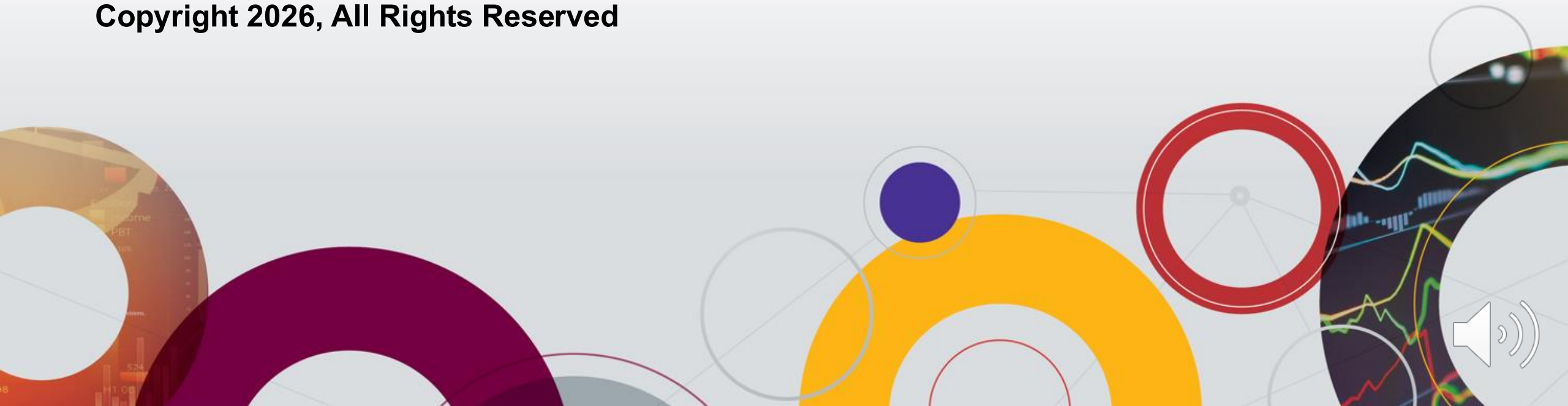


# 1.3a Problems in Healthcare Motivating Biomedical Informatics and AI

**10x10 – Introduction to Biomedical Informatics & Artificial Intelligence**  
**William Hersh, MD, FACMI, FAMIA, FIAHSI**  
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# Problems in healthcare motivating biomedical informatics and AI

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Some perspective

Overview of healthcare systems in US and elsewhere

Notable successes of modern healthcare

Problems of current healthcare

- Cost
- Quality
- Variation
- Access

Healthcare reform in the US

# Who said this and when?

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“I am fain to sum up with an urgent appeal for adopting ... some uniform system of publishing the statistical records of hospitals. There is a growing conviction that in all hospitals, even in those which are best conducted, there is a great and unnecessary waste of life ... In attempting to arrive at the truth, I have applied everywhere for information, but in scarcely an instance have I been able to obtain hospital records fit for any purposes of comparison ... If wisely used, these improved statistics would tell us more of the relative value of particular operations and modes of treatment than we have means of ascertaining at present.”

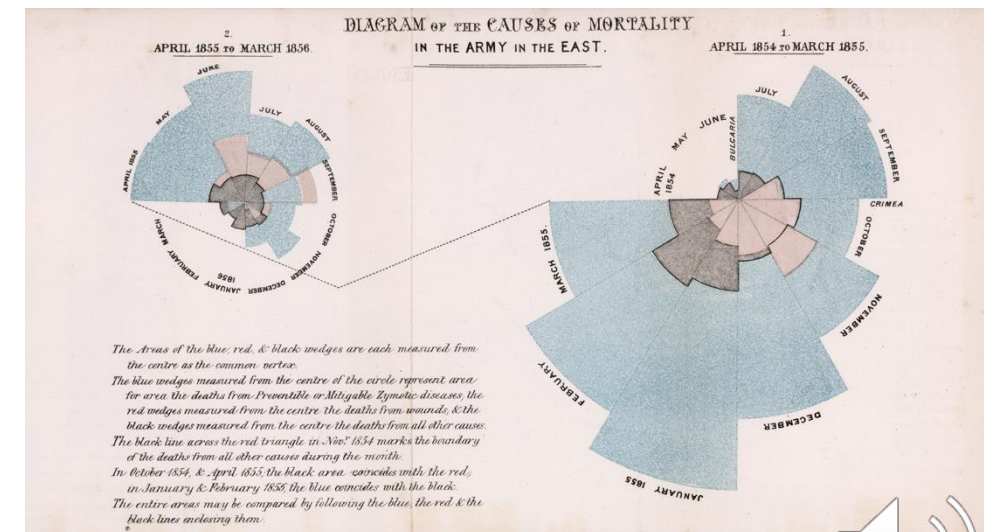
# Who and when...

Florence Nightingale, *Notes on Hospitals*, London: Longman, Green, Roberts, Longman, and Green, 1863

The first informatician?

