

## Calculating life expectancy to inform prostate cancer screening and treatment decisions

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Current guidelines for prostate cancer (PCa) consider life expectancy (LE) to be an important factor when making screening and treatment decisions. For patients with LE <10 years, most guidelines recommend against PCa screening and active surveillance or definitive treatment of low-risk disease [1,2]. Nevertheless, recent work has shown that men with limited LE often undergo PSA screening and biopsy for PCa [3,4]. With an increasing emphasis on guideline-directed management, pragmatic tools for point-of-care 10-year LE estimates are needed to inform these clinical decisions.

Existing methods for calculating LE have several weaknesses; they do not adequately adjust for comorbidities, can be cumbersome to use, and/or provide LE estimates in a format inconsistent with guideline recommendations, which are based on a patient's expected remaining number of years of life [5]. These weaknesses may result in inaccurate assessments of LE, difficulty incorporating LE estimates into clinical decisions, or foregoing point-of-care LE estimations altogether.

In a recent study from the Michigan Urological Surgery Improvement Collaborative (MUSIC), we found that nearly 20% of men undergoing initial prostate biopsy had an LE <10 years [4]. As a result, we felt that implementing an LE calculator in clinical practice may help further refine the selection of patients for prostate biopsy. In this context, we created a 10-year LE calculation tool using a comorbidity-adjusted model by Cho et al. [6], designed to improve cancer screening strategies. Implementation of this tool may help address the discordance among guideline-recommended care and observed practice patterns in men with limited LE.

Using Medicare claims, Cho et al. reported LE in remaining number of life-years, stratified by sex, race, age in 5-year increments, and comorbidity group, classified as none, low/

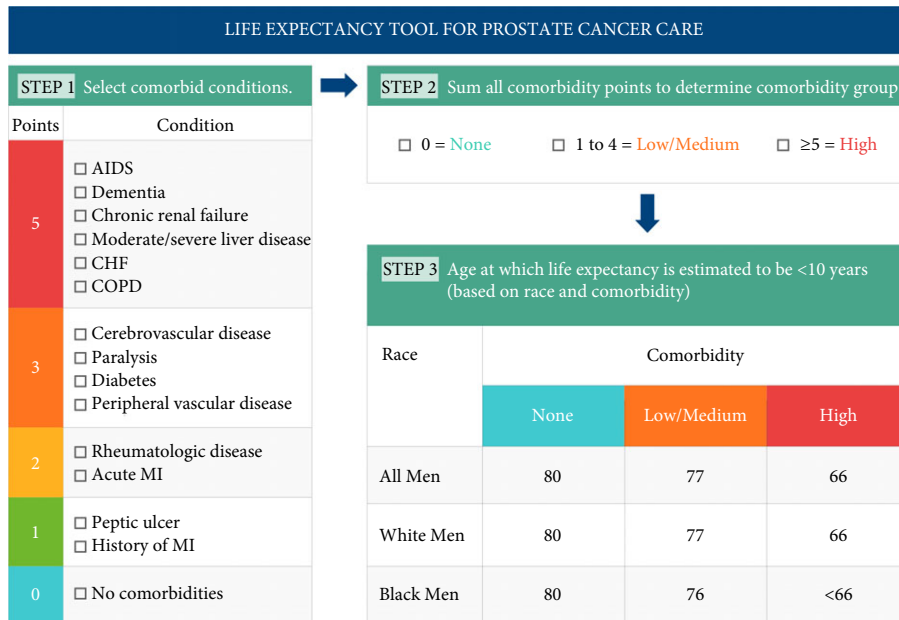
medium and high. Comorbidity groups were assigned based on a patient's comorbidity score, which accounted for the number of comorbidities included in the Charlson comorbidity index that were present, and the relative impact of each on survival [6]. These LE estimates were intended to inform PCa and other cancer screening strategies.

Although the results of Cho et al. are comprehensively reported, the data of greatest relevance for PCa guidelines – age at which LE is <10 years – are somewhat complicated to derive and not available for all comorbidity groups. To streamline this model for point-of-care use, we made several modifications. First, we created a new comorbidity point system that easily sums to a simplified comorbidity score. Comorbidities are assigned a point value of 1–5, based on their relative impact on survival; each patient's respective comorbidity points are summed, and this sum is classified into one of three comorbidity groups (0, none; 1–4, intermediate; ≥5, high). Table S1 shows our validation process for assuring that patients with all combinations of comorbidities are categorized consistently across the different groups.

