Cost-effectiveness of a Multi-Cancer Early Detection (MCED) Test in Individuals with a Personal or Family History of Cancer

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INTRODUCTION

- Individuals with a family or personal history of some cancer types are at a higher risk of a cancer diagnosis than the general population.[1,2] For example, having at least two relatives with breast cancer more than doubles an individual's risk of developing this cancer.[3,4]
- Cancer screening has been designed to differentiate recommendations in individuals with risk factors, including having a personal or family history of cancer,[5] and is associated with a reduction in mortality in populations with these screening programs.[6,7]
- Recently, multi-cancer early detection (MCED) tests, which can simultaneously screen for multiple types of cancer, have been developed.[8-10]

OBJECTIVE

- Individuals with personal/family history of cancer may choose to receive MCED screening earlier than the general population, assuming the potential benefits outweigh any harms, such as false positive results and/or increased costs.
- This analysis estimates the cost-effectiveness of an MCED test in adults with a personal/family cancer history in the US as compared to the general population.

KEY RESULTS

- Among those with a personal history of cancer, when screening starting age was decreased to 40 years, the MCED test in addition to SoC screening had a lower incremental cost/QALY ($95,094/QALY) than this screening approach started at age 50 in the general population ($100,000/QALY; Table 1).

Table 1. Summary of Results

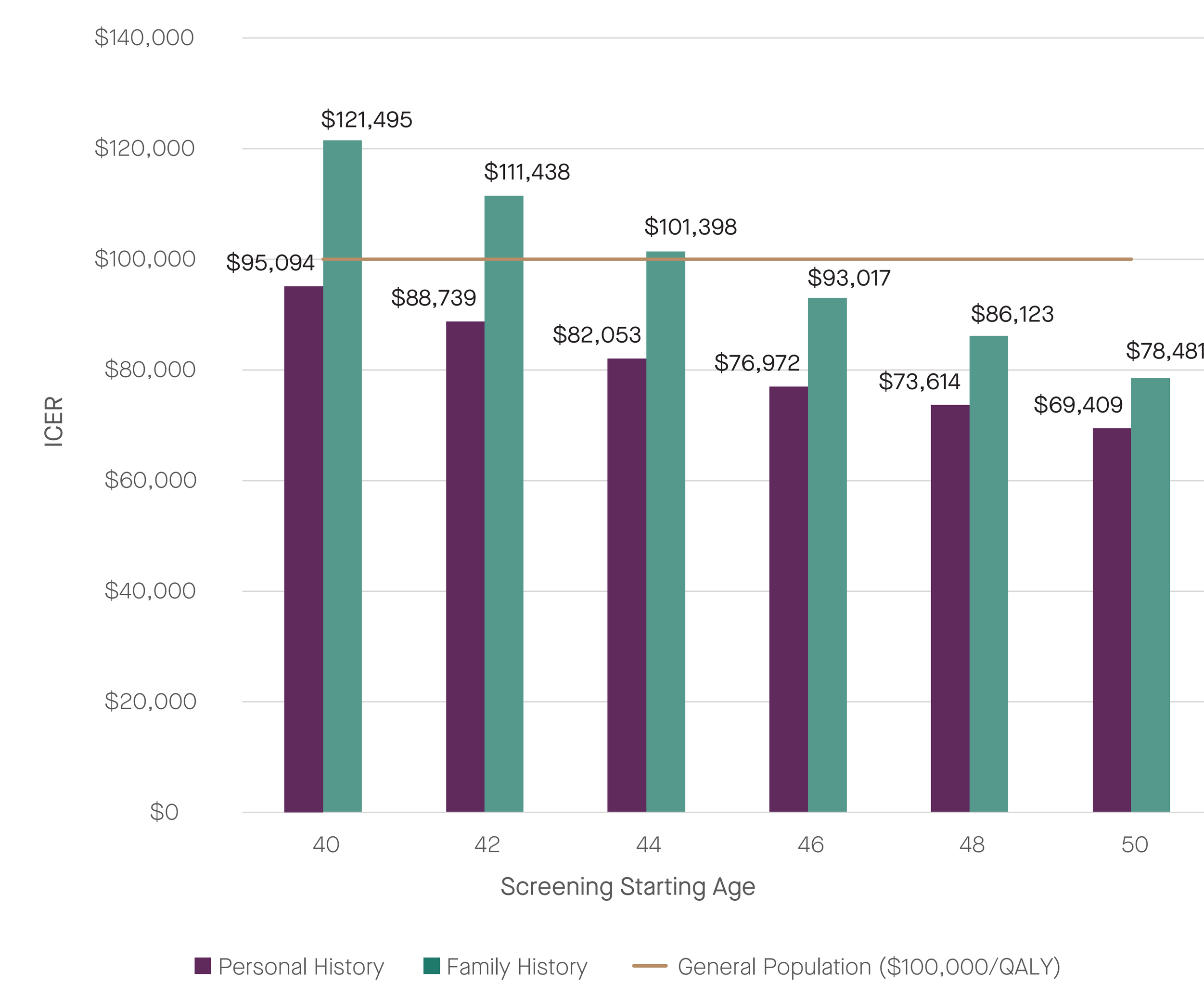
	General Population	Personal History		Family History	
Screening Starting Age	50	40	50	40	50
Incremental LYs	0.096	0.139	0.083	0.147	0.107
Incremental QALYs	0.091	0.140	0.088	0.136	0.102
Incremental Costs	$9,098	$13,267	$6,090	$16,531	$7,993
ICER	$100,000	$95,094	$69,409	$121,495	$78,481
Number of Cancers Detected by MCED test	4,933	6,311	5,393	5,638	5,148
Number of False Positives Detected by MCED test	7,772	10,341	6,057	12,000	7,278
TP/FP Ratio	0.63	0.61	0.89	0.47	0.71