- Historical perspective (History.com, 2022, McHugh, 2022)
- "Unexpected master of data" (Bradshaw, 2020)
- Early pioneer in data visualization (Andrews, 2022)

Also has [Web site](#) (and museum in London)



## Another British insight (Chantler, 1999)

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*“Medicine used to be simple, ineffective, and relatively safe. Now it is complex, effective, and potentially dangerous. The mystical authority of the doctor used to be essential for practice, now we need to be open and work in partnership with our colleagues in health care and with our patients. We must recognize and encourage our patients’ right to make fully informed decisions about available treatments and provide care and support, not just technically advanced interventions.”*

# Overview of healthcare systems in US and elsewhere

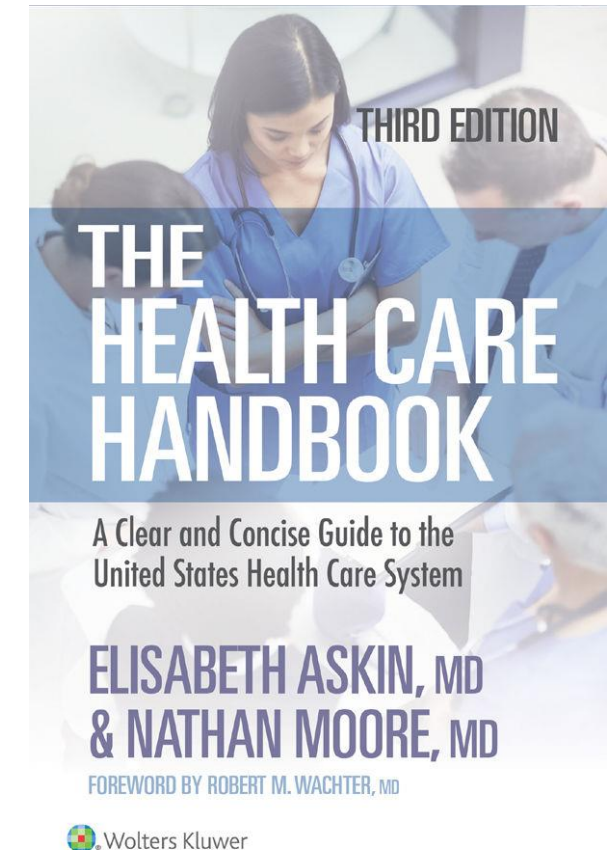
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Overview text recently updated (Askin, 2022)

Understanding healthcare important for context of use of IT in healthcare

Topics include

- Healthcare delivery and systems
- Insurance
- Healthcare economics and financing
- Quality and technology
- Research, pharmaceuticals, and medical devices
- Policy
- Healthcare workforce



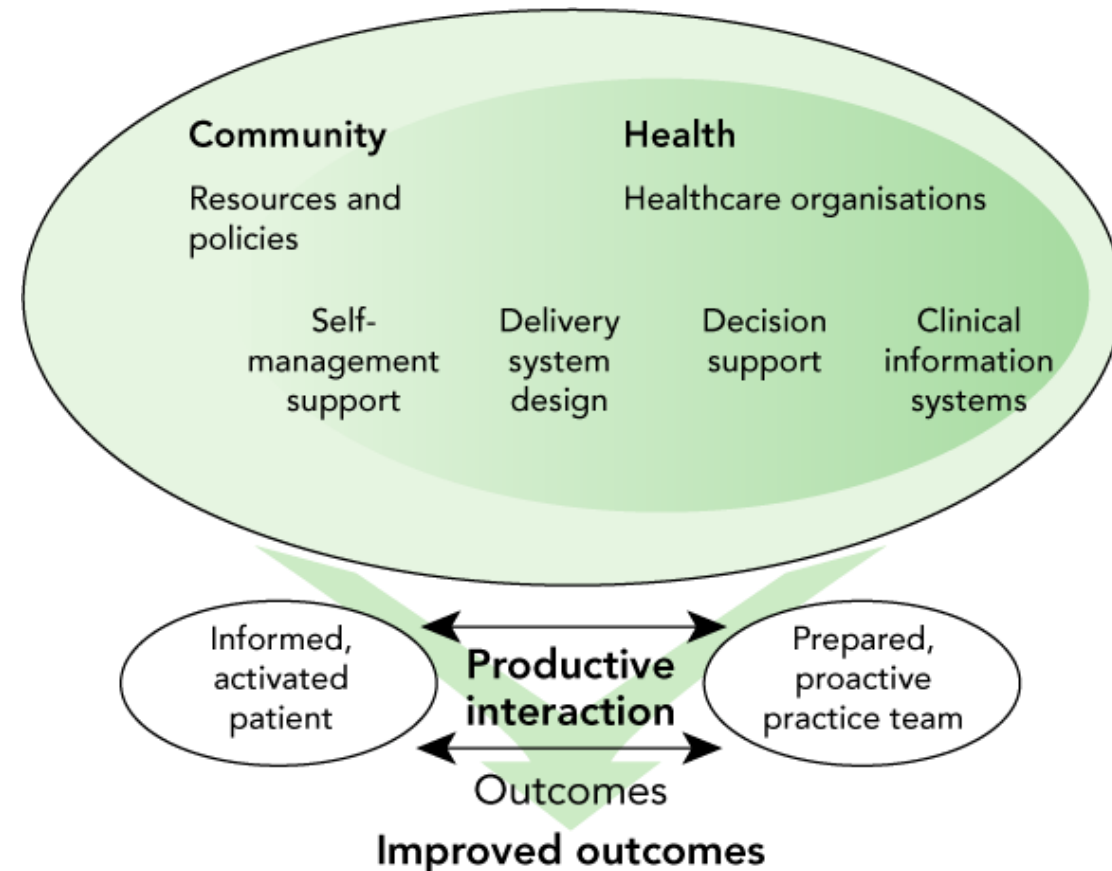
# System is increasingly addressing “chronic illness”

