Biomedical Engineering for Global Health

Lecture Sixteen

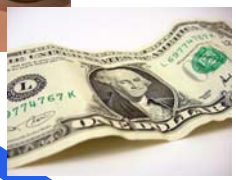
Review of Lectures 13-15

- What is the goal of cancer screening?
- Successful cancer screening examples?
- Can screening hurt more people than it helps?
- What are the challenges in cancer screening?
- Is cancer screening a good investment?

Science of Understanding Disease

Bioengineering

Emerging Health Technologies

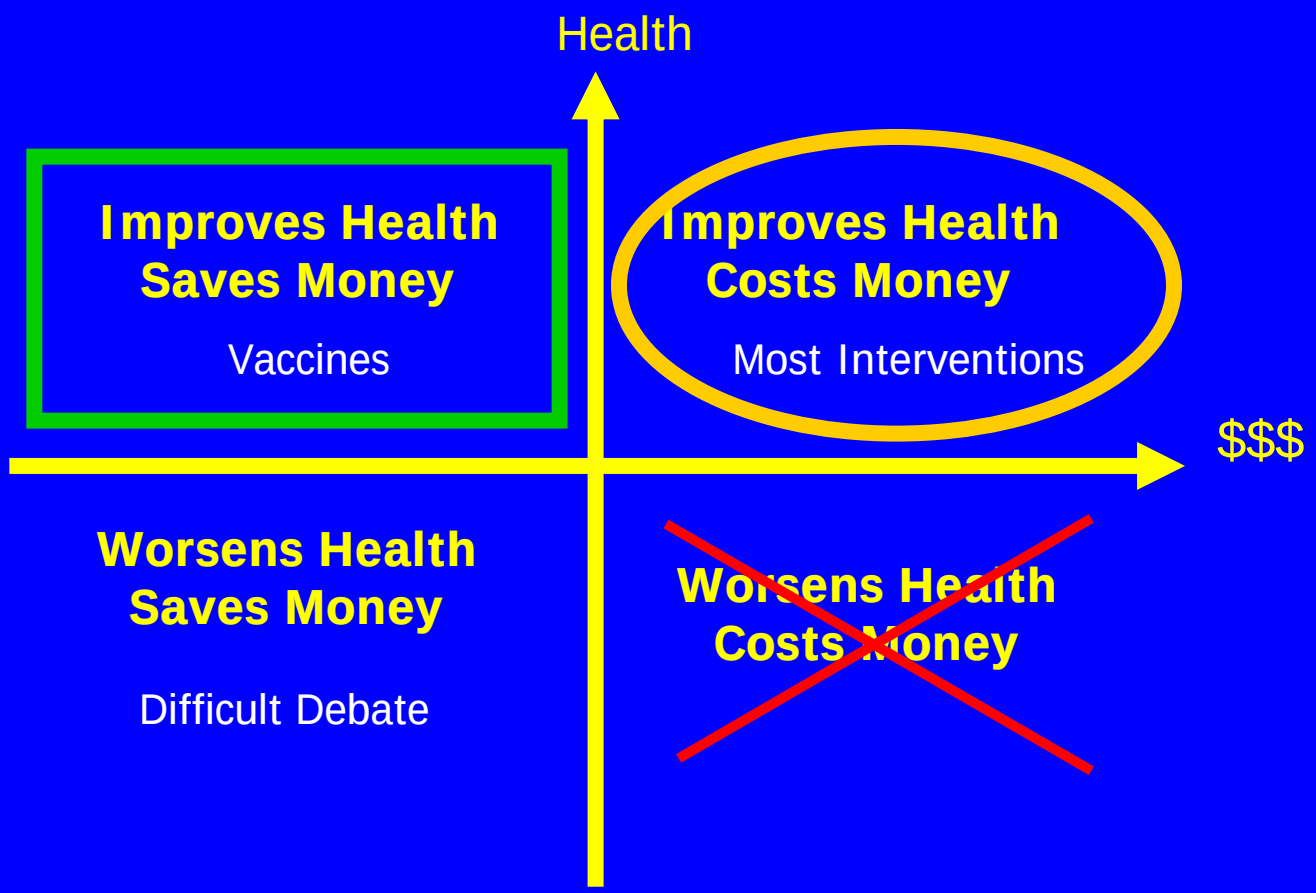


Adoption & Diffusion

Abandoned due to:

- Poor performance
- Safety concerns
- Ethical concerns
- Legal issues
- Social issues
- Economic issues

Health Policy Space



Health Care Reform in Oregon

- Health services ranked according to cost-effectiveness

$$priorityrating = \frac{CostofTreatment}{NetExpectedBenefit \times DurationofBenefit}$$

$$/DALY or $$/QALY

- What does a DALY measure?
- How much are we willing to spend to gain a year of life?
- Name two health interventions that result in cost SAVINGS.

