cancer at approximately $35,000 and of treating late cancer at $45,000. Another study of the three-year (undiscounted) costs of treating colorectal cancer in a mid-Atlantic region HMO estimated the stage-specific costs as follows: Dukes A: $21,825; Dukes B: $23,000; Dukes C: $33,674; and Dukes D: $37,814 (Myers et al., 1993). Because these estimates were truncated three years after diagnosis, they underestimate the full costs of CRC treatment. They are roughly consistent with the Kaiser estimates, however. In this paper we use the Kaiser estimates of the cost of cancer care.

RESULTS

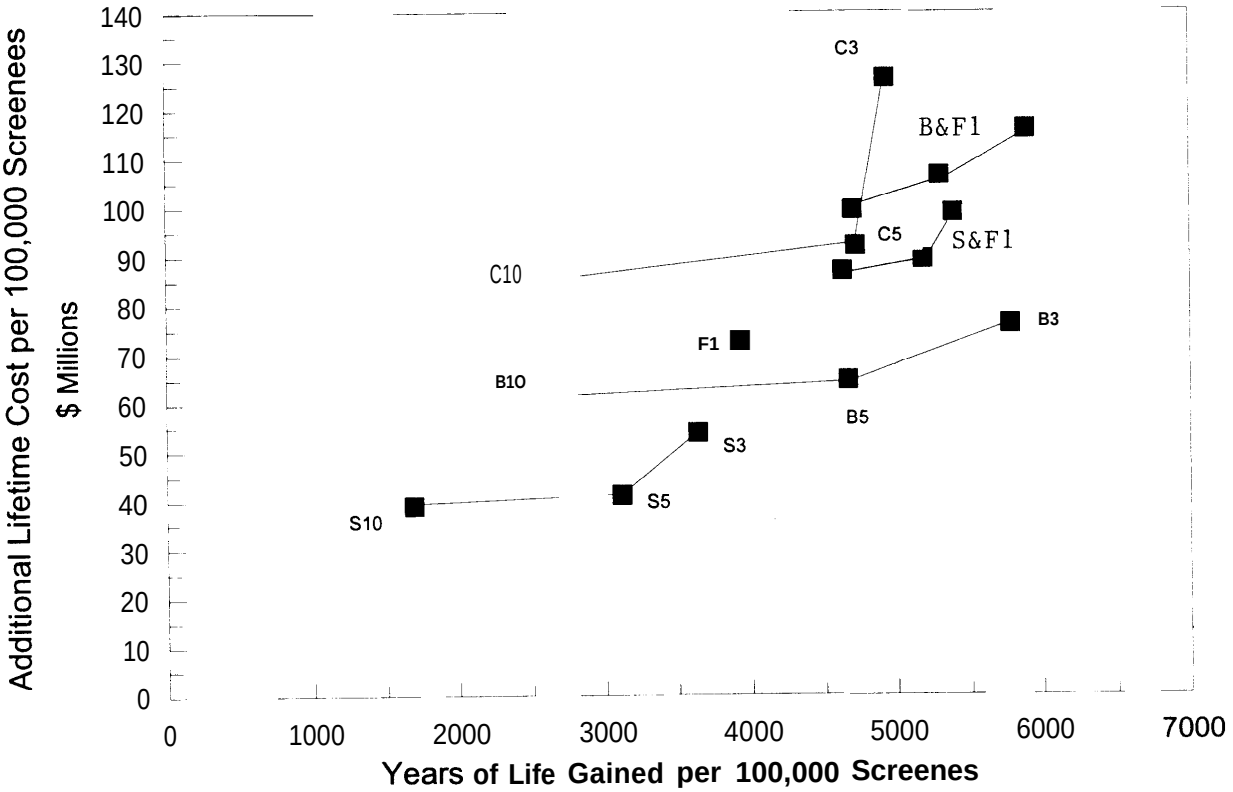
Base Case

Figures 1A and 1B show the base case results for each screening strategy under study for polyp dwell times of 5 and 10 years respectively.[5] Any strategy lying above and to the left of another strategy on these charts is dominated by the other strategy because it is both more costly and less effective than the other strategy. Regardless of whether the polyp dwell time is short or long, FSIG or DCBE strategies dominate all others, including those involving CSCPY and FOBT (alone or in combination with another technology). If the polyp dwell time is 5 years, a DCBE every 5 years is roughly equal in cost-effectiveness to FSIG every 5 years. (The cost-effectiveness ratio for DCBE is $13,844 per added year of life and for FSIG is $13,216 per added year of life.) Although they are comparable in terms of the cost per added year of life, DCBE is both more costly overall and more effective in preventing cancers and finding them early. Thus, the economic issue in selecting among the two screening technologies is one of affordability, not of relative efficiency.

[5] Detailed tables showing the cost-effectiveness ratios are presented in an appendix to his paper.

