Using real-world data to determine preliminary health system costs of Canadian women screened for breast cancer

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Introduction & Objective

- The Ontario Breast Screening Program (OBSP) began in 1990 and screens average risk women aged 50–74 years with biennial mammography, and women aged 50–74 years with certain breast cancer risk factors with annual mammography. Currently more than 90% of screening mammograms are performed within the OBSP, but some are performed opportunistically at facilities outside of the program (1).
- Although the OBSP began in 1990, program data were centralized from 2000 onwards when Cancer Care Ontario (CCO) developed a provincial breast screening database to facilitate the operation, monitoring and evaluation of OBSP screening and assessment called the Integrated Client Management System (ICMS).
- The cost-effectiveness of screening programs has been a topic of debate. A few studies (2,3) using simulation models that were modified to reflect the Canadian experience have generally indicated that the more screens a women has during her life, the greater the financial cost to the health care system, but the greater the gain in life-years and quality-adjusted life-years.
- Recently, the multi-institutional study "Personalized risk assessment for prevention and early detection of breast cancer: Integration and implementation" was initiated (4) where the objective of one key is to determine the real-world health system resources and costs associated with breast cancer screening in Ontario using provincial databases.

Methods

- DEFINITION: Screening episode (SE)= screening phase + diagnostic phase (up to 8 months).
- DESIGN: Longitudinal, population-level study of women aged 49–74 years of average risk.
- ETHICS: The use of data in this project was authorized under section 45 of Ontario's Personal Health Information Protection Act, which does not require review by a Research Ethics Board.
- DATA SOURCES: Administrative data from the OBSP database and other provincial health databases.
- STUDY POPULATION: We identified the earliest screening mammogram among community dwelling women aged 49–74 years between 1-January-2013 and 31-December-2019 using physician billings. We excluded women potentially at higher risk for breast cancer such as those who had any screening between the ages of 30–48 years, a prior breast cancer diagnosis, mastectomy, or breast implants. Women were followed for 8-months and were stratified into four groups: by OBSP vs. non-OBSP screening, and if negative or positive. A positive SE was characterized by any follow-up diagnostic procedure (e.g., ultrasound, CT/MRI or biopsy).
- FORMULA: Provincial billing codes/costs for breast cancer screening and diagnostic procedures were used, and other costs associated with the OBSP, overhead and genetic testing. We then calculated the sum of all breast cancer screening and diagnostic costs incurred by each woman during the SE. Costing was ended if a woman developed breast cancer, had a mastectomy or breast implant procedure, was admitted to long-term care, or became ineligible for provincial health insurance during follow-up.
- OUTCOMES: Overall and mean cost per woman for each of the four groups (CAD 2021) were determined for all encounters using standard fee-for-service amounts.

