Technology in Medical Care: An Introduction

Fall 2007

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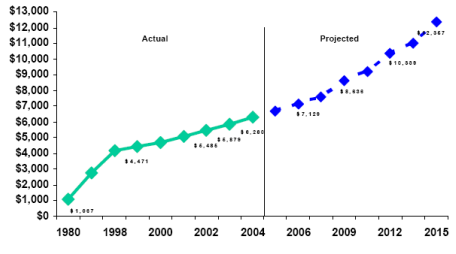
Table 1.2
National Health Expenditures Per Capita, 1980-2015

National health spending per capita is projected to increase rapidly over the next decade.



Source: CMS, Office of the Actuary, National Health Statistics Group.

Centers for Medicare & Medicaid Services

Office of the Assistant Secretary for Planning and Evaluation

Table 1
Growth in Real Health Care Expenditure and GNP, by Decade
(% per year)

	Growth in real health care dollars, per capita	*Growth in real GNP per capita*	*Health care share of GNP at end of period*
1929–1940	1.4%	0.0%	4.0%[a]
1940–1950	4.0%	3.1%	4.5%
1950–1960	3.6%	1.5%	5.3%
1960–1970	6.5%	2.5%	7.3%
1970–1980	3.8%	1.7%	9.1%
1980–1990	4.4%	1.7%	12.2%

Newhouse

- Why have expenditures increased so rapidly in HC?
- Simple decomposition
  - Expenditures = price*quantity
  - E=PQ
  - $\Delta E = P\Delta Q + \Delta PQ$
  - How much due to ΔP , how much to ΔQ

Candidate reasons for increase in health care expenditures

- Aging of the population
- Increased insurance
- Increased income (income effects)
- Supplier induced demand
- Factor productivity in service sector
- End of life care

Aging

- Average age of the population has been increasing for past half century
  - Population over 65 represented 8% in 1950
  - 12 percent today
  - 20 percent by 2040
- Newhouse: hold 1950's spending constant, increase share of elderly
- Explains only 15% of the increase

- Let θ_i be fraction of people in group i
  - 3 groups <18, 19-64, 65+
- S_i be average spending per capita in group
- Total spending is a weighted average of spending across groups
- Hold spending per group constant but impose 1950's population weights

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- $S^{50} = \theta_1^{50}S_1^{50} + \theta_2^{50}S_2^{50} + \theta_3^{50}S_3^{50}$
- $S^{87} = \theta_1^{87}S_1^{87} + \theta_2^{87}S_2^{87} + \theta_3^{87}S_3^{87}$
- $S^{*50} = \theta_1^{50}S_1^{87} + \theta_2^{50}S_2^{87} + \theta_3^{50}S_3^{87}$
- $(S^{87} - S^{*50})/S^{*50} = 0.15$, only 15%

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Insurance

- Over time, fraction of people with insurance increased considerably
  - 1940, 10%
  - 2000, 85%
- Average coinsurance rate went from 67% to 27% between 1950 and 1987
- RAND HEI:
  - Movement from 95% to 0% coinsurance increases demand by 31%

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TABLE 3—VARIOUS MEASURES OF PREDICTED MEAN ANNUAL USE OF MEDICAL SERVICES, BY PLAN

Plan	Likelihood of Any Use (%)	One or More Admissions (%)	Medical Expenses (1984 $)
Free	86.7	10.37	777
	(0.67)	(0.420)	(32.8)
Family Pay			
25 Percent	78.8	8.83	630
	(0.99)	(0.379)	(29.0)
50 Percent	74.3	8.31	583
	(1.86)	(0.400)	(32.6)
95 Percent	68.0	7.75	534
	(1.48)	(0.354)	(27.4)
Individual Deductible	72.6	9.52	623
	(1.14)	(0.529)	(34.6)

Big change in The probability Of use, 21% decline

25% reduction In hospitalization

31% reduction In costs

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- 95 percentage drop in price generated a 31 percent increase in use for an elasticity of demand of roughly -0.32
- 1950-1980 saw a (27-67)/67 = -0.60 or a 60%drop in price (coinsurance)
- Which means demand should have increased by 18% (-0.6)(-0.3)
- Use increased by a factor of 5, so < 3%

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- What is potentially wrong with the reasoning in the previous analysis?

