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Defining low-value PSA testing in a large retrospective cohort: Finding common ground between discordant guidelines

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ABSTRACT

Background: Reports of low-value prostate-specific antigen (PSA) testing (testing in which the harms outweigh the benefits) generally employ population level data sources. While such results may be generalizable, they often lack the detail necessary to understand provider clinical decision making and guideline concordance. Using a retrospective study of PSA testing at our institution we intend to characterize the frequency and patterns associated with low-value PSA testing.

Methods: We leveraged the electronic health record to determine guideline-defined low-value testing in our health system from 07/01/2012 to 06/30/2017. Secondarily, we measured the between-testing interval for repeat tests and the rates of prostate cancer risk factors and comorbidities among men receiving screening.

Results: Overall, 21,145 PSA tests were performed on 12,303 men. The rate of low-value testing ranged from 23.4 to 56.8%, depending upon the specific guideline. For repeat tests, the median between-testing interval was 12.6 months. Risk factors for prostate cancer were uncommon, but more frequent in men age < 55 years compared to men age 55–69 years (17.6% vs. 13.5%, $p < 0.001$). Screened older men (age > 70 years) were more likely to have a Charlson Comorbidity Index ≥ 3, compared to the 55–69 reference group (31.4% vs. 17.3%, $p < 0.001$).

Conclusion: Low-value prostate cancer testing is prevalent. Between-testing intervals were often times shorter than recommended. Screening among younger men was frequent despite low rates of risk factors. High rates of comorbidity may limit life expectancy among older men receiving screening. These findings highlight the need for improved guidance with prostate cancer screening.

1. Introduction

There are significant differences between professional societies' recommendations/guidelines for considering PSA testing for early detection of prostate cancer. Guidelines differ in relation to the age at which shared decision making might begin, the between-testing intervals utilized, and the relative impact of race and family history on screening decisions [1–5]. Furthermore, the 2012 the United States Preventive Services Task Force (USPSTF) giving prostate cancer screening a "D" recommendation (recommend against) has been recently changed to a "C" recommendation (offer in select patients) for men age 55–69 [4,6]. These changes and inconsistencies leave primary care providers to navigate a difficult and ever-changing landscape in prostate cancer screening and these inconsistencies may contribute to the variation in PSA testing prevalent across the country [7]. One of the more important factors associated with PSA screening is the performance of low-value testing, defined as PSA testing in which the harms outweigh the benefits.

While each of the major societal guidelines has differing cutoffs for the definition of low-value testing [1–5], there are some consistent themes: 1) younger men are less likely to benefit from screening, particularly if they do not have risk factors for prostate cancer (e.g. African-American race [8] and family history [9,10]); 2) annual PSA testing likely increases the risks of identifying clinically insignificant

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cancer without improving the detection of significant cancers compared to longer between-test intervals [11,12]; and 3) men with a life-expectancy less than 10 years are unlikely to benefit from screening due to the long natural history of prostate cancer [13,14]. Yet, within these parameters it is unclear how these are typically incorporated in real world clinical decision making.

In this study, we sought to characterize PSA screening patterns in a large academic health system. The primary outcome of interest was the proportion of PSA tests that were low-value based on various professional guidelines. Of note, this does not involve measurement of providers' performance of shared decision making and only identifies low-value tests that are performed where guidelines recommend against screening entirely. We hypothesized that low-value tests represented a substantial proportion of tests. Secondary outcomes of interest were between-test intervals and the degree to which family history and life expectancy (estimated by age and Charlson Comorbidity index or CCI) [15] factored into screening. We hypothesized that the majority of men undergo repeat screening annually rather than at more extended intervals (irrespective of previous PSA value) and that risk factors and life expectancy are inconsistently factored into screening.

2. Materials and methods

2.1. Data

The enterprise data warehouse of a large academic health system was queried to identify PSA tests completed between July 1, 2012 and June 30, 2017 in men without prostate cancer. Order-associated diagnoses, encounter diagnoses, problem list entries, family history data, and patient demographics (age at time of test, race) were also identified through the data warehouse. The source of the data was the electronic health record.

All tests completed for men who had ever had a PSA test associated with a transplant or hypogonadism were excluded. Individual PSA tests completed after the date of PCa diagnosis were excluded, but any screening tests completed in any individual prior to a diagnosis of PCa were included. This study was approved by the Institutional Review Board where the study was conducted. All statistical analyses were completed in Stata/MP 13.1 (StataCorp LP, College Station, TX). P-values less than 0.05 were considered significant.

