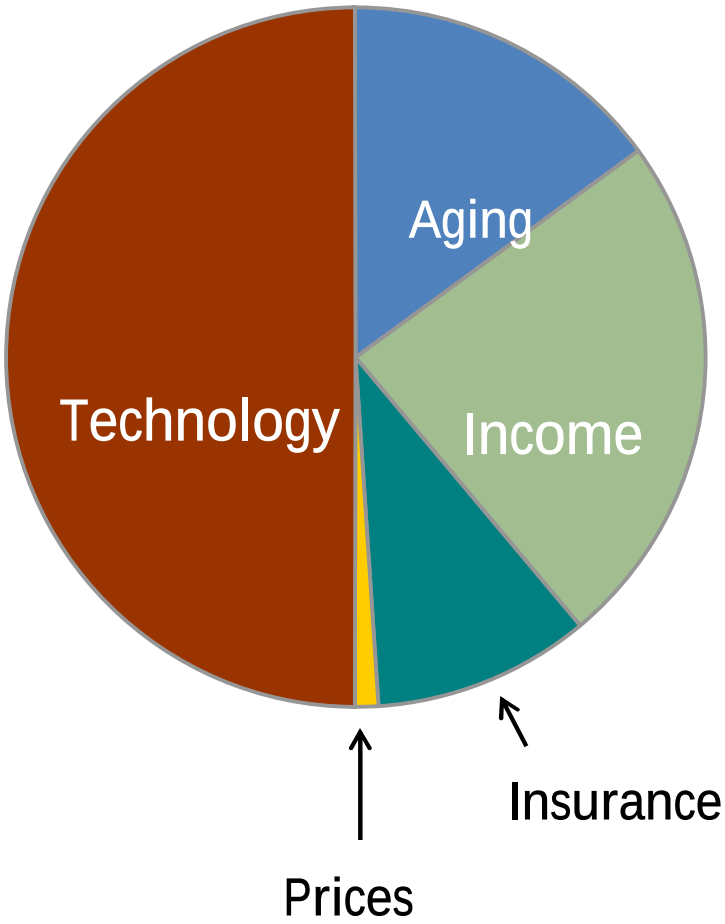
The Value of Health Investments

Dana Goldman

What Explains the Increase in Total Medical Spending over the Last Fifty Years?



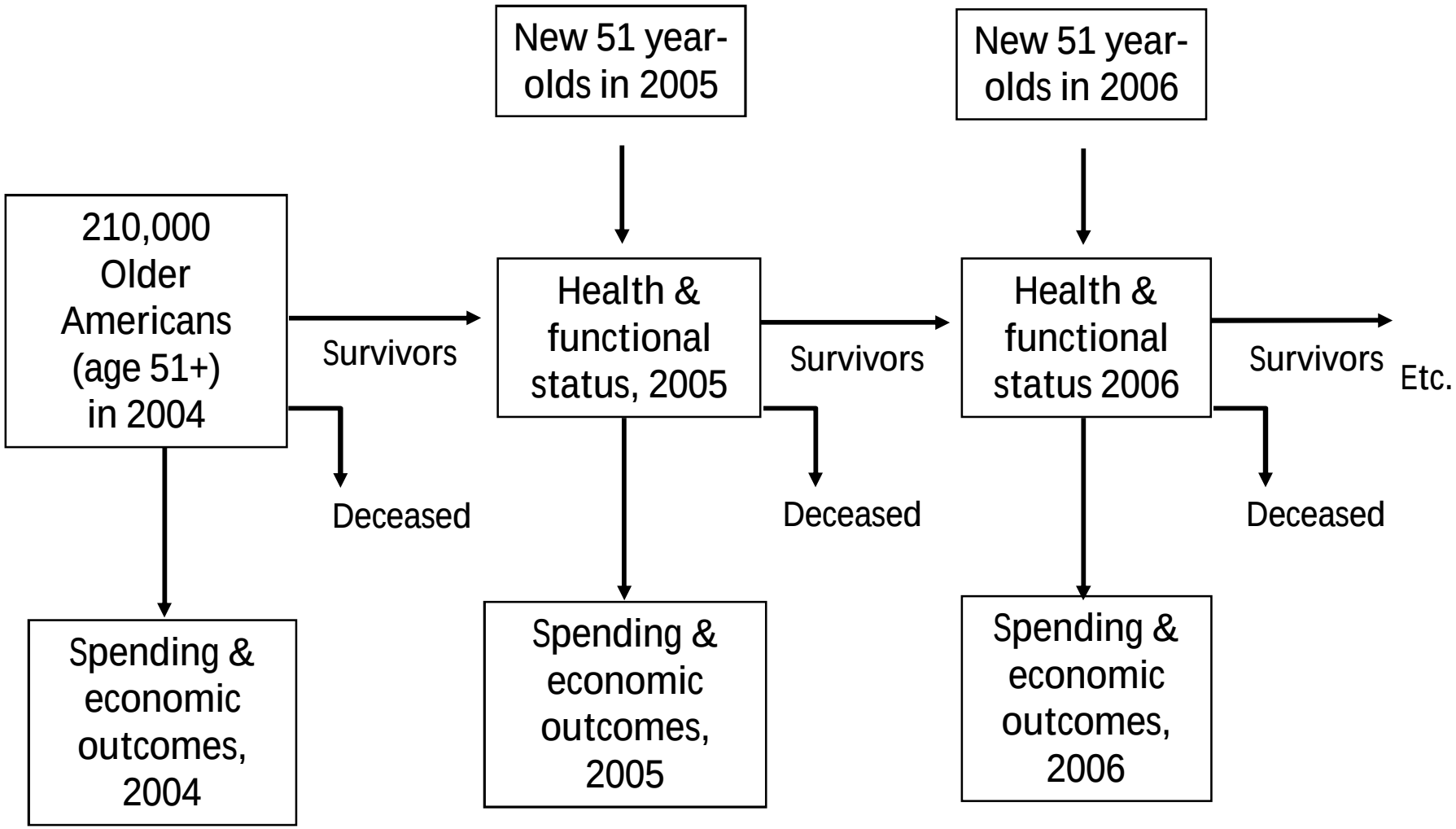
Source: Newhouse, *Journal of Economic Perspectives*, 1992.

Roybal Center Models Impact of Medical Technology and Health Investments in Older Populations

- Step 1: Reviewed vast literature on emerging technologies
  - Devices, drugs, treatments, clinical practices
  - 21,400 articles screened
- Step 2: Convened panels of private and academic experts
    - Cardiovascular disease
    - Neurological disorders
    - Cancer / biology of aging
    - Geriatricians and social scientists
  - Identified 34 key emerging technologies
- Step 3: Modeled their consequences

Note: Funding comes from NIA, CMS, Dept of Labor, and MacArthur Foundation.

Microsimulation Tracks Individuals Over Time



Source: Goldman et al, *Health Affairs*, 2005.

Marginal Effects on Probabilities of Developing Disease

Selected Risk Factor		Health Conditions						
		Heart Disease	Stroke	Cancer	HBP	Diabetes	Lung	Memory Disorder
Transition	**(mean)**	**3.4%**	**1.5%**	**2.2%**	**4.5%**	**2.3%**	**1.7%**	**0.9%**
Race/ Ethnicity [Ref=white]	**Black**	-1.2*	-0.1	-0.3	2.0*	0.4*	-0.7*	0.0
	Hispanic	-1.5*	-0.2	-0.6*	0.4	1.0*	-0.6*	0.0
Education [ref=HS degree]	**Less than HS**	0.4*	0.1	-0.1	0.6	0.4*	0.1	0.1
	College	0.0	0.1	0.3*	-0.3	0.1	-0.1	0.1
Gender	**Male**	1.1*	0.1	0.8*	-2.0*	0.6*	-0.0	0.2
Conditions	**Heart disease**		0.6*					
	Stroke							
	Cancer		-0.0					
	Hypertension	1.6*	0.4*					
	Diabetes	1.1*	1.0*		4.8*			
	Lung							
Functional status	**1+ IADL**							3.3*
	1-2 ADL							1.4*
	3+ ADL							1.1*
	Currently Smoking	1.2*	0.2	0.1	0.3	-0.5*	0.9*	0.1
Marital status [ref=married]	**Widowed**	-0.6	0.2	0.0	2.2*	0.2	0.0	-0.1
	Single	-0.1	-0.2	0.6*	-0.4	0.3*	0.3*	0.0
BMI	**min(llogbmi, 3.40)**	-1.3	-1.1	-0.3	12.1*	3.4*	-0.8	-2.2*
	max(llogbmi - 3.4, 0)	3.5*	-1.8*	1.9	4.8	5.4*	2.5*	-0.5

