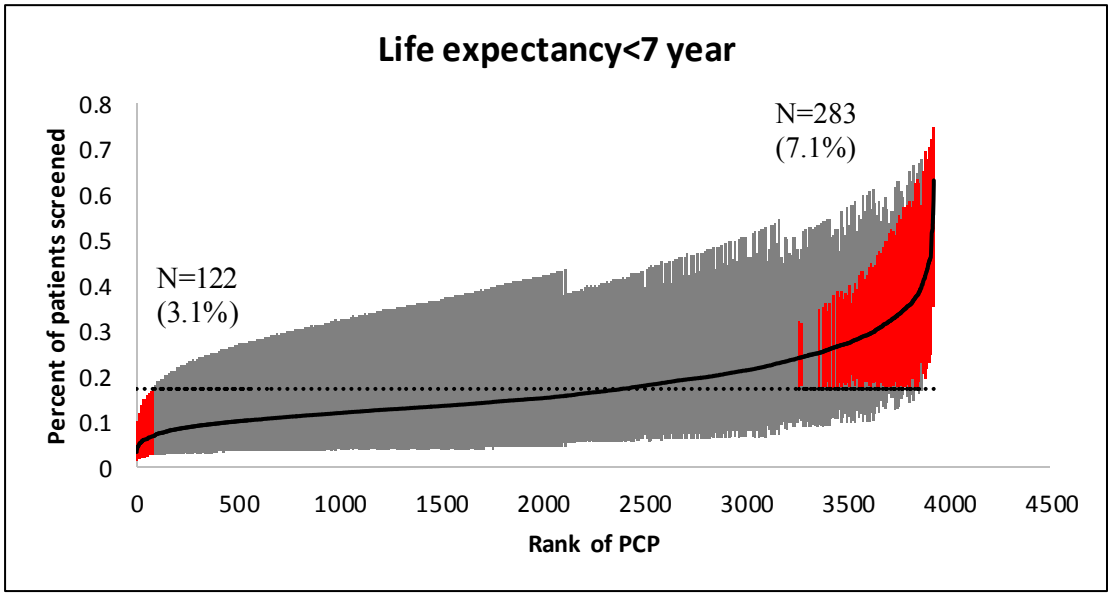

Figure 2: Cumulative Distribution of 3,961 Texas Primary Care Physicians by adjusted percentage of their patients with less than 7 years life expectancy who underwent Mammography screening by their own Primary Care Physician.

IMAGING FOR ACUTE LOW BACK PAIN

This cohort included 145,320 patients and 3,297 PCPs. Figure 3 presents a cumulative distribution of estimated PSA screening rates for each of the 3297 PCPs, adjusted for all patient and PCP characteristics in the multilevel model. There were 580 PCPs (17.59%) who had rates significantly greater than the average mean and 734 PCPs (22.26%) had rates significantly lower than the average mean. The ICC was 0.251.

Table 2 presents patient characteristics significantly associated with receipt of cancer screening or x-rays for acute low back pain. The characteristics associated with receiving x-rays for acute low back pain were living in a metro location 1.148 (1.029-1.280), Medicaid ineligibility 1.195 (1.146-1.247), increasing age (age 70-74 1.071 (95% CI, 1.032-0.002), age 75-79 1.191 (1.146-1.238), age 80-84 1.297 (1.244-1.353), and age ≥ 85 1.350 (1.291-1.413)), race/ethnicity (Non-Hispanic Black 0.875 (95% CI, 0.826-0.927) and Hispanic 0.908 (95% CI, 0.870-0.948)) and number of visits to the physician in the prior year (1 visit 0.931 (95% CI, 0.889-0.976), 2 visits 0.916 (95% CI, 0.875-0.958), and 3+ visits 0.839 (95% CI, 0.810-0.869). There was no significant association with gender, comorbidity score, percentage of high school education in the zip code area, or non-metro locations.

Table 3 presents PCP characteristics significantly associated with receipt of cancer screening or x-rays for acute low back pain. The characteristics associated with receiving x-rays for acute low back pain were Family Practice specialty 1.140 (95% CI, 1.108-1.173), increasing years in practice (14-22 years 1.164 (95% CI, 1.120-1.209), 22-29 years 1.078 (95% CI, 1.038-1.121), >29 years 1.173 (95% CI, 1.129-1.219)), receipt of non US training 0.836 (95%CI, 0.810-0.864) and without board certification 0.911 (95% CI, 0.881-0.942).