Figure 1A

Effects and Costs of CRC Screening
5-Year Polyp Dwell Time



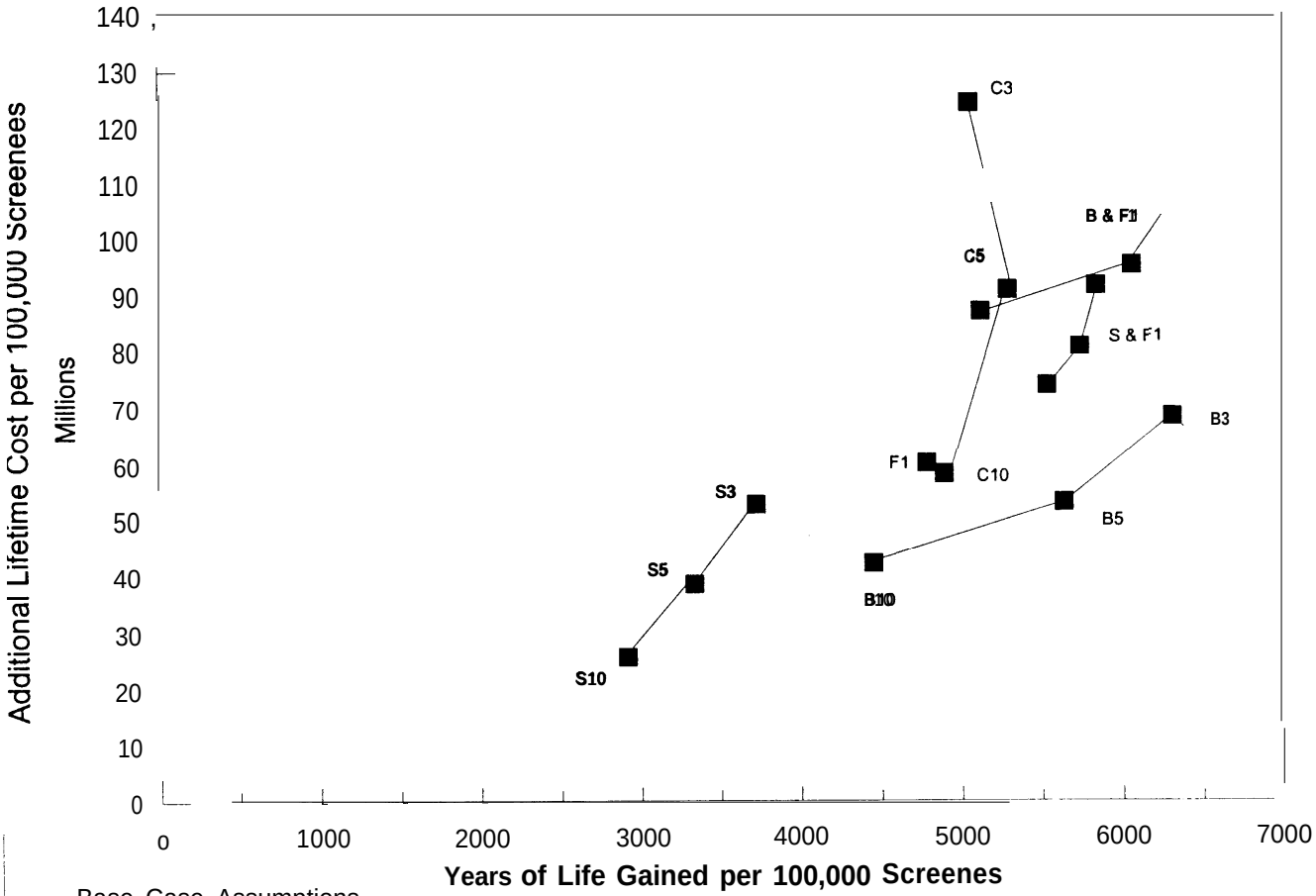
Base Case Assumptions
Source: OTA, 1995

Key: S# = FSIG every # years;
B# = DCBE every # years
C# = CSCPY every # years;
F# = FOBT every # years;
S & F1 = combination strategies of FSIG (various intervals) and FOBT
B $ F1 = combination strategies of DCBE (various intervals) and FOBT

Figure 1-B

Effects and Costs of CRC Screening

10-Year Polyp Dwell Time



Base Case Assumptions
Source: OTA, 1995

Key: Sx = **flexible sigmoidoscopy every x years; Bx = double contrast barium enema every x years; Cx = screening colonoscopy every x years; Fx = fecal occult blood test every x years; B & F1 are strategies combining double contrast barium enema and annual fecal occult blood; S & F1 are strategies combining flexible sigmoidoscopy and annual fecal occult blood test.**

If the vast majority of cancers arising from polyps progress through the polyp phase very slowly, then infrequent screening schedules are more cost-effective than more frequent intervals. If the vast majority of colorectal cancers remain as precancerous adenomas for 10 years or more, the cost-effectiveness of a 10-year schedule for either DCBE or FSIG would be in the neighborhood of $9,000 per added year of life regardless of the technology applied.