Results

- Several consultations took place between the OBSP and study team to develop the breast cancer screening cost formula (see Figure 1 schematic).
- 1,546,386 eligible women were identified, and Table 1 baseline characteristics shows a median age of 59 years and a mean of 7.9 years of follow-up for the entire cohort. The four groups consisted of Negative OBSP (74%), Positive OBSP (13%), Negative Non-OBSP (11%), and Positive Non-OBSP (3%).
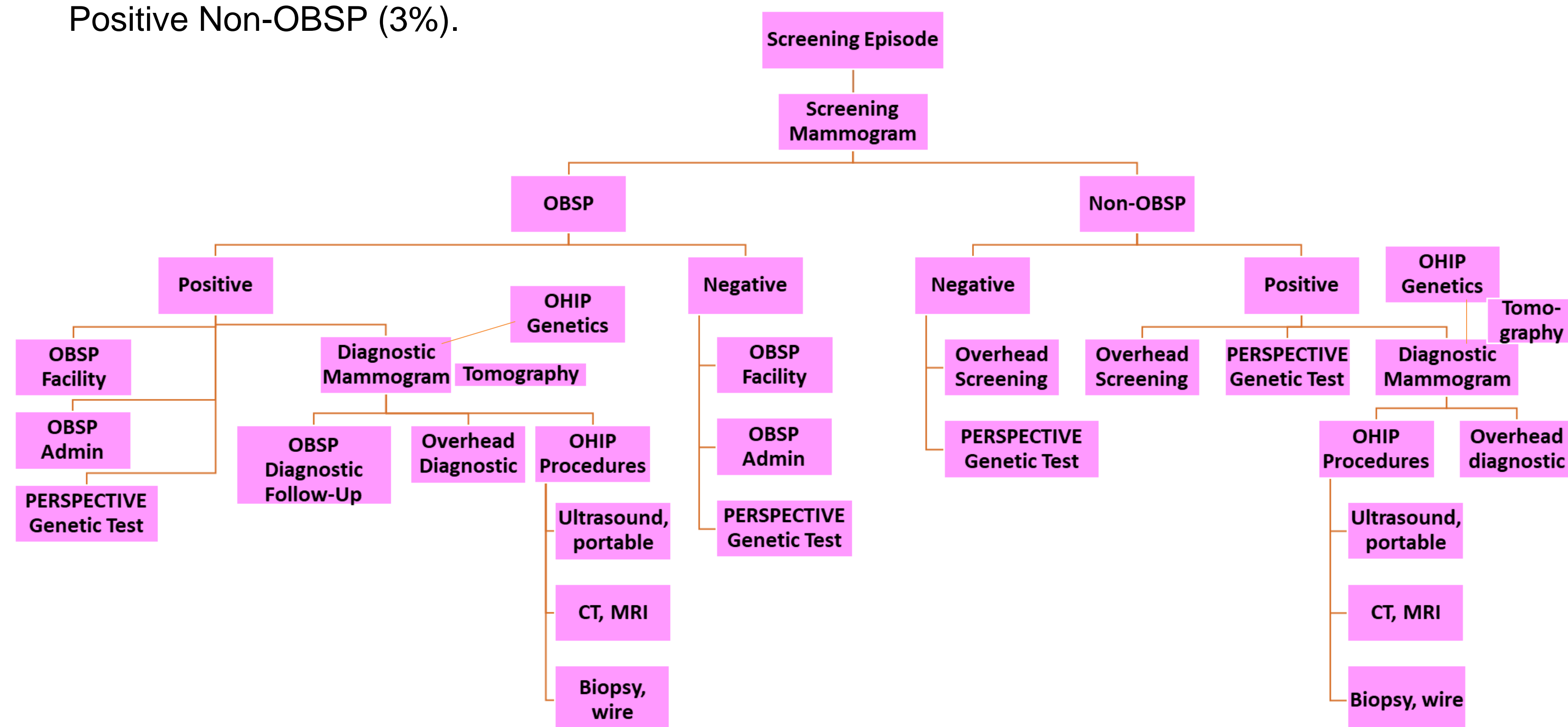

Figure 1: Ontario breast cancer screening cost schematic.

Table 1: Baseline characteristics of entire cohort and the four subgroups.