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Income effects

- 1940 and 1990, real GDP/capita increased by 180%
- Income elasticity of demand for medical care is 0.2 to 0.4
- Demand should have increased by 36% to 72%
- Actual use increased by 780% over this time period, about 10% of total

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End of life care

- Dying have incredibly high medical costs
  - 6% of seniors die each year in Medicare
  - Represent 27.9% of all expenses in 1999
  - Average Medicare spending for person in last year of life, $25,000 in 1999
  - about $3,000 for survivors
- This fraction has been pretty stable over time. Was 28% in 1978

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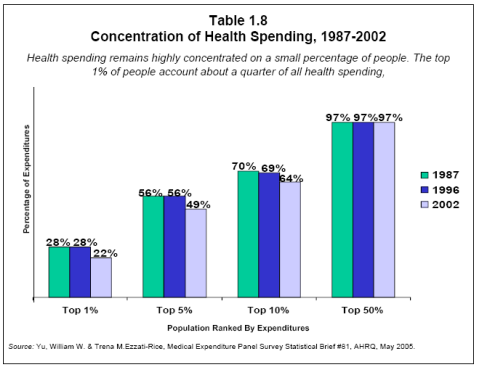

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Technology

- All of the factors so far, probably about 25% of the increase in medical care use over time
- What explains the rest? Technology
- MRIs, open heart surgery (CABG), angioplasty, CT scans, anti-psychotropic drugs, hip-knee replacements, neo-natal intensive care All **not** available 40 years ago. Now, commonplace

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Some evidence for Technology

- Rate of increase in medical costs similar across countries – suggests something broad based like technology
- Next table: If these other factors were important, we would see big increase in hospital admissions over time and length of stay. We don't. What we see is an increase in price/admission

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Table 3
Utilization of Short Stay General Hospitals

Year	*Adm / 1000*	*Length of Stay (days)*	*Days / 1000*	*Adjusted Cost / Day (1982 dollars)*
1950	110.5	8.1	895.1	n.a.
1960	128.9	7.6	980.0	$114[a]
1970	144.9	8.2	1188.1	$172
1980	160.4	7.6	1219.2	$282
1986	135.4	7.1	961.3	$437
1989	134.6	n.a.	n.a.	n.a.

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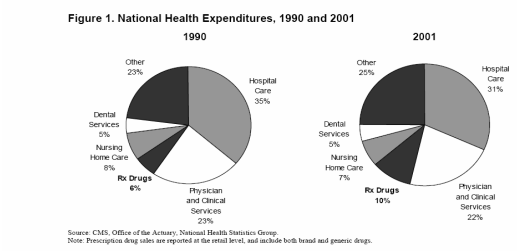

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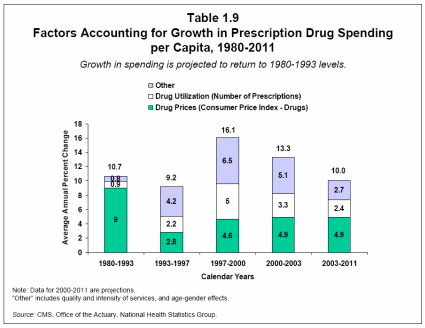

Centers for Medicare & Medicaid Services

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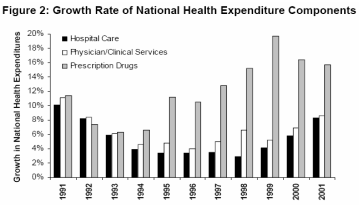

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HIV/AIDS Drugs

- Early 1990s, quarterly mortality rates for patients w/ AIDS of 7.5/8%, annual rates of roughly 30%
- 1995:4, 1996:1, three new drug introduced to fight virus
  - Work by preventing the virus from replicating in the host
- Use rates increase immediately and aggregate mortality falls 70% in 18 months

