

Costs and cost-effectiveness of colorectal cancer screening

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Background

- Colorectal cancer (CRC): an important cause of death that appears amenable to screening
- CRC is costly:
 - \$35-80,000 per case for direct treatment
 - \$8.3 billion in 2007 for US
- Several different methods screening tests are available, each supported by different evidence
- Screening is under-utilized: interventions needed (clinical and policy) to improve screening availability and uptake

Uses for cost-effectiveness analysis

- Cost-effectiveness analysis can help effectively allocate resources
- Compare the value of services for different conditions
- Compare different test and / or treatment strategies for the same condition
- Direct implementation efforts and resources

Cost-effectiveness analysis

- Provides a measure of value by comparing the incremental health benefits and costs of different strategies
 - Comprehensive
 - Benefits often expressed as life-years gained, sometimes with quality-adjustment
 - Costs in monetary units (dollars)
- Cost per life-year gained:

$$\frac{\text{Cost (a)} - \text{Cost (b)}}{\text{Life-years (a)} - \text{Life years (b)}}$$

Modeling

- Mathematical simulation of populations with the ability to superimpose interventions
- Requires data on:
 - Natural history
 - Test accuracy
 - Effects of treatment
 - Costs
 - Utilities / value of different health states
- Different techniques for acute or chronic issues

Which costs?

- Costs of tests and treatments
- Avoided costs from better health outcomes
- Non-health costs
 - Patient / caregiver time
 - Indirect costs (value of productivity lost)
- Costs of implementation / adherence-building programs (rarely considered)

Other modeling factors

- Perspective – which outcomes and costs?
- Discounting
- How to address uncertainty?
 - One-way sensitivity analysis
 - Probabilistic sensitivity analysis
 - Net benefit analysis / cost-effectiveness acceptability curves

What cost per life year gained is considered a good value?

- No agreed upon standard
- Many have cited \$50,000 per life year gained based on previously expressed opinion, but this value has not risen with inflation
- Economists have developed techniques to estimate an appropriate benchmark:
 - willingness to pay
 - GDP-based thresholds
 - Observed behaviors
- These techniques often yield estimates for the US that are quite a bit higher than \$50,000

Example of colorectal cancer screening

Value of CRC screening

Cost-effectiveness c/w No Screening

Study	Wagner	Khandker	Frazier	Sonnenberg	Vijan
FOBT q1	16,075	17,805	13,656	10,463	5,691
FS q5	14,141	15,630	12,804	39,359	19,068
FOBT q 1 + FS q5	16,144	22,518	18,693		17,942
DCBE q5	15,974	21,712	25,624		
COL q10	26,243	21,889	22,012	11,840	9,038

Costs in Year 2000 dollars

All strategies effective and cost-effective compared with no screening

Prevention Priorities Project

- Used modeling to determine best value among recommended preventive services
- Evaluated cost per life year gained and unmet burden of need
- CRC screening received 4/5 scores in each category and was among the 5 most highly recommended services overall