Note: TP/FP ratio is defined as number of cancers detected by MCED test to the number of false positives detected by MCED test in each cohort.

Abbreviations: FP = false positive; ICER = incremental cost-effectiveness ratio; LYs = life years; QALYs = quality-adjusted life years; TP = true positive

- Screening became more cost-effective as the screening starting age increased to age 50 in those with personal history of cancer (Figure 1).
- Among those with family history of cancer, the MCED test plus SoC screening led to better incremental cost/QALY when screening started at age 45 ($96,286/QALY at age 45) as compared to screening the general population starting at age 50.

Figure 1. Incremental Cost-Effectiveness Ratio by Population and Screening Starting Age



*Note: The ICER for those with family history at screening starting age of 45 years is $96,286/QALY. The orange line represents the ICER for the general population at screening starting age of 50 ($100,000/QALY).
Abbreviations: ICER = incremental cost-effectiveness ratio

- Compared to screening the general population after age 50, MCED screening in individuals with a family history of cancer had a more favorable ratio of cancers detected by MCED test per false positive detected by MCED when screening started at age 48 and had >10% more cancers detected (Figure 2). Those with personal history of cancer had a more favorable ratio starting at age 41 and had >40% more cancers detected when screening started at 50 in the general population.

Figure 2. Ratio of Detected Cancers to False Positives by Population and Screening Starting Age

Note: Percentages in black show the percent change of the ratio of detected cancers by MCED test to false positives detected by MCED test for each population as compared to the general population at age 50. The ratio for those with personal history at screening starting age of 41 years is 0.66. The orange line represents the ratio of detected cancers to false positives detected by MCED testing for the general population at screening starting age of 50 (0.63).

- In sensitivity analysis, the multipliers for incidence associated with family history and the multipliers for incidence/survival associated with personal history were varied by +/-20%. Higher incidence was associated with improved cost-effectiveness when screening was lowered from age 45 to 40 as compared to the base case for individuals with family history of cancer.

LIMITATION

- The model does not account for the additional post-diagnosis risk of developing cancer later in life or consider cancer recurrence or patients who have multiple types of cancers.

CONCLUSION

- Relative to general population from 50 to 79 years, individuals with family or personal cancer history can achieve a better ratio of cancers detected per false positives and comparable or improved cost-effectiveness when initiating MCED screening up to 10 years earlier.

References

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Disclosures

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METHODS

- A Markov model was developed to compare annual MCED testing plus standard of care (SoC) screening vs SoC alone in adults aged 50 to 79 years and adapted to consider individuals with personal or family history of cancer up to 10 years younger. Patient survival, cost, and quality of life measures were calculated pre- and post-diagnosis over a lifetime time horizon, capped at age 100 years.
- SoC was defined as current screening practices as recommended by National Comprehensive Cancer Network (NCCN) and US Preventive Services Task Force (USPSTF) for lung, colon, breast, cervical, and prostate cancers.[11-16]
- The balance of clinical benefits and harms was assessed by comparing the number of cancers detected and the ratio of cancers detected by MCED test per false positive detected by MCED test, while cost-effectiveness was measured as incremental cost/QALY.
- Costs of MCED testing were set at $1,199, which met a willingness-to-pay threshold of $100,000/QALY[17] when screening the general population (ages 50-79). All costs and outcomes were discounted at 3% annually.
- To handle an earlier diagnosis with MCED screening than with SoC screening alone, the model stage and time shifted the cancer diagnosis to an earlier time and age.[18]
- Further details of the model structure, approach to stage and time shift, and inputs for the general population have been described previously.[19]
- To account for individuals with a personal history of cancer, the incidence and survival of the general population were adjusted based on SEER (Tables 2 and 3).[20] For individuals with a family history of cancer, incidence was adjusted based on data from the literature, and survival was assumed the same as the general population.[21]