Marginal Effects on Probabilities of Changes in Functional Status

Selected Risk Factor		Functional Status						
		Mortality	Nursing Home	Healthy	IADL Only	1-2 ADL	3+ ADL	
Mean (transition, unweighted)		7.6%	10%					
Race/ Ethnicity [Ref=white]	Black	0.2	-0.1*	-1.5*	0.3*	1.0*	0.2*	
	Hispanic	-0.6*	-0.1*	-2.9*	0.6*	1.9*	0.3*	
Education [ref=HS degree]	Less than high school	0.1	0.0	-1.3*	0.3*	0.9*	0.1*	
	College	-0.2	0.0*	0.3	-0.1	-0.2	-0.0	
Gender	Male	1.4*	0.0*	-1.3*	0.3*	0.9*	0.1*	
Conditions	Heart disease	1.3*	0.0	-2.9*	0.6*	1.9*	0.3*	
	Stroke	1.6*	0.4*	-10.8*	2.0*	7.3*	1.5*	
	Cancer	6.4*	-0.1*	-1.7*	0.4*	1.1*	0.2*	
	Hypertension	0.9*	0.1*	-0.7	0.1	0.4	0.1	
	Diabetes	1.21*	0.1*	-2.9*	0.6*	1.9*	0.3*	
	Lung	3.3*	-0.1*	-5.1*	1.0*	3.4*	0.6*	
Functional status	1+ IADL	2.0*	0.7*	-20.0*	3.2*	13.3*	3.5*	
	1-2 ADL	2.5*	0.4*	-30.9*	4.3*	20.1*	6.4*	
	3+ ADL	9.1*	1.6*	-66.4*	2.7*	32.8*	30.9*	
	Currently Smoking	0.6*		-0.3	0.1	0.2	0.0	
Marital status [ref=married]	Widowed	0.2	0.1*	-0.1	0.0	0.1	0.0	
	Single	0.6*	0.2*	-1.1*	0.2*	0.7*	0.1*	
BMI	min(llogbmi, 3.4)			11.2*	-2.5*	-7.5*	-1.2*	
	max(llogbmi - 3.4, 0)			-22.0*	4.8*	14.8*	2.4*	
	Work							

Marginal Effects on Predicted Medical Costs

Selected Risk Factor		Cost Categories						
		Total Expenditures MCBS	Total Expenditures MEPS	Out of Pocket Expenditures MCBS	Out of Pocket Expenditures MEPS	Medicare Part A	Medicare Part B	
Mean (value)		**13444**	**5030**	**2455**	**1015**	**3759**	**3032**	
Race/ Ethnicity [Ref=white]	**Black**	1,812*	-951*	-487*	-430*	1,122*	895*	
	Hispanic	172	-1,483*	-471*	-331*	139	347*	
Education [ref=HS degree]	**Less than high school**	-196	-647*	-468*	-130*	195	57	
	College	634*	372	257*	135*	-47	92	
Gender	**Male**	-353	-188	-365*	-315*	2	-7	
Conditions	**Heart disease**	3,282*	4,545*	518*	373*	1,233*	896*	
	Stroke	4,024*	3,727*	364	750*	1,925*	1,209*	
	Cancer	3,143*	5,785*	138	509*	734*	1,760*	
	Hypertension	1,044*	1,783*	228*	332*	32	225*	
	Diabetes	1,150*	3,286*		555*		795*	
	Lung	2,415*	2,019*	141	290*	797*	753*	
Functional status	**1+ IADL**							
	1-2 ADL							
	3+ ADL	7,916*		929*		4,129*	2,088*	
	Currently Smoking							
Marital status [ref=married]	**Widowed**	-288	-373	57	69	103	-12	
	Single	-533	834*	-334*	109*	332	34	
BMI	**min(llogbmi, 3.401197)**							
	max(llogbmi - 3.401197, 0)							
	Work							

Marginal Effects on Probabilities of Program Participation

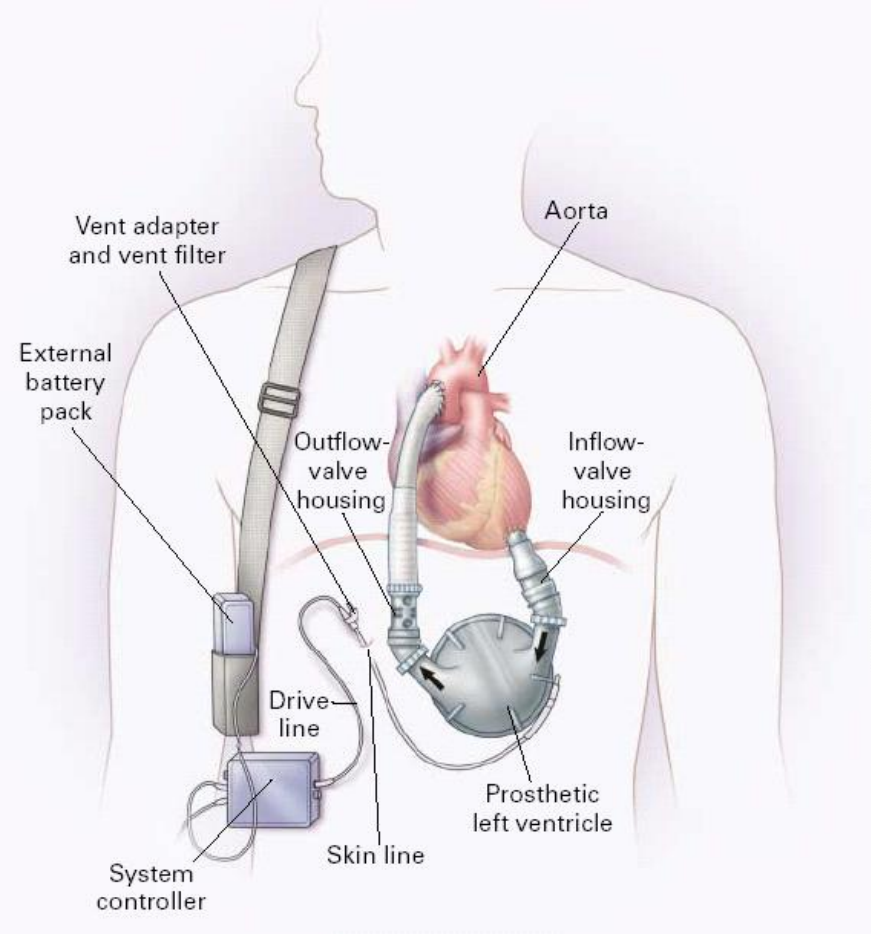
Selected Risk Factor		Program Participation						
		SS Claim	SSI Claim	DI Claim	Medicare Part B Newly Eligible	Medicare Part B Currently Eligible	Medicare Part D	
Mean		10.3%	2.6%	7.8%	85.8%	16.4%	51.0%	
Race/ Ethnicity [Ref=white]	Black	-0.3	0.1	-0.1	-4.32	-5.0*	4.7*	
	Hispanic	-0.1	-0.0	-1.0*	-8.8*	-3.3	9.2*	
Education [ref=HS degree]	Less than high school	0.2	0.1	0.2	1.9	-5.3*	11.7*	
	College	-0.7*	-0.1	-0.6*	-1.5	-4.1*	-1.7	
Gender	Male	-0.9*	0.3*	-2.01e-06	-3.3	-3.0	-8.0*	
Conditions	Heart disease	0.3	0.2*	1.8*	-4.0	2.9	0.9	
	Stroke	-0.3	0.3	1.1	3.6	21.9*	2.0	
	Cancer	0.2	0.2	0.8	1.1	1.7	-0.9	
	Hypertension	0.1	-0.1	0.0	8.4*	3.7*	1.0	
	Diabetes	0.2	0.2	0.9*		1.7	3.4*	
	Lung	0.4	-0.0	0.2		4.0		
Functional status	1+ IADL	-0.1	0.3*	1.6*	4.3			
	1-2 ADL	-0.1	0.2*	2.4*				
	3+ ADL	-0.5	0.0	2.3*	3.4	0.8	3.3	
	Currently Smoking							
Marital status [ref=married]	Widowed	-0.3	0.1	3.6*	2.5	1.6		
	Single	-0.6*	0.3*	0.1				
BMI	min(llogbmi, 3.401197)							
	max(llogbmi - 3.401197, 0)							
	Work	1.5*	-0.1	-0.1	-12.5*	-11.2*	-57.3*	

Marginal Effects on Labor Outcomes

Selected Risk Factor		Labor Outcomes						
		Working	DB Pension Claiming					
Mean		**42.1%**	**10.7%**					
Race/ Ethnicity [Ref=white]	Black	-0.1	1.4					
	Hispanic	-0.7	0.4					
Education [ref=HS degree]	Less than high school	-4.0*	-0.2					
	College	2.8*	-2.4*					
Gender	Male	-1.0	0.9					
Conditions	Heart disease	-3.4*	0.9					
	Stroke	-8.7*	0.3					
	Cancer	-1.6	-2.2					
	Hypertension	-0.9	-2.3*					
	Diabetes	-2.4	0.2					
	Lung	-4.7*	-0.4					
Functional status	1+ IADL	-2.1	3.0					
	1-2 ADL	-7.8*	3.5*					
	3+ ADL	-17.6*	11.6*					
	Currently Smoking							
Marital status [ref=married]	Widowed	2.2	0.9					
	Single	-1.7*	0.4					
BMI	min(llogbmi, 3.401197)							
	max(llogbmi - 3.401197, 0)							
	Work	46.6*						