Care of acute conditions accounts for increasingly less of healthcare (Mattke, 2015)

- The most common condition is “multimorbidity” (Tinetti, 2012)

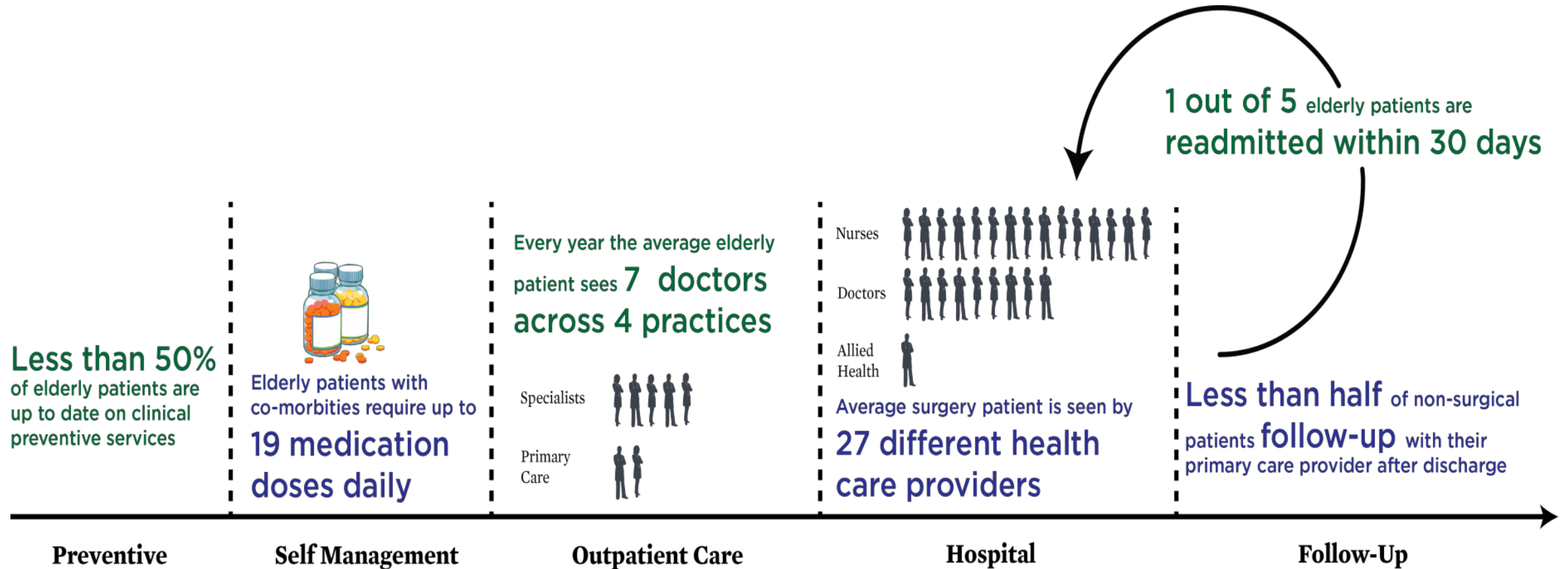
Growing importance of “noncommunicable” diseases (WHO, 2018)

- Even in “developing world” (Lancet, 2018)



(Wagner, 1998)

# And patients face increasingly complex system (IOM, 2012)



# Healthcare system has not evolved to new needs and priorities

## Healthcare system compared to Choluteca Bridge in Honduras (Berwick, 2013)

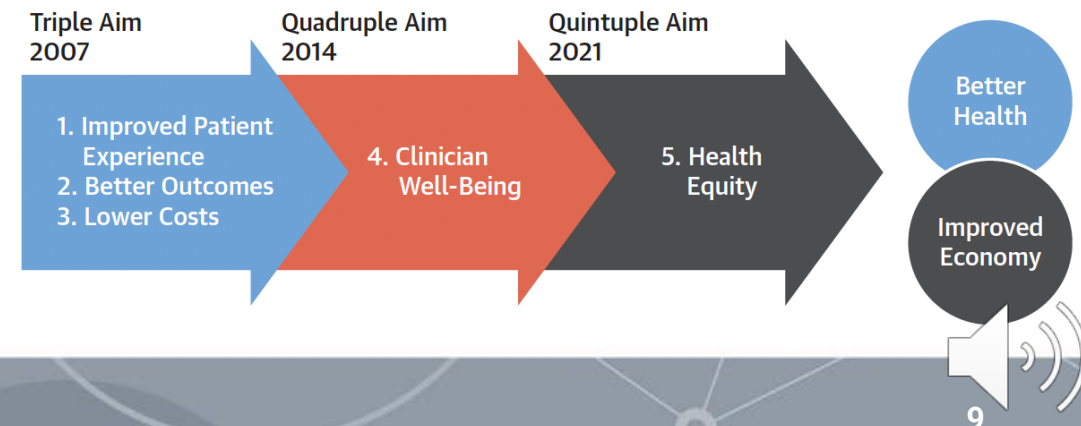
- Built in 1930s to withstand hurricanes, but not results of Hurricane Mitch in 1998