Baseline Characteristics	Variable Value	Negative OBSP screening	Positive OBSP screening	Negative Non-OBSP screening	Positive Non-OBSP screening	Total
	Sample Size	N=1,144,851	N=195,286	N=163,166	N=43,083	N=1,546,386
Year of index screening	2013	406,083 (35.5%)	51,587 (26.4%)	61,426 (37.6%)	14,041 (32.6%)	533,137 (34.5%)
	2014	316,208 (27.6%)	41,977 (21.5%)	43,671 (26.8%)	8,769 (20.4%)	410,625 (26.6%)
	2015	129,590 (11.3%)	25,504 (13.1%)	24,179 (14.8%)	6,146 (14.3%)	185,419 (12.0%)
	2016	86,702 (7.6%)	20,784 (10.6%)	13,081 (8.0%)	4,630 (10.7%)	125,197 (8.1%)
	2017	77,058 (6.7%)	19,415 (9.9%)	8,821 (5.4%)	3,582 (8.3%)	108,876 (7.0%)
	2018	67,137 (5.9%)	18,246 (9.3%)	6,571 (4.0%)	3,202 (7.4%)	95,156 (6.2%)
	2019	62,073 (5.4%)	17,773 (9.1%)	5,417 (3.3%)	2,713 (6.3%)	87,976 (5.7%)
Age at screening	Mean (SD)	59.66 (6.99)	57.95 (7.00)	59.26 (7.54)	57.70 (7.55)	59.35 (7.09)
	Median (Q1-Q3)	59 (53-65)	56 (52-63)	58 (52-65)	56 (51-64)	59 (53-65)
	Min - Max	49 - 74	49 - 74	49 - 74	49 - 74	49 - 74
Age group	49-54 yr	342,778 (29.9%)	81,636 (41.8%)	56,033 (34.3%)	19,161 (44.5%)	499,608 (32.3%)
	55-59 yr	253,159 (22.1%)	39,408 (20.2%)	32,886 (20.2%)	7,843 (18.2%)	333,296 (21.6%)
	60-64 yr	227,624 (19.9%)	31,788 (16.3%)	28,140 (17.2%)	6,374 (14.8%)	293,926 (19.0%)
	65-69 yr	198,147 (17.3%)	27,085 (13.9%)	25,611 (15.7%)	5,413 (12.6%)	256,256 (16.6%)
	70-74 yr	123,143 (10.8%)	15,369 (7.9%)	20,496 (12.6%)	4,292 (10.0%)	163,300 (10.6%)
Rural	Missing Data	1,050 (0.1%)	222 (0.1%)	178 (0.1%)	55 (0.1%)	1,505 (0.1%)
	No	999,176 (87.3%)	174,606 (89.4%)	146,664 (89.9%)	39,679 (92.1%)	1,360,125 (88.0%)
	Yes	144,625 (12.6%)	20,458 (10.5%)	16,324 (10.0%)	3,349 (7.8%)	184,756 (11.9%)
Neighbourhood income quintile	Missing Data	2,535 (0.2%)	432 (0.2%)	315 (0.2%)	107 (0.2%)	3,389 (0.2%)
	1	193,364 (16.9%)	34,774 (17.8%)	28,885 (17.7%)	8,269 (19.2%)	265,292 (17.2%)
	2	220,977 (19.3%)	37,957 (19.4%)	32,728 (20.1%)	8,590 (19.9%)	300,252 (19.4%)
	3	230,601 (20.1%)	39,002 (20.0%)	32,862 (20.1%)	8,440 (19.6%)	310,905 (20.1%)
	4	239,798 (20.9%)	40,376 (20.7%)	34,091 (20.9%)	8,601 (20.0%)	322,866 (20.9%)
	5	257,576 (22.5%)	42,745 (21.9%)	34,285 (21.0%)	9,076 (21.1%)	343,682 (22.2%)
Charlson comorbidity score (2 years prior)	0	459,696 (40.2%)	78,745 (40.3%)	63,789 (39.1%)	17,512 (40.6%)	619,742 (40.1%)
	1	54,554 (4.8%)	9,033 (4.6%)	7,719 (4.7%)	1,975 (4.6%)	73,281 (4.7%)
	2+	29,540 (2.6%)	9,687 (5.0%)	4,380 (2.7%)	2,347 (5.4%)	45,954 (3.0%)
	No hospitalization	601,061 (52.5%)	97,821 (50.1%)	87,278 (53.5%)	21,249 (49.3%)	807,409 (52.2%)
Length of follow-up (months)	Mean (SD)	7.92 (0.60)	7.67 (1.42)	7.89 (0.71)	7.62 (1.50)	7.87 (0.80)
	Median (Q1-Q3)	8 (8-8)	8 (8-8)	8 (8-8)	8 (8-8)	8 (8-8)
	Min - Max	0 - 8	0 - 8	0 - 8	0 - 8	0 - 8

Cost Results

- Over the six-year period, the overall total cost to screen was $234 million and 74% of costs were due to negative and positive screenings while 26% of costs were due to diagnostic procedures following a positive screen (Figure 2A).
- OBSP was responsible for screening 1.3 million women (Figure 2B) and $203 million in total costs (Figure 2A). Among OBSP women, 85% screened negative and mean cost per negative/positive OBSP screen was $112/$384, respectively (Figure 2C).
- Non-OBSP screenings were observed for 0.2 million women (Figure 2B) with $31.5 million in total costs (Figure 2A). Among Non-OBSP women, 79% screened negative and mean cost per negative/positive non-OBSP screen was $117/$287, respectively (Figure 2C).