Next, by incorporating unpublished supplemental data from Cho et al., we report estimated ages where LE is <10 years in men, stratified by comorbidity group and race. This allows providers to easily determine if individuals have LE <10 years. Figure 1 shows our LE tool for informing PCa care decisions. The age at which estimated LE is <10 years, accounting for race and comorbidity, is determined using the table included in the figure.

Comparing our LE estimates with those of published LE calculators, we saw that our results were generally consistent, although we report remaining life-years rather than risk estimates. For example, a 78-year-old man with peripheral

**Fig. 1** Life Expectancy Tool for Prostate Cancer Care: a three-step process for calculating <10 year life expectancy. Acquired immune deficiency syndrome (AIDS), moderate/severe liver disease and cirrhosis or chronic hepatitis, congestive heart failure (CHF), chronic obstructive pulmonary disease (COPD), acute myocardial infarction (MI). For a detailed list of the disease included within each condition see Cho et al. [6].



vascular disease has an LE of <10 years in our model. For this same patient, the age-adjusted prostate-cancer-specific comorbidity index score used by Daskivich et al. [7] calculates a 60% 10-year cumulative incidence of other-cause mortality. Similarly, the model used by Kent et al. [5] calculates a 10-year other-cause mortality of 62% in this same scenario.

In summary, we designed a pragmatic tool, based on US national data, to facilitate clinical decisions incorporating LE for men undergoing PCa screening or treatment. Our tool allows these decisions to be viewed within the context of recent guidelines by reporting LE in an easily interpretable format consistent with recommendations. Adopting this tool in practice may have implications for patients with PCa and providers. For patients, information on LE may be helpful for understanding how guideline recommendations pertain to individual cancer diagnoses or screening options. This may encourage conversations about goals of care, and ultimately lead to improved shared decision-making. For providers, easily obtainable LE estimates may prove useful when counselling patients on the long-term risks and benefits of screening or treatment in the context of patients' existing comorbidities.

Our tool has several limitations. First, not all comorbidities are included in the Charlson comorbidity index, and there are other conditions that may affect mortality. Nevertheless, the Charlson comorbidity index has been found to be similar to

other comorbidity measures in predicting mortality. Second, the method used by Cho et al. was modelled in a non-cancer cohort aged  $\geq 66$  years residing in areas covered by the Surveillance Epidemiology and End Results programme, potentially limiting the generalizability of our results to countries other than the USA. Furthermore, because that cohort did not include men aged <66 years, we were unable to precisely estimate the age at which black men with high comorbidity first develop an LE <10 years; this is because LE for this group at 66 years is already <10 years (9.1 remaining life-years). Third, the competing risk of PCa mortality is not calculated, making this tool less useful for men diagnosed with higher-risk disease who may benefit from treatment despite limited LE [5]. Fourth, the method used by Cho et al. utilized health-adjusted age concepts to calculate LE and extrapolate survival data using US life tables, which limits the calculation of uncertainty measures. Instead, sensitivity analyses were conducted to examine assumptions in the authors' model; these revealed only slight changes in LE estimates (e.g. a maximum of a 1.3-year LE estimate increase in white people) [6].

Despite these limitations, our tool represents a method for incorporating LE into decisions surrounding PCa care in accordance with guidelines. Moving forward, we plan to disseminate this tool throughout the state of Michigan through MUSIC, and assess the impact of point-of-care LE estimates on PCa treatment appropriateness. Our goal is that

these LE estimates will aid in identifying patients with limited LE, and improve communication regarding the risks and benefits of screening or treatment in this setting.

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## Conflict of Interest

Dr David C. Miller receives salary support from BCBSM as the director of MUSIC and the Michigan Value Collaborative. Dr Firas Abdollah is a consultant/advisor for GenomeDx Biosciences. Dr Khurshid R. Ghani receives salary support from the BCBSM as the co-director of MUSIC and has research grant support from Intuitive Surgical. No other conflicts of interests are reported.

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**Abbreviations:** LE, life expectancy; PCa, prostate cancer.

## Supporting Information

Additional Supporting Information may be found in the online version of this article:

**Table S1.** Life expectancy tool for prostate cancer care: comorbidity scoring system validation.