## Should be guided by “triple aim” (Berwick, 2008)

- Better health
- Better healthcare
- Lower cost

## Newer aims

- “Quadruple aim” – provider well-being (Bodenheimer, 2014)
- “Quintuple aim” – achieve health equity (Itchhaporia, 2021)



# Some definitions of care

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Primary care – initial and ongoing care, typically provided in an office or clinic

Secondary care – specialty care provided in the community

Tertiary care – highly specialized care usually provided by referral in a large, typically academic, medical center

# Healthcare system “stakeholders” (the “p”s)

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Patient – the one who gets healthcare, often called a consumer or citizen when they are well

Provider – those who “provide” healthcare, e.g., physicians, nurses, allied health

Purchaser – those who buy healthcare, usually employers or the government

Payor – those who “pay” the healthcare system, i.e., the insurance companies and government

Public health – protectors of the public’s health

# How is healthcare financed?

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No matter who pays the cost (patient, employer, or government), most healthcare is financed on the notion of *insurance*

- Everyone pays some, those who need it use it

## Payment methods

- Private fee-for-service
- Private managed care, a.k.a., HMOs, PPOs
- Government-financed, a.k.a., single-payer
- Government-provided

# Different approaches to healthcare delivery and finance (Reid, 2010)

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| Name                      | Description                                  | Countries                      | US analog                          |
|---------------------------|----------------------------------------------|--------------------------------|------------------------------------|
| Beveridge                 | Provided and financed by government          | Great Britain, Hong Kong, Cuba | Veteran's Administration (VA)      |
| Bismarck                  | Regulated private insurance – must cover all | Germany, France, Switzerland   | Employer-provided health insurance |
| National health insurance | Private system with government-run insurance | Canada, Taiwan, South Korea    | Medicare, Medicaid                 |
| Out-of-pocket             | Pay as you go                                | Most poor countries            | US uninsured                       |

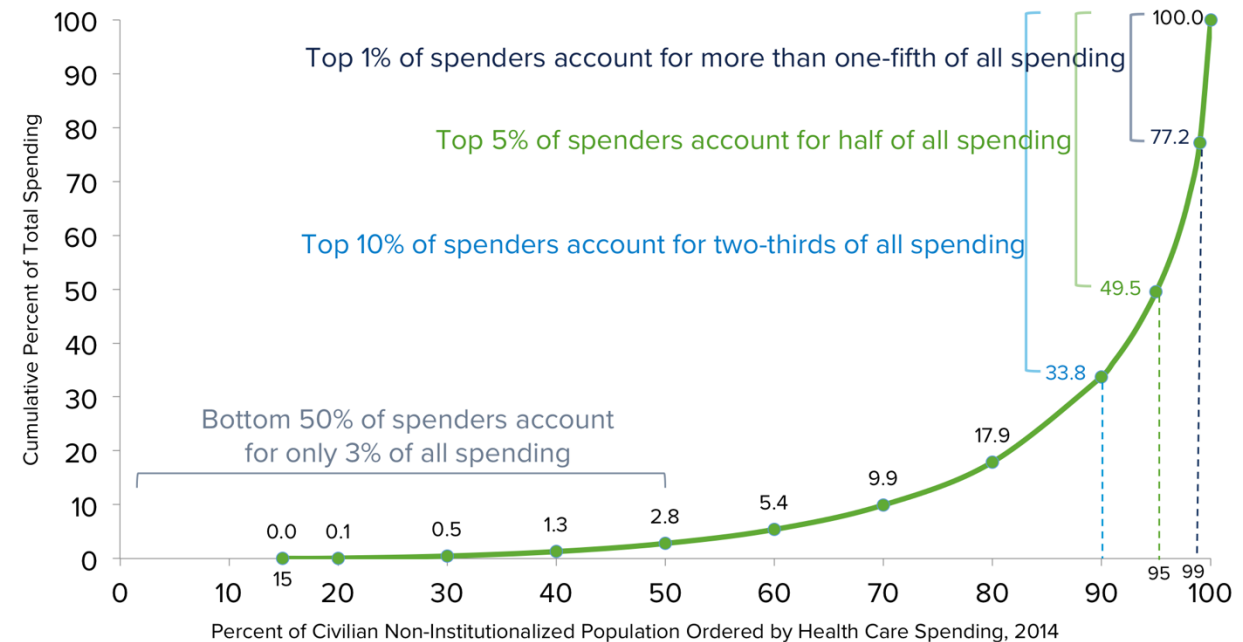


# With all insurance, some use more care than others

From AHRQ Medical Expenditure Survey Panel (Hernandez-Viver, 2024) – % of spenders who use % of spending