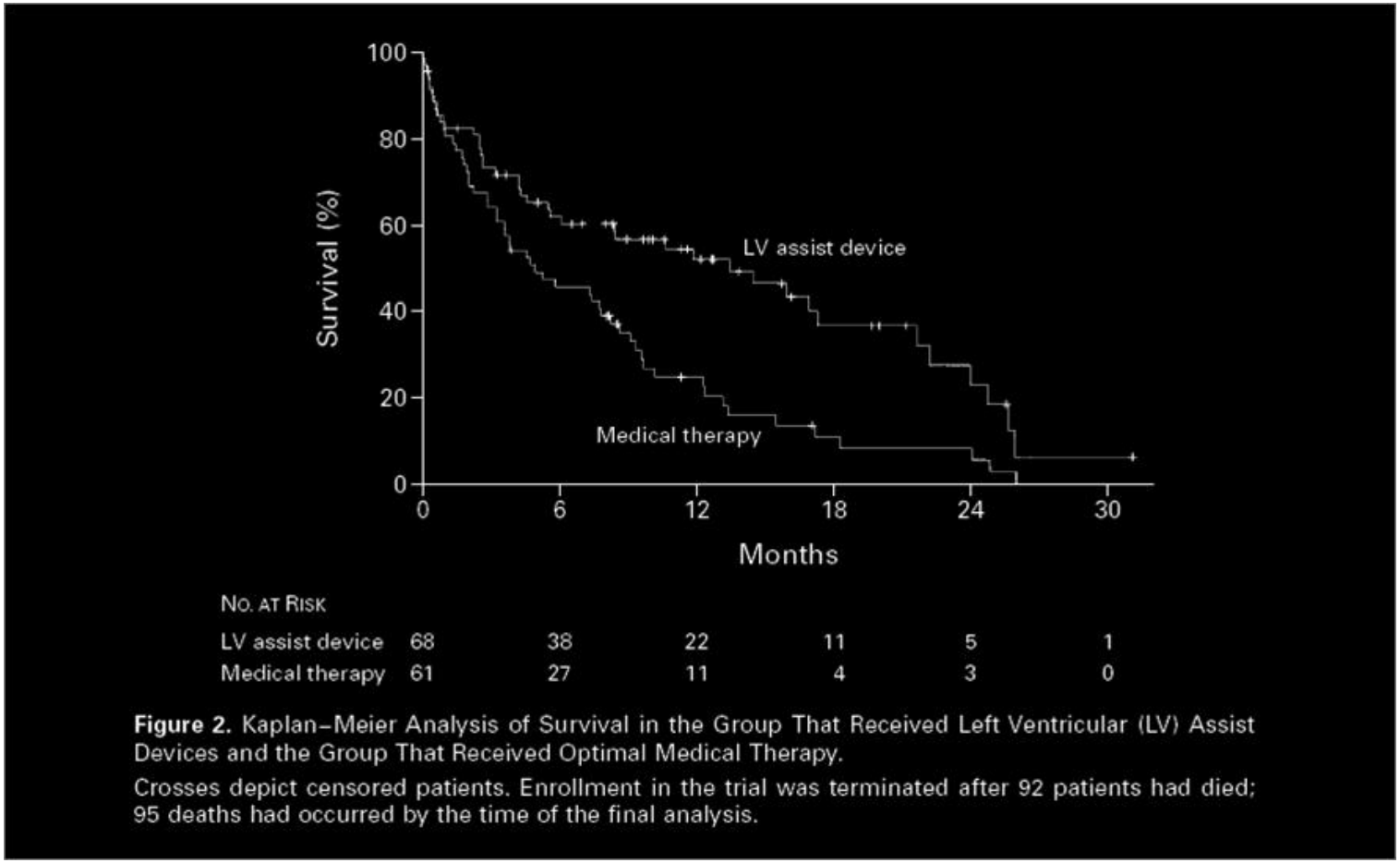
Example of a Technology Identified by the Cardiovascular Experts: LVADs

The Left Ventricular Assist Device



Source: Rose et al, *NEJM*, 2001.

LVAD Has Limited Survival Benefit



No. at Risk						
LV assist device	68	38	22	11	5	1
Medical therapy	61	27	11	4	3	0

Figure 2. Kaplan–Meier Analysis of Survival in the Group That Received Left Ventricular (LV) Assist Devices and the Group That Received Optimal Medical Therapy.

Crosses depict censored patients. Enrollment in the trial was terminated after 92 patients had died; 95 deaths had occurred by the time of the final analysis.

Source: Rose et al, *NEJM*, 2001.

The Hunt is On for Anti-Aging Compounds

Unlocking the Secrets of Longevity Genes

A handful of genes that control the body's defenses during hard times can also dramatically improve health and prolong life in diverse organisms. Understanding how they work may reveal the keys to extending human life span while banishing diseases of old age

By David A. Sinclair and Lenny Guarente

You can assume quite a bit

about the state of a used car just from its mileage and model year. The wear and tear of heavy driving and the passage of time will have taken an inevitable toll. The same appears to be true of aging in people, but the analogy is flawed because of a crucial difference between inanimate machines and living creatures: deterioration is not inexorable in biological systems, which can respond to their environments and use their own energy to defend and repair themselves.

At one time, scientists believed aging to be not just deterioration but an active continuation of an organism's genetically programmed development. Once an individual achieved maturity, "aging genes" began to direct its progress toward the grave. This idea has been discredited, and conventional wisdom now holds that aging really is just wearing out over time because the body's normal maintenance and repair mechanisms simply wane. Evolution—or natural selection, the logic goes, has no reason to keep them working once an organism has passed its reproductive age.

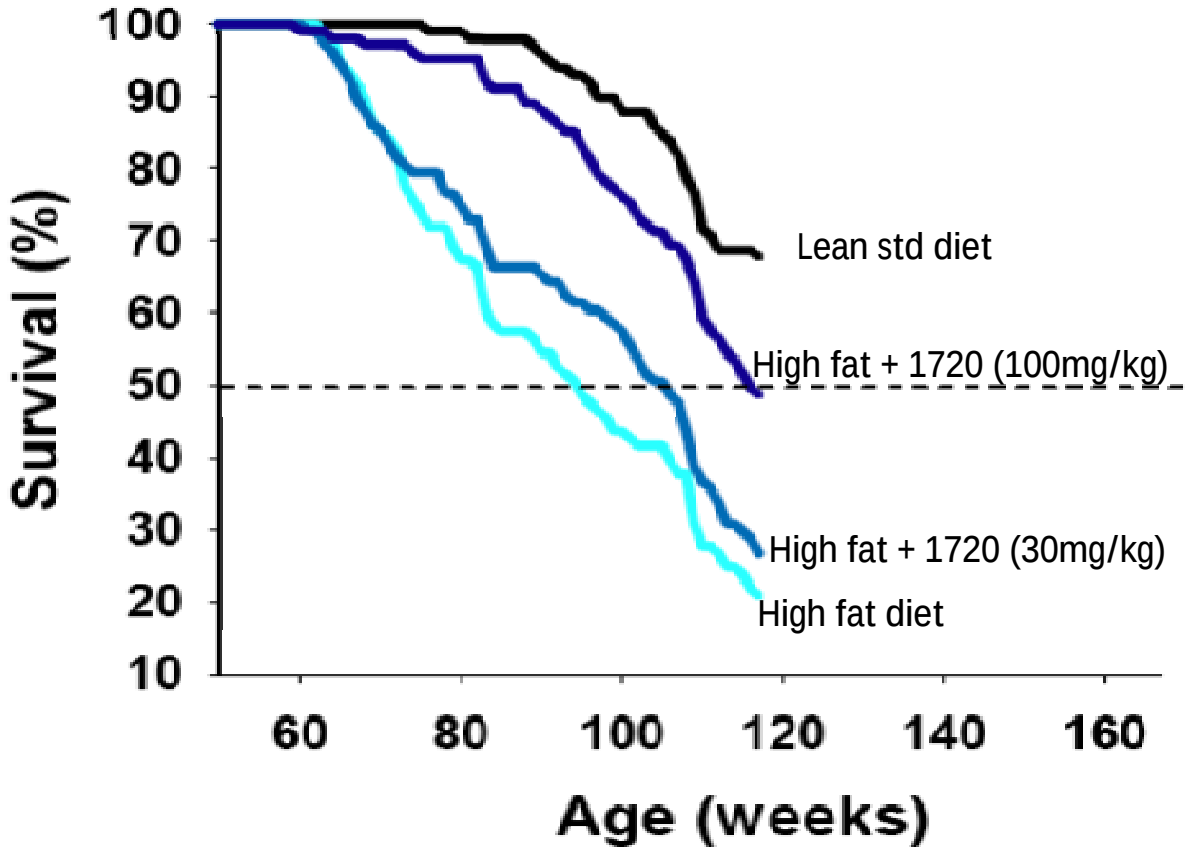
Yet we and other researchers have found that a family of genes involved in an organism's ability to withstand a stressful environment, such as excessive heat or scarcity of food or water, have the power to keep its natural defense and repair activities going strong regardless of age. By optimizing the body's functioning for survival, these genes maximize the individual's chances of getting through the crisis. And if they remain activated long enough, they can also dramatically enhance the organism's health and extend its life span. In essence, they represent the opposite of aging genes—longevity genes.

