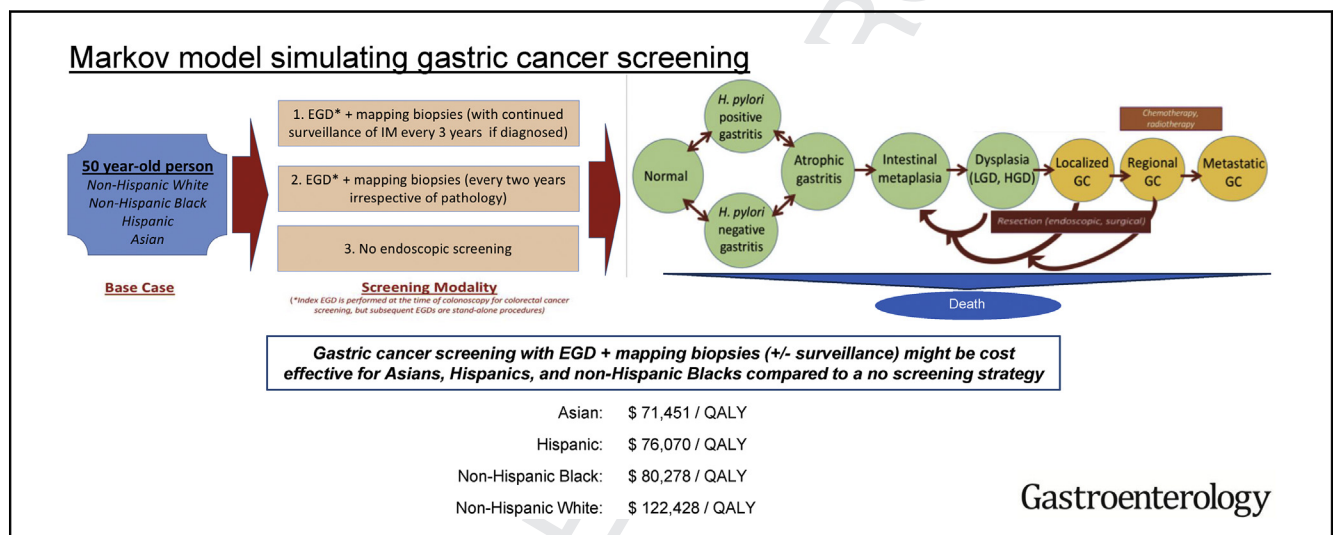


Cost Effectiveness of Gastric Cancer Screening According to Race and Ethnicity

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BACKGROUND & AIMS: There are marked racial and ethnic differences in non-cardia gastric cancer prevalence within the United States. Although gastric cancer screening is recommended in regions of high prevalence, screening is not routinely performed in the United States. Our objective was to determine whether selected non-cardia gastric cancer screening for high-risk races and ethnicities within the United States is cost effective. **METHODS:** We developed a decision analytic Markov model with the base case of a 50-year-old person of non-Hispanic white, non-Hispanic black, Hispanic, or Asian race or ethnicity. The cost effectiveness of a no-screening strategy (current standard) for non-cardia gastric cancer was compared with that of 2 endoscopic screening modalities initiated at the time of screening colonoscopy for colorectal cancer: upper esophagogastroduodenoscopy with biopsy examinations and continued surveillance only if intestinal metaplasia or more severe pathology is identified or esophagogastroduodenoscopy with biopsy examinations continued every 2 years even in the absence of identified pathology. We used prevalence rates, transition probabilities, costs, and quality-adjusted life years (QALYs) from publications and public data sources. Outcome measures were reported in incremental cost-effectiveness ratios, with a willingness-to-pay threshold of \$100,000/QALY. **RESULTS:** Compared with biennial and no screening, screening esophagogastroduodenoscopy

with continued surveillance only when indicated was cost effective for non-Hispanic blacks (\$80,278/QALY), Hispanics (\$76,070/QALY), and Asians (\$71,451/QALY), but not for non-Hispanic whites (\$122,428/QALY). The model was sensitive to intestinal metaplasia prevalence, transition rates from intestinal metaplasia to dysplasia to local and regional cancer, cost of endoscopy, and cost of resection (endoscopic or surgical). **CONCLUSIONS:** Based on a decision analytic Markov model, endoscopic non-cardia gastric cancer screening for high-risk races and ethnicities could be cost effective in the United States.

Keywords: *Helicobacter pylori*; Neoplasm; Precancer; Preneoplasia.

Abbreviations used in this paper: AG, atrophic gastritis; CRC, colorectal cancer; EGD, esophagogastroduodenoscopy; ESD, endoscopic submucosal dissection; GA, gastric adenocarcinoma; ICER, incremental cost-effectiveness ratio; IM, intestinal metaplasia; NCGA, non-cardia gastric adenocarcinoma; QALY, quality-adjusted life year; SEER, Surveillance, Epidemiology, and End Results.