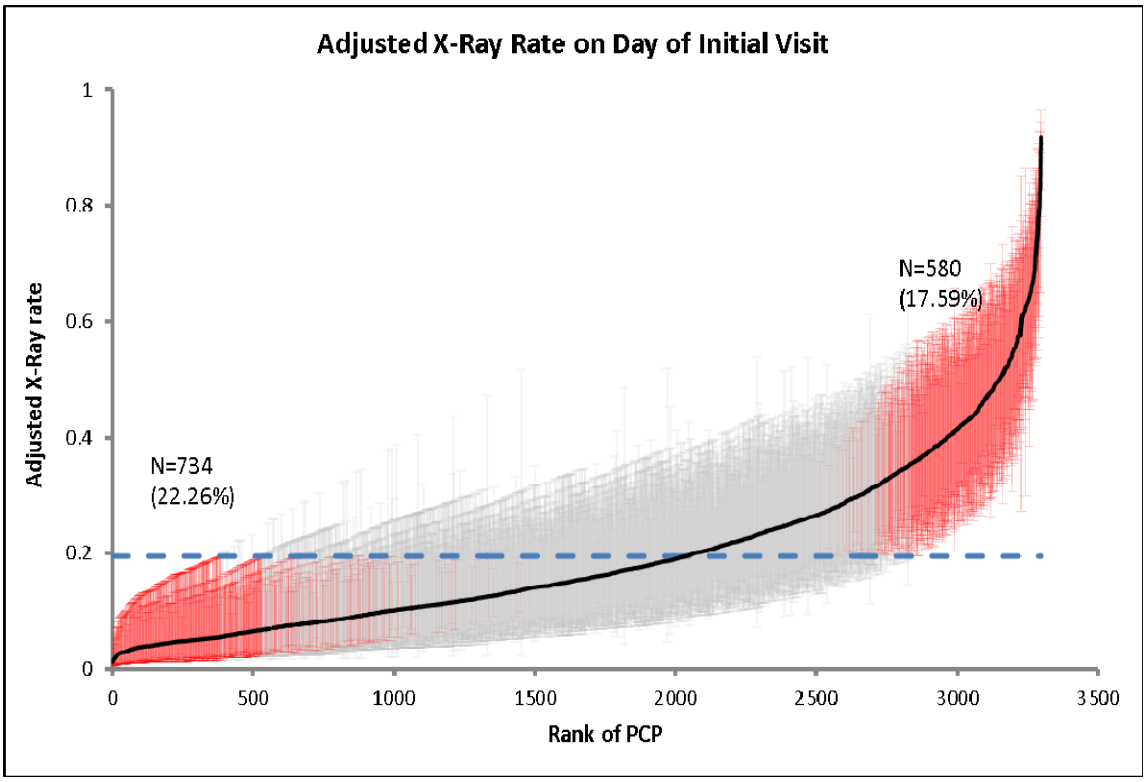

Figure 3: Cumulative distribution of 3,297 Texas primary care physicians by the percentage of their uncomplicated acute low back pain patient receiving an X-ray on the day of the initial visit.

PATIENT AND PHYSICIAN CHARACTERISTICS ASSOCIATED WITH OVERUSE OF MORE THAN ONE TEST

Age > 85 was a patient characteristic significantly associated with receiving each of the tests. The patient characteristic significantly associated with receiving PSA screening and imaging for acute low back pain was age >80. Patient characteristics significantly associated with receiving mammography screening and imaging for acute low back pain were age 75-79, age >85, Hispanic ethnicity, Medicaid ineligibility, and metro location. Age >85 was a patient characteristics significantly associated with receipt of cancer screening.

PCP characteristics significantly associated with receiving each of the tests was Family Medicine specialty and not having residency training in the United States. PCP characteristics significantly associated with receiving PSA screening and imaging for acute low back pain were Family Medicine specialty and not having U.S. training. PCP characteristics significantly associated with receiving mammography screening and imaging for acute low back pain were 2^{nd} and 4^{th} quartile for years in practice, Family Medicine specialty, and not having U.S. training. PCP characteristics significantly associated with receipt of cancer screening were Family Medicine specialty and not having U.S. training.