League Table

Intervention	Cost-Effectiveness Ratio
Pneumococcal vaccine for adults over 65 years of age	Cost saving
Tobacco cessation counseling	Cost saving to $2,000/QALY saved
Chlamydia screening for women 15-24 years old	$2,500/QALY saved
Colorectal cancer screening for people >50 years old	$13,000/QALY saved

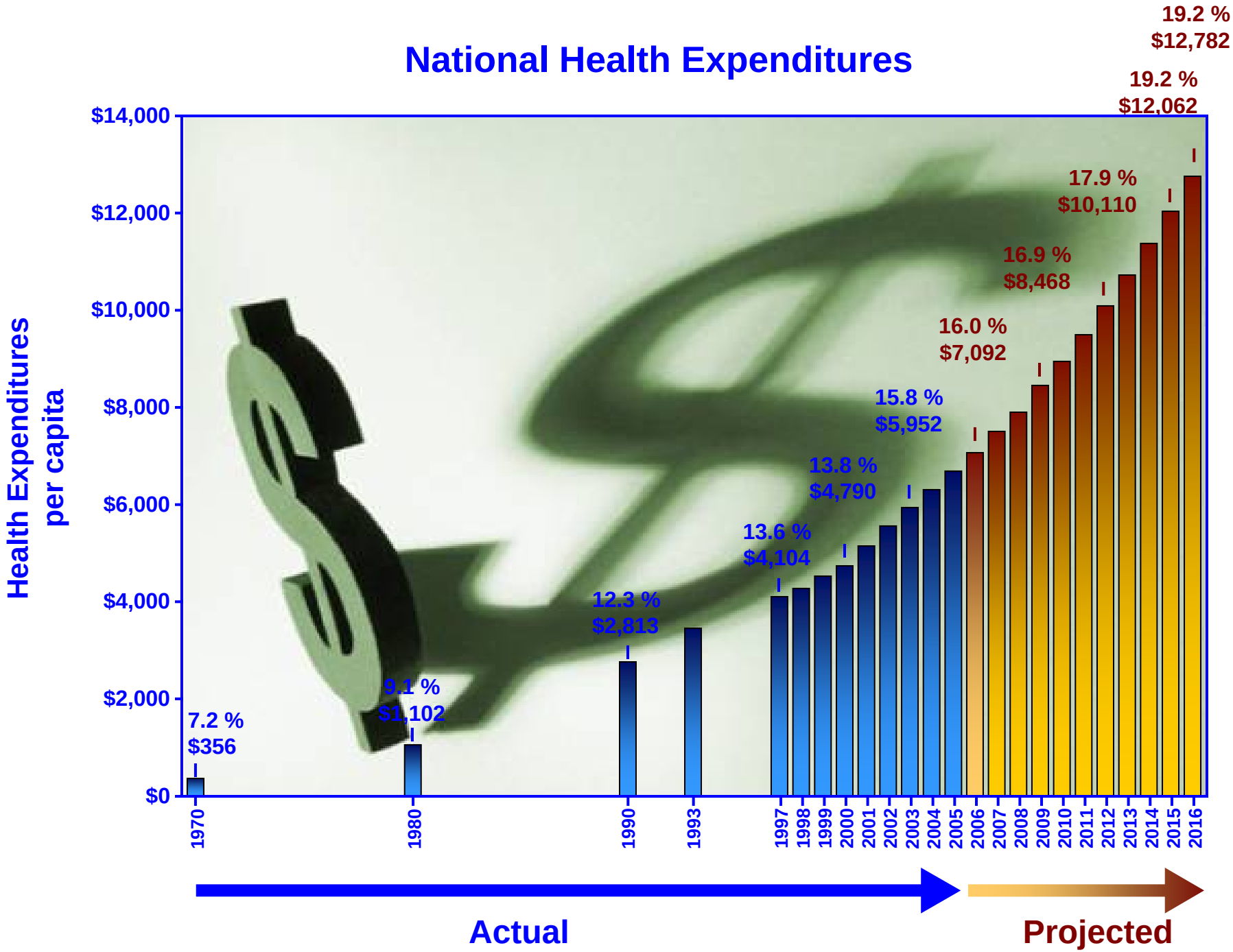
What is Society's Threshold Ratio?