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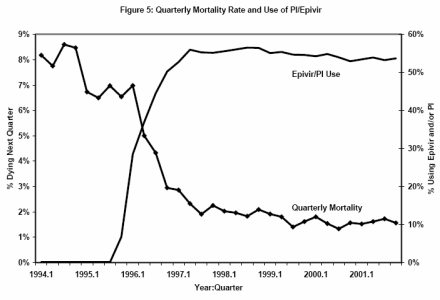

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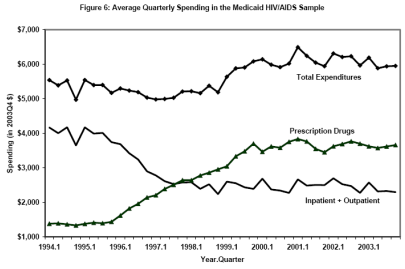

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- AIDS drugs are expensive, $12K/year in some cases
- AIDS patients are expensive, $20K/year
- ARVs extend life considerably
- This medical advance by construction increases lifetime spending by a considerably amount

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Lifetime costs of treating AIDS patient w/out ARVs

Real price increase per quarter

$$(6)\ LT_{wo} = \sum_{t=0}^{\infty} M_0[(1+\rho)/(1+r)]^t\ (1-\delta)^t$$

Cost per period at diagnosis

Discount rate

Period mortality rate

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- Let r=ρ, so lifetime costs are now M_0/δ
- After ARVs, assume costs increase to M_a and period mortality rates falls to δ_A
- Change in life expectancy is $(1/\delta_A) - (1/\delta)$
- Quarterly mortality falls from 7.5 to 2.2 percent (life expectancy goes from 3.6 to 11.2 years)
- M_0 is $6242 and ARVs increase spending by 16% to $7241
- Lifetime costs increase from $83K to $329K

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- Cost per life saved is ($329K-$83K)/(11.2-3.6) =$33K/life year saved
- Cost effective in relative terms
- So although costs are increasing a lot, this is a cost-effective program

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NICU

- Neonatal intensive care units
- Specialty wards of hospitals that provide "constant nursing and continuous cardiopulmonary and other support for severely ill infants"
- Developed in late 1950 early 1970s
- Growth has been rapid since

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TABLE 1—Trends in Neonatal Intensive Care Unit (NICU) Hospitals, NICU Beds, and Neonatologists: US Metropolitan Statistical Areas, 1980–1995

	1980	1995	% Change, 1980–1995
Births, thousands	2729	3210	+17.6
No. of hospitals with obstetric beds and children's hospitals	2135	1810	-15.2
No. of hospitals with NICU beds	351	698	+98.9
Obstetric/children's hospitals with NICUs, %	16.8	38.6	+129.8
No. of NICU beds	7021	16702	+137.9
No. of neonatologists[a]	710	2613	+268.0
NICU beds per 1000 births	2.57	5.20	+102.3
Neonatologists per 1000 births	0.26	0.81	+211.5
Occupancy rate of NICUs	76.4	78.5[b]	+2.7

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Costs, 2001 CA

- NICU discharge $50,000
- Non-NICU, $4,500
- In CA, 10% of births are for a NICU
- Therefore, more than half the hospital cost of childbirth are attributable to NICUs

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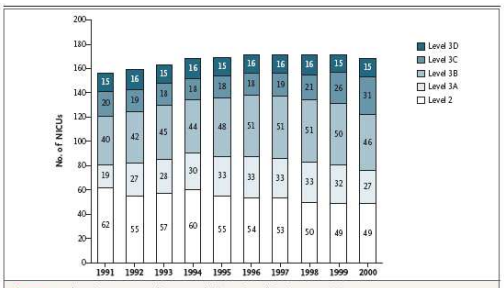

Figure 1. Number of NICUs, According to Level of Care, in California, 1991–2000.