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WHAT YOU NEED TO KNOW**BACKGROUND AND CONTEXT**

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NEW FINDINGS

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LIMITATIONS

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Although decreasing in incidence, gastric adenocarcinoma (GA) remains the third leading cause of cancer death globally, with non-cardia tumors representing more than 80% of all GAs.^{1,2} However, when diagnosed at an early and resectable stage, 5-year survival approaches 95%–99% compared with less than 30% when diagnosed in advanced stages.^{3–6} For this reason, in countries where non-cardia intestinal-type GA (NCGA) is endemic, such as Japan and Korea, national screening guidelines have been implemented for NCGA that include annual or biennial upper endoscopy in men and women starting at 40–50 years old.^{7–9} Screening efforts not only have been associated with significantly lower NCGA-related morbidity and mortality due at least in part to earlier detection and opportunity for curative resection but also are cost effective.^{10–15} By contrast, in the United States, 75% of NCGAs are diagnosed in the advanced stage with limited curative options and poor prognosis. Because the United States is a relatively low-prevalence country, with gastric cancer ranked the 15th most common cancer overall,⁵ population-based NCGA screening is not recommended and has not been proved cost effective.^{16,17} However, NCGA screening for high-risk subgroups within otherwise low- to intermediate-prevalence areas has previously been shown to be a cost-effective intervention.¹⁸

There are high-risk groups in the United States who could similarly benefit from targeted screening for NCGA. Race and ethnicity are one way to identify such high-risk groups. Hispanics, non-Hispanic blacks, East Asians, and other immigrant groups from areas where NCGA is endemic have at least 2–3 times the prevalence of NCGA as US-born non-Hispanic whites, if not higher, with a burden of disease even tantamount to colorectal cancer (CRC) in some groups.^{1,19–24} Although NCGA has been decreasing overall,

these trends are far from uniform in the United States; in fact, there has been an increase in gastric cancer incidence in young Hispanic men in the United States, particularly advanced-stage NCGA.²⁵ Intestinal-type GA develops as a stepwise and typically asymptomatic progression from preneoplastic mucosal changes (atrophic gastritis [AG] and intestinal metaplasia [IM]) before malignant transformation, with *Helicobacter pylori* (*H pylori*) believed to be the primary trigger for the cascade.²⁶ Not surprisingly, the prevalence of *H pylori* and IM in Hispanics, non-Hispanic blacks, and immigrant populations from areas endemic for NCGA is disproportionately higher than in US-born non-Hispanic whites.^{20,21,27,28} Because a diagnosis of gastric IM is one of the strongest risk factors for NCGA development, screening offers an opportunity for earlier detection and a higher likelihood of candidacy for endoscopic or surgical curative resection. Although there are no guidelines for NCGA screening in the United States, the American Society for Gastrointestinal Endoscopy acknowledges the racial and ethnic differences with respect to NCGA incidence and prevalence. As such, they recommend *considering* screening for NCGA with upper endoscopy among new US immigrants older than 40 years from high-risk endemic regions (Japan, Korea, China, Russia, and South America), particularly in those with a first-degree relative with a history of NCGA.²⁹ The society notably offers no recommendations regarding other high-risk races and ethnicities in the United States, specifically Hispanics and non-Hispanic blacks. Whether such a targeted model of endoscopic screening for NCGA is cost effective in the United States has not been investigated. We hypothesized that targeting NCGA screening for high-risk subgroups in the United States according to race and ethnicity would be a cost-effective strategy and could increase the percentage of NCGA cases diagnosed at a curable and resectable stage.

Methods

We developed a state-transition Markov decision process model using TreeAge Pro 2017 release 1.2 (TreeAge, Williamstown, MA), simulating a base case scenario of NCGA screening at 50 years of age for non-Hispanic whites, non-Hispanic blacks, Hispanics, and Asians in the United States (Figure 1A). This model was used to evaluate the cost effectiveness of implementing 1 of 2 endoscopic modalities for NCGA screening initiated at the time of colonoscopy for CRC screening and compared with a no endoscopic screening strategy: (1) upper endoscopy (esophagogastroduodenoscopy [EGD]) with biopsy examinations (2 sets each from the antrum and body) with continued endoscopic surveillance with biopsy examinations only if IM is identified (or appropriate management if more severe pathology is diagnosed) or (2) EGD with biopsy examination continued every 2 years even if no IM or higher grade pathology is identified (Figure 1A).

The Markov model was adapted from a previously published model by Yeh et al.^{16,30} A systematic review of the Medline and EMBASE databases for studies published in the English language from 1947 through July 2017 was conducted to identify key variables for the model, including baseline, transition, and outcome probabilities for each race and

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