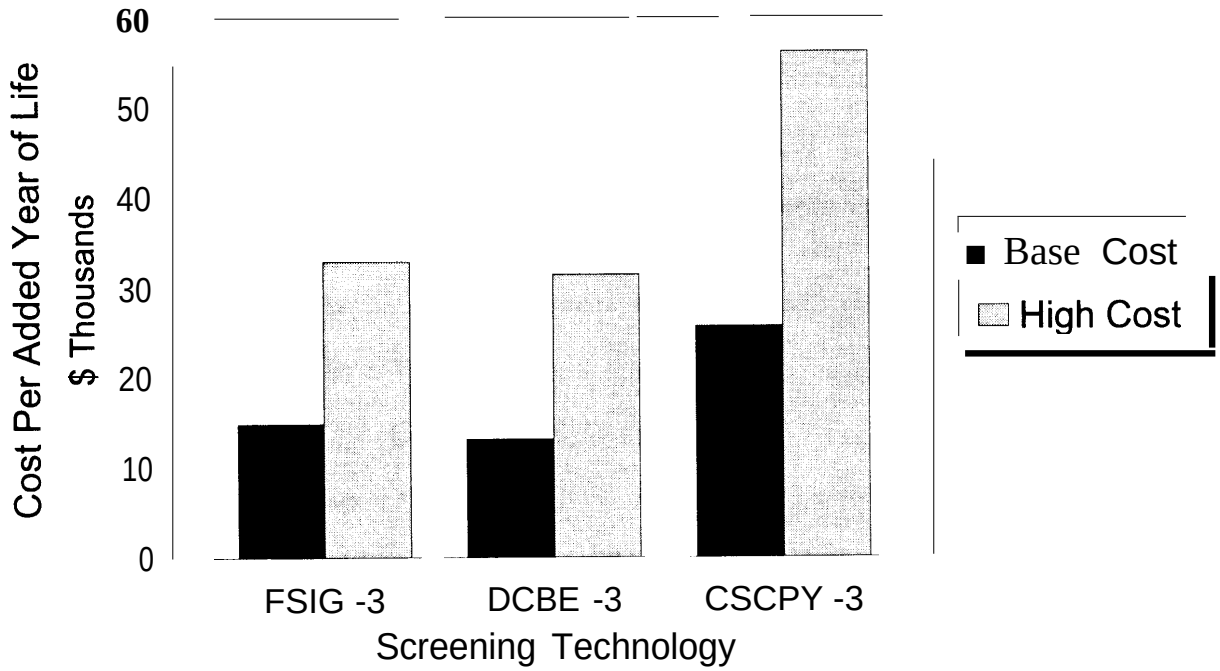
Strategies involving CSCPY as a screening technology do not perform well compared with DCBE. Under the 5-year polyp dwell time scenario, CSCPY every 5 years saves more lives than does DCBE every 5 years, but a 3-year DCBE schedule delivers more health benefits at a lower cost than does a 5-year CSCPY schedule. In the case of a slower polyp dwelling time, more frequent CSCPY schedules cost both dollars and years of life, largely because of the risks of the procedure.

Sensitivity Analysis

Figures 2, 3, and 4 show the impact of doubling the cost of every screening and diagnostic procedure simultaneously. The cost per added year of life increases substantially for all screening strategies. Two observations are very important, however. The relative balance among the alternative screening technologies does not change: what was relatively costly before remains so under the higher cost assumptions. Perhaps more important, the cost-effectiveness ratio remains under $40,000 per added year of life for every screening technology except CSCPY. Thus, if we were wrong by a factor of two in estimating the costs of screening and diagnostic tests, periodic colorectal cancer screening is still a cost-effective intervention when compared with commonly used benchmarks.

