Research Article

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Long-term economic benefits of early cancer detection through enhanced multimodal screening: a modeling study of whole-body MRI and liquid biopsy

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Aim: Cancer poses a substantial health and economic burden in the US Although early detection is associated with improved outcomes and lower treatment costs, many cancers are still diagnosed at advanced stages. Enhanced multimodal screening combining whole-body magnetic resonance imaging (WB MRI) and blood-based multicancer early detection (MCED) may shift diagnoses earlier, but its long-term economic impact remains uncertain. **Materials & methods:** We developed an economic model to estimate expected cancer-related costs under two scenarios: status quo with conventional screening and enhanced multimodal screening incorporating WB MRI and MCED. The analysis included common cancers with an annual incidence of ≥10,000 new cases in the US in 2025. Expected cancer management costs were estimated using incidence-based 5-year stage-specific medical costs. Productivity losses were estimated using a simplified human capital approach, applying published stage-specific work-loss durations to sex-specific annual earnings. Under the intervention arm, conservative, moderate and maximum cancer stage-shift assumptions were evaluated. These scenarios reflected increasing degrees of earlier cancer detection, with a greater proportion of cancers assumed to be diagnosed at earlier stages rather than at advanced stages. Total expected cancer-related costs per person were derived by combining direct medical costs and productivity losses, weighted by cancer risk and stage distribution. **Results:** Under the status quo, expected cancer-related costs were estimated at $74,431 for men and $78,818 for women. With enhanced multimodal screening under the moderate stage-shift assumption, costs, including screening and false positive workup, declined to about $66,000 and $69,500, respectively, representing approximately 12% reduction. Under the conservative stage-shift assumption, total costs were similar to those under the status quo, whereas under the maximum stage-shift assumption, cost reductions ranged from 24.0% to 24.3% for men and from 24.7% to 25.0% for women. **Conclusion:** Enhanced multimodal screening may reduce the economic burden of cancer by shifting diagnosis toward earlier stages, although the magnitude of benefit depends substantially on the extent to which cancers are detected at earlier stages in practice. These findings highlight the potential long-term economic value of earlier cancer detection while underscoring the need for prospective evidence on the real-world performance of WB-MRI and MCED screening strategies. Because long-term real-world data for population-level WB-MRI and MCED screening remain limited, these findings should be interpreted as estimates of potential economic impact rather than projections of a specific screening program.

Plain language summary: Could whole-body MRI & multicancer blood tests reduce the long-term cost of cancer?

What is this article about? Cancer causes a major health and financial burden in the US. Finding cancer earlier may improve outcomes and reduce treatment costs. This study used an economic model to estimate the potential impact of combining whole-body MRI and blood-based multicancer early detection tests to identify cancer at earlier stages.

What were the results? Under current cancer diagnosis patterns, the expected cancer-related cost burden was estimated at about $74,000 per man and $79,000 per woman. In the main analysis, earlier cancer

detection through enhanced multimodal screening reduced these costs by approximately 12%, even after accounting for screening and follow-up testing costs. Greater shifts toward early-stage diagnosis produced larger savings, while smaller shifts resulted in little or no cost reduction.

What do the results mean? Why is this important? These findings suggest that earlier cancer detection through whole-body MRI and multicancer blood testing could reduce the economic burden of cancer by lowering treatment costs and productivity losses associated with advanced disease. However, the results are based on a model and assumptions about future screening performance rather than real-world population screening data. Further prospective studies are needed to confirm the actual benefits, costs and potential harms of these screening strategies.

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Keywords: cost analysis • early detection of cancer • health care economics • health expenditures • liquid biopsy • magnetic resonance imaging • mass screening • productivity loss • US

Cancer remains a leading cause of morbidity and mortality worldwide, with early detection being a critical factor in improving survival rates and reducing treatment costs [1]. In the US, the financial burden of cancer is substantial, with direct medical costs exceeding $200 billion annually and lost societal cost of about $286 billion due to lost productivity and other indirect effects contributing significantly to the national healthcare expenditure [2,3]. Recent studies have highlighted the economic benefits of early cancer detection, estimating that cancer screenings have saved the US healthcare system at least $6.5 trillion over a 25-year period [4].

Traditional cancer screening methods, including mammography for breast cancer, colonoscopy for colorectal cancer, pap smears for cervical cancer and low-dose CT for lung cancer, have been widely implemented and contribute to earlier detection and improved survival for specific cancers. Mammography sensitivity across modalities, including screen-film, digital mammography and digital breast tomosynthesis, is reported between 55 and 91% with generally high specificity [5]. Colonoscopy remains the gold standard for colorectal cancer screening, with sensitivity for detecting colorectal cancers and larger adenomas often 90–95% [6]. Pap smear screening has been associated with a substantial reduction in cervical cancer incidence in the US [7]. Despite these benefits, these cancer-specific approaches detect only a subset of malignancies and often miss early-stage disease across the broader cancer spectrum.

Enhanced multimodal screening, including whole-body magnetic resonance imaging (WB MRI) and blood-based multicancer early detection (MCED), offers the potential to detect various cancers simultaneously at earlier, more treatable stages [8–15]. WB MRI can detect previously unrecognized cancers in approximately 1.1–1.7% of screened, asymptomatic individuals [16,17], while blood-based MCED tests have an overall detection rate of around 0.5% [14]. Although clinical evidence of these technologies is present, it remains constrained [17]. The paucity of economic evidence is even greater.

A key concern with highly sensitive screening is overdiagnosis, particularly the detection of low-grade cancers that may not require immediate treatment and could lead to unnecessary intervention [18,19]. However, imaging based screening is designed not only for detection but also for risk stratification, enabling discrimination between low- and high-grade disease and supporting longitudinal monitoring [20]. Extensive clinical evidence from prostate cancer and other indolent malignancies, such as small renal masses, demonstrates that active imaging surveillance for low-risk disease achieves comparable cancer-specific survival with reduced treatment-related morbidity and lower costs compared with upfront intervention [21–23]. Viewed this way, enhanced imaging screening with WB MRI guides early intervention for high-grade cancers and avoid unnecessary treatment in low-risk disease by enabling surveillance-based management.

This study aims to evaluate the cost savings associated with implementing enhanced multimodal screening for common cancers with an annual incidence of at least 10,000 new cases in the US as of 2025.

Materials & methods

Overview

We developed a cancer stage-shift economic model to evaluate the potential economic impact of enhanced multimodal screening using WB-MRI and MCED for the early detection of cancer in the US. The model was designed to estimate the economic consequences of alternative stage distributions at diagnosis. Specifically, the model assumed

varying degrees of cancer stage shift, whereby a greater proportion of cancers are diagnosed at earlier stages rather than at more advanced stages as a result of enhanced screening. The model evaluated direct medical costs and productivity losses attributable to common cancers with an estimated annual incidence of ≥10,000 cases in 2025 in the US, under two alternative scenarios: a status quo without intervention and an intervention incorporating enhanced multimodal screening. Under scenario 2, we incorporated the estimated costs of WB MRI and blood-based MCED screening. Cost savings were defined as the difference in expected costs between these two scenarios, with savings attributed to earlier detection of cancer leading to less costly treatment and reduced productivity losses.

Cancer types & incidence

Using 2025 Surveillance, Epidemiology, and End Results (SEER) program data, we identified the 17 most common cancers in men and the 18 most common cancers in women, each with 10,000 or more estimated new cases in 2025. (Table 1). For each cancer type, the number of incident cases and the distribution of stage at diagnosis (localized, regional, distant) were obtained. Stage distributions were subsequently converted to American Joint Committee on Cancer (AJCC) stages I–IV, based on expert opinion. Leukemia and myeloma were treated separately because these hematologic malignancies do not use the AJCC stage I–IV classification system applied to solid tumors. Consequently, stage distributions were not assigned for these cancers. Disease-specific aggregate cost estimates were incorporated directly into the model using published sources [24], and these cancers were excluded from stage-shift analyses. Observed SEER stage distributions were used directly in the status quo arm and therefore implicitly reflect current screening practices, diagnostic pathways and real-world adherence in the US.

Cost of cancer management

For each cancer stage (stage I–IV), published sources were used to estimate stage-specific direct medical costs of cancer management. Stage I was further divided into 'early stage I' and 'remaining stage I', with costs and stage distribution proportions derived from published data supplemented by expert input. The expected direct medical cost for each cancer type was calculated as the weighted average of stage-specific costs, using the proportion of cases diagnosed at each stage as weights.

Stage-specific cancer management costs were obtained from Reddy *et al.* who estimated cancer-attributable expenditures among US Medicare beneficiaries according to cancer type and stage at diagnosis. This represented incidence-based cancer-attributable medical expenditures incurred during the first 5 years following diagnosis. We summed the reported yearly costs to derive total 5-year management costs for each cancer-stage combination. All costs were converted to 2025 US dollars. Because the source estimates were reported in 2025 US dollars and already incorporated the timing of expenditures during follow-up, no additional discounting was applied in the present analysis. The model assumes that relative differences in management costs between stages remain representative of contemporary US practice.

For several cancer types, stage-specific cost estimates were unavailable from the primary source. In these instances, costs were derived from clinically and economically comparable cancers identified from the literature. Melanoma costs were assumed to be comparable to breast cancer costs based on published cost-of-illness estimates demonstrating similar ranges of cancer-attributable expenditures [25]. Thyroid cancer costs were assumed to be comparable to prostate cancer costs because both cancers are frequently diagnosed at an early stage and commonly managed with surveillance-oriented approaches [26]. Brain and other nervous system cancers were assigned costs comparable to pancreatic cancer because both are associated with intensive treatment requirements and high resource utilization [27]. These assumptions were applied only when cancer-specific stage-based cost estimates were unavailable.

Productivity losses

Productivity losses were estimated using a simplified human capital approach. Average years of productivity loss associated with cancer stage were obtained from published literature and expert opinion: early stage I: 0.3 years, stage I: 0.3 years, stage II: 1.0 year, stage III: 1.5 years and stage IV: 2.6 years [28]. Lost productive time was valued using sex-specific annual earnings obtained from US Bureau of Labor Statistics data: $72,739 for men and $59,599 for women [29]. For each cancer, expected productivity losses were calculated by multiplying stage-specific years of productivity loss by annual earnings and weighting by stage distribution.

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Table 1. Common cancers in the U.S., 2025.

Cancer	Estimated new cases in 2025, n
Male	
Male	
Prostate	313,780
Lung and bronchus	110,680
Colon and rectum	82,460
Bladder	65,080
Melanoma of the skin	60,550
Kidney and renal pelvis	52,410
Non-Hodgkin lymphoma	45,140
Oral cavity and pharynx	42,500
Leukemia	38,720
Pancreas	34,950
Liver and intrahepatic bile duct	28,220
Myeloma	20,030
Stomach	17,720
Esophagus	17,430
Brain and other nervous system	14,040
Thyroid	12,670
Larynx	10,110
Female	
Breast	316,950
Lung and bronchus	115,970
Colon and rectum	71,810
Uterus	69,120
Melanoma of the skin	44,410
Non-Hodgkin lymphoma	35,210
Pancreas	32,490
Thyroid	31,350
Kidney and renal pelvis	28,570
Leukemia	28,170
Ovary	20,890
Bladder	19,790
Oral cavity and pharynx	17,160
Myeloma	16,080
Liver and intrahepatic bile duct	14,020
Cervix uteri	13,360
Stomach	12,580
Brain and other nervous system	10,780

Source: https://seer.cancer.gov/statfacts/.

Total cost estimation

For each type of cancer, total expected costs (direct medical costs plus productivity losses) were calculated by summing the weighted averages of stage-specific costs and productivity losses. These were then aggregated across all cancer types, weighted by the proportion of each cancer type in the total cancer incidence.

We estimated the lifetime risk of developing at least one of these cancers in the US population using SEER lifetime risk estimates. The probability of developing any of common cancers was calculated as

$$1 - \prod_{i=1}^{n} (1 - p_i)$$

where p_i is the lifetime risk of cancer type i. Multiplying total expected costs among cancer patients by these lifetime risks yielded the total expected cancer-related costs at the population level.

Intervention scenario & cost savings

In Scenario 2 (with intervention), the enhanced multimodal screening was assumed to occur biennially between ages 40 and 50 and annually from ages 51 through 75, based on expert opinion. Each individual would undergo a total of 31 WB-MRI and MCED screening tests over their lifetime. The cost of a WB-MRI and an MCED screening was assumed to be $400 and $300, respectively. Screening frequency and starting age were based on expert opinion and were intended to represent a hypothetical long-term surveillance strategy rather than a recommendation derived from clinical guidelines. Similarly, the assumed screening costs of WB-MRI and MCED were exploratory model inputs reflecting anticipated future implementation costs and were evaluated to estimate the potential economic implications of earlier cancer detection.

In this scenario, enhanced multimodal screening was assumed to shift the cancer stage distribution at diagnosis toward earlier-stage disease. Because long-term population-level data for multimodal screening are not yet available, three alternative cancer stage-shift assumptions were evaluated. The conservative stage-shift assumption allocated 60% of cancers to stage I, 20% to stage II, 12% to stage III and 8% to stage IV. The moderate stage-shift assumption, which served as the primary analysis, allocated 75% of cancers to stage I, 12% to stage II, 8% to stage III and 5% to stage IV. The maximum stage-shift assumption allocated 90% of cancers to stage I, 5% to stage II, 3% to stage III and 2% to stage IV. These cancer stage-shift assumptions were intended to represent potential population-level outcomes of multimodal screening rather than the stage-specific sensitivity of any individual screening modality.