CORRELATIONS OF THE RATES OF THE THREE TESTS

The Pearson correlation coefficient for the PSA test vs mammography was 0.21243 ($p<0.0001$), for the mammography vs X-rays was 0.10573 ($p<0.0001$), and for PSA vs X-rays was 0.06873 ($p=0.0067$).

	PSA screening in men ≥ 75	**Mammography screening <7 years life expectancy**	**X-ray in incident uncomplicated low back pain**
PSA screening in men ≥ 75	1	CORR=0.20210 N=3,796 P-Value=0.0001†	CORR=0.04543 N=5,551 P-Value=0.0007†
Mammography screening <7 years life expectancy		1	CORR=0.10108 N=4,090 P-Value<0.0001†

Table 4: Pearson correlation table for PSA screening in men ≥ 75 years old, Mammography screening in elderly women with < 7 years life expectancy, and X-rays for Acute Low Back Pain in the elderly.

†The P-values in this table are tested under the null hypothesis of no difference between the Pearson correlation coefficients and 0.

Chapter 5: Discussion

AIM 1: COMPARISON OF OVERTESTING RATES AND ICC SCORES FOR ALL THREE TESTS

For the PSA screening test there were 474 PCPs (24.2%) who had rates significantly greater than the average mean and 314 PCPs (16.0%) had rates significantly lower than the average mean. There is a greater percentage of physicians overusing the test than underusing it. This is consistent with previous studies[22,32].

For the mammography screening test there were 283 PCPs (7.1%) who had rates significantly greater than the average mean and 122 PCPs (3.1%) had rates significantly lower than the average mean. There were a greater percentage of physicians overusing the test than underusing it although only 7.1% of physicians are overusing the test. This is a much smaller rate than the other two tests. This could be because physicians are starting to decrease overuse of mammogram screenings in the United States. It could also be because guidelines for older women are similar between organizations now compared to in the past.

For the x-rays for acute low back pain there were 580 PCPs (17.59%) who had rates significantly greater than the average mean and 734 PCPs (22.26%) had rates significantly lower than the average mean. There were a greater percentage of physicians underusing the test than overusing it. This is almost the exact opposite of the PSA screening test. This could be because physicians are starting to understand the consequences of overuse of x-rays in acute low back pain.

The ICC scores represent the portion of the total variation attributable to physician factors alone. All of the ICC scores were high: 0.27 for PSA screening, 0.15 for mammography screening, and 0.25 for X-rays for acute low back pain. This means for PSA screening and X-rays for acute low back pain at least one fourth of the variation among physicians ordering the test was due to physician factors alone. In the past, mammography screening in older women had an ICC of 0.10[12]. In this study the population was limited to women who had life expectancy < 7 years. The ICC increased from 0.10 to 0.15 which could be related to physicians not knowing how to calculate life

expectancy. Previous studies have shown up to 31.1% of women with limited life expectancy had undergone mammography screening by their usual care provider[12].

Higher variation rates are usually associated with medical diagnoses and procedures that have few or no published guidelines, contradictory guidelines from medical organizations, and/or controversy surrounding the topic. The USPSTF guidelines for PSA screening test and mammography screening were widely publicized when they were initially released and again as guidelines of other medical associations, such as the American Cancer Society, were released. However, there was more controversy regarding use of PSA screening in elderly men compared to mammography screening in elderly women, which could be contributing to the higher variation rates in PSA screening.

Guidelines for X-rays for acute low back pain have had less publicity and the use of X-rays for acute low back pain is much less controversial than cancer screening. However, the variation between physicians was greater than with mammography screening which had much more publicity and controversy. It is possible in this case that physician beliefs and habits are more cause for variation than lack of guideline publicity or controversy. One survey showed that physicians will sometimes order x-rays for acute low back pain to alleviate patient anxiety even though they know the film will not contribute medically. It is also known that doctors who have a tendency to order many tests tend to keep that behavior over time. This behavior can be difficult to change.

AIM 2: PCP CHARACTERISTICS ASSOCIATED WITH OVERTESTING

Family Medicine specialty and not having U.S. training had significant associations with patient receipt of each test. Family Medicine specialty was associated with decreased odds of receipt of PSA and mammography screening but increased odds in receipt of x-rays for acute low back pain. Not having U.S. training was associated with increased odds of receipt of PSA and mammography screening but associated with decreased odds of receiving imaging for acute low back pain.