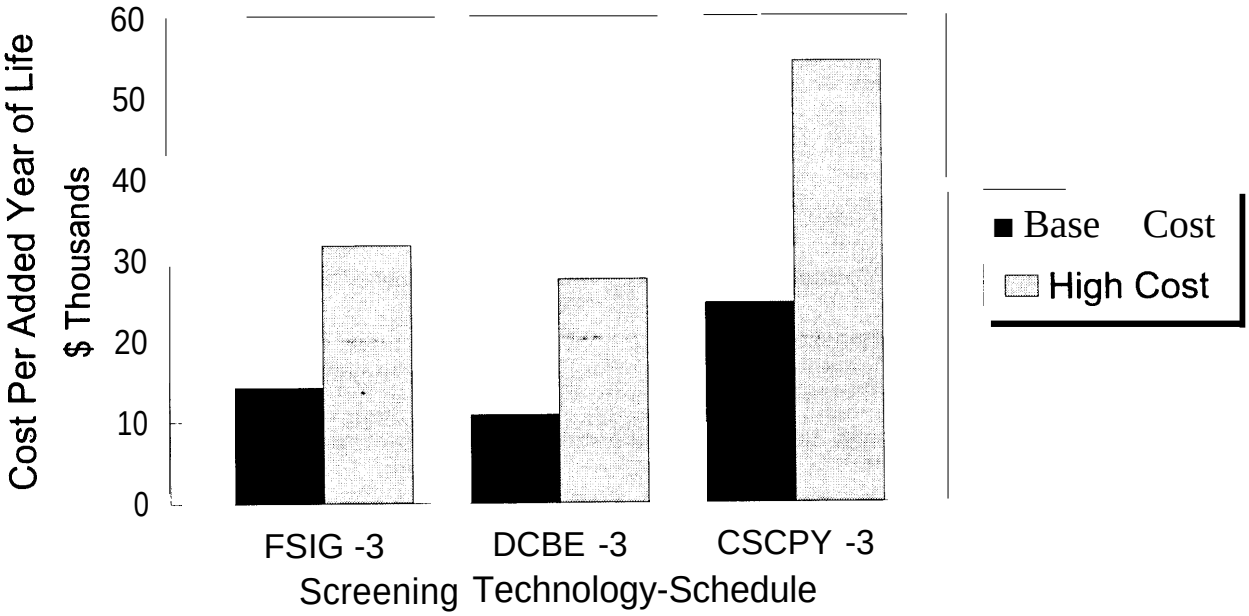
Figure 5 shows how the cost-effectiveness ratio varies with changes in the assumed sensitivity of FOBT. In the Minnesota trial, FOBT sensitivity for cancer was found to be 92 percent with dehydrated slides (Mandel et al., 1993). Assuming a higher sensitivity for cancer

Figure 2A: Sensitivity of Results to Screening Procedure Cost
Five Year Polyp Dwell Time



Source: Office of Technology Assessment, 1995

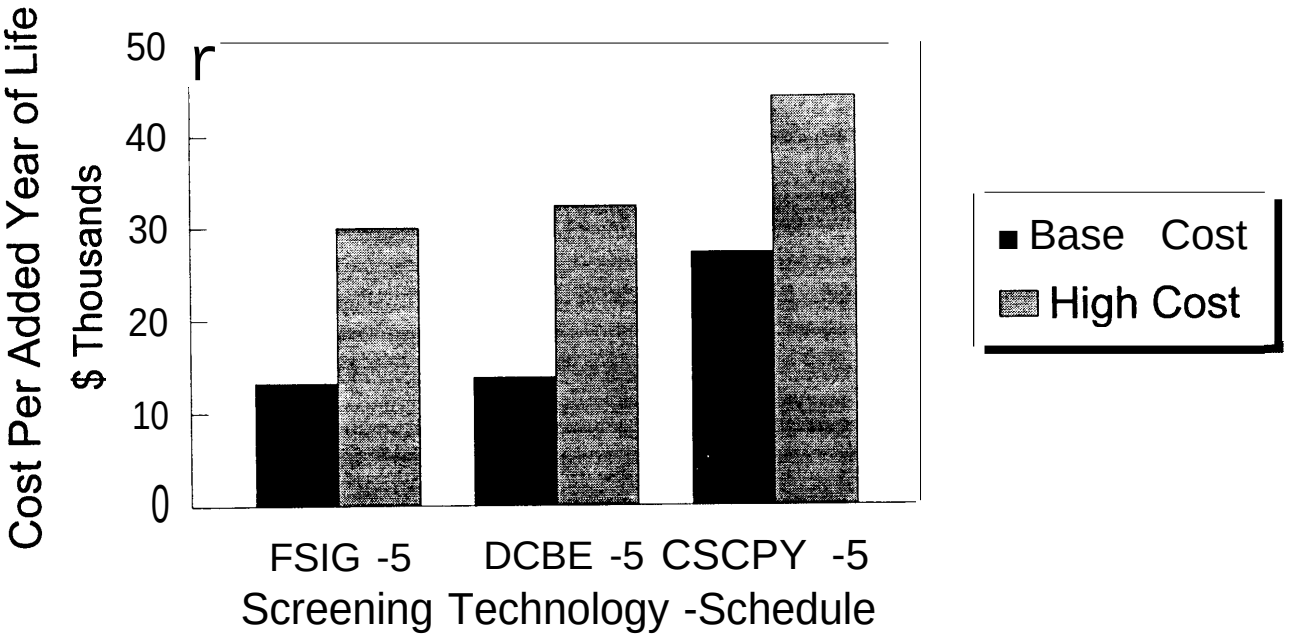
Figure 2B: Sensitivity of Results to Screening Procedure cost
Ten Year Polyp Dwell Time