Enhanced multimodal screening may generate false-positive findings requiring additional diagnostic evaluation. To account for this downstream utilization, false-positive workup costs were incorporated into the intervention arm. A false-positive rate of 8% was assumed based on published WB-MRI surveillance data [30], and each false-positive finding was assumed to incur a diagnostic workup cost of $1000 [31]. Expected false-positive costs were calculated as the product of the false-positive rate and diagnostic workup cost. Sensitivity analyses evaluated a higher false-positive rate of 15% and a higher workup cost of $2000.

We also assumed that the multimodal screening increased the rate of active surveillance (AS) for prostate, kidney and thyroid cancers at stage I and II (prostate: 55–80% for stage I, 10–20% for stage II; kidney: 30–40% for stage I, 5–10% for stage II; thyroid: 40–60% for stage I, 5–10% for stage II) [32–34]. The literature suggested the cost of AS being lower than that of treatment; the cost ratio of AS versus treatment was 51.6% for prostate cancer, 64.3% for kidney cancer and 54.7% for thyroid cancer [22,35,36]. The total expected costs were recalculated using these updated distributions and ratios, applying the same methods described above for direct medical costs and productivity losses.

Cost savings attributable to enhanced multimodal screening were estimated as the difference in total expected costs between the intervention scenario (Scenario 2) and the status quo (Scenario 1).

Results

Cancer types & stage distribution under status quo (Scenario 1)

Supplementary Table 1 presents the conversion of the stage distribution (localized, regional, distant) for each cancer to AJCC stages I–IV based on expert opinion, under Scenario 1. The estimated distribution of cancer patients for each AJCC stage for each cancer under Scenario 1 is presented in Table 2.

Direct medical costs of cancer management

Stage-specific cancer management costs were derived from Reddy *et al.* which reported incidence-based cancer-attributable expenditures among Medicare beneficiaries from year 1 through year 5 after diagnosis [37]. We summed these values to estimate cumulative 5-year management costs for each cancer-stage combination. Stage I was further subdivided into 'early stage I' and 'remaining stage I,' with proportions and relative costs informed by published data and expert opinion (Supplementary Tables 2 & 3).

Across cancers, the lowest estimated cost was for prostate cancer diagnosed at early stage I ($2463), whereas the highest was for pancreatic and brain cancer at stage IV ($452,947). Table 3 summarizes stage-specific management costs for each cancer type under Scenario I. Supplementary Table 4 presents the costs under Scenarios II where patients with prostate, kidney and thyroid cancers experience lower costs as a result of the higher likelihood of AS.

Table 2. Percentage (%) of cancer patients in AJCC stage for each cancer.

	Stage 1	Stage 2	Stage 3	Stage 4
Male				
Prostate	37.5	35.9	17.3	9.3
Lung and bronchus	18.7	19.9	21.3	40.0
Colon and rectum	24.2	25.9	27.6	22.3
Bladder	74.3	12.4	7.5	5.8
Melanoma of the skin	44.2	40.2	10.6	5.0
Kidney and renal pelvis	37.9	30.2	16.7	15.2
Non-Hodgkin lymphoma	38.0	14.0	15.0	33.0
Oral cavity and pharynx	23.8	26.6	28.6	21.0
Leukemia				
Pancreas	23.2	20.7	18.2	37.8
Liver and intrahepatic bile duct	32.0	28.9	22.3	16.7
Myeloma				
Stomach	25.6	24.4	23.0	27.0
Esophagus	23.1	24.6	26.2	26.0
Brain and other nervous system	36.7	32.2	20.2	10.9
Thyroid	35.6	33.3	24.6	6.5
Larynx	31.8	27.4	21.3	19.5
Female				
Breast	36.3	33.5	23.4	6.8
Lung and bronchus	18.7	19.9	21.3	40.0
Colon and rectum	24.2	25.9	27.6	22.3
Uterus	46.8	27.0	14.7	11.5
Melanoma of the skin	44.2	40.2	10.6	5.0
Non-Hodgkin lymphoma	38.0	14.0	15.0	33.0
Pancreas	23.2	20.7	18.2	37.8
Thyroid	35.6	33.3	24.6	6.5
Kidney and renal pelvis	37.9	30.2	16.7	15.2
Leukemia				
Ovary	18.9	22.7	28.0	30.4
Bladder	74.3	12.4	7.5	5.8
Oral cavity and pharynx	23.8	26.6	28.6	21.0
Myeloma				
Liver and intrahepatic bile duct	32.0	28.9	22.3	16.7
Cervix Uteri	31.4	28.6	24.2	15.9
Stomach	25.6	24.4	23.0	27.0
Brain and other nervous system	36.7	32.2	20.2	10.9

Leukemia and myeloma are not staged using the AJCC I-IV framework; therefore stage distributions and stage-specific costs are not shown.

Productivity losses

Expected productivity losses, estimated using a human capital approach based on annual earning, varied substantially by cancer type and stage. The greatest productivity losses were observed for lung and bronchus cancer ($117,117 for male and $95,961 for female) and pancreatic cancer ($111,072 for male and $91,008 for female), reflecting both high incidence and late-stage diagnosis (Table 4).

Total expected costs of cancer management & cost savings among all US population

By combining stage-specific management costs and productivity losses, we estimated the total cost burden of common cancers under current practice (Scenario 1). Applying SEER-based estimates of lifetime-risk that a person would have one of common cancers (33.7% for men and 36.4% for women; Supplementary Table 5), the overall

Table 3. Expected total cost of cancer management by cancer stage under Scenario I.

Total cost for 5 years	Early stage 1	Stage 1	Stage 2	Stage 3	Stage 4
Male					
Prostate	$2463	$16,421	$40,048	$51,168	$233,885
Lung and bronchus	$99,068	$116,551	$188,829	$267,525	$402,120
Colon and rectum	$48,934	$69,905	$105,618	$158,565	$406,914
Bladder	$56,480	$75,307	$145,433	$166,080	$288,958
Melanoma of the skin	$23,298	$42,360	$69,602	$131,389	$356,514
Kidney and renal pelvis	$45,908	$54,009	$92,858	$123,665	$393,979
Non-Hodgkin lymphoma	$129,746	$144,162	$200,747	$231,120	$257,051
Oral cavity and pharynx	$22,516	$64,330	$110,887	$142,639	$180,632
Leukemia					
Pancreas	$140,633	$175,791	$297,975	$379,826	$452,947
Liver and intrahepatic bile duct	$49,035	$196,141	$218,986	$328,067	$417,723
Myeloma					
Stomach	$85,914	$126,344	$198,583	$268,151	$394,097
Esophagus	$115,053	$130,742	$196,473	$262,940	$380,528
Brain and other nervous system	$140,633	$175,791	$297,975	$379,826	$452,947
Thyroid	$4926	$16,421	$40,048	$51,168	$233,885
Larynx	$22,516	$64,330	$110,887	$142,639	$180,632
Female					
Breast	$31,770	$42,360	$69,602	$131,389	$356,514
Lung and bronchus	$99,068	$116,551	$188,829	$267,525	$402,120
Colon and rectum	$48,934	$69,905	$105,618	$158,565	$406,914
Uterus	$25,957	$39,934	$67,575	$123,384	$281,427
Melanoma of the skin	$23,298	$42,360	$69,602	$131,389	$356,514
Non-Hodgkin lymphoma	$129,746	$144,162	$200,747	$231,120	$257,051
Pancreas	$140,633	$175,791	$297,975	$379,826	$452,947
Thyroid	$4926	$16,421	$40,048	$51,168	$233,885
Kidney and renal pelvis	$45,908	$54,009	$92,858	$123,665	$393,979
Leukemia					
Ovary	$27,139	$77,540	$141,540	$272,316	$345,202
Bladder	$56,480	$75,307	$145,433	$166,080	$288,958
Oral cavity and pharynx	$22,516	$64,330	$110,887	$142,639	$180,632
Myeloma					
Liver and intrahepatic bile duct	$49,035	$196,141	$218,986	$328,067	$417,723
Cervix Uteri	$22,701	$63,059	$95,413	$162,739	$261,679
Stomach	$85,914	$126,344	$198,583	$268,151	$394,097
Brain and other nervous system	$140,633	$175,791	$297,975	$379,826	$452,947