- No correct answer
- Common guesses:
  - $20,000-$100,000 / QALY
  - Median estimate = about $150,000/QALY
  - [Hirth RA, et al. What should society be willing to pay for a QALY? Evidence from the value of life literature (abstract). Medical Decision Making 1999;18:459.]

How Much Life Can $50,000 Buy?

What is Society's Threshold Ratio?

- No correct answer
- Common guesses:
  - $20,000-$100,000 / QALY
  - Median estimate = about $150,000/QALY
  - [Hirth RA, et al. What should society be willing to pay for a QALY? Evidence from the value of life literature (abstract). Medical Decision Making 1999;18:459.]
- What about in developing countries?
  - Very cost-effective:
    - amount to gain one QALY is < per person GDP
  - Cost-effective:
    - amount to gain one QALY is < 3 x per capita GDP


National Health Expenditures
Health Expenditures per capita
$14,000
$12,000
$10,000
$8,000
$6,000
$4,000
$2,000
$0
7.2 %
$356
9.1 %
$1,102
12.3 %
$2,813
13.6 %
$4,104
13.8 %
$4,790
15.8 %
$5,952
16.0 %
$7,092
16.9 %
$8,468
17.9 %
$10,110
19.2 %
$12,062
19.2 %
$12,782
1970
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2012
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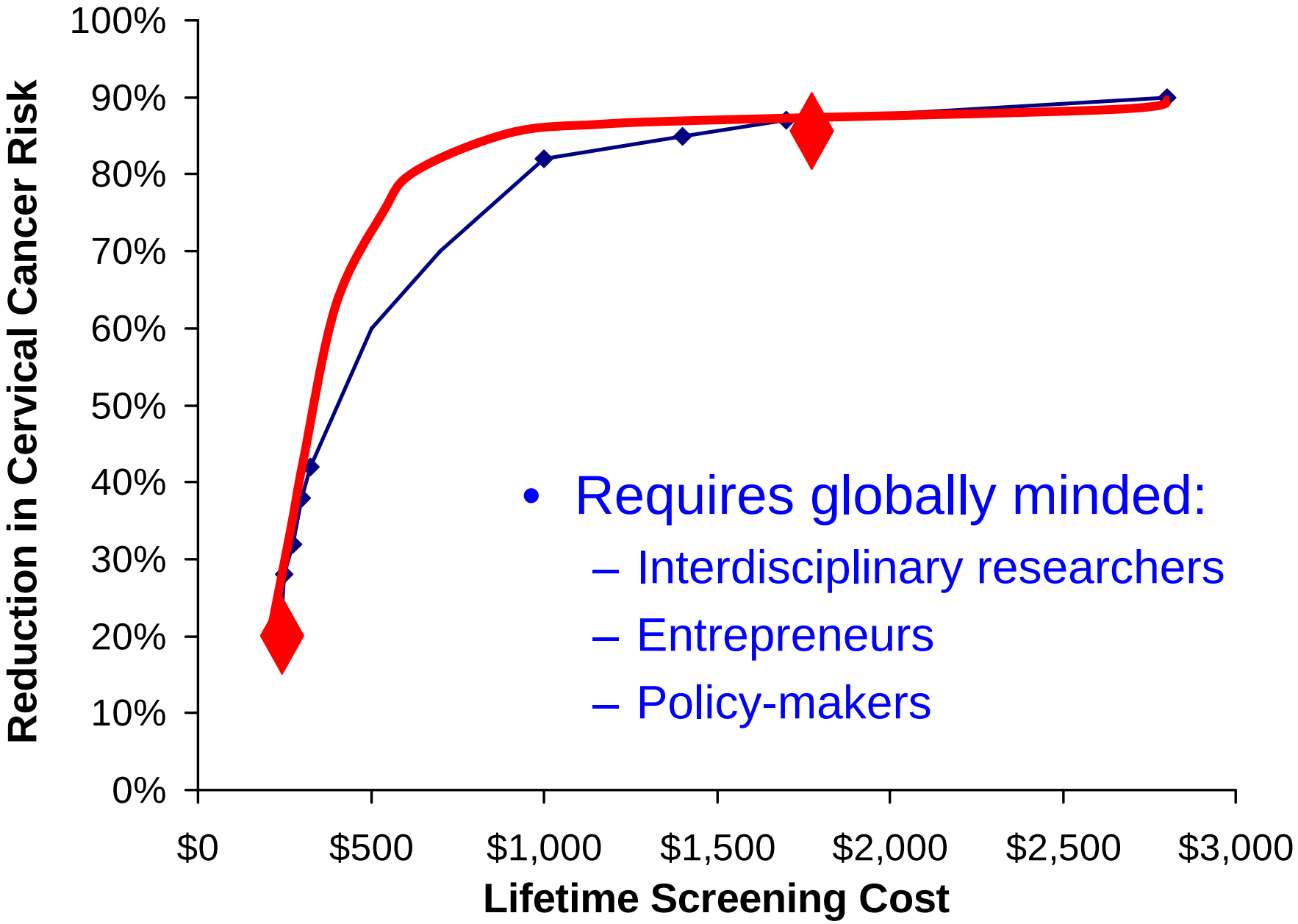
2014
2015
2016
Actual
Projected