Source: Office of Technology Assessment, 1995

Figure 3A: Sensitivity to Procedure costs

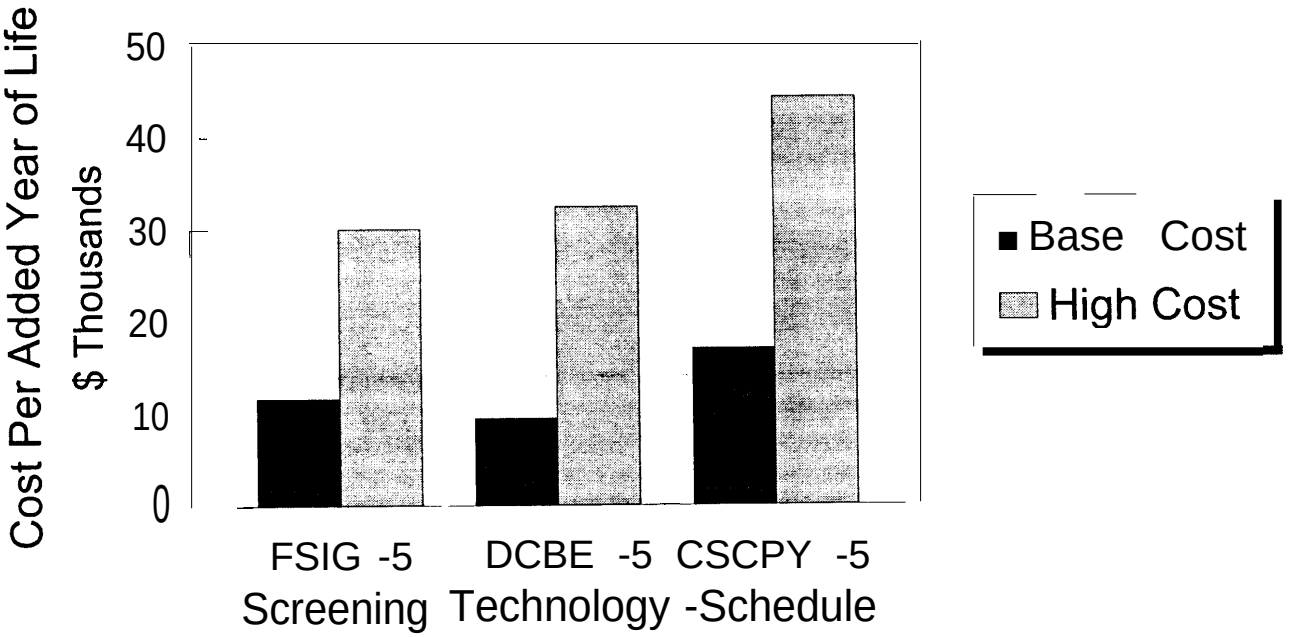
Five Year Polyp Dwell Time



Office of Technology Assessment, 1995

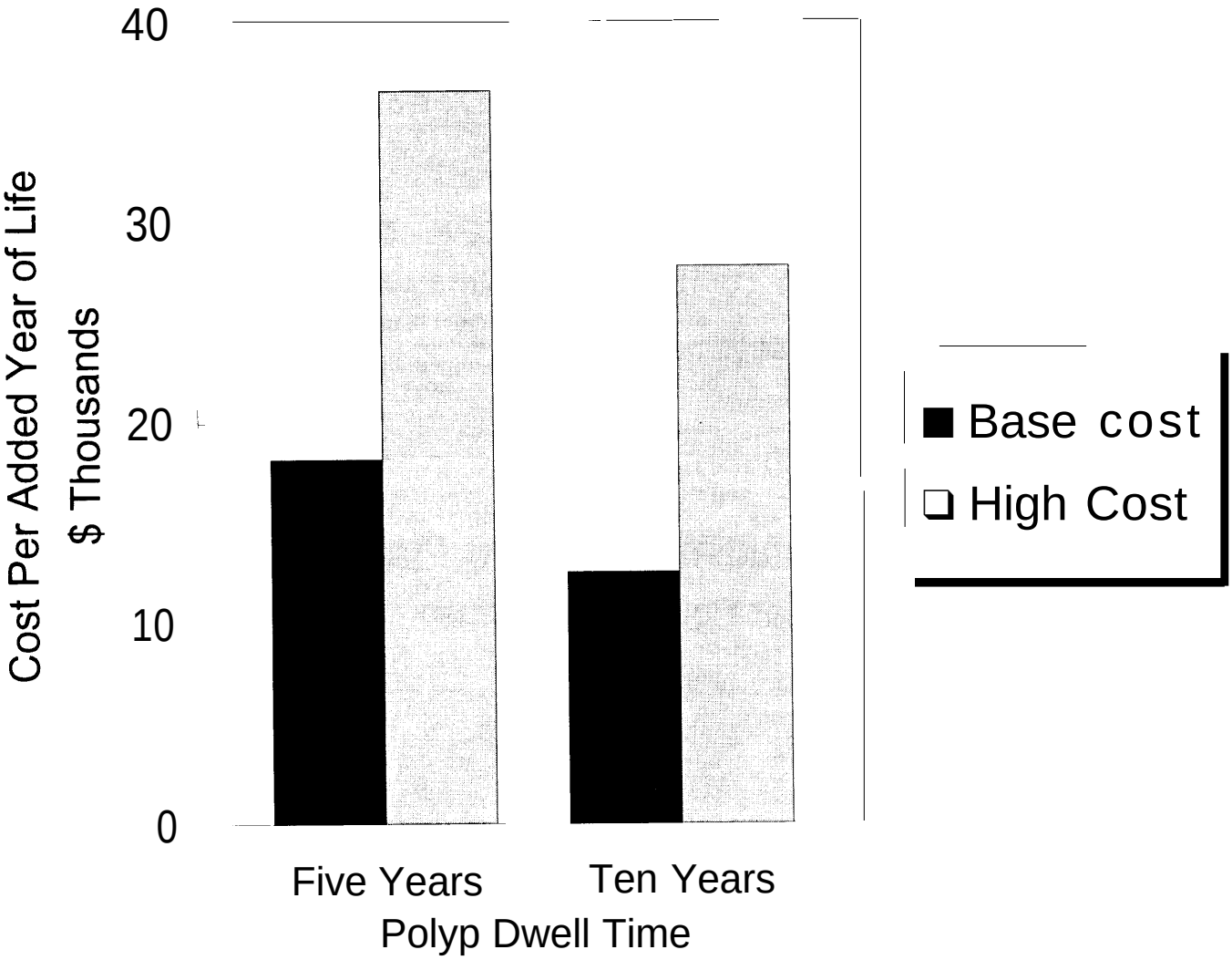
Figure 3B: Sensitivity to Procedure Costs