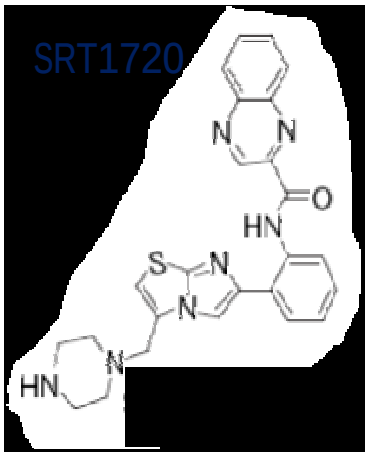
We began investigating this idea nearly 15 years ago by imagining that evolution would have favored a universal regulatory system to coordinate this well-known response to environmental stress. If we could identify the genes or genes that serve as its master controllers and thereby act as master regulators of an organism's life span, then natural defense mechanisms might be turned into weapons against the diseases and decline that are now apparently synonymous with human aging.

We Modeled an Anti-Aging Scenario

- Suggested by biologists and cancer experts in our project
- Based on the overwhelming biomedical evidence on caloric restriction
- Assumed compounds that can mimic this behavior

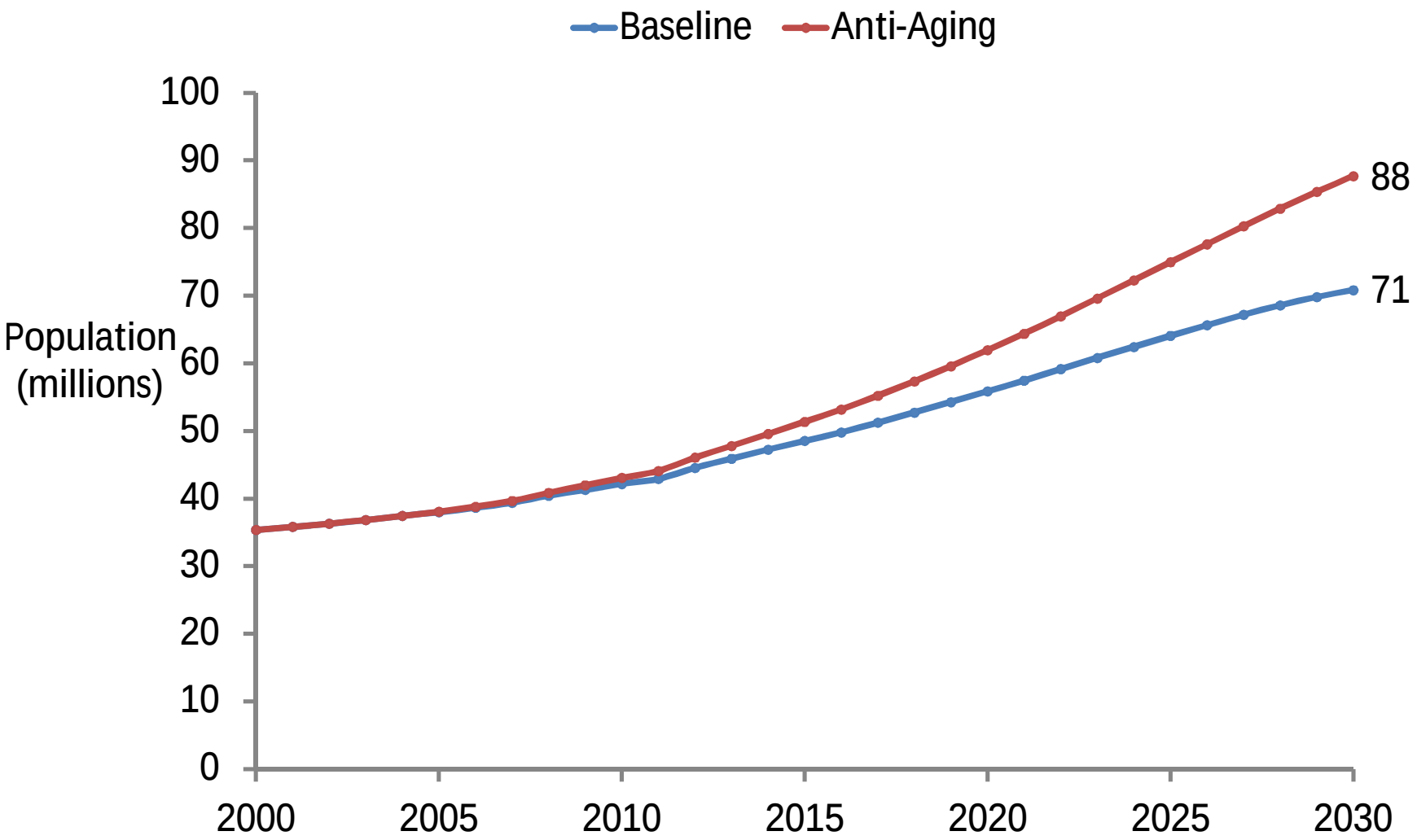
Example:
Anti-Aging Compound



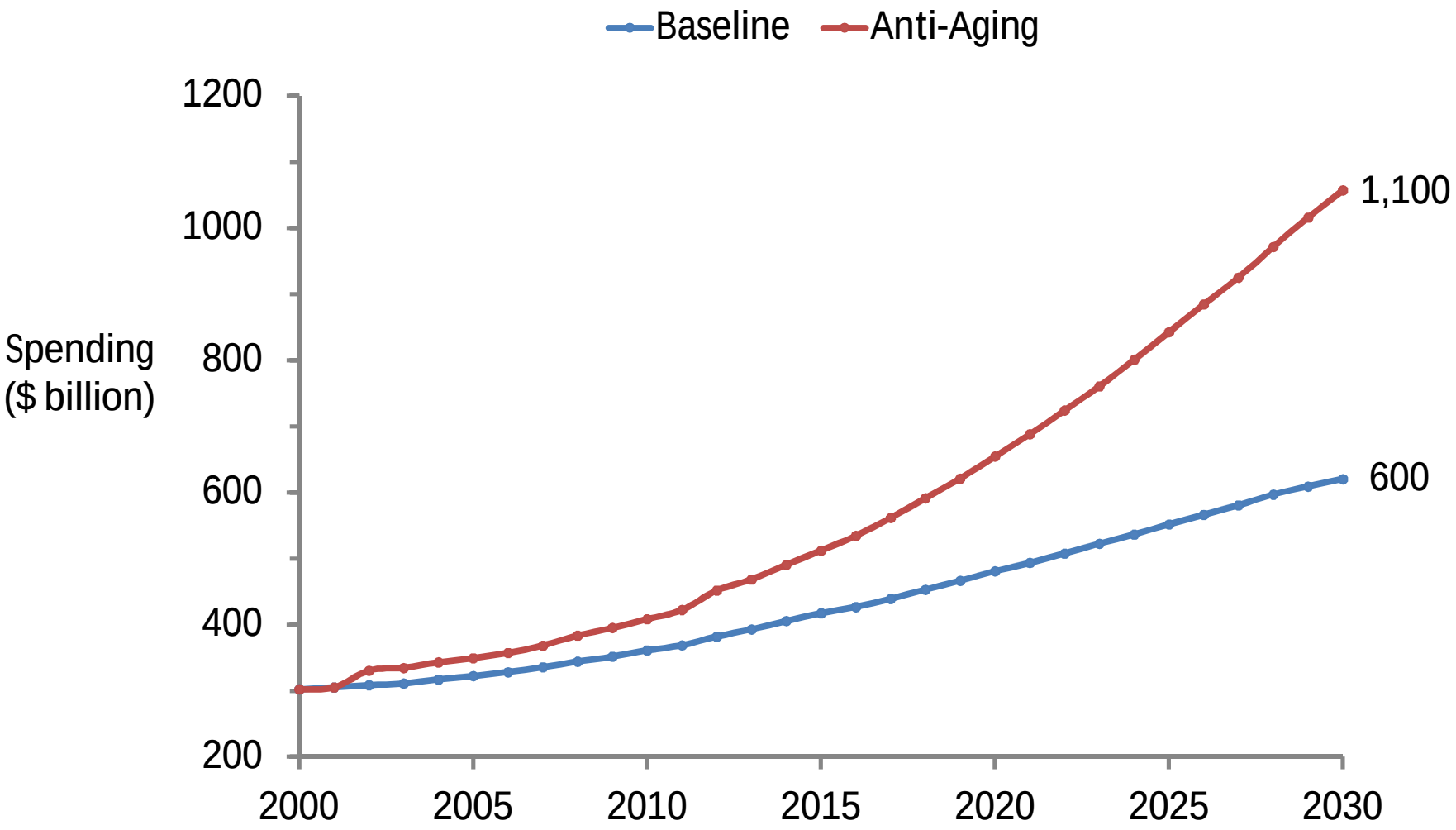


Source: Rafael de Cabo and David Sinclair, unpublished

Medicare Population Would Swell by 17 Million by 2030…



...and Elderly Health Care Spending Could Be up to 70% Higher



Anti-Aging Technology is one of the Better Deals in Health Care

Technology	Increase in medical spending* (%)	Cost per additional life-year
Anti-aging compound (healthy)	13.8	9,000
Anti-aging compound (unhealthy)	70.4	30,000
Left ventricular assist devices	2.3	500,000

*Increase in 2030 health care spending relative to status quo without the technology.

Source: Goldman D et al. "Consequences of Health Trends and Medical Innovation for the Future Elderly."*Health Affairs*, 2005.