Where stage-specific cost estimates were unavailable, costs from clinically and economically comparable cancers were used. Melanoma was represented using breast cancer costs; thyroid cancer using prostate cancer costs; oral cavity, pharyngeal and laryngeal cancers using head and neck cancer costs; and brain and other nervous system cancers using pancreatic cancer costs. These substitutions were based on similarities in reported economic burden, clinical management and resource utilization patterns. Relevant references are cited above. Leukemia and myeloma are not staged using the AJCC I-IV framework; therefore stage distributions and stage-specific costs are not shown.

expected cost burden of common cancers in the US was $74,431 per male and $78,818 per female, regardless of whether they develop cancer or not (Table 5).

Under the intervention scenario (Scenario 2), where enhanced multimodal screening was assumed to detect most cancers at early stage and increase the rate of patients for selected cancers undergoing AS, the total expected cost burden was substantially reduced. The estimated cancer-related cost burden under the moderate cancer stage-shift assumption was $44,238 per male and $47,586 per female. With the screening costs of WB MRI and MCED and false-positive costs included, the total cost was $66,018 for male, and $69,366 for female.

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Table 4. Expected productivity loss.	
Male	
Prostate	$66,966
Lung and bronchus	$117,117
Colon and rectum	$94,096
Bladder	$36,778
Melanoma of the skin	$55,992
Kidney and renal pelvis	$73,349
Non-Hodgkin lymphoma	$93,659
Oral cavity and pharynx	$94,031
Leukemia	$55,282
Pancreas	$111,072
Liver and intrahepatic bile duct	$81,175
Myeloma	$55,282
Stomach	$96,620
Esophagus	$99,103
Brain and other nervous system	$71,440
Thyroid	$67,993
Larynx	$83,928
Female	
Breast	$55,686
Lung and bronchus	$95,961
Colon and rectum	$77,098
Uterus	$51,830
Melanoma of the skin	$47,959
Non-Hodgkin lymphoma	$76,740
Pancreas	$91,008
Thyroid	$55,711
Kidney and renal pelvis	$60,099
Leukemia	$45,295
Ovary	$89,059
Bladder	$30,134
Oral cavity and pharynx	$77,045
Myeloma	$45,295
Liver and intrahepatic bile duct	$66,511
Cervix uteri	$66,390
Stomach	$79,166
Brain and other nervous system	$58,535

Comparing the two scenarios, enhanced multimodal screening was associated with reductions of $8193–8413 for men (11.0–11.4%) and $9233–9453 for women (11.7–12.1%) in cancer-related costs. While the intervention substantially reduced treatment-related costs by approximately 35%, total medical costs, including both treatment and screening expenditures borne predominantly by payors, increased for the intervention scenario (10.2% among males and 4.6% among females), reflecting the added upfront costs of screening. In contrast, patient-level productivity losses were markedly reduced, declining by 51%. Table 5 summarizes total costs under Scenario 1 and Scenario 2 with the moderate cancer stage-shift assumption and highlights the absolute and relative reductions.

Under the conservative cancer stage-shift assumption, the total cancer-related costs with enhanced multimodal screening were slightly more than the costs under the status-quo scenario by $370–590 for men and $242–462 for women (Supplementary Table 6). Under the maximum assumption, enhanced multimodal screening was associated with reductions of $17,855–18,075 for men (24.0–24.3%) and $19,447–19,667 for women (24.7–25.0%) in cancer-related costs (Supplementary Table 7).

Table 5. Expected total economic burden per person with or without cancer (w/o cancer), moderate cancer stage-shift assumption.

	Without intervention				With intervention					
Expected cost burden per person	Expected cost of cancer management among cancer patients	Expected productivity loss among cancer patient	Total costs among cancer patients	Expected total economic burden per person (w/o cancer)	Expected cost of cancer management among cancer patients	Expected productivity loss among cancer patients	Total costs among cancer patients	Expected total economic burden per person (w/o cancer)	Burden plus screening and false positive costs	Total saving per person (w/o cancer)
Male										
Prostate	$47,518	$66,966	$114,484	$74,431	$24,516	$35,642	$60,158	$44,238	$66,018–66,238	$8193–8413 (11.0–11.3% reduction)
Lung and bronchus	$276,925	$117,117	$394,042		$149,614	$41,643	$191,257			
Colon and rectum	$175,393	$94,096	$269,489		$87,910	$36,188	$124,098			
Bladder	$93,353	$36,778	$130,131		$89,934	$33,751	$123,685			
Melanoma of the skin	$73,311	$55,992	$129,303		$59,881	$36,733	$96,614			
Kidney and renal pelvis	$126,985	$73,349	$200,335		$75,336	$35,642	$110,978			
Non-Hodgkin lymphoma	$198,820	$93,659	$292,479		$156,525	$36,188	$192,713			
Oral cavity and pharynx	$119,521	$94,031	$213,552		$69,452	$38,916	$108,368			
Leukemia	$242,833	$55,282	$298,114		$242,833	$55,282	$298,114			
Pancreas	$342,004	$111,072	$453,076		$217,206	$41,861	$259,067			
Liver and intrahepatic bile duct	$240,912	$81,175	$322,087		$154,318	$36,733	$191,051			
Myeloma	$242,833	$55,282	$298,114		$242,833	$55,282	$298,114			
Stomach	$240,982	$96,620	$337,602		$137,003	$35,097	$172,100			
Esophagus	$244,783	$99,103	$343,886		$155,811	$37,824	$193,636			
Brain and other nervous system	$280,155	$71,440	$351,595		$207,449	$37,824	$245,274			
Thyroid	$44,456	$67,993	$112,450		$26,835	$36,733	$63,568			
Larynx	$107,754	$83,928	$191,681		$61,612	$36,188	$97,800			

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Table 5. Expected total economic burden per person with or without cancer (w/o cancer), moderate cancer stage-shift assumption (cont.).