Ten Year Polyp Dwell Time



Office of Technology Assessment, 1995

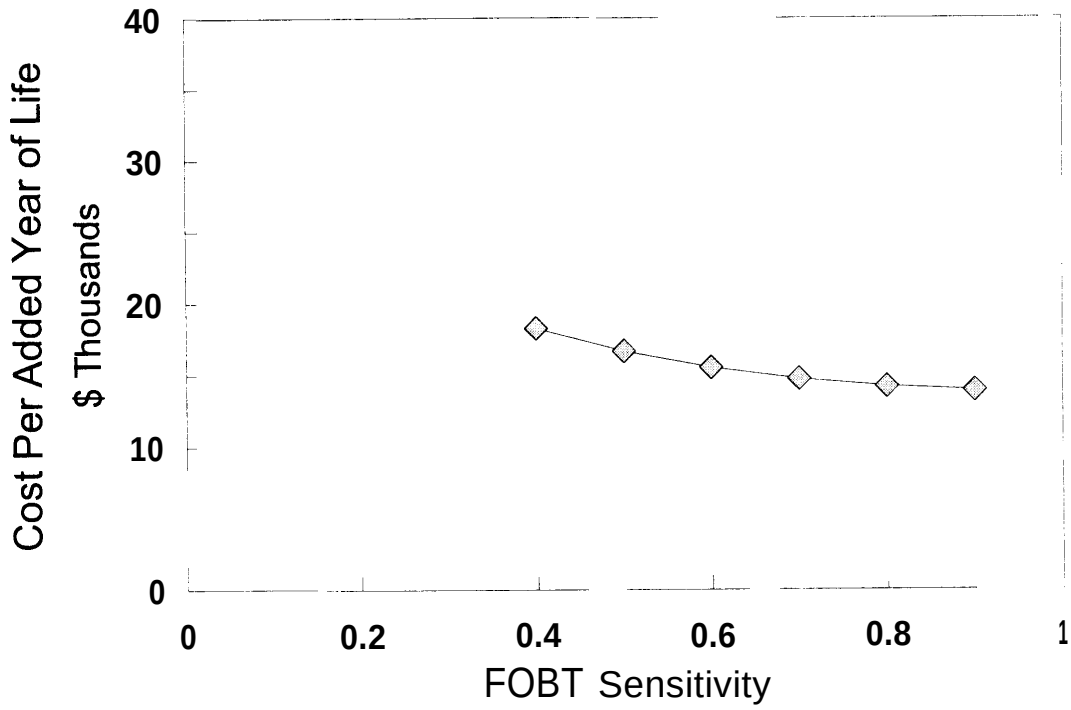
Figure 4: Cost-Effectiveness of Annual FOBT



Source: Office of Technology Assessment

Figure 5: Cost-Effectiveness of Annual FOBT

Five Year Polyp Dwell Time



Assumes FOBT specificity= .90

Source: OTA, 1995

does not markedly change the cost-effectiveness ratio for annual FOBT. This result reflects the fact that the cost saving from finding a cancer earlier ($10,000) is dwarfed by the cost saving from preventing a cancer altogether ($35,000-$45,000).[6]