Figure 2A: Total Screening Costs

Figure 2B: Number of Negative and Positive Screens

Figure 2C: Mean Screening Cost per Patient
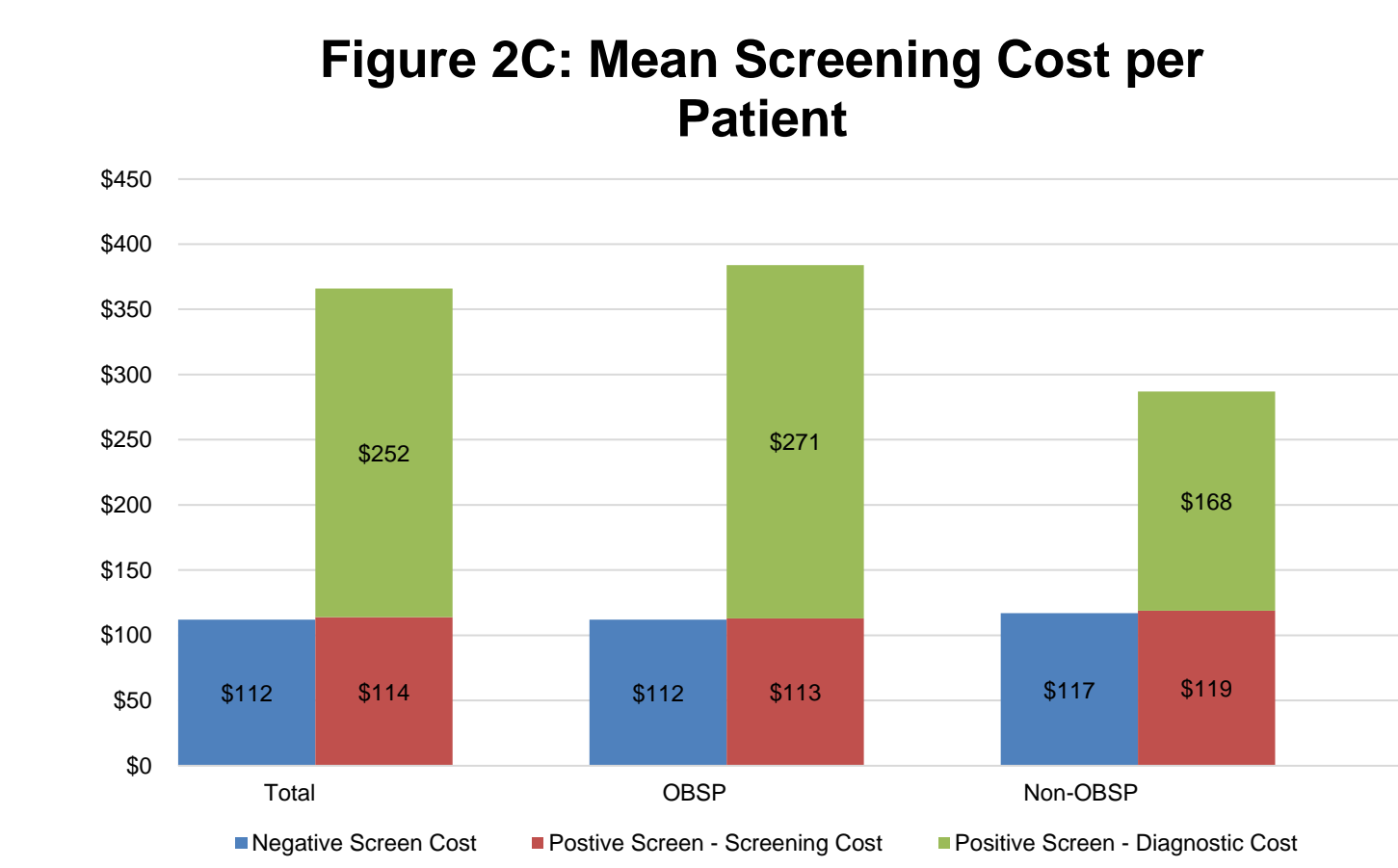