Female										
Breast	$91,622	$55,686	$147,308	$78,818	$64,488	$30,992	$95,479	$47,586	$69,366–69,586	$9233–9454 (11.7–12.0% reduction)
Lung and bronchus	$276,925	$95,961	$372,885		$149,614	$34,121	$183,735			
Colon and rectum	$175,393	$77,098	$252,491		$87,910	$29,651	$117,561			
Uterus	$83,241	$51,830	$135,070		$55,188	$29,651	$84,839			
Melanoma of the skin	$73,311	$47,959	$121,269		$59,881	$30,098	$89,979			
Non-Hodgkin lymphoma	$198,820	$76,740	$275,560		$156,525	$29,651	$186,176			
Pancreas	$342,004	$91,008	$433,011		$217,206	$34,299	$251,505			
Thyroid	$44,456	$55,711	$100,167		$26,835	$30,098	$56,933			
Kidney and renal pelvis	$126,985	$60,099	$187,085		$75,336	$29,204	$104,540			
Leukemia	$242,833	$45,295	$288,128		$242,833	$45,295	$288,128			
Ovary	$224,206	$89,059	$313,266		$99,065	$35,462	$134,526			
Bladder	$93,353	$30,134	$123,487		$89,934	$27,654	$117,588			
Oral cavity and pharynx	$119,521	$77,045	$196,566		$69,452	$31,886	$101,338			
Myeloma	$242,833	$45,295	$288,128		$242,833	$45,295	$288,128			
Liver and intrahepatic bile duct	$240,912	$66,511	$307,423		$154,318	$30,098	$184,416			
Cervix uteri	$119,657	$66,390	$186,047		$65,172	$29,651	$94,823			
Stomach	$240,982	$79,166	$320,148		$137,003	$28,757	$165,760			
Brain and other nervous system	$280,155	$58,535	$338,690		$207,449	$30,992	$238,441			

Discussion

In this modeling study, we evaluated the potential economic value of enhanced multimodal screening, in particular WB MRI and MCED, for the early detection of common cancers in the US We compared the current stage distribution of cancer at diagnosis with a hypothetical scenario in which multimodal screening shifted the majority of cancers to detection at stage I. Our results suggest that early detection through enhanced multimodal screening could reduce the cancer-related economic burden by approximately 12% for both men and women, with reductions stemming from both lower treatment costs and decreased productivity losses.

These results highlight the substantial economic consequences of delayed cancer detection. In the status quo scenario, late-stage diagnoses were associated with higher direct medical costs, consistent with published literature showing exponential increases in cancer management expenditures at advanced stages [37,38]. Likewise, productivity losses were greatest among cancers frequently diagnosed at later stages, such as lung and pancreatic cancers, reflecting both the morbidity of disease and the years of productive life lost. By contrast, under the enhanced multimodal screening scenario, earlier detection shifted the distribution of cases toward lower-cost, more treatable stages, reducing both direct medical costs and productivity losses.

A prior study estimated cost savings associated with earlier cancer diagnosis using a cancer stage-shift modeling approach across multiple cancer types [39]. Their analysis provided an important foundation for quantifying the economic value of early detection. Our study expands on this work by integrating productivity losses in addition to direct medical costs, and specifically evaluating the impact of implementing multimodal screening including WB MRI and MCED. This approach allows us to estimate the broader cancer-related economic burden by incorporating productivity losses in addition to direct medical costs.

Our findings build upon prior analyses of early cancer detection strategies, including cost-effectiveness evaluations of specific screening modalities such as mammography, colonoscopy and low-dose CT for lung cancer [40–47]. While these interventions have demonstrated value within individual cancer types, our study extends the perspective to a broader, multicancer multimodal screening approach. Under the moderate cancer stage-shift assumption, the model projected an approximately 10–12% reduction in economic burden, demonstrating that, despite the high upfront costs of routine WB MRI and MCED screening, early detection can yield substantial economic benefits. Although the present analysis was conducted at the individual level, these findings suggest that even modest shifts toward earlier cancer diagnosis could translate into substantial aggregate economic savings given the large national burden of cancer.

This finding is consistent with earlier modeling studies highlighting the value of detecting disease at an early stage. Importantly, by incorporating productivity losses in addition to direct medical costs, our analysis provides a more comprehensive estimate of societal burden than many prior evaluations.

These findings underscore the potential long-term value of investing in latest technology screening strategies. Although the upfront costs of WBMRI and liquid biopsy are not trivial, our results suggest that downstream savings could offset these investments by reducing the incidence of late-stage disease. From a payer perspective, such savings may be realized over a longer horizon than is typically used in reimbursement decision-making, raising questions about how to align incentives for adoption. For health systems, integration of enhanced multimodal screening may also require changes in infrastructure, workforce training, and follow-up care pathways to ensure that early detection translates into improved outcomes.

At present, WB MRI and MCED are not endorsed by major clinical guidelines for routine cancer screening, while it is recommended for patients with cancer predispositions syndromes [48]. This lack of policy support stems largely from the lack of evidence [16], concerns regarding insufficient evidence of mortality benefit, the high rate of false positives and incidental findings, the economic burden of follow-up testing, and the absence of standardized imaging protocols. These concerns were underscored by the recent trial, in which population-scale screening with a broad multicancer blood test did not demonstrate a statistically significant reduction in late-stage cancer diagnoses [49]. This outcome highlights the biological and operational challenges of pan-cancer screening approaches that rely on a single assay across heterogeneous tumor types and prevalence. Importantly, such findings do not preclude the potential value of MCED-based screening strategies, particularly when applied to a limited number of high-mortality cancers with defined biology, optimized assays and more targeted downstream evaluation [50]. To reflect the uncertainty surrounding the magnitude of cancer stage shift achievable through multimodal screening, the present analysis evaluated conservative, moderate and maximum stage-shift assumptions. These alternative

assumptions were intended to explore the robustness of the projected economic impact under varying levels of screening effectiveness.

However, many of these concerns are rooted in earlier generations of screening technologies and historical study designs. With ongoing advances in imaging resolution, shorter scan times, artificial intelligence (AI)-assisted interpretation, and optimized protocols for WB MRI, as well as improved assay sensitivity, enhanced biomarker panels and AI-driven analysis for MCED tests, the rate of false positives may decrease substantially [51] and the cost of the screening will decrease, improving both the clinical utility and the cost-effectiveness such screening. These technological developments warrant a reassessment of prior assumptions and suggest that the potential role of WB MRI and MCED in population-level cancer screening may evolve in the coming years.

