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Universal Lung Cancer Screening Guidelines Under Heterogeneous Patient Responses

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Health organizations (society) prefer to recommend universal screening guidelines to at-risk individuals (patients) for various diseases, with coverage typically provided by third-party payers. However, patients are heterogeneous both in disease risk and disutility associated with screening, resulting in varying health outcomes. Infrequent recommendations leave at-risk patients to decide if to pay out-of-pocket in the interim, while frequent recommendations may result in unnecessary screening disutility for low-risk patients and unnecessary costs to society. Moreover, patient adherence to guidelines remains low for many diseases, further complicating the health benefits and costs realized in practice. We address these challenges in the context of lung cancer screening for eligible ever-smokers and employ a bilevel optimization model to compute universal lung cancer screening guidelines that maximize the societal net monetary benefit (NMB). With society (leader) determining the covered universal screening schedule, representative patient classes (followers) are modeled as partially observable Markov decision processes (POMDPs), maximizing their own NMB with respect to their smoking level, screening disutility, willingness-to-pay for out-of-pocket costs, and adherence rate. We employ a grid-based approximation scheme to embed the follower problems within a mixed-integer bilevel program.

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