Levels of care were empirically determined by the authors on the basis of a modified version of American Academy of Pediatrics definitions.[8] Level 2 denotes an intermediate-care NICU, with no mechanical ventilation; level 3A denotes mechanical ventilation with restrictions (e.g., only for infants whose birth weight is greater than 1000 g); level 3B denotes no restrictions on mechanical ventilation but no major surgery; level 3C denotes major neonatal surgery but no cardiac surgery and no extracorporeal membrane oxygenation (ECMO); and level 3D denotes cardiac surgery, ECMO, or both.

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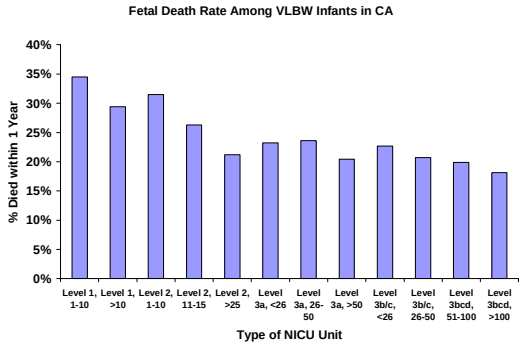

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Problem

- Consumer prices in health care are increasing much faster than general CPI
- In response, some have proposed price controls
- Price indexes are designed to keep 'all else constant' but difficult to do when quality is changing rapidly (e.g., medical)
- Boskin commission report on CPI, CPI overstates true MC growth by 3 per pts/yr

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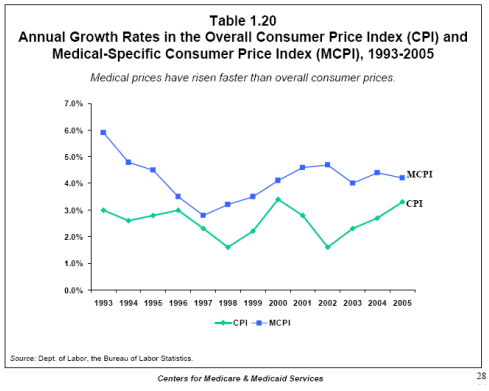

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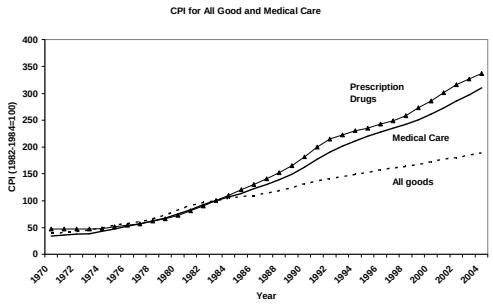

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Price changes, 1983 to 2004

- All goods 89%
- Medical Care 208%
- Prescription drugs 237%

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- Q: how much of rising expenditures reflects true improvements in quality
- Impossible to do in all aspects of medical care
- Cutler et al., construct price index for treatment of AMI (heart attack)
- CPI/PPI for services are Service Price Index
  - What is price for service provided?
  - Lack quality component
- Incorporate COL index – how much people are willing to pay for medical treatment changes over time

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Laspayers Price Index

Price vector

$$SPI_{t_0,t_1} = \frac{p(t_1) \cdot m(t_0)}{p(t_0) \cdot m(t_0)} = \alpha \cdot \frac{p(t_1)}{p(t_0)},$$

Vector or services in base period

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Problems

- What is a medical service and how to measure?
- What is price? In CPI, p(t) is OOP only but insurance raises prices
- As product quality changes, and market based in CPI does not, then price change may reflect quality
-

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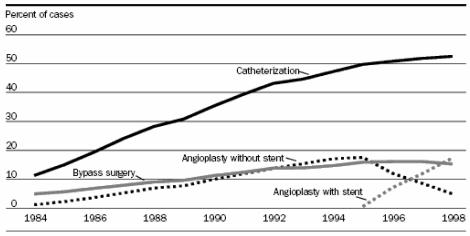
EXHIBIT 2
Changes In The Surgical Treatment Of Heart Attacks, 1984–1998



SOURCE: Authors' analysis of Medicare claims records for all elderly patients with a heart attack.
NOTES: Procedure use is within ninety days of the initial admission for the heart attack. See references in text for more detail.