Beyond early detection, an important and often underappreciated role of WB MRI screening is its potential to facilitate AS-based management for low-risk diseases. While highly sensitive diagnostics may increase the detection of indolent, early-stage abnormalities, growing clinical evidence across prostate cancer, small renal masses, and low-risk thyroid cancers demonstrates that AS can safely replace immediate treatment for selected stage I and II disease without compromising cancer-specific survival [21,52–54]. In this context, multimodal screening does not necessarily increase overtreatment but instead enables more accurate risk stratification, longitudinal monitoring, and timely escalation of care only when disease progression is observed. More broadly, longitudinal multimodal phenotyping may also support earlier risk stratification for chronic disease trajectories and inform preventive or lifestyle-based interventions before irreversible clinical end points are reached. From an economic perspective, this distinction is critical: although multimodal imaging may identify incidental findings that prompt additional evaluation, population-based studies indicate that downstream utilization is largely driven by non-invasive surveillance rather than procedures [55,56]. Prospective cohort data further suggest that participation in WB-MRI screening is associated with a modest increase in outpatient healthcare utilization, driven primarily by additional imaging and specialist visits [57]. The downstream economic and clinical impact of incidental findings is therefore highly dependent on management pathways, with protocolized, risk-stratified follow-up enabling most findings to be managed conservatively, limiting unnecessary procedures and minimizing patient and healthcare system burden [56,58,59].

The present analysis should be viewed as a stage-shift economic model rather than a comprehensive screening simulation. Unlike natural-history screening models, which explicitly represent disease progression, preclinical detectability, adherence patterns, competing mortality and test-specific diagnostic performance, the current model evaluates the economic consequences of alternative stage distributions at diagnosis. This approach was chosen because robust long-term data describing the population-level effectiveness of combined WB-MRI and MCED screening across multiple cancer types remain limited. Accordingly, the results should be interpreted as estimates of the potential economic impact of earlier diagnosis rather than projections of the performance of any specific screening program.

Several limitations should be noted. First, our model relied on incidence-based 5-year cancer management costs derived primarily from Medicare beneficiaries. These estimates do not capture all costs associated with long-term survivorship, recurrence or expenditures occurring beyond 5 years after diagnosis and may not fully reflect costs in younger commercially insured populations. Second, long-term empirical data describing population-level stage distributions achievable through multimodal WB-MRI and MCED screening are currently limited. To address this uncertainty, we evaluated conservative, moderate and maximum stage-shift assumptions rather than relying on a single estimate. The moderate assumption was designated as the primary analysis, while the other assumptions were evaluated in sensitivity analyses. Although these assumptions do not directly represent the diagnostic performance of any individual screening test, they provide a range of plausible early-detection effects and allow assessment of the robustness of the economic findings across varying levels of screening effectiveness. Third, productivity losses were estimated using a simplified human capital approach. The model did not explicitly incorporate caregiver productivity losses, presenteeism, retirement timing, quality-of-life impacts or other indirect societal costs. Fourth, although false-positive workup costs were considered, the model does not explicitly estimate additional cancers detected solely through overdiagnosis. Because stage-specific treatment costs were derived from observed real-world populations, some degree of overdiagnosis may already be reflected within the underlying cost estimates. Nevertheless, intensive screening may increase detection of indolent disease and therefore the projected savings should be interpreted cautiously. Fifth, screening frequency, age of initiation and screening costs were based on simplifying assumptions rather than established clinical guidelines for population-level WB-MRI and MCED screening. The model also did not explicitly account for factors that may influence real-world implementation, including screening uptake, adherence, contraindications, imaging capacity, reimbursement

policies and downstream utilization. Consequently, the results should be interpreted as estimates of potential economic impact under assumed implementation conditions rather than projections of a specific screening program.

Conclusion

This study estimates the potential economic implications of earlier cancer detection through WB-MRI and MCED-based multimodal screening. By reducing the proportion of late-stage diagnoses, enhanced multimodal screening could lower both treatment costs and productivity losses, ultimately decreasing the economic burden of cancer in the US population. Enhanced multimodal screening was associated with an estimated reduction in total cancer-related costs ranging from approximately 12% under the moderate stage-shift scenario to nearly 25% under the maximum stage-shift scenario. Future research should incorporate real-world performance metrics, implementation costs and longitudinal data on health outcomes to further refine these estimates. Nevertheless, our findings suggest that, if substantial cancer stage shift toward earlier diagnosis can be achieved, investment in WB-MRI and MCED screening may generate long-term economic benefits. Additional prospective studies are needed to establish real-world screening performance, implementation feasibility, false-positive burden and downstream healthcare utilization before firm conclusions regarding cost savings can be drawn.

Summary points

- Cancer-related medical costs and productivity losses create a substantial economic burden in the US.
- Earlier cancer detection is associated with lower treatment costs and reduced productivity losses compared with diagnosis at advanced stages.
- This study developed an economic model to evaluate the potential impact of enhanced multimodal screening using whole-body MRI (WB-MRI) and multicancer early detection (MCED) blood testing.
- The model included common cancers with at least 10,000 new US cases annually and incorporated both direct medical costs and productivity losses.
- Three cancer stage-shift scenarios (conservative, moderate, maximum) were evaluated to reflect uncertainty regarding the real-world effectiveness of multimodal cancer screening.
- Under the moderate scenario, enhanced multimodal screening reduced the expected cancer-related economic burden by approximately 12% for both men and women, after accounting for screening and false-positive workup costs.
- Cost reductions were driven primarily by shifting cancer diagnoses from advanced stages toward earlier, less costly stages of disease.
- Productivity losses declined by approximately 50% under the enhanced screening scenario because earlier-stage cancers were associated with shorter work-loss durations.
- The magnitude of economic benefit depended strongly on the degree of stage shift achieved in practice, with minimal savings under conservative assumptions and substantially larger savings under aspirational assumptions.
- Because long-term population-level data for combined WB-MRI and MCED screening remain limited, these findings should be interpreted as estimates of potential economic impact rather than projections of a specific screening program.

Supplementary data

To view the supplementary data that accompany this paper please visit the journal website at https://becarispublishing.com/doi/epdf/10.57264/cer-2026-0099

Author contributions

D Karow conceptualized and supervised the paper, R Sato led the analytical work and interpreted the result, C Bolan, Barbaros S. Erdal, E Middlebrooks, E Chini, K McVeigh reviewed, validated and approved the paper. All coauthors provided the final approval of the version to be published; and all coauthors agreed to be accountable for all aspects of the work.

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Competing interests disclosure

R Sato is an employee of Siemens Healthineers. E Chini reports intellectual property interests related to CD38 inhibitor technologies, including patents that have been licensed for therapeutic development (including through Elysium Health). E Chini declares

consulting relationships with biotechnology companies including TeneoBio, Calico, Mitobridge, Estee Lauder, Oddity labs, Vesalius and Cytokinetics and reports membership on the scientific advisory board of Eolo Pharma and Neolaia. E Chini also discloses equity ownership in TeneoBio, Eolo and Neolaia. E Middlebrooks declares consulting relationship with Boston Scientific Corp and received travel support from Boston Scientific Corp and SIemens Healthineers. D Karow declares clinical advisor and consulting relationships with Human Longevity Inc, Simplify Genomics, CorTechs AI and SimonMed. D Karow is a board member of Human Longevity, Inc. and has equity ownership in Simplify Genomics. P Brar declares a clinical advisor and consulting relationship with Human Longevity Inc. Other authors declare no competing financial interests. The authors have no other competing interests or relevant affiliations with any organization or entity with the subject matter or materials discussed in the manuscript apart from those disclosed.