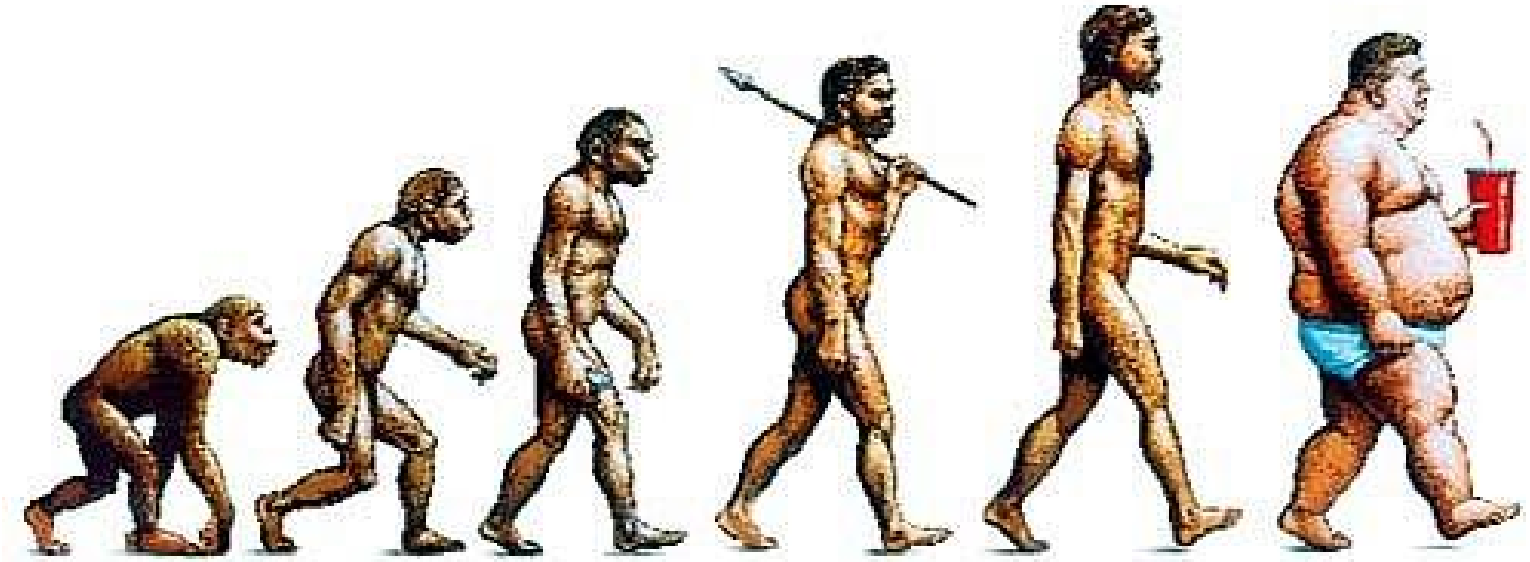
Anti-Aging Technology is one of the Better Deals in Health Care

Technology	Increase in medical spending* (%)	Cost per additional life-year
Anti-aging compound (healthy)	13.8	9,000
Cancer vaccines	0.4	18,000
Treatment of acute stroke	0.4	22,000
Anti-aging compound (unhealthy)	70.4	30,000
Telomerase inhibitors (cancer)	0.5	62,000
Implantable cardio-defibrillators	3.7	103,000
Antiangiogenesis (cancer)	8.0	500,000
Left ventricular assist devices	2.3	500,000
Pacemaker for atrial fibrillation	2.3	1,400,000

*Increase in 2030 health care spending relative to status quo without the technology.

Source: Goldman D et al. "Consequences of Health Trends and Medical Innovation for the Future Elderly."*Health Affairs*, 2005.

What About Prevention at Older Ages?



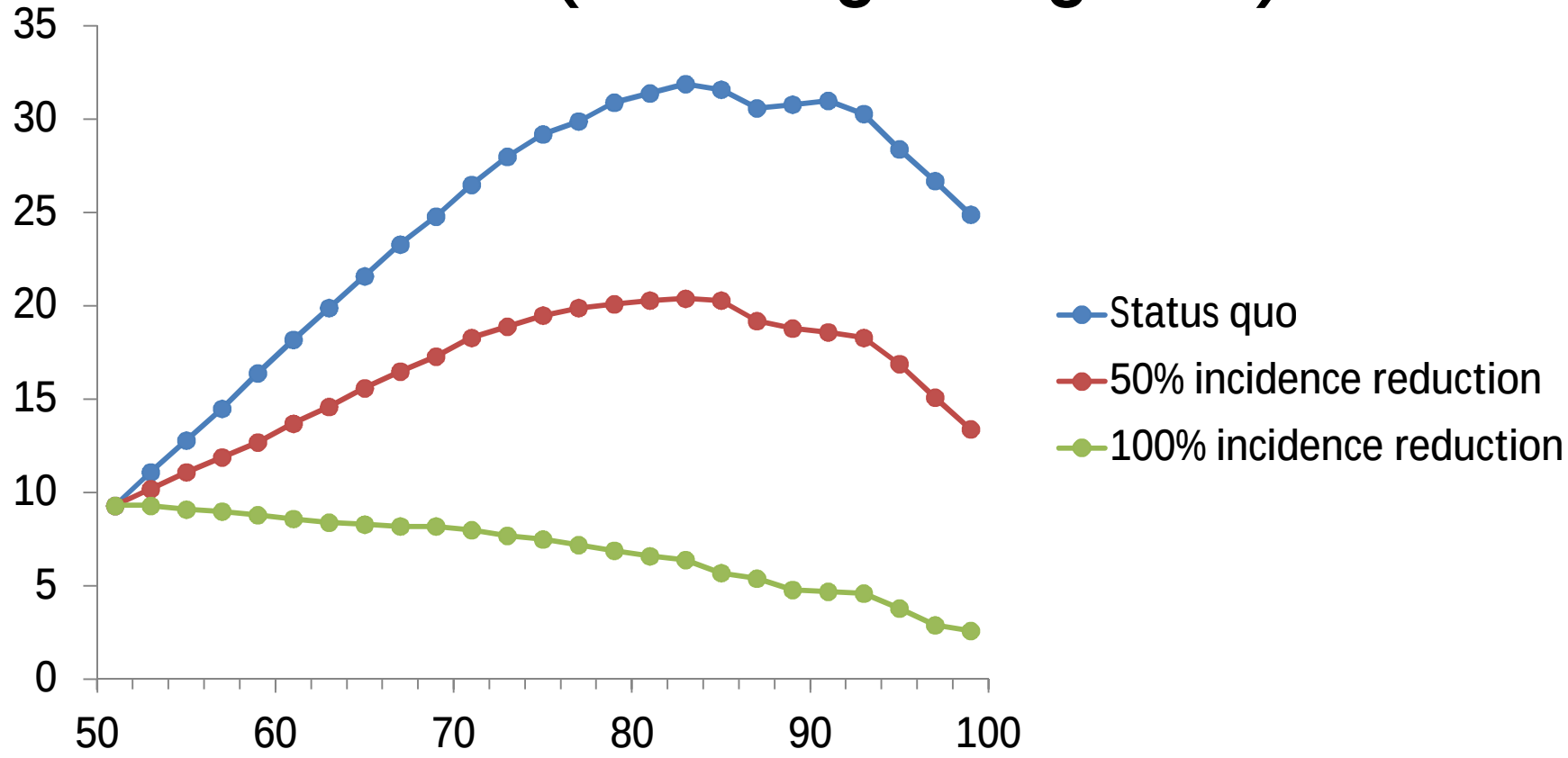
Source: *The Economist*, December 13, 2003

Investments in Young vs. Old

- Many believe health investments in the young have the greatest return
  - Longer life over which to accrue benefits
  - More active (better quality of life)
- But this view must be tempered for 2 reasons
  - Discounting: Most diseases will not manifest until much later in life
  - Imprecision: Hard to target to the riskiest
- Older populations may have less remaining life, but:
  1. Returns are more immediate
  2. Interventions may be better targeted
  3. Life may be more precious at the end of the life

Regardless, young versus old is a false dichotomy. We should invest wherever the social return is positive.