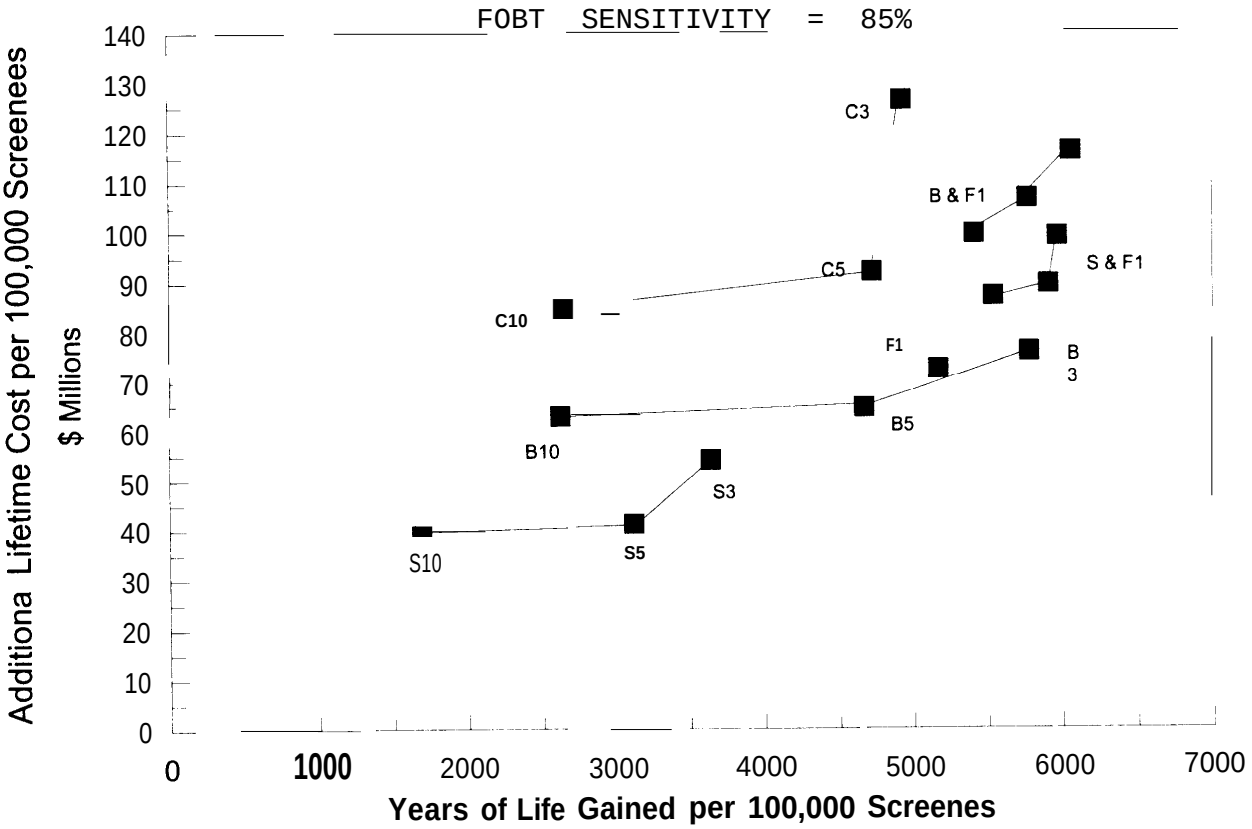
Assuming a higher FOBTsensitivity (i.e., 85 percent) does change the performance of FOBT relative to that of other screening technologies. Figures 6A and 6B show the placement of the different screening strategies when FOBT sensitivity is assumed to be 85 percent. Annual FOBT is no longer dominated by other screening technologies but is on the efficient trade-off frontier along with FSIG and DCBE. Combination strategies (i.e., those combining annual FOBT with periodic FSIG or with periodic DCBE) still remain costly, however, with little gained over frequent DCBE. If most cancers come from polyps, and if polyps move to cancer quite slowly (as assumed in Figure 6B), then little is gained by adding a test with a low sensitivity for polyps to tests that detect cancers and polyps.

The test sensitivity of DCBE is uncertain, especially in a screening context. We examined the effect on costs and years of life lived of assuming a DCBE sensitivity of 50 percent rather than 70 percent, holding all other assumptions to the base case. Table 4 contains the results of that analysis. While the years of life saved decrease by roughly 20-30 percent depending on the screening schedule, the costs of the program do not change very much. Hence, the cost-effectiveness ratio stays well under $40,000. If the true sensitivity of DCBE is only 50 percent, however, FSIG would be slightly more cost-effective. For example, under a 10-year polyp dwell time scenario, the FSIG every 5 years adds 3,334 years of life to a cohort of 100,000 screenees at a discounted net lifetime cost of $38.7 million, compared with 4,561 added years of

[6]In examining the effect of higher sensitivity, we did not change the specificity of FOBT, because the base case value (90%) corresponds to that found in the Minnesota trial with dehydrated slides. A higher specificity of FOBT would reduce the cost per year of life added for the strategies involving lower sensitivity.