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No funded writing assistance was utilized in the production of this manuscript.

Ethical conduct of research

This research was a modelling study based on publicly available data. Therefore, this study was exempt from Institutional Review Board (IRB) approval. All analyses were conducted in accordance with the data usage terms of the source.

AI assistance disclosure

Generative AI tools were used solely for language editing and proofreading purposes, including identifying typographical errors and improving the clarity and readability of the manuscript text. No AI tools were used for data generation, statistical analysis, modeling, or interpretation of results.

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References

1. Bray F, Laversanne M, Sung H *et al.* Global cancer statistics 2022: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J. Clin.* 74(3), 229–263 (2024).
2. OECD. *Tackling the Impact of Cancer on Health, the Economy and Society – Country Notes: Unites States*. OECD Health Policy Studies, OECD, France (2024). https://www.oecd.org/content/dam/oecd/en/publications/reports/2024/11/tackling-the-impact-of-cancer-on-health-the-economy-and-society-country-notes_db760f3f/united-states_934b9939/f488c113-en.pdf
3. National Cancer Institute. *Cancer Trends Progress Report*. National Cancer Institute, NIH, HHS, MD, USA (2022). https://progressreport.cancer.gov/
4. Philipson TJ, Durie T, Cong Z *et al.* The aggregate value of cancer screenings in the United States: full potential value and value considering adherence. *BMC Health Serv. Res.* 23, 829 (2023).
5. Shi J, Li J, Gao Y *et al.* The screening value of mammography for breast cancer: an overview of 28 systematic reviews with evidence mapping. *J. Cancer Res. Clin. Oncol.* 151(3), 102 (2025).
6. Talpur AS, Atasi A, Knowles CG *et al.* Colorectal cancer screening methods: a systematic review. *Medicine (Baltimore)* 104(40), e44759 (2025).
7. Huh WK. The changing face of cervical cancer screening in the United States. *J. Natl Compr. Cancer Netw.* 8(12), 1329–1330 (2010).
8. Dummer R, Siano M, Hunger RE *et al.* The updated Swiss guidelines 2016 for the treatment and follow-up of cutaneous melanoma. *Swiss Med. Wkly* 146, w14279 (2016).
9. Chantry A, Kazmi M, Barrington S *et al.* Guidelines for the use of imaging in the management of patients with myeloma. *Br. J. Haematol.* 178(3), 380–393 (2017).
10. Petralia G, Zugni F, Summers PE *et al.* Whole-body magnetic resonance imaging (WB-MRI) for cancer screening: recommendations for use. *Radiol. Med. (Torino)* 126(11), 1434–1450 (2021).
11. Hou YCC, Yu HC, Martin R *et al.* Precision medicine integrating whole-genome sequencing, comprehensive metabolomics, and advanced imaging. *Proc. Natl Acad. Sci. U.S.A.* 117(6), 3053–3062 (2020).
12. Perkins BA, Caskey CT, Brar P *et al.* Precision medicine screening using whole-genome sequencing and advanced imaging to identify disease risk in adults. *Proc. Natl Acad. Sci. U.S.A.* 115(14), 3686–3691 (2018).
13. Cieszanowski A, Maj E, Kulisiewicz P *et al.* Non-contrast-enhanced whole-body magnetic resonance imaging in the general population: the incidence of abnormal findings in patients 50 years old and younger compared to older subjects. *PloS ONE* 9(9), e107840 (2014).
14. Hurt RT, Ghosh AK, Dougan BM *et al.* Implementation of a multicancer detection (MCD) test in a tertiary referral center in asymptomatic patients: an 18-month prospective cohort study. *J. Prim. Care Community Health* 16, 21501319251329290 (2025).