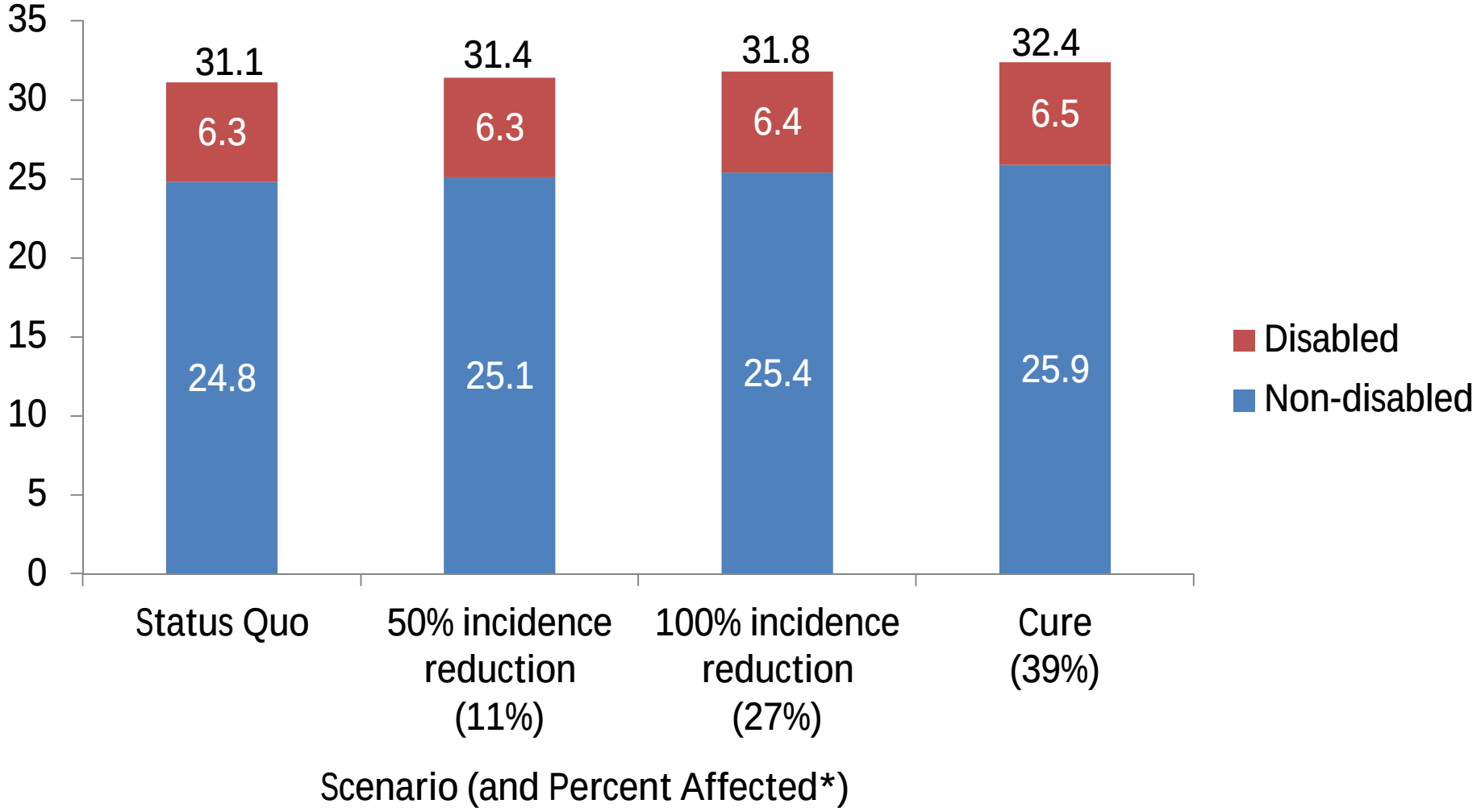
Diabetes Prevention in One Older Cohort (starting at age 50)



Note: Prevention is implemented for the obese and overweight only.

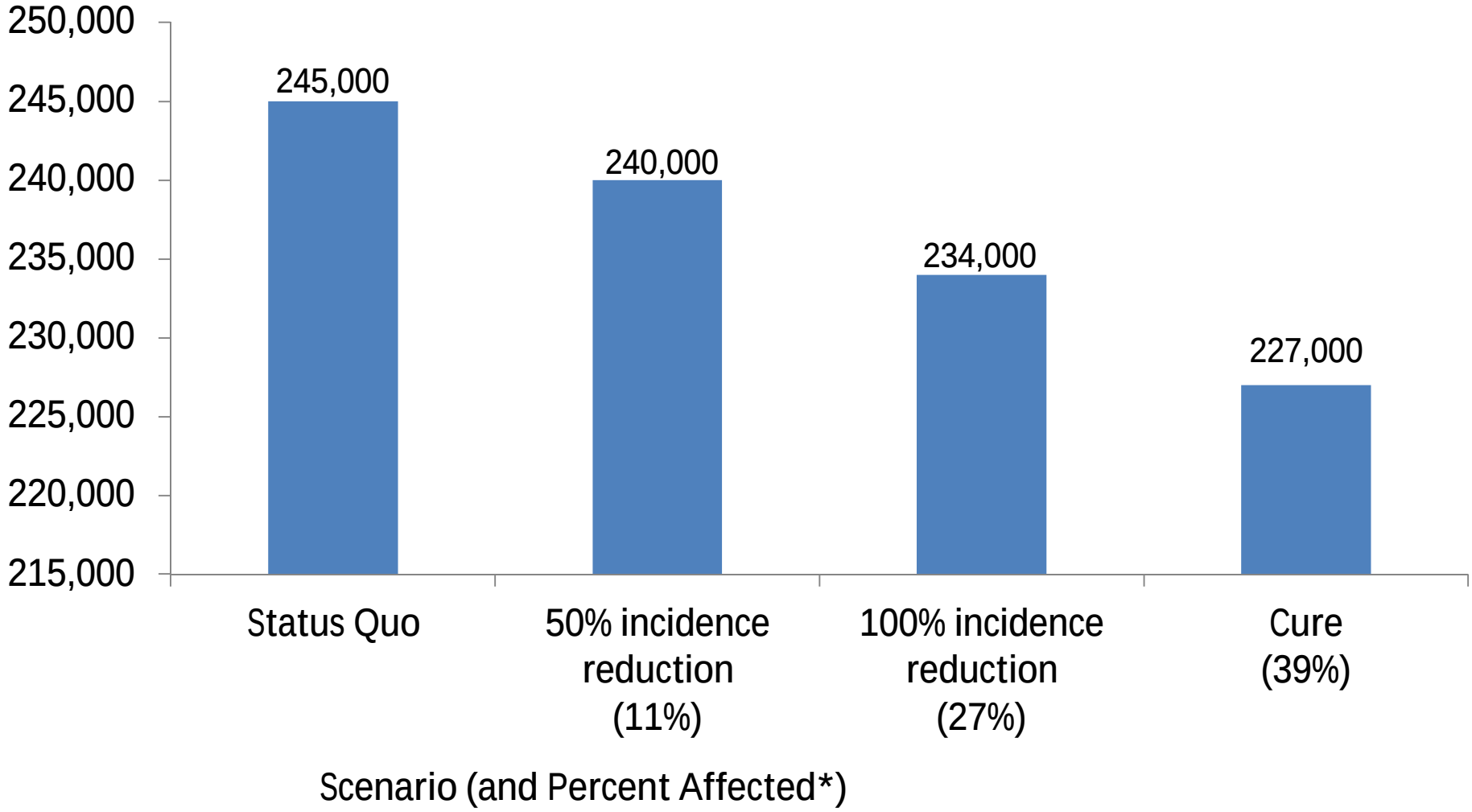
Source: Goldman, Zheng, Girosi, Michaud, Olshansky, Cutler, Rowe. "The Benefits of Risk Factor Prevention in Americans Aged 51 Years and Older." *AJPH*, 2009