It is possible Family Medicine training encourages a decrease in cancer screening as patients' age or that somehow they are more aware of the guidelines than Internal

Medicine physicians. Having decreased odds of cancer screening with increased odds of x-ray receipt could also be related to guideline publicity as noted above. It is also possible they are seeing many vague complaints and do not have enough time for a thorough history and physical during the patient's appointment so they order imaging instead.

Not having U.S. training was associated with increased odds of receiving a screening PSA test. Other countries may have different guidelines for cancer screening than the United States. Physicians training in other countries would be more familiar with those guidelines. Not having U.S. training was also associated with decreased odds of receiving imaging for acute low back pain. Undeveloped countries may not have the resources to routinely order imaging for acute back pain. Physicians trained in those countries might have a tendency to order x-rays less often than U.S. trained physicians.

AIM 3: CORRELATION BETWEEN TESTS

The correlation between the PSA and mammography tests had the strongest correlation of the three tests at a correlation at 0.21. The correlation was very weak between mammography and X-rays for Acute Low Back Pain (0.11) and between the PSA test and the X-rays (0.07). The stronger correlation between the cancer screening tests may be due to the similarities of the tests.

The finding of a correlation between the cancer screening tests between physicians is important in that physicians who overuse one test may potentially overuse another test. It may be possible to determine an overuse score if physicians who overuse one test may overuse another test. This would allow us to identify those physicians with a tendency to overuse tests and target them for educational interventions to change that behavior, thus decreasing patient harm.

Chapter 6: Conclusions

In conclusion, the rate of overtesting among physicians varied with the three tests. 24.2% of physicians significantly overused the PSA screening test compared to their peers, 7.1% of physicians significantly overused the screening mammogram test compared to their peers, and 17.59% of physicians significantly overused x-rays for acute low back pain compared to their peers.

The ICC scores were high for each of the tests (0.27 for PSA screening, 0.15 for mammography screening, and 0.25 for X-rays for acute low back pain). This means physician characteristics were responsible for a large part of the overall variation in ordering rates.

Family Medicine specialty and not having U.S. training were the two physician characteristics with significant associations with patient receipt of the tests. Family Medicine specialty was associated with decreased odds of receipt of PSA and mammography screening but increased odds in receipt of x-rays for acute low back pain. Not having U.S. training was associated with increased odds of receipt of PSA and mammography screening but associated with decreased odds of receiving imaging for acute low back pain.

There is a weak correlation between overuse of the PSA and mammography screening tests. There is a very weak correlation between x-rays for acute low back pain and each cancer screening test. With further research, an overtesting score may be developed to identify physicians with a tendency to overuse multiple tests.

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Vita

Elizabeth Anne Jaramillo was born on May 31, 1983 in Muskogee, Oklahoma. She graduated from Comeaux High School in Lafayette, Louisiana in 2001. In 2005 she graduated from the University of Texas Pan American in Edinburg, Texas with Honors, receiving a Bachelor's degree in Biology (PreMed emphasis) and a minor in Chemistry. In 2009 she graduated from The University of Texas Medical Branch (UTMB) in Galveston, Texas with a Doctorate in Medicine. She continued her training at UTMB, completing an Internal Medicine residency in 2012 and a Geriatric fellowship in 2013.

In 2009 she received the Beiersdorf History of Dermatology Award and was inducted into the Dame Cicely Saunders Society in 2011. She became a Research Career and Development Core scholar in 2013 and a Sealy Center on Aging Scholar in 2014. She received a Faculty Development KL-2 Award in 2014 from the UTMB Clinical and Translational Science Award.

She has published four journal articles since 2013, two as first author and two in high impact journals (the Journal of the American Medical Association and the Journal of the National Cancer Institute). In 2014 she was invited to present at Geriatric Grand Rounds at the University of Texas Southwestern Medical Center. She has given several lectures to the Geriatric Fellows at UTMB and to older adults at the Osher Lifelong Living Society in Galveston, Texas.

She is currently an Assistant Professor at UTMB in the Institute for Translational Science and in Internal Medicine, Division of Geriatrics. She lives with her family in Galveston, Texas. Her permanent address is 7166 Spanish Grant, Galveston, Texas 77554.

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