How Can New Technologies Help?



Cost-Effectiveness Assessment

- Define the problem
- Identify the perspective
- Identify the alternatives
- Analyze the effectiveness
- Analyze the costs
- Perform discounting
- Perform sensitivity analysis
- Address ethical issues
- Interpret the results

Example: Cervical Cancer Screening for Elderly Women

- 1988:
  - Medicare did not cover cervical cancer screening
  - Elderly accounted for 40% of cervical CA deaths
- Question:
  - Should Medicare pay?

Cost-Effectiveness Assessment

- Define the problem:
  - Is cervical cancer screening for elderly women cost-effective?
- Identify the perspective
  - Societal perspective
- Identify the alternatives
  - No screening
- Analyze the costs & effectiveness
  - Real clinical trial
  - Projected costs and benefits

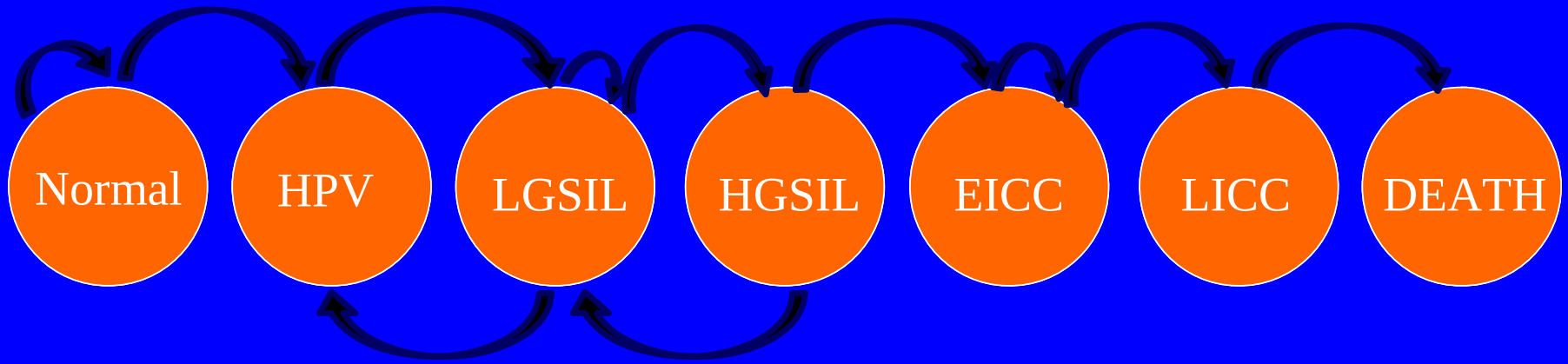
Cost-Effectiveness Assessment

- Perform discounting
  - 5% discount rate
- Perform sensitivity analysis
  - Screening would be cost-saving in elderly women who had never been screened
- Address ethical issues
  - Is it ethical for Medicare to pay for smears only for women who have never been screened?
- Interpret the results