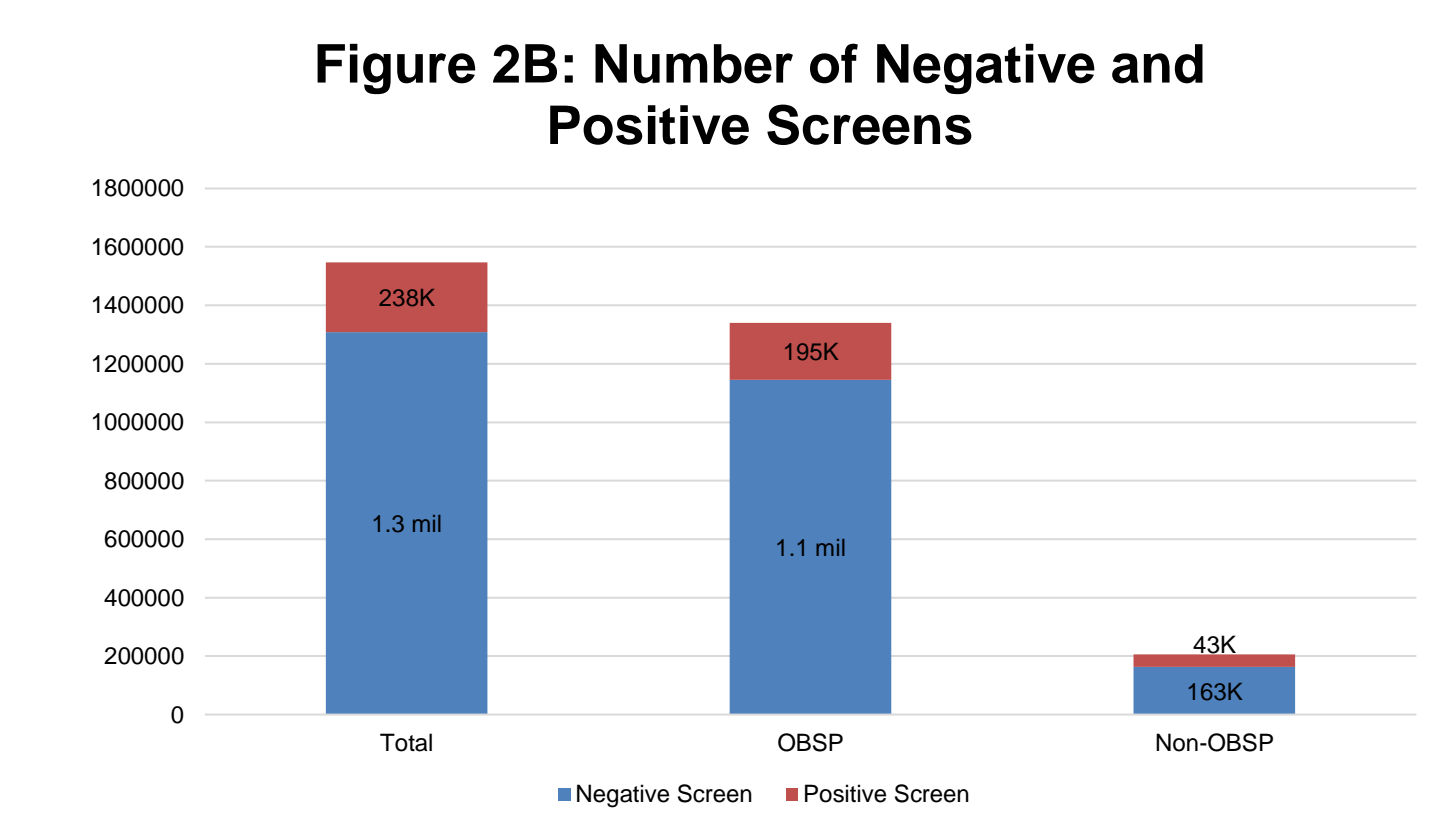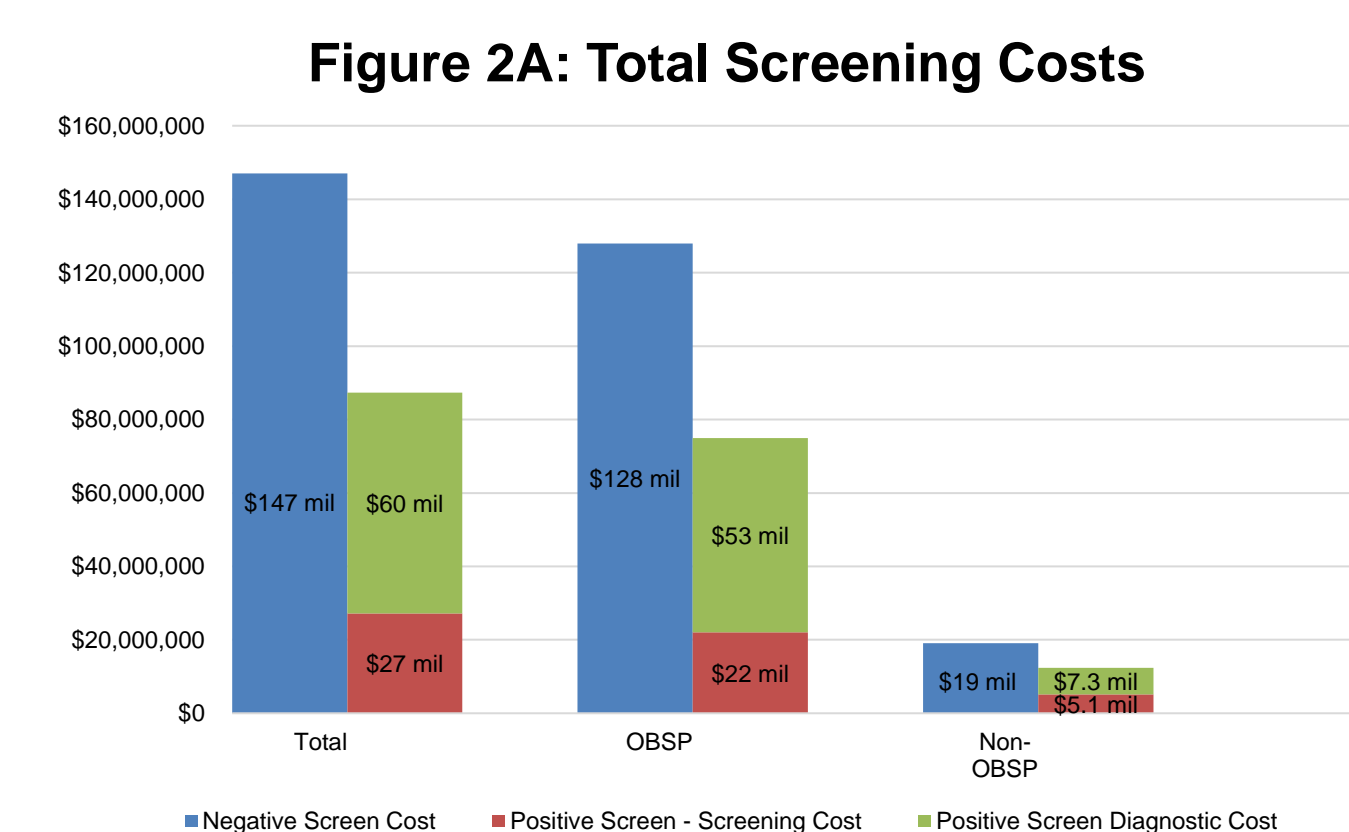
Conclusions

- These preliminary screening cost results stratified by OBSP/non-OBSP and negative/positive screening are currently being further investigated and clinical implications will need to be considered.

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