[Figure from earlier study](#) depicts graphically

| Year | Top 1% | Top 5% | Top 10% | Top 50% | Bottom 50% |
|------|--------|--------|---------|---------|------------|
| 2021 | 24.0   | 51.2   | 66.9    | 97.2    | 2.8        |
| 2020 | 24.2   | 52.9   | 68.6    | 97.4    | 2.6        |
| 2019 | 20.7   | 48.8   | 65.0    | 97.0    | 3.0        |
| 2018 | 21.0   | 48.3   | 64.3    | 96.8    | 3.2        |



# Major healthcare payors in US

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Private health insurance – for most employed citizens and their dependents, except those in lower-paying jobs

Medicare – government insurance for elderly and disabled

- Part A – hospital/hospice insurance
- Part B – medical insurance
- Part C – Medicare Advantage
- Part D – prescription drug coverage

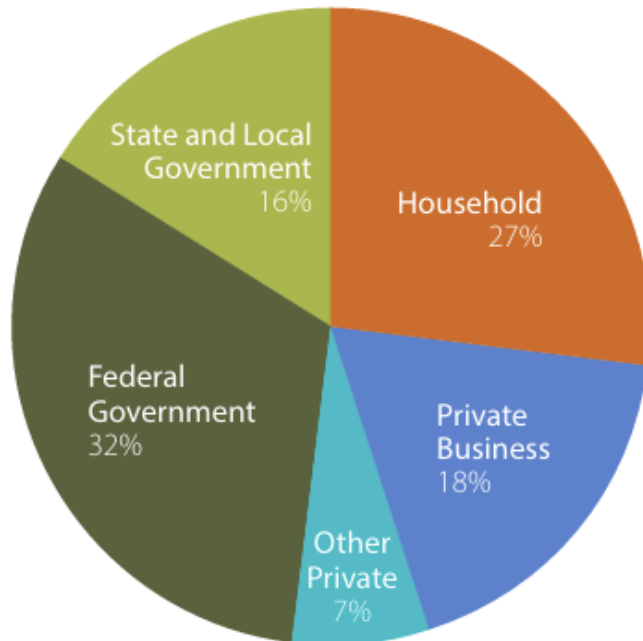
Medicaid – government insurance for indigent

Children's Health Insurance Program (CHIP, formerly SCHIP) – government insurance for uninsured low-income children

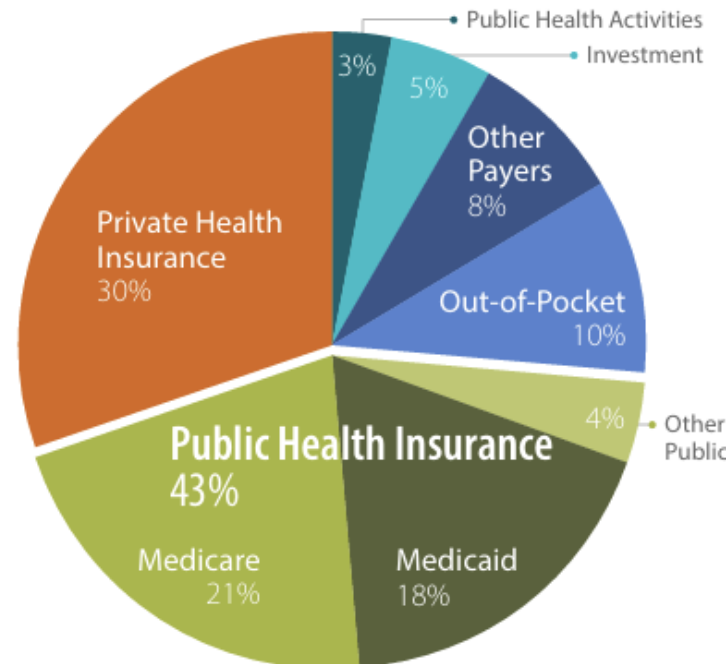
Other expenses due to out-of-pocket, public health, and other expenditures

# How is the money spent and paid? (National Health Spending Almanac; Wilson, 2025)

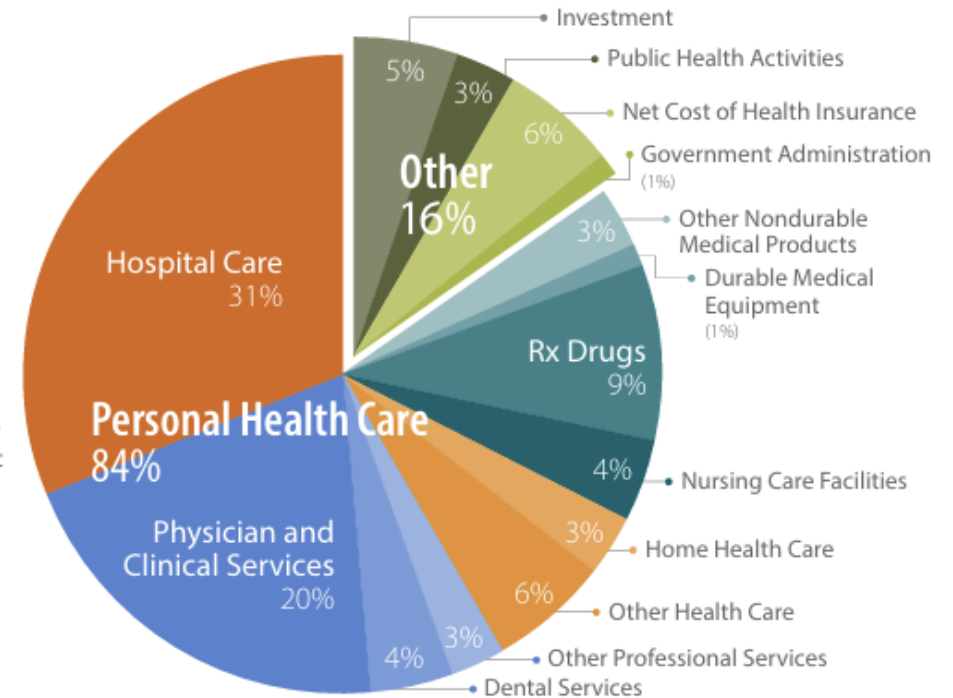
SPONSORS, 2023



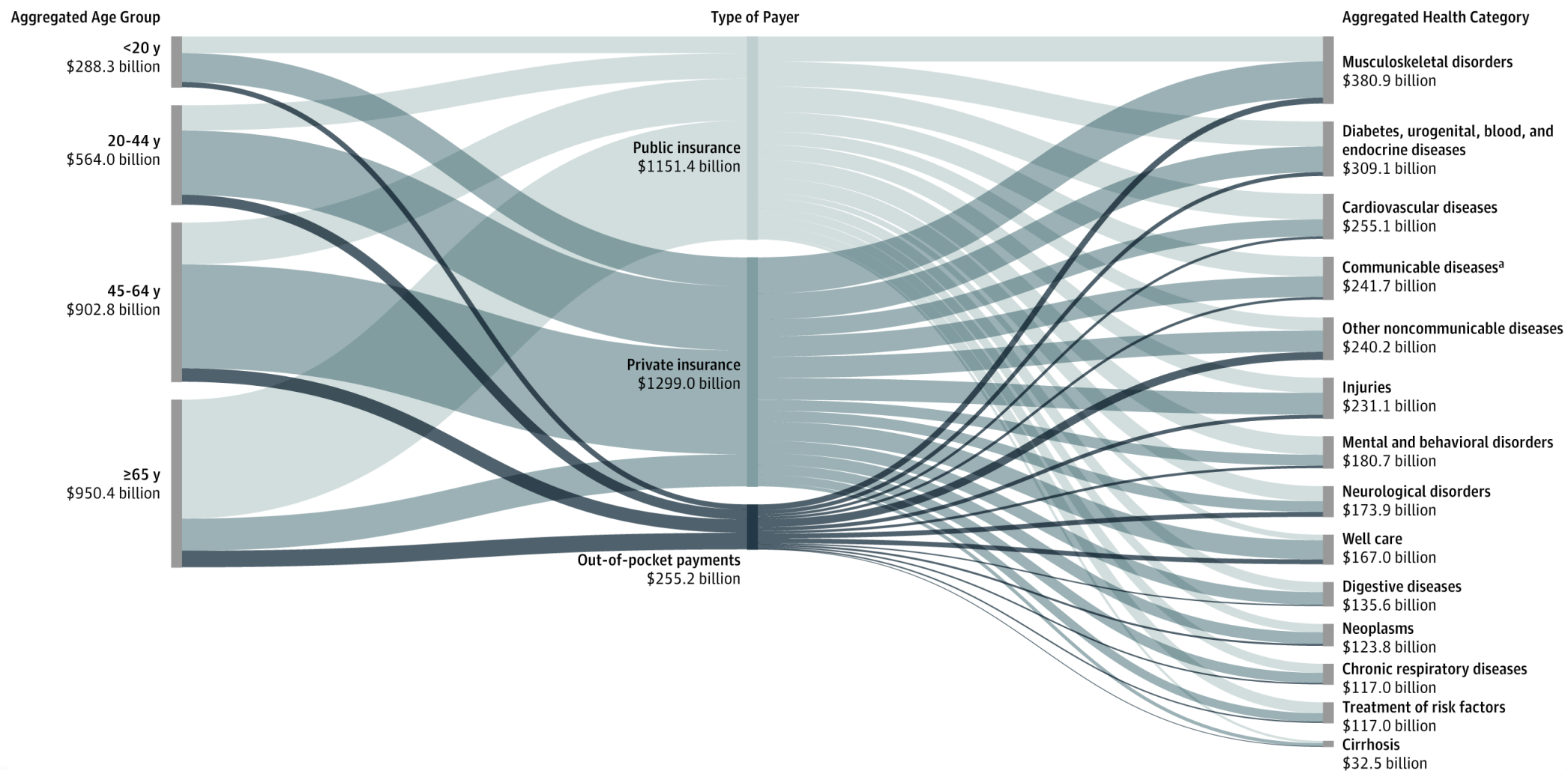
PAYMENT SOURCES, 2023



SPENDING CATEGORIES, 2023



# Another perspective of spending (Dieleman, 2020)



# Major problems with US health

US has a “health disadvantage”: life expectancy among lowest of advanced countries (NAM, 2021; Woolf, 2023)