Life Expectancy in 3 Diabetes Scenarios (50 year old cohort)



*Percentage of cohort that would have gotten diabetes in absence of prevention

Per-Capita Lifetime Spending in Diabetes Prevention Scenarios (50 year old cohort)



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Benefits of Prevention in Older Americans

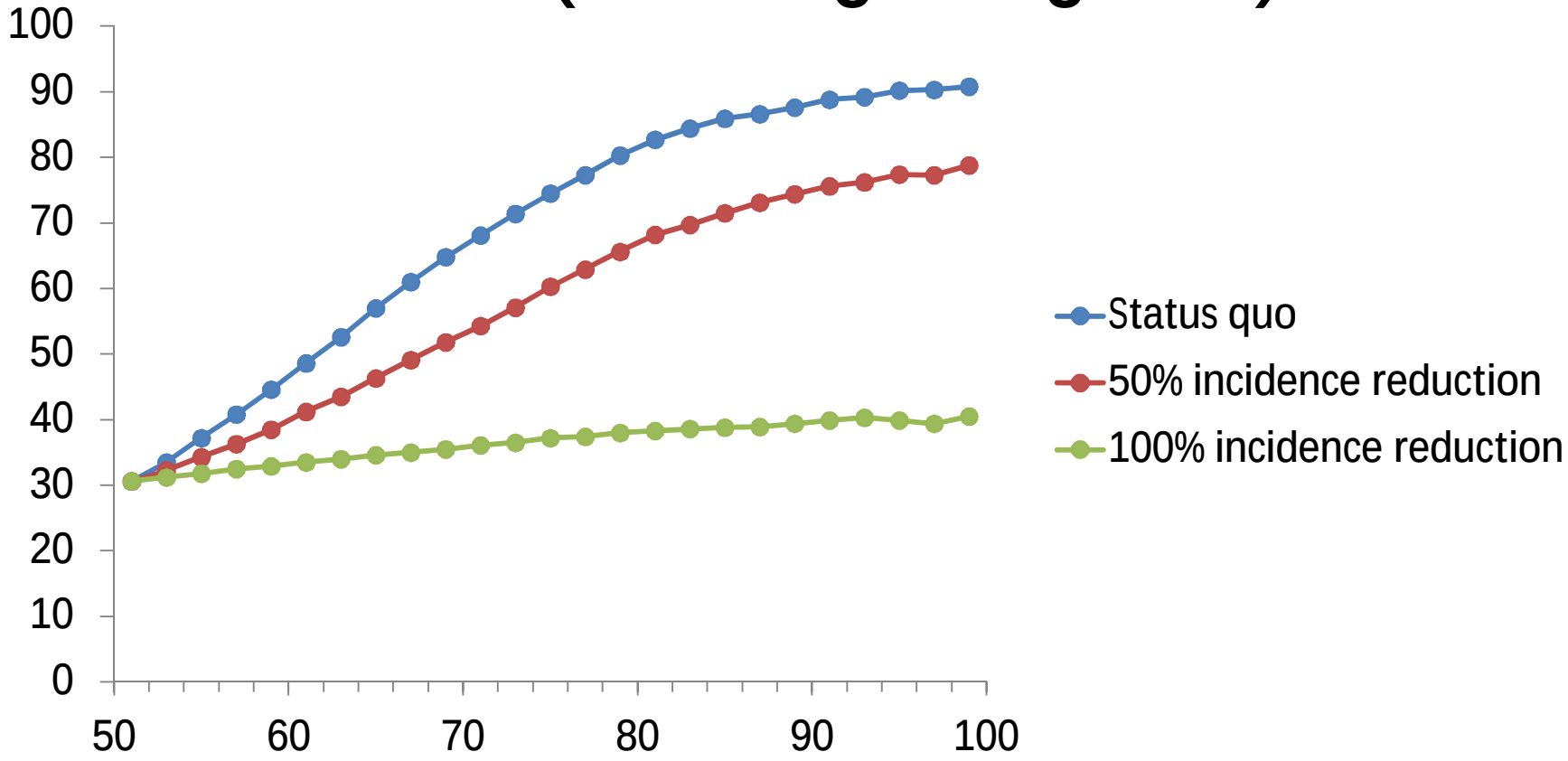
TABLE 2—Per Capita Effects of Prevention of Cardiovascular Risk Factors for Successfully Treated Americans Aged 51 or 52 Years in 2004

Treatment Effective for 100% of At-Risk Population	Additional Life Years	Additional QALYs	Additional Medical Spending,[a] $	Value of Treatment,[a] $
Diabetes	3.17	1.64	-34 483	198 018
Hypertension	2.05	1.24	-13 702	137 964
Obesity	0.85	0.45	7 168	51 750
Smoking	3.44	1.35	15 959	118 946

Diabetes cure would be worth about $1.5 trillion to the 20 million Americans aged 50-54.

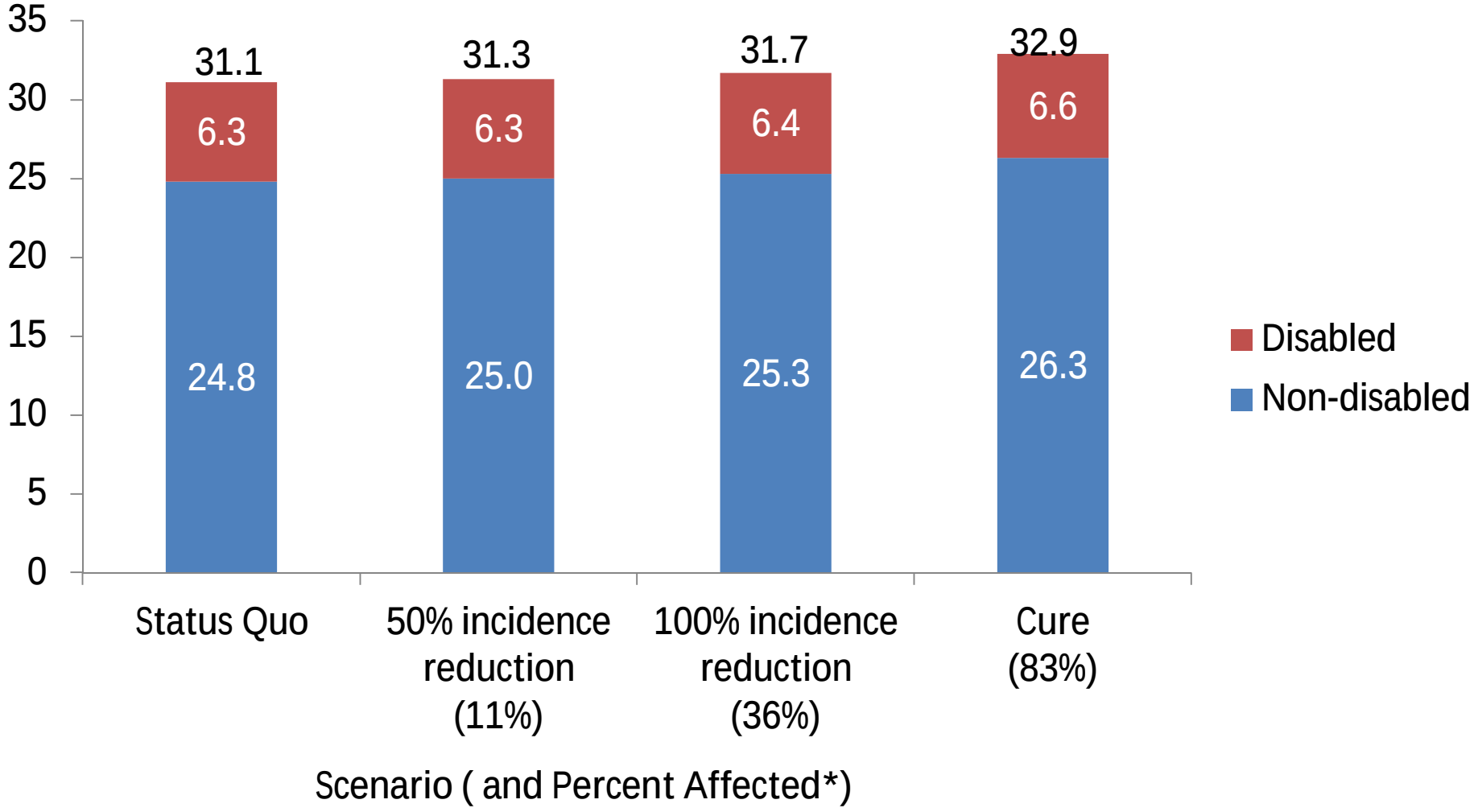
Source: Goldman, Zheng, Girosi, Michaud, Olshansky, Cutler, Rowe. "The Benefits of Risk Factor Prevention in Americans Aged 51 Years and Older." *AJPH*, 2009