Figure 6A: Effects and costs of CRC Screening

5-Year Polyp Dwell Time



FOBT Sensitivity = 85%

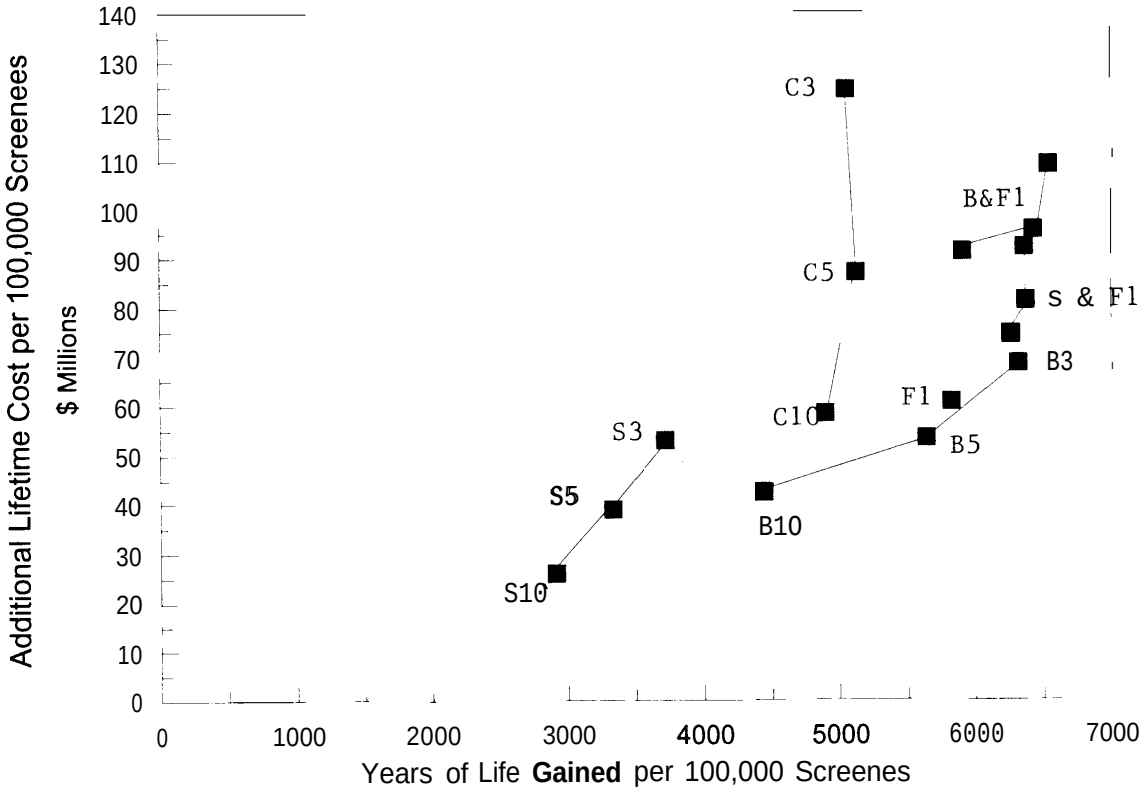
Source: OTA, 1995

KEY: S# = FSIG every # years;
B# = DCBE every # years;
C# = CSCPY every # years
F# = FOBT every # years;
S & F1 = combination strategies of FSIG (various intervals) and FOBT;
B & F1 = combination strategies of DCBE (various intervals) and FOBT.

Figure 6B: Effects and Costs of CRC Screening

10-Year Polyp Dwell Time

FOBT SENSITIVITY = 85%



Base Case Assumptions
Source: OTA, 1995

Key: S# = FSIG every # years
B# = DCBE every # years;
C# = CSCPY every # years;
F# = FOBT every # years;
S & F1 = combination strategies of FSIG (various intervals) and FOBT;
B & F1 = combination strategies of DCBE (various intervals) and FOBT.

Table 4 : Effect of Lower Sensitivity on the Cost-Effectiveness of DCBE

	Years of Life Saved*		Total Lifetime Costs* ($ Millions)		Cost Per Added Year of Life*	
Polyp Dwell Time = 5 years						
DCBE Sensitivity	0.7	0.5	0.7	0.5	0.7	0.5
DCBE Schedule						
DCBE = 3	5,777	4,582	$75.8	$81.8	$13,129	$17,858
DCBE = 5	4,669	3,363	64.6	69.2	13,844	20,571
DCBE = 10	2,630	1,842	63.1	57.9	23,998	31,421
Polyp Dwell Time = 10 Years						
DCBE Sensitivity	0.7	0.5	0.7	0.5	0.7	0.5
DCBE Schedule						
DCBE = 3	6,312	5,554	$68.5	$69.7	$10,848	$12,557
DCBE = 5	5,641	4,561	53.3	55.6	9,450	12,197
DCBE = 10	4,450	3,192	42.5	43.1	9,541	13,495

*All Effects and Costs are discounted to present value at 5% per year.
Source, OTA, 995.