Georgia Tech Health & Humanitarian Systems
Interdisciplinary Research Center

SYSTEMS ENGINEERING TO REDUCE STRESS AND BURNOUT IN HEALTH SYSTEMS

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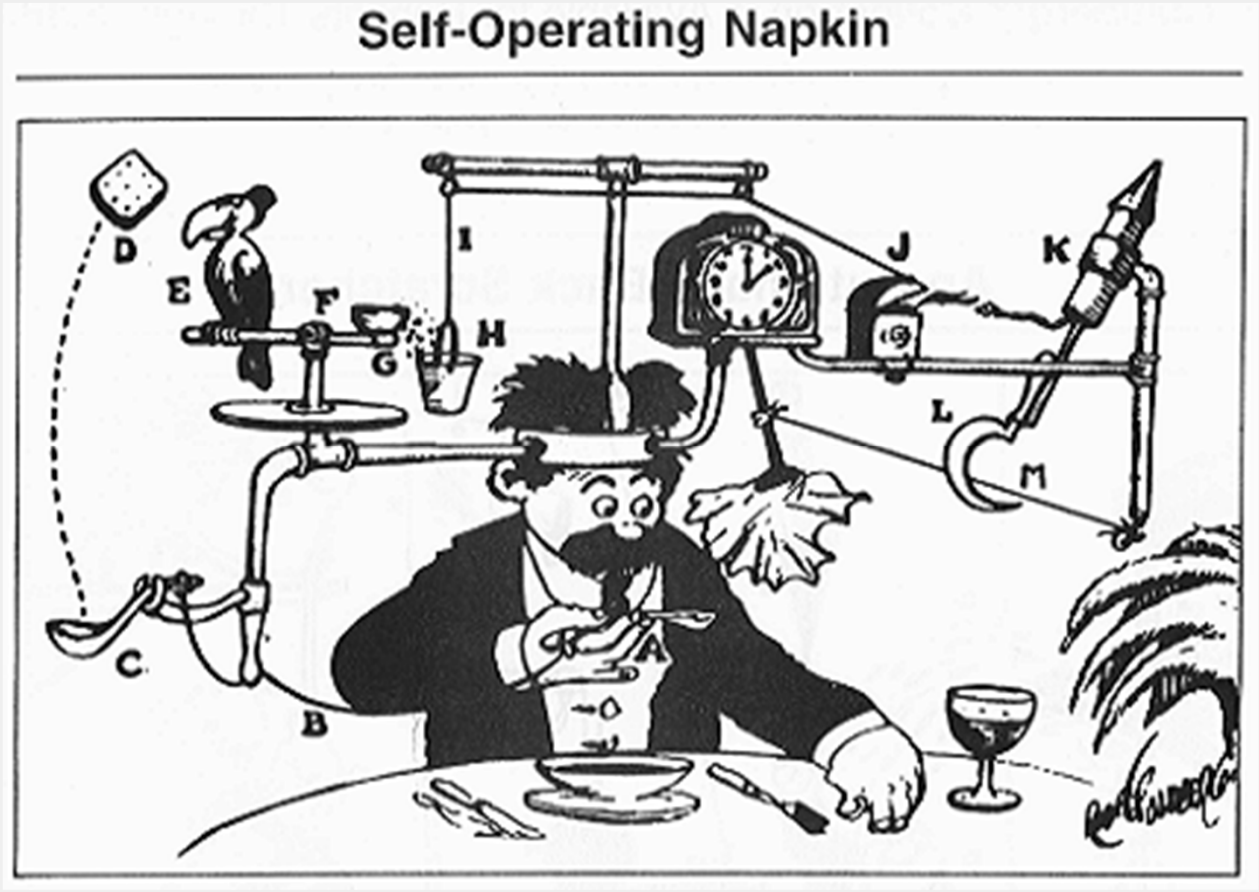
This Rube Goldberg machine may look complex…



Source: Rube Goldberg's "Self-Operating Napkin" , WikiCommons

- in reality, it is much simpler than a system with
  - multiple stakeholders, physical spaces, different organizations, limited resources, etc.
  - multiple, often conflicting objectives/incentives
  - information limitations or asymmetry
  - uncertainty

Work-related stress

- Excessive or unmanageable pressure
  - Work demands and pressures not matched to knowledge, abilities, needs
  - Insufficient support from supervisors and colleagues
  - Little control over work processes
  - Unsatisfactory working conditions
    - Workload, pace/intensity, working hours, etc.
  - "Culture" of the work environment
- Poor design or management of the "system"

→ Impact on mental or physical health, absenteeism, high turnover, errors, patient outcomes, …

Adapted from http://www.who.int/occupational_health/topics/stressatwp/en/
Picture: https://calaborlawnews.com/legal-news/interview-california-labor-law-12-18053.php

Interventions

- Focus on individuals
  - Mindfulness training, support groups, employee assistance programs, skills training, etc.
- Focus on the system, e.g.,
  - **Policies** or **programs**
  - Redesigning **processes** or **workflow** to eliminate "waste"; revisiting **incentives**
  - Easier access to useful **information**
  - Improved **protocols** (e.g., for rounding or handoffs)
  - Improved **scheduling** practices

→ Most of the current practices focus on interventions at the individual, or department/unