H. MEDICAL TECHNOLOGY

H.1 Brief History of Technology

H.2 Technology and Health Expenditures

H.3 Returns to Medical Technology

H.4 Technology Overuse

Bhattacharya, Hyde, Tu Chapter 13: Technology and the Price of Health Care

H.1 BRIEF HISTORY: LIFE EXPECTANCY

- Stone Age — 5 mill – 10,000 BC
  4 million at end — Life expectancy = 28 years
- Agricultural Age — 10,000 BC – 1800 AD
  400 million at end — LE = 24 years
- Industrial Age — 1800AD – 1950 AD
  1.6 billion at end — LE = 40 years
- Information Age — 1950 AD – on
  7.9 billion in 2022 — LE up to 80 years

Population rose because of decreased mortality rates, due mostly to higher incomes.

Pop growth rate now slowing due to decreased fertility.
[U.N. in 2021 predicts 9.7 billion in 2050.]

BRIEF HISTORY: MEDICAL TECHNOLOGY

- 1500 Paracelsus Showed protein in urine
- 1569 Kircher Microscope saw bacteria & protozoans
- 1619 Harvey Blood circulation
- 1668 von Leewenhoek Saw red blood cells
- 1798 Jenner Smallpox vaccination
- 1816 Laennec Stethoscope
- Late 1800's Pasteur, Semmelweiss, Koch bacteria cause anthrax, childbirth fever TB, …
- 1885 Roentgen X-Rays

H.2 TECHNOLOGY AND HEALTH EXPENDITURES

- $E = P \times Q$ Expenditure = Price × Quantity
- Prices up due to increased wages, expensive new technology, possibly less competition
- Quantity up due to aging, higher incomes, more insurance, increased quality of care, new procedures.
- Laspeyre price index overstates inflation

$$I_{CPI} = \frac{\text{Price of same bundle in time 1}}{\text{Price of a given bundle in time 0}}$$

as does not adjust for quality changes and for new methods.

- Hodgkins lymphoma – much better survival.
  Peptic ulcers – now treat with antibiotic.
  Hepatitits C drug treatment.
- New technology a big driver of increased expenditures.

H.3 RETURNS TO MEDICAL TECHNOLOGY

- Cutler and McClellan (2001), "Is Technological Change Worth it?" Health Affairs, 20(5).
- Note that in aggregate over 1950-1990:
  Lifetime medical spending up $35,000 in PDV
  Life expectancy up 7 years with PDV $130,000
  So medical spending worth it if led to at least one quarter of the gain in life expectancy!
- More detailed analysis considers five medical innovations.
  Cost benefit analysis with discount rate of 3%.
  One life-year valued at $100,000.
  Quality-adjusted where appropriate.

- Cutler and McClellan (2001) consider
  (1) Heart attacks: intervention e.g. angioplasty
  (2) Low-birth weight infant: ventilators ...
  (3) Depression: SSRI's e.g. Prozac
  (4) Cataracts: less invasive surgery
  (5) Breast cancer: better chemotherapy
- Conclude that for first four there is net benefit.
  In fact for 1-4 MB is at least 6 times MC!!

(1) Heart Attacks 1984-98
MC = $10,000 MB = $70,000
Intervention (bypass and angioplasty and diagnostic catheterization) rather than just monitor.

Benefit is one more year (5 to 6 years) less $25,000 for annual health costs of elderly discounted.

(2) Low-birthweight Infants 1950-90
MC = $40,000 MB = $240,000

Ventilators, artificial surficant for lung development

Increased costs include $20,000 at birth plus $20,000 through life (special needs)

Benefit is live extra 12 years.

(3) Depression 1991-96

MC = $0 MB = $6,000

New drugs: selective serotonin reuptake inhibitors (SSRI's) e.g. Prozac

Benefit is 8 weeks less depressed x 0.4 QALY improvement x $100,000 per year

(4) Cataracts 1969-98

MC = $0 MB = $95,000

Changed from major surgery to simple procedure

Benefit is 5 years x 0.2 QALY improvement x $100,000 per year

(5) Breast Cancer 1985-96

MC = $20,000 MB = $20,000

Better chemotherapy regimens and supportive care.

Live 4 months longer.

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

SOURCES: Authors' own work and summary of other studies; see below.

[a] See Note 7 in text.

[b] D. Cutler and E. Meara, "The Technology of Birth: Is It Worth It?" in *Frontiers in Health Policy Research,* vol. 3, ed. A. Garber (Cambridge, Mass.: MIT Press, 2000), 33–67.

[c] See Note 16 in text.

[d] I. Shapiro, M.D. Shapiro, and D.W. Wilcox, "Measuring the Value of Cataract Surgery," in *Medical Care Output and Productivity,* ed. D. Cutler and E. Berndt (Chicago: University of Chicago Press, 2001).

[e] D.M. Cutler and M. McClellan, "The Productivity of Cancer Care" (Unpublished paper, 2001).

- Cutler et al. (2022), "A Satellite Account for Health in the United States", American Economic Review, 494-533.
- Aggregate productivity growth of 1.5 percent per year for a comprehensive set of 80 conditions for elderly over 1999-2012
  - whereas Natiomal Income and Product Accounts (NIPA) estimate 0.4 percent annual decline 1987-2018
  - difference because NIPA does not control for improved quality.
- Over 1999-2012 time period QALE at age 65
  - increased by 1.7 years due to medical technology
  - fell by 0.7 years due to obesity and other nonmedical factors
  - for a net gain of 1 year.
- Considerable heterogeneity across conditions
  - big productivity gains for cardiovascular disease
  - but none for e.g. musculoskeletal disease.

H.4 TECHNOLOGY OVERUSE

- Considerable small area variation in practice styles.
- Let X_j be observed medical use rate in region j
  Compute coefficient of variation
  CV = St.dev(X) / Mean(X)
  If CV > 0.20 then view as high variation across regions.
- e.g. Suppose 95% in range (0.15, 0.35) so mean=0.25, sd=0.05.
  Then CV = 0.05/0.25 = 0.20
- Dartmouth Atlas breaks U.S. into 307 regions.
- Finds big CV (even after control for supply factors and socioeconomic variables) with little variation in outcomes
  - e.g. use of c-sections for baby delivery.
- Due to local medical cultures, physician-induced demand, …
- Should establish evidence-based medical practice guidelines.