Table 2. Summary of Input Adjustments for Individuals with Personal/Family History of Cancer as Compared to General Population

Cancer	Incidence	Post-Diagnosis Mean Survival
General Population	Derived from SEER[19]	Derived from SEER[19]
Personal History	Cancer- and age-specific RR derived from SEER[19] and applied to incidence of general population	Derived from SEER using data specific to those with personal history of cancer[19]
Family History	Cancer-specific RR derived from literature[20] and applied to incidence of general population	Assumed same as general population

Note: Incidence for individuals with family history was adjusted using a RR for those with a first degree relative with any cancer type.

Abbreviations: RR = relative risk

Table 3. Adjustments to Cancer Incidence for Patients with Personal or Family History of Cancer

	Personal History												Family History
Cancer	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-100	All Age Bands
Lung and bronchus	3.07	2.27	2.04	1.77	1.58	1.37	1.28	1.22	1.16	1.10	1.10	1.10	1.25
Colon and Rectum	2.10	1.68	1.28	1.16	1.03	0.96	0.98	1.01	1.00	1.02	1.02	1.02	1.34
Pancreas	1.97	1.65	1.38	1.30	1.13	1.10	1.09	1.04	1.03	0.96	0.96	0.96	1.37
Liver and Intrahepatic Bile Duct	4.27	3.62	2.94	2.49	2.04	1.89	1.95	1.79	1.84	1.77	1.77	1.77	1.87
Breast: HR-negative	2.42	1.90	1.67	1.52	1.35	1.22	1.21	1.22	1.24	1.22	1.22	1.22	1.221
Esophagus	3.31	1.87	1.92	1.63	1.28	1.32	1.03	1.16	1.11	1.08	1.08	1.08	2.24
Head and Neck	4.32	3.90	3.03	2.39	2.08	1.62	1.49	1.40	1.33	1.40	1.40	1.40	1.602
Stomach	2.07	2.20	2.03	1.41	1.28	1.13	1.14	1.09	1.01	1.06	1.06	1.06	1.38
Ovarian	2.41	1.46	1.23	1.10	0.89	0.86	0.77	0.86	0.72	0.80	0.80	0.80	1.32
Kidney and Renal Pelvis	2.78	1.99	1.75	1.57	1.44	1.25	1.17	1.12	1.10	1.02	1.02	1.02	1.31

(Continued)	Personal History												Family History
Cancer	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-100	All Age Bands
Prostate	2.84	1.32	0.97	0.73	0.54	0.42	0.36	0.35	0.36	0.44	0.44	0.44	1.29
Breast: HR-positive	2.42	1.90	1.67	1.52	1.35	1.22	1.21	1.22	1.24	1.22	1.22	1.22	1.221
Lymphoma	2.47	2.22	1.84	1.68	1.45	1.29	1.18	1.16	1.12	1.09	1.09	1.09	1.273
Anus	6.19	3.56	1.92	1.42	1.17	1.12	1.22	1.22	1.38	1.04	1.04	1.04	1.55
Uterus	1.69	1.47	1.30	0.91	0.79	0.87	0.92	1.04	1.08	1.19	1.19	1.19	1.00
Bladder	2.16	2.37	1.96	1.57	1.42	1.26	1.14	1.19	1.19	1.16	1.16	1.16	1.22
Cervix	0.92	0.88	0.87	0.72	0.56	0.62	0.79	0.69	0.77	0.97	0.97	0.97	1.60
Urothelial	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Other	10.86	9.38	6.85	6.07	5.52	4.98	4.91	5.14	6.14	5.47	5.47	5.47	1.00

Note: Incidence was adjusted by cancer- and age-specific multipliers for individuals with personal history of cancer, while it was adjusted for cancer-specific multipliers (not age-specific) for individuals with family history of cancer.

[1]Assume same for HR-and HR+, based on breast cancer incidence rates; [2]Considers salivary, lip, tongue, pharnyx, larynx; [3]Considers non-Hodgkin's and Hodgkin's lymphoma

Abbreviation: HR = hormone-receptor