Summary of Study

- New Technology:
  - Pap screening in low-income, elderly women
- Alternative:
  - No screening
- Number of tests performed:
  - 816
- Costs of Technology:
  - $59,733

Markov Model



Summary of Study

- Benefits of Technology:
  - 30.33 life years gained
  - 36.77 QALYs gained
- Net Costs of Intervention:
  - $59,733-$107,936 = -$48,203
  - Intervention SAVES money
- Cost-effectiveness:
  - SAVE $1311/QALY

Impact of Study

- 1990:
  - Medicare extended to cover triennial screening with Pap smears for all women with no upper age limit
- Study was a one-time screen in population with limited prior access to screening!
- Should results be generalized?
  - $2,254/QALY gained for triennial screening in elderly women in US

Cost-Effectiveness Study of Cervical Cancer Screening for Low-Income, Elde

"I previously worked in the Harlem community and other New York City neighborh very poor in resources: housing, healthcare, and other resources. The issue I wa was whether we should screen older women for cervical cancer. The reason I, someone else, did this is that I was the only person in the primary care clinic who gynecologic examinations, and I was the first person in 10 years to observe that tables had stirrups! This was the beginning of my life's work.

In the first few years of our screening program, the nurse practitioner and I screened more than 800 women. They were on average 74 years old and had largely been unscreened previously. As a result, we found that screening these women actually saved lives as well as health care costs (3.72 lives and $5907 saved for every 100 Pap smears done)-an ideal program.

But then serendipity came into play. We were doing this work at a time when there was an explosion in the growth of the older population and members of congress were receiving a lot of pressure from their older constituents to include preventive services.

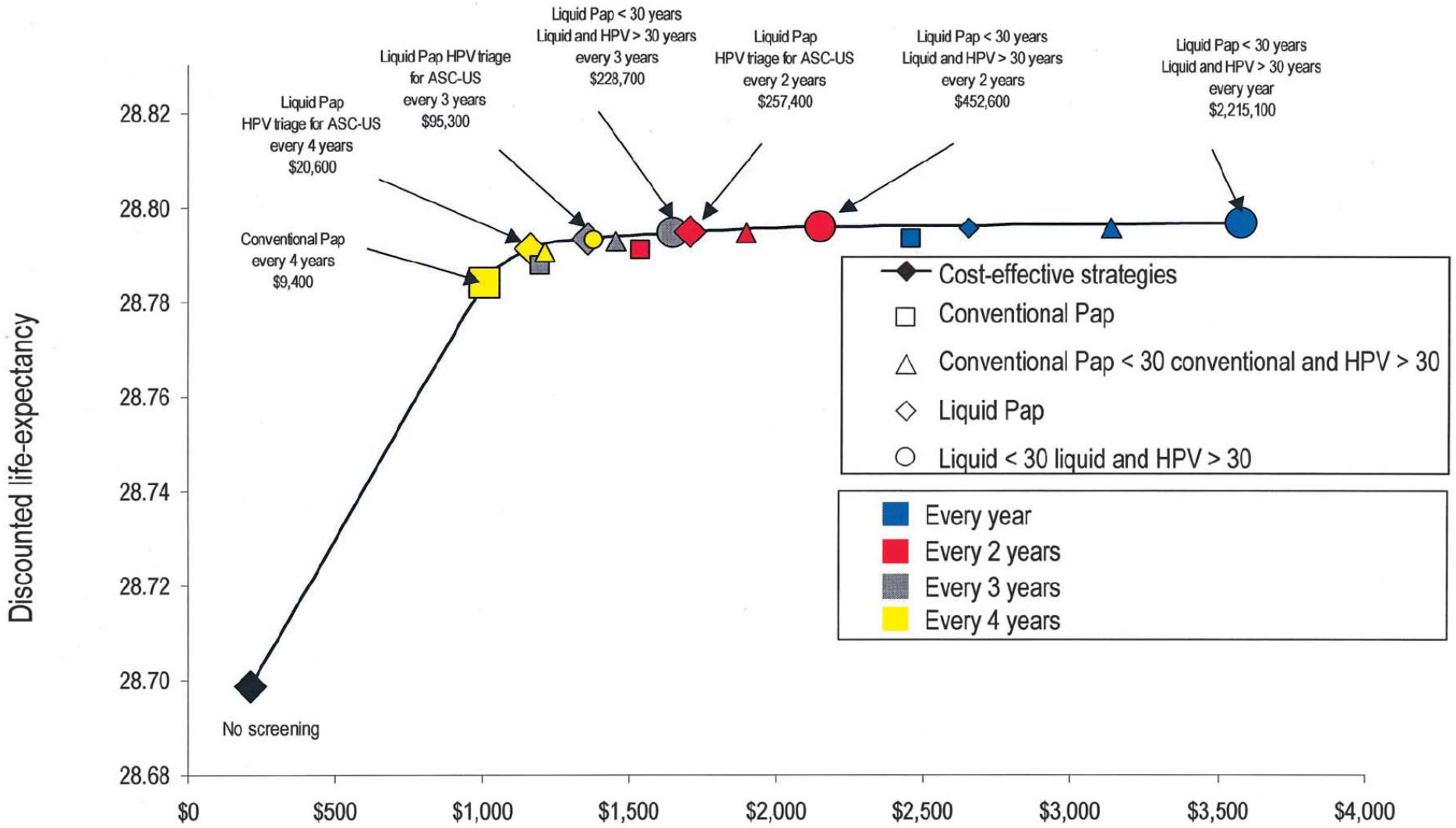
Along I came with my Pap smear analysis and showed that if we were to screen the average elderly population at that point Pap smear screening would be a good buy. It would cost about $2,200 per year of life saved. Of great importance was that we could save money if we targeted screening to women who had not been screened previously, but the cost-effectiveness would worsen by more than 10-fold if screening were applied to women who had already been regularly screened.

What were our responsibilities and what were the issues that came out of this work? When we presented this work to the OTA, we proposed considering cervical cancer screening as a targeted benefit and perhaps even including benefits to do outreach to women who have never been screened. The OTA said that under Medicare, benefits must be included for all (or no) women, so our recommendation could not be implemented….The actual cost-effectiveness for Medicare might not be as favorable as it could have been if targeted to the highest-risk women."

New Technologies for Cervical CA Screening

Technology	Sensitivity	Specificity	Cost per Test
Liquid Cytology	84%	88%	$71
Pap	69%	97%	$58
HPV	88%	95%	$49
HPV + cytology	94%	93%	

New Technologies for Cervical CA Screening



Goldie et al., Obstet. Gynecol. ***103**: 619–31, 2004*

New Technologies for Cervical CA Screening

Intervention	Sensitivity	Specificity
VIA	76%	81%
Pap	63%	94%
HPV DNA	88%	93%

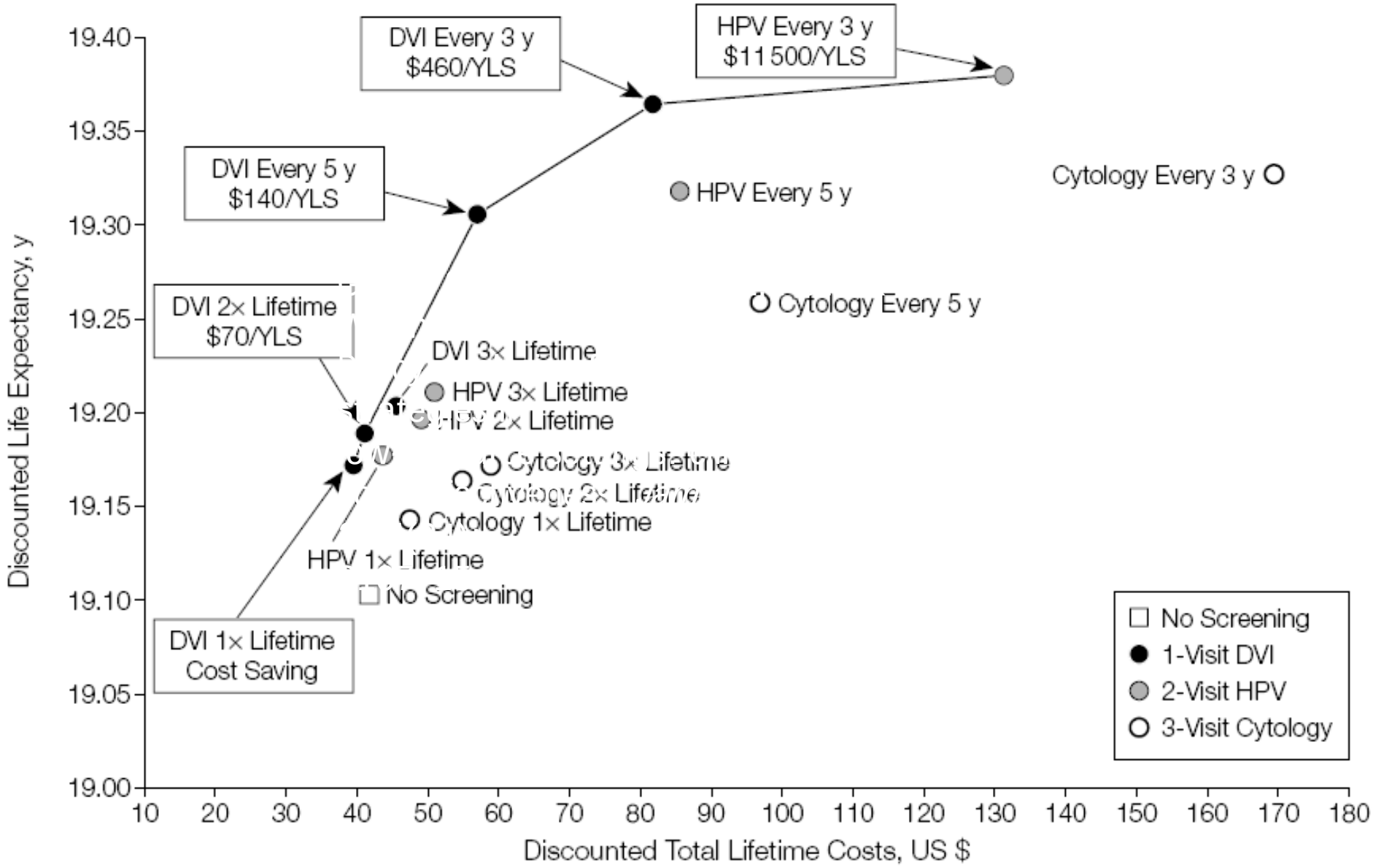
Cost-effectiveness of cervical-cancer screening in five developing countries. *The New England Journal of Medicine*. 2005 Nov 17; **353**(20): 2158–68.