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EXHIBIT 1
Accounting For The Increased Cost Of Heart Attack Treatments, 1984 And 1998

	1984	1998	Annual change
Total spending (billions)	$3.0	$4.8	3.4%
Number of cases	245,687	221,133	−0.8
Average spending per case	$12,083	$21,714	4.2

SOURCE: Authors' analysis of Medicare claims records for all elderly patients with a heart attack in 1984 and 1998.

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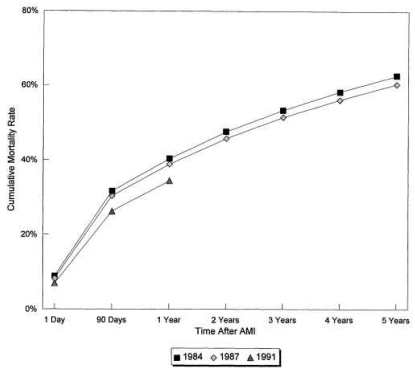

FIGURE IV
Changes in Mortality Rates After AMI

- VSLY == value of a statistical life year
- Sum VSLY over all year for VSL
- VSL = Σ_i VSLY/(1+r)^i
- VSLY = $150,000, r=0.03, 40 years VSL=$3.5 million
- Cutler et al. assume $25,000 which is pretty low

TABLE III
LIFE EXPECTANCY AND COST FOLLOWING A HEART ATTACK

	AMI population					General population		AMI population net value
			Change in value of life for net value of life-year:					
Year	Life expectancy (years)	Costs	$10,000/ year	$25,000/ year	$50,000/ year	Life expectancy (years)	Costs	$25,000/ year
1984	5 2/12	$11,175	—	—	—	10 3/12	$1,667	—
1985	5 1/12	11,691	$ 613	$ 2,306	$ 5,126	10 2/12	1,768	$3,230
1986	5 1/12	11,998	455	2,421	5,698	10 3/12	1,779	2,163
1987	5 2/12	12,253	946	4,054	9,234	10 1/12	1,791	2,748
1988	5 5/12	12,725	1,497	6,177	13,976	10 3/12	1,865	6,460
1989	5 5/12	13,019	2,403	8,936	19,826	10 5/12	1,936	6,018
1990	5 3/12	13,623	2,897	11,079	24,716	10 6/12	1,945	6,334
1991	5 10/12	14,772	2,217	11,133	25,994	10 7/12	2,080	5,015

The sample is all elderly Medicare beneficiaries with a new heart attack. Costs are in 1991 dollars, adjusted using the GDP deflator.

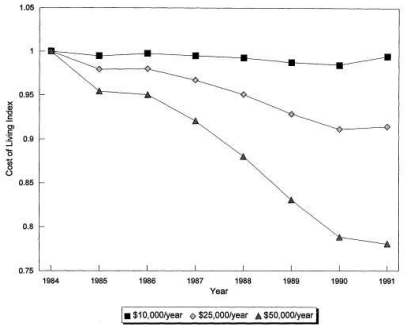

FIGURE V
Cost of Living Index

EXHIBIT 3
Summary Of Research On The Value Of Medical Technology Changes

Condition	Years	Change in treatment costs	Outcome Change	Value	Net benefit
Heart attack[a]	1984–98	$10,000	One-year increase in life expectancy	$70,000	$60,000
Low-birthweight infants[b]	1950–90	$40,000	Twelve-year increase in life expectancy	$240,000	$200,000
Depression[c]	1991–96	$0	Higher remission probability at some cost for those already treated		
		<$0	More people treated, with benefits exceeding costs		
Cataracts[d]	1969–98	$0	Substantial improvements in quality at no cost increase for those already treated		
		<$0	More people treated, with benefits exceeding costs		
Breast cancer[e]	1985–96	$20,000	Four-month increase in life expectancy	$20,000	$0