Great disparities in disease-specific mortality in different parts of US; one of best predictors is zip code (Dwyer-Lindgren, 2016; Arias, 2018)

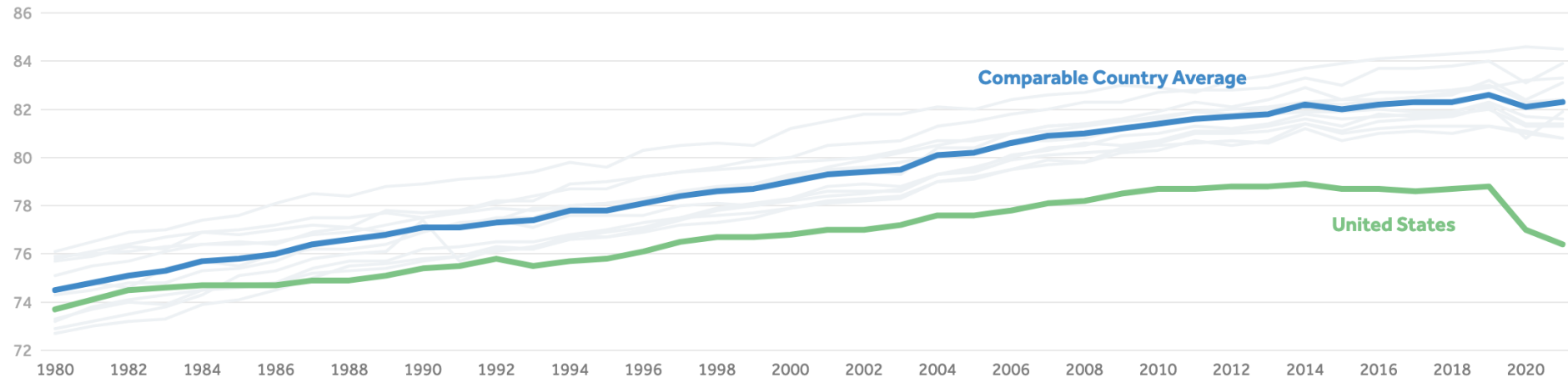
US spends much more on healthcare than most countries but has lower life expectancy (Rakshit, 2023)

Life expectancy in US increased for most of past 60 years, but decreased after 2014 (NAM, 2021)

- Major drivers, especially among young, have been drug overdose, alcoholic liver disease, and suicide (Woolf, 2024)
- Further declines due to COVID-19, disproportionate in Black and Latino populations (Andrasfay, 2021; Xu, 2022; Rakshit, 2023)
- Also proportional decline among men vs. women (Yan, 2024)



# Life expectancy and health spending in advanced economies (Rakshit, 2023)



| Country                           | Life expectancy ▲ | Health spending, per capita |
|-----------------------------------|-------------------|-----------------------------|
| United States                     | 76.4              | \$12,197                    |
| Germany                           | 80.8              | \$7,518                     |
| United Kingdom                    | 80.8              | \$5,467                     |
| Austria                           | 81.3              | \$6,690                     |
| Netherlands                       | 81.4              | \$6,785                     |
| Canada                            | 81.6              | \$6,278                     |
| Belgium                           | 81.9              | \$6,022                     |
| <b>Comparable Country Average</b> | <b>82.3</b>       | <b>\$6,345</b>              |
| France                            | 82.4              | \$6,106                     |
| Sweden                            | 83.1              | \$6,228                     |
| Australia                         | 83.3              | \$6,226                     |
| Switzerland                       | 83.9              | \$7,582                     |
| Japan                             | 84.5              | \$4,899                     |

# Other health disparities – between rural and urban settings

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Higher rural mortality at state level; explained by (Gong, 2019)

- Socioeconomic deprivation
- Physician shortages
- Lack of health insurance

Rural residence associated with (Johnston, 2019)

- 40% higher preventable hospitalization rate
- 23% higher mortality rate, compared to urban residence

Access to specialists accounts for 55% and 40% of rural-urban difference in preventable hospitalizations and mortality (Johnston, 2019)

Avoidable mortality – which could be prevented by healthcare or preventive services – varies widely across US states and also higher than other advanced countries (Papanicolas, 2025)

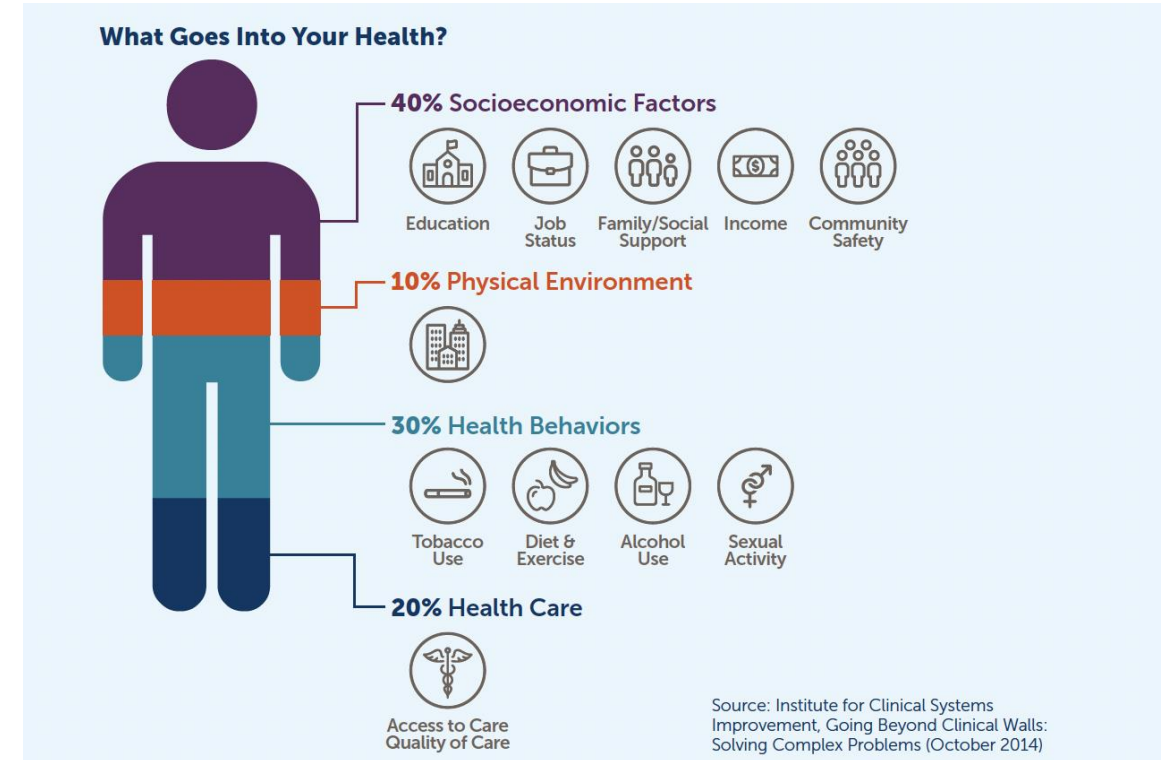
Rural hospitals vulnerable and closing at higher rates, especially in states without Medicaid expansion (Topchik, 2020; CHQPR, 2025)

# US spends less on social spending

US spends slightly below average for high-income countries on social services (Papanicolas, 2019)

Of social determinants of health (SDOH), healthcare only responsible for 20% of health outcomes (Magnan, 2017; RWJF, 2019)

- Recent update of term is social drivers of health (still SDOH) (CMS, 2024)



# How can healthcare address SDOH?

Many factors within SDOH to address (Artiga, KFF, 2018)

Only 24% of hospitals and 16% of physician practices reported screening for food insecurity, housing instability, utility needs, transportation needs, and interpersonal violence (Fraze, 2019)

Clinical and public health approaches can be at odds; need “upstream” interventions (Silverstein, 2019)

Must be part of improving healthcare system (DeSalvo, 2020; Butkus, 2020; HHS, 2023)

Broadband Internet access another SDOH (Benda, 2020; Sieck, 2021; Arias López, 2023)?

| Economic Stability | Neighborhood and Physical Environment | Education                 | Food                      | Community and Social Context | Health Care System                          |
|--------------------|---------------------------------------|---------------------------|---------------------------|------------------------------|---------------------------------------------|
| Employment         | Housing                               | Literacy                  | Hunger                    | Social integration           | Health coverage                             |
| Income             | Transportation                        | Language                  | Access to healthy options | Support systems              | Provider availability                       |
| Expenses           | Safety                                | Early childhood education |                           | Community engagement         | Provider linguistic and cultural competency |
| Debt               | Parks                                 | Vocational training       |                           | Discrimination               | Quality of care                             |
| Medical bills      | Playgrounds                           | Higher education          |                           |                              |                                             |
| Support            | Walkability                           |                           |                           |                              |                                             |
|                    | Zip code / geography                  |                           |                           |                              |                                             |

**Health Outcomes**  
Mortality, Morbidity, Life Expectancy, Health Care Expenditures, Health Status, Functional Limitations



# But there have been notable successes in US health

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Healthcare and public health accomplished a great deal in the 20th century (CDC MMWR, 1999)

- Vaccination
- Motor-vehicle safety
- Safer workplaces
- Control of infectious diseases
- Decline in deaths from coronary heart disease and stroke
- Safer and healthier foods
- Healthier mothers and babies
- Access to family planning
- Fluoridation
- Recognition of tobacco use as a health hazard

Provision of medical care cost-effective in treating many prevalent diseases (Wamble, 2019)

US cancer death rate fell 29% since 1991 (Siegel, 2020)

Biomedical research enterprise has provided benefits both to health and the economy (Frank, 2009)