New Technologies for Cervical CA Screening

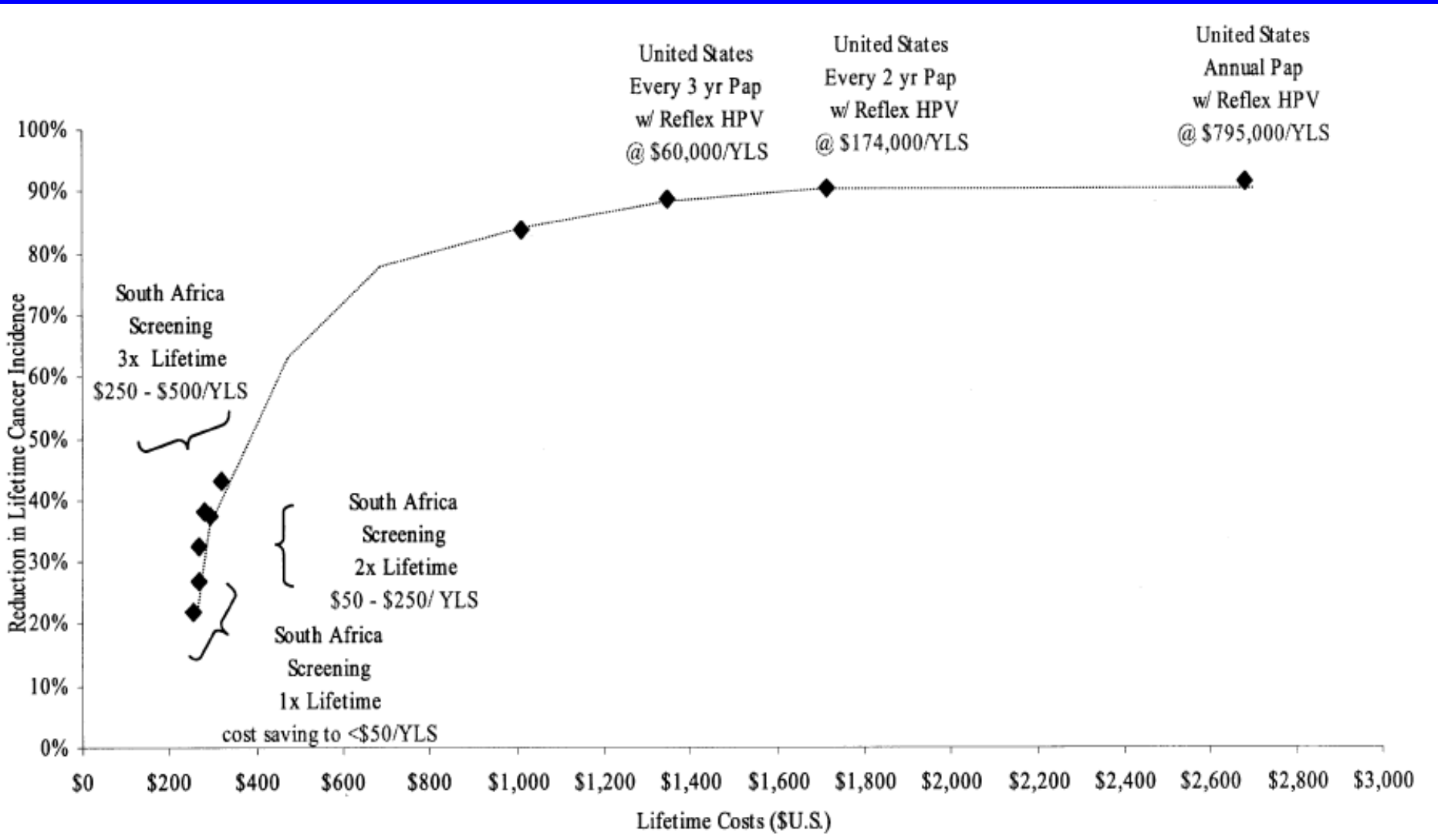
Characteristic	India	Kenya	Peru	South Africa	Thailand
Total population (millions)	1,016	30	26	44	61
Rural population (% of total)	72.34	64.11	27.23	44.51	68.86
Population density (no. of persons/km²)	341.69	52.87	20.26	36.03	118.87
Women 35–39 yr of age (% of total population)	3.28	2.18	3.21	3.35	4.10
Literacy rate among women ≥15 yr of age (%)	45.39	76.02	85.24	84.56	90.52
Women employed in informal sector (% of women employed)	86	83	58	58	54
Average hourly wage rate (2000 international dollars)†	0.48	1.94	2.26	9.90	2.59
Female life expectancy at birth (yr)‡	63.56	47.37	71.69	48.97	71.06
Cervical-cancer incidence (age-standardized incidence per 100,000)§	186.50	200.10	238.30	174.80	129.60
HIV prevalence among adults (% of total population)	0.70	14	0.40	19.90	2.20
Per capita gross domestic product (2000 international dollars)†	2,430	1,005	4,747	9,486	6,373

* Data are from the World Bank,[9] the International Labor Office,[10] and the U.S. Department of Commerce.[11]
† The international dollar is a unit of currency that minimizes the consequences of differences in price levels existing among countries.
‡ The average life expectancy for women who reach 35 to 40 years of age in Kenya is 67.9 years and in South Africa 68.8 years.
§ Age-standardized incidence is computed as a weighted average of age-specific cancer rates, with the population proportions of a global standard age pattern used as weights.

Source: Goldie, NEJM **353**: 2158–2168, 2005.



*Policy analysis of cervical cancer screening strategies in low-resource settings: clinical benefits and cost-effectiveness. Jama. 2001 Jun 27; **285**(24): 3107–15.*



*Virus Research, Vol. **89**, S. J. Goldie, Health economics and cervical cancer prevention, pp. 301–9, copyright Elsevier (2002).*

Summary of Lecture 16

- Cost-effectiveness analysis can aid in decision making in all countries
  - Can answer clinical questions
  - Can answer policy questions
- New cost-effective technologies can:
  - Improve health globally
  - Reduce disparities in health