Maciosek Am J Prev Med 2006; 31:90-96

Using cost-effectiveness analysis
to compare different
CRC screening strategies

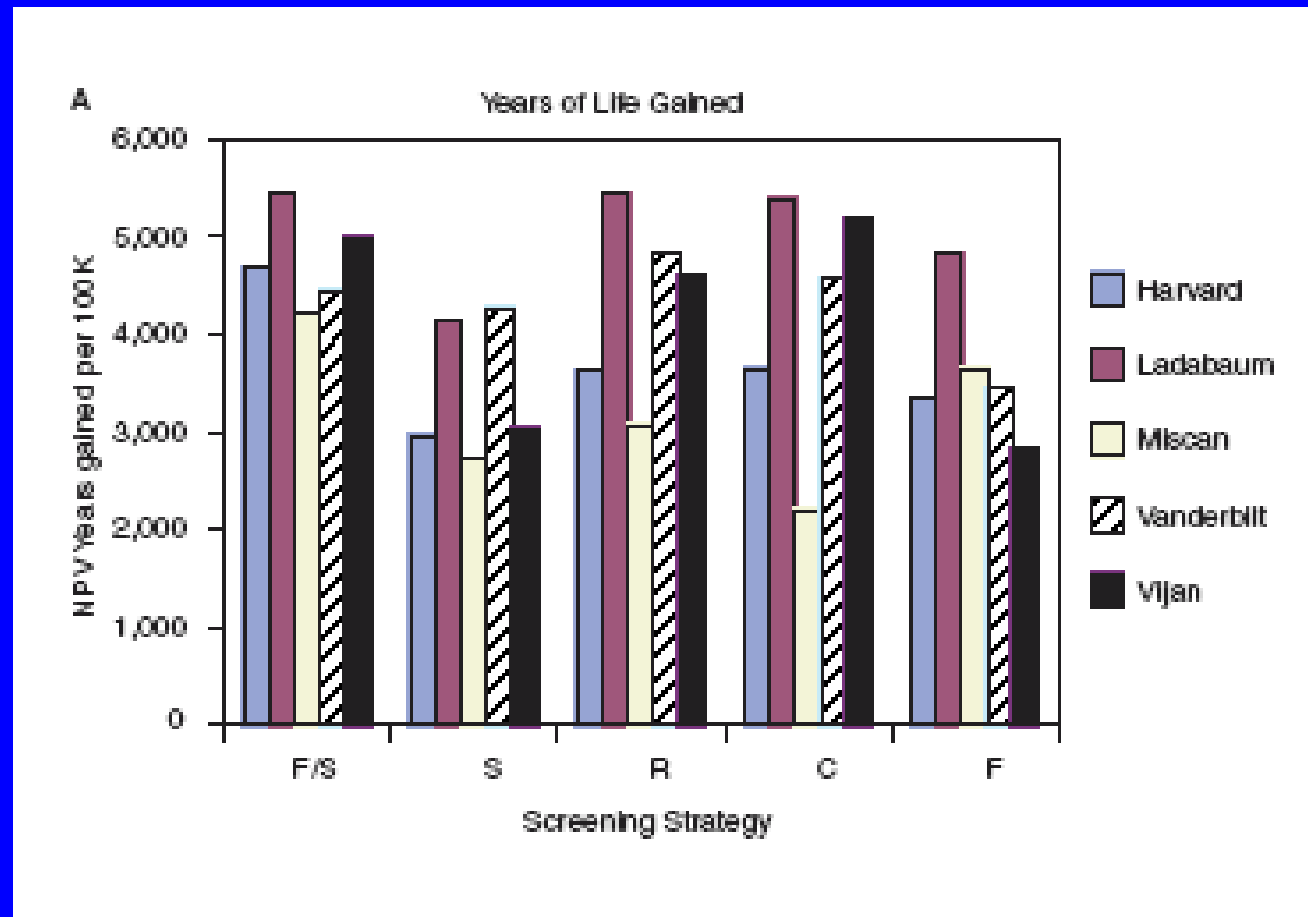
Incremental C/E ratios

	Wagner	Frazier	Khandker	Sonnenberg	Vijan
FS q5	WD	\$12,804	\$15,630	SD	SD
FOBT q1	SD	\$16,568	\$31,570	\$10,463	\$5760
DCBE	SD	SD	\$53,948	N/A	N/A
COL	\$8721	SD	\$61,848	\$12,270	\$33,063
FOBT+ FS	\$34,760	\$33,805	SD	N/A	\$106,153

Strategies ordered from least to most effective

No clear best test across models

Relative effects of different strategies for CRC screening



Important variables accounting for variation among studies

- natural history (% cancers from adenomas, polyp dwell time, cancer dwell time)
- harms considered (perforation, bleeding)
- costs of colonoscopy / subsequent care
- how adherence is modeled

Newer models reach similar conclusions

Table 4. Outcomes for the Recommendable Set of Efficient Screening Strategies

Test, Age Begin–Age Stop, Interval*	Outcomes per 1000 Persons			Efficiency Ratio†	Incidence Reduction, %	Mortality Reduction, %
	COL	Non-COL Tests	LYG			
MISCAN						
COL, 50–75, 10	4136	0	230	29.6	51.9	64.6
Hemoccult SENSA, 50–75, 1	3350	9541	230	30.9	49.7	66.0
FIT, 50–75, 1	2949	11 773	227	25.9	47.2	64.6
Hemoccult II, 50–75, 1	1982	16 232	194	14.3	37.1	55.3
FSIG, 50–75, 5	1911	4139	203	9.7	46.8	58.5
FSIG + SENSA, 50–75, 5, 3	2870	5822	230	16.3	51.2	65.7
SimCRC						
COL, 50–75, 10	3756	0	271	34.7	80.6	84.4
Hemoccult SENSA, 50–75, 1	2654	9573	259	22.9	73.2	81.2
FIT, 50–75, 1	2295	11 830	256	19.7	70.8	80.0
Hemoccult II, 50–75, 1	1456	16 239	218	9.6	56.6	69.0
FSIG, 50–75, 5	995	4483	199	8.4	59.0	62.2
FSIG + SENSA, 50–75, 5, 3	1655	11 623	257	7.0	72.2	79.3

COL = colonoscopy; FIT = fecal immunochemical test; FSIG = flexible sigmoidoscopy; LYG = life-years gained compared with no screening; MISCAN = Microsimulation Screening Analysis; SimCRC = Simulation Model of Colorectal Cancer.

* Age and intervals expressed as years.

† Efficiency ratio corresponds with $\Delta\text{COL}/\Delta\text{LYG}$ in the Appendix Table and represents the relative burden per unit of benefit achieved.

Zauber, A. G. et. al. Ann Intern Med 2008;149:659-669

CT colonography

- Good accuracy, particularly for larger polyps
- Requires preparation like optical colonoscopy, and has similar discomfort
- Low rate of perforation
- Unclear if radiation risk significant
- Positive test requires colonoscopy
- Impact of extra-colonic findings unclear
- Costs unclear

Cost-effectiveness analyses

Study*	Referral threshold	Sensitivity-med. polyps	Threshold cost**
MISCAN	6 mm	66%	43%
Ladabaum	all	87%	60%
Vijan	all	83%	75%
Pickhardt	6 mm	70%	70%

*CTC every 5 years except Ladabaum (every 10 years)

**For cost-effectiveness compared with COL every 10 years

Conclusions

1. Screening for colorectal cancer by any standard method is consistently cost-effective compared to no screening.
2. CRC screening is a high-priority area for investment of health resources.
3. A single best method of screening can not be confidently defined based on available evidence.