15. Hu YS, Wu CA, Lin DC *et al.* Applying ONCO-RADS to whole-body MRI cancer screening in a retrospective cohort of asymptomatic individuals. *Cancer Imaging* 24(1), 22 (2024).
16. Zugni F, Padhani AR, Koh DM *et al.* Whole-body magnetic resonance imaging (WB-MRI) for cancer screening in asymptomatic subjects of the general population: review and recommendations. *Cancer Imaging* 20, 34 (2020).
17. Martins da Fonseca J, Trennepohl T, Pinheiro LG *et al.* Whole-body MRI for opportunistic cancer detection in asymptomatic individuals: a systematic review and meta-analysis. *Eur. Radiol.* 36(3), 1813–1823 (2025).
18. Welch HG, Kramer BS, Black WC. Epidemiologic signatures in cancer. *N. Engl. J. Med.* 381(14), 1378–1386 (2019).
19. Carter SM, Barratt A. What is overdiagnosis and why should we take it seriously in cancer screening? *Public Health Res. Pract.* 27(3), 2731722 (2017).
20. Rose SMSF, Contrepois K, Moneghetti KJ *et al.* A longitudinal big data approach for precision health. *Nat. Med.* 25(5), 792–804 (2019).
21. Hamdy FC, Donovan JL, Lane JA *et al.* Fifteen-year outcomes after monitoring, surgery, or radiotherapy for prostate cancer. *N. Engl. J. Med.* 388(17), 1547–1558 (2023).
22. Sharma V, Wymer KM, Borah BJ *et al.* Cost-effectiveness of active surveillance, radical prostatectomy and external beam radiotherapy for localized prostate cancer: an analysis of the ProtecT Trial. *J. Urol.* 202(5), 964–972 (2019).
23. Schieda N, Krishna S, Pedrosa I *et al.* Active surveillance of renal masses: the role of radiology. *Radiology* 302(1), 11–24 (2022).
24. Ferro C, Fitch K, Pittinger S. *The Cost Burden of Blood Cancer Care in Medicare*. Milliman (2019). https://us.milliman.com/en/insight/the-cost-burden-of-blood-cancer-care-in-medicare
25. Yabroff KR, Lamont EB, Mariotto A *et al.* Cost of care for elderly cancer patients in the United States. *J. Natl Cancer Inst.* 100(9), 630–641 (2008).
26. Boltz MM, Hollenbeak CS, Schaefer E *et al.* Attributable costs of differentiated thyroid cancer in the elderly Medicare population. *Surgery* 154(6), 1363–1369; discussion 1369–1370 (2013).
27. Price RA, Stranges E, Elixhauser A. Cancer hospitalizations for adults, 2009. In: *Healthcare Cost and Utilization Project (HCUP) Statistical Briefs*. Agency for Healthcare Research and Quality, MD, USA (2006). [Accessed 28 July 2026]. http://www.ncbi.nlm.nih.gov/books/NBK92614/
28. Yang SC, Lai WW, Wu TI *et al.* Losses of lifetime employment duration and productivity for patients with different subtypes and stages of lung cancer. *Eur. J. Health Econ.* 25(5), 775–785 (2024).
29. US Bureau of Labor Statistics. Median weekly earnings were $1,204 in 2025: The Economics Daily. Bureau of Labor Statistics. [Accessed 28 July 2026]. https://www.bls.gov/opub/ted/2026/median-weekly-earnings-were-1204-in-2025.htm
30. Que FVF, Ishak NDB, Li ST *et al.* Utility of whole-body magnetic resonance imaging surveillance in children and adults with cancer predisposition syndromes: a retrospective study. *JCO Precis. Oncol.* 9, e2400642 (2025).
31. Onega T, Tosteson ANA, Weiss J *et al.* Costs of diagnostic and preoperative workup with and without breast MRI in older women with a breast cancer diagnosis. *BMC Health Serv. Res.* 16, 76 (2016).
32. Ajjawi I, Loeb S, Cooperberg MR *et al.* Active surveillance or watchful waiting for intermediate-risk prostate cancer, 2010–2020. *JAMA* 332(23), 2033–2036 (2024).
33. Sawka AM, Ghai S, Rotstein L *et al.* Long-term durability of active surveillance of small, low-risk papillary thyroid cancer. *JAMA Surg.* 160(10), 1117–1124 (2025).
34. Alkhatib KY, Cheaib JG, Pallauf M *et al.* Active surveillance vs primary intervention for clinical T1a kidney tumors: 12-year experience of the delayed intervention and surveillance for small renal masses prospective comparative study. *J. Urol.* 214(2), 197–209 (2025).
35. Asnis-Alibozek AG, Fine MJ, Russo P *et al.* Cost of care for malignant and benign renal masses. *Am. J. Manag. Care* 19(8), 617–624 (2013).
36. Faro FN, Bertelli AAT, Scalissi NM *et al.* Active surveillance versus immediate surgery in the management of low-risk papillary thyroid microcarcinoma: comparison of long-term costs in Brazil. *Arch. Endocrinol. Metab.* 68, e230349 (2024).
37. Reddy SR, Broder MS, Chang E *et al.* Cost of cancer management by stage at diagnosis among Medicare beneficiaries. *Curr. Med. Res. Opin.* 38(8), 1285–1294 (2022).
38. McGarvey N, Gitlin M, Fadli E *et al.* Increased healthcare costs by later stage cancer diagnosis. *BMC Health Serv. Res.* 22, 1155 (2022).
39. Kakushadze Z, Raghubanshi R, Yu W. Estimating cost savings from early cancer diagnosis. *Data* 2(3), 30 (2017).
40. Stout NK, Rosenberg MA, Trentham-Dietz A *et al.* Retrospective cost-effectiveness analysis of screening mammography. *J. Natl Cancer Inst.* 98(11), 774–782 (2006).
41. Sharaf RN, Ladabaum U. Comparative effectiveness and cost-effectiveness of screening colonoscopy vs. sigmoidoscopy and alternative strategies. *Am. J. Gastroenterol.* 108(1), 120–132 (2013).
42. Black WC, Gareen IF, Soneji SS *et al.* Cost-effectiveness of CT screening in the National Lung Screening Trial. *N. Engl. J. Med.* 371(19), 1793–1802 (2014).

43. Snowsill T, Yang H, Griffin E *et al.* Low-dose computed tomography for lung cancer screening in high-risk populations: a systematic review and economic evaluation. *Health Technol. Assess.* 22(69), 1–276 (2018).
44. Ladabaum U, Mannalithara A, Meester RGS *et al.* Cost-effectiveness and national effects of initiating colorectal cancer screening for average-risk persons at age 45 years instead of 50 years. *Gastroenterology* 157(1), 137–148 (2019).
45. Tina Shih YC, Dong W, Xu Y *et al.* Assessing the cost-effectiveness of updated breast cancer screening guidelines for average-risk women. *Value Health* 22(2), 185–193 (2019).
46. Cao P, Jeon J, Levy DT *et al.* Potential impact of cessation interventions at the point of lung cancer screening on lung cancer and overall mortality in the United States. *J. Thorac. Oncol.* 15(7), 1160–1169 (2020).
47. Tollens F, Baltzer PAT, Dietzel M *et al.* Cost-effectiveness of MR-mammography in breast cancer screening of women with extremely dense breasts after two rounds of screening. *Front. Oncol.* 11, 724543 (2021).
48. Petralia G, Koh DM, Attariwala R *et al.* Oncologically relevant findings reporting and data system (ONCO-RADS): guidelines for the acquisition, interpretation, and reporting of whole-body MRI for cancer screening. *Radiology* 299(3), 494–507 (2021).
49. Cohen D. Galleri cancer tests: controversial NHS trial fails to meet key goal. *BMJ* 392, S364 (2026).
50. Guler GD, Ning Y, Ku CJ *et al.* Detection of early stage pancreatic cancer using 5-hydroxymethylcytosine signatures in circulating cell free DNA. *Nat. Commun.* 11(1), 5270 (2020).
51. Que FVF, Ishak NDB, Li ST *et al.* Utility of whole-body magnetic resonance imaging surveillance in children and adults with cancer predisposition syndromes: a retrospective study. *JCO Precis. Oncol.* 9, e2400642 (2025).
52. Newcomb LF, Schenk JM, Zheng Y *et al.* Long-term outcomes in patients using protocol-directed active surveillance for prostate cancer. *JAMA* 331(24), 2084–2093 (2024).
53. Tsuboi I, Rajwa P, Campi R *et al.* Oncological outcomes of active surveillance versus surgery or ablation for patients with small renal masses: a systematic review and quantitative analysis. *Eur. Urol. Oncol.* 8(2), 544–553 (2025).
54. Kim MJ, Moon JH, Lee EK *et al.* Active surveillance for low-risk thyroid cancers: a review of current practice guidelines. *Endocrinol. Metab.* 39(1), 47–60 (2024).
55. O'Sullivan JW, Stevens S, Hobbs FDR *et al.* Temporal trends in use of tests in UK primary care, 2000-15: retrospective analysis of 250 million tests. *BMJ* 363, k4666 (2018).
56. Davenport MS. Incidental findings and low-value care. *AJR Am. J. Roentgenol.* 221(1), 117–123 (2023).
57. Schmidt CO, Sierocinski E, Baumeister S *et al.* Effects of whole-body MRI on outpatient health service costs: a general-population prospective cohort study in Mecklenburg-Vorpommern, Germany. *BMJ Open* 12(1), e056572 (2022).
58. Darbà J, Ascanio M, Rodríguez A. A systematic review of the economic burden of prostate cancer: direct and indirect cost perspectives. *Pharmacoeconomics*,44(5), 559–583 (2026).
59. Su ZT, Patel HD, Huang MM *et al.* Active surveillance versus immediate intervention for small renal masses: a cost-effectiveness and clinical decision analysis. *J. Urol.* 208(4), 794–803 (2022).