Hypertension Prevention in One Older Cohort (starting at age 50)



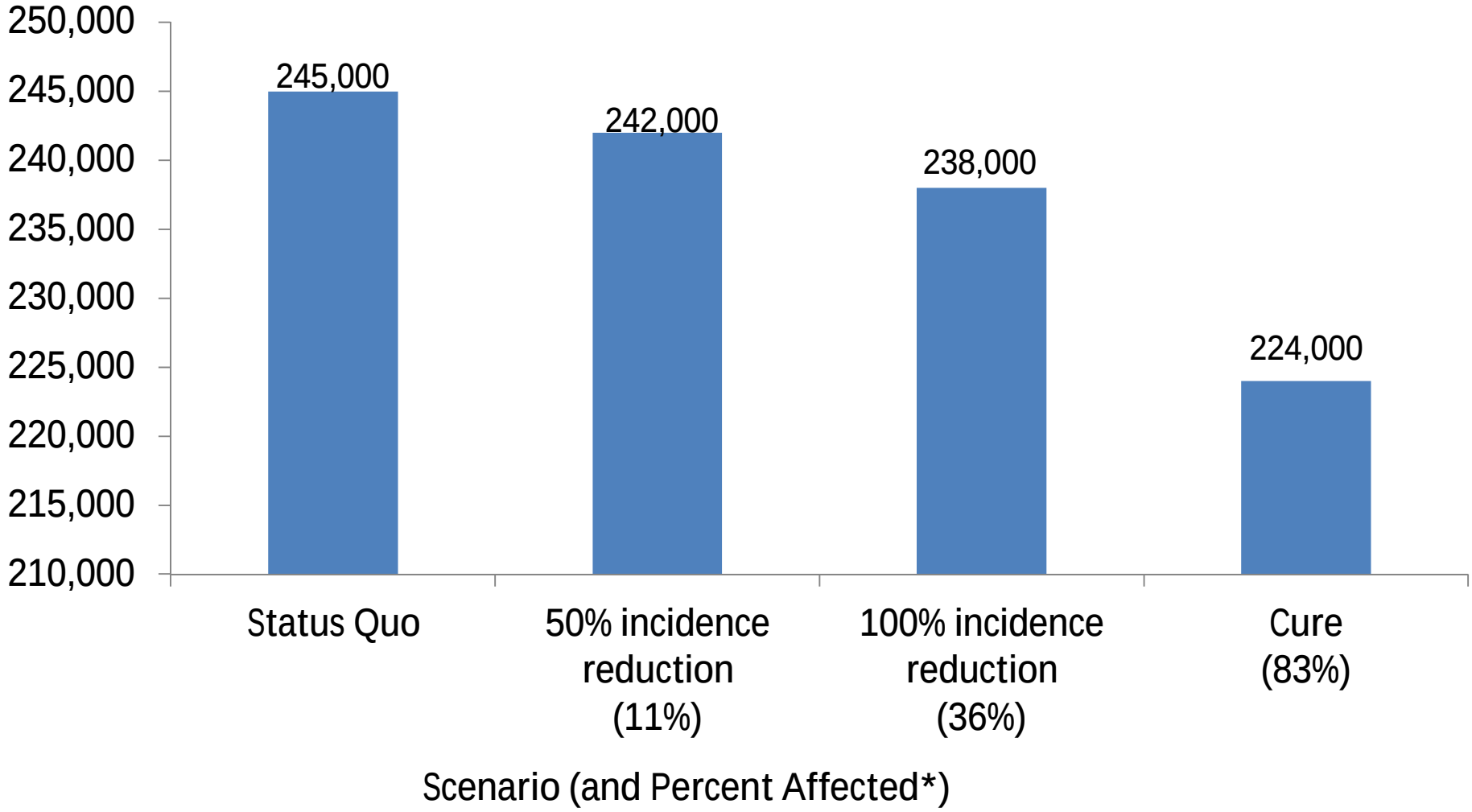
Source: Goldman, Zheng, Girosi, Michaud, Olshansky, Cutler, Rowe. "The Benefits of Risk Factor Prevention in Americans Aged 51 Years and Older." *AJPH*, 2009

Life Expectancy in 3 Hypertension Scenarios (50 year old cohort)



*Percentage of cohort that would have gotten diabetes in absence of prevention

Per-Capita Lifetime Spending in Hypertension Prevention Scenarios (50 year old cohort)



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Obesity	0.85	0.45	-7168	51 750
Smoking	3.44	1.35	15 959	118 946

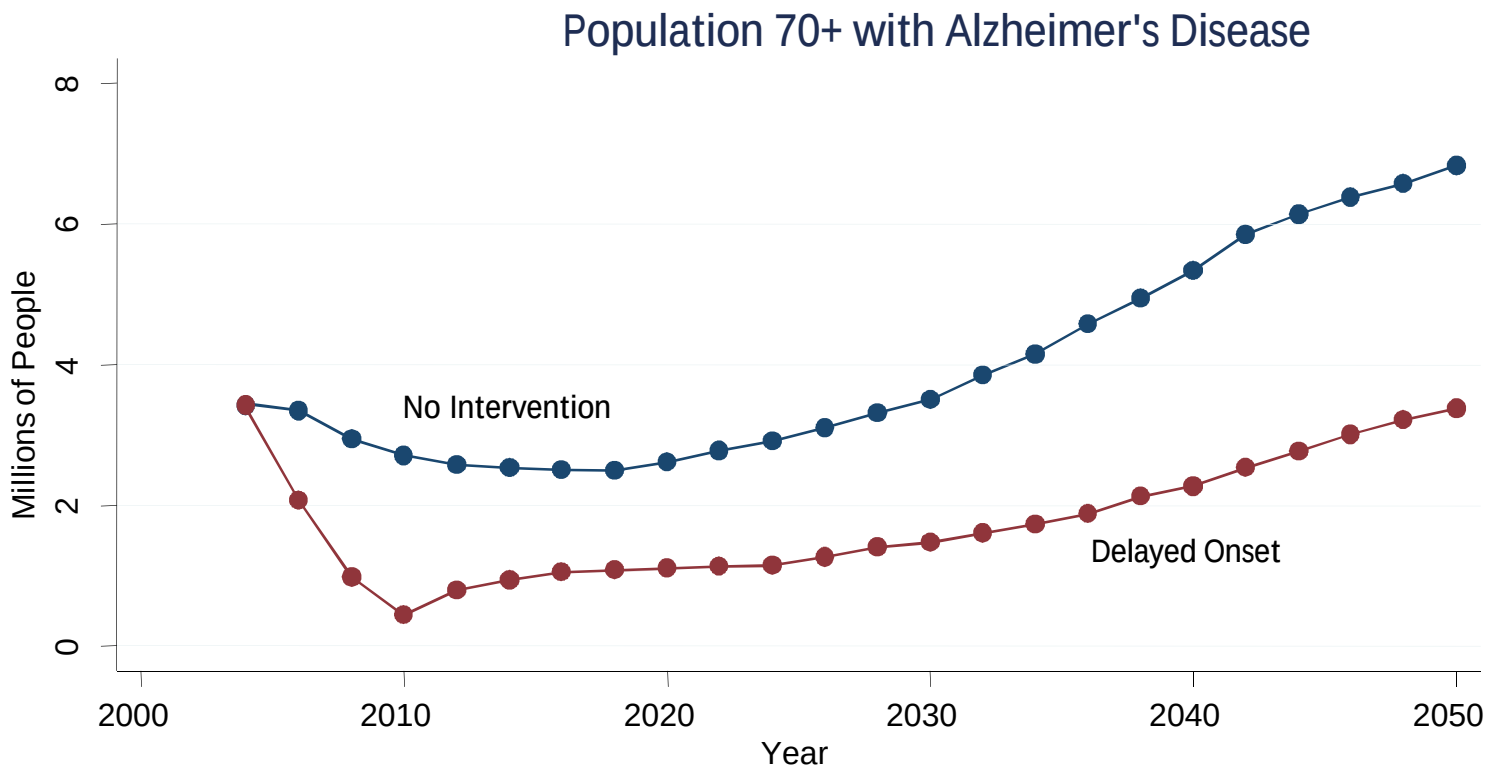
Hypertension cure would be worth about $2.3 trillion to the 20 million Americans aged 50-54.

Source: Goldman, Zheng, Girosi, Michaud, Olshansky, Cutler, Rowe. "The Benefits of Risk Factor Prevention in Americans Aged 51 Years and Older." *AJPH*, 2009

Implications

- Investments in older Americans can have substantial returns
- Young vs. old is a false dichotomy
- Prevention may represent some of our best social investments

Alzheimer's Scenario



Alzheimer's Has Great Value in Reduced Social Costs