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ABSTRACT

TITLE: Developing Behavior-Based Diabetic Retinopathy Screening Guidelines

ABSTRACT BODY:

Purpose: Personalized screening guidelines can be an effective strategy to prevent diabetic retinopathy (DR)-related vision loss. However, these strategies typically do not capture behavior-based factors such as a patient's compliance or cost preferences. This study develops a mathematical model to identify screening policies that capture both DR progression and behavioral factors to provide personalized recommendations.

Methods: A partially observable Markov decision process model (POMDP) is developed to provide personalized screening recommendations. For each patient, the model estimates the patient's probability of having a sight-threatening diabetic eye disorder (STDED) yearly via Bayesian inference based on natural history, screening results, and compliance behavior. The model then determines a personalized, threshold-based recommendation for each patient annually—either no action (NA), teleretinal imaging (TRI), or clinical screening (CS)—based on the patient's current probability of having STDED as well as patient-specific preference between cost saving ($) and QALY gain. The framework is applied to a hypothetical cohort of 40-year-old African American male patients.

Results: For the base population with TRI and CS compliance rates of 65% and 55% and equal preference for cost and QALY, NA is identified as an optimal recommendation when the patient's probability of having STDED is less than 0.72%, TRI when the probability is [0.72%, 2.09%], and CS when the probability is above 2.09%. Simulated against annual clinical screening, the model-based policy finds an average decrease of 7.07% in cost/QALY (95% CI; 6.93-7.23%) and 15.05% in blindness prevalence over a patient's lifetime (95% CI; 14.88-15.23%). For patients with equal preference for cost and QALY, the model identifies 6 different types of threshold-based policies (See Fig 1). For patients with strong preference for QALY gain, CS-only policies had an increase in prevalence by a factor of 19.2 (see Fig 2).

Conclusions: The POMDP model is highly flexible and responsive in incorporating behavioral factors when providing personalized screening recommendations. As a decision support tool, providers can use this modeling framework to provide unique, catered recommendations.

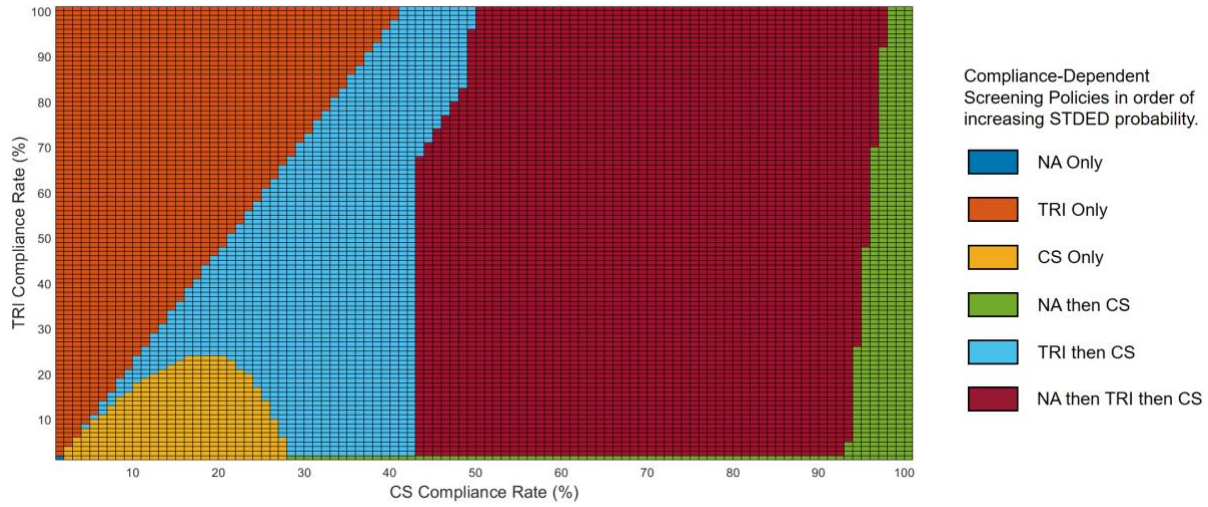

Fig (1) Screening policies in order of increasing STDED probability with equal costs ($) and QALYs preference.

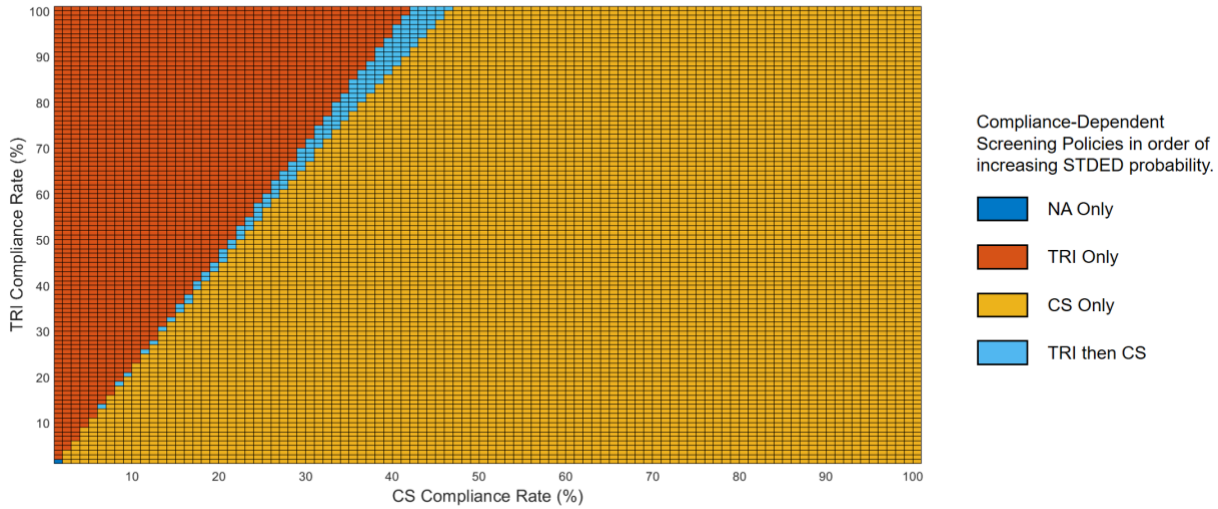

Fig (2) Screening policies in order of increasing STDED probability with strong QALYs preference.

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.: While innovations in screening technologies, such as teleretinal imaging, create multiple new options for patients' routine screenings for diabetic retinopathy, indicating the potential for personalized recommendations, there exists a lack of quantitative understanding about how patients with different characteristics can truly benefit from these new technologies. This study aims to address this gap by providing a mathematical model that can be utilized as a decision support tool for eye care professionals and general practitioners in providing personalized recommendations. By estimating and adaptively updating the patient's diabetic retinopathy status and behavior-based compliance level, this tool can generate distinct, tailored recommendations that are optimized to the patient's unique preference for costs and health outcomes. Simulation results show that personalized recommendations made by the tool improve cost-effectiveness as well as decrease the likelihood of patients becoming blind compared to widely accepted annual clinical screening.