2.2. Guideline-defined low-value testing

USPSTF, American Urologic Association (AUA), National Comprehensive Cancer Network (NCCN), American Cancer Society (ACS), and American College of Physicians (ACP) guidelines were each applied to the PSA tests to determine low-value testing (Appendix Table A1). Though the 2012 USPSTF recommendations (rather than the 2018 USPSTF recommendations) guided clinical decision making during the study time period, we did not include those recommendations in our analysis. This is because the Grade D recommendation would have considered any PSA testing performed to be low-value.

In addition to age at test, family history of prostate cancer and African American race were considered risk factors in the AUA and ACS guidelines. Comorbidities known at the time of test were identified using the billing diagnoses (including those for both the current visit and every patient visit prior to testing). CCI score [15] was used in combination with age to achieve an estimate of life expectancy for the AUA, NCCN, and ACS guidelines (which allow testing in older men, but recommend against testing in men with a < 10 year life expectancy). Published retrospective series within the Medicare population suggest that men age 70–74 with a CCI of 4 or more and men age 75–79 with a CCI of 3 or more have a < 10 year life expectancy [16]. Use of CCI and age has not be validated in young cohorts. As a result, life expectancy for men < 70 years old was assumed to be at least 10 years regardless of CCI, which likely underestimates the true rate of low-value testing based on life expectancy. For family history, order associated diagnoses, family history entries, and problem list entries were used to determine a positive family history of prostate cancer known to the record at time of testing.

2.3. The role of risk factors and health status in testing

Testing in men aged 55–69 is concordant with all included guidelines. As a result, this age group was used as a reference to understand how risk factors (family history and African American race) and comorbidities were considered with testing in younger and older men, respectively. First, to determine if risk factors played a role in ordering PSA tests in men younger than 55 years, a random effects logistic regression model was used to compare the proportion of tests ordered when at least one risk factor was present at time of testing in men less than 55 years compared to the reference group of 55–69 years. The random effects model was used to account for the non-independence of multiple tests completed in the same individual. A random effects logistic regression model was also used to compare the proportion of tests completed in men with a CCI ≥ 3 in the reference age group (55–69 years) versus men 70 years of age or older.

2.4. Repeat testing intervals

For men with multiple tests, the between-testing interval was calculated. Tests were divided into groups depending on the age-specific value of the previous test [17]. These were above or below the median, or above the 95th percentile. Appendix Table A2 includes the age-specific PSA values [17]. The between-test intervals for repeat tests were compared between the above or below median groups using a random effects linear regression model. Histograms of between-test intervals were generated for the two groups, as well as for tests completed after a previous PSA value above the age-adjusted 95% cutoff.

3. Theory/Calculation

Across the literature, low-value testing measurement is based on population-based analyses that focus on testing in elderly or unhealthy populations. Analysis among Medicare data demonstrates substantial low-value PSA testing in older men [18]. In surveys conducted by the US Census Bureau, an estimated 1.5 million men over 80 years old receive a screening PSA test each year [19]. Much less information is available regarding low-value testing in younger populations (US Census Bureau data suggest 9.4–16.6% of 40–49 year olds receive screening tests each year) [19], and little to no information is available regarding the interval between screening tests. Appreciating how prostate cancer risk factors (family history and African American race), age, and comorbidities/life expectancy interplay in screening decisions and characterizing which men are actually receiving screening is key to understanding the steps necessary for health care systems to improve the value of PSA testing.

4. Results

Over the study period, 21,145 PSA tests were performed on 12,303 individuals without a diagnosis of prostate cancer. The majority of tests (57.0%) were completed in the reference age group of 55–69 years (Fig. 1).

Family history of prostate cancer was noted in the medical record at the time of first PSA test during the study period in 10.5% of men. The breakdown of self-reported race for cohort was 83.0% "White or Caucasian", 2.6% "Asian", 1.6% "Black or African American", 0.9% "Native Hawaiian and Other Pacific Islander", 0.5% "American Indian and Alaska Native" and 11.4% unknown race, other race or multiple race. "Hispanic/Latino" ethnicity was reported in 9.3%. Depending upon the guideline, the rate of low-value testing ranged from 23.4% for NCCN to 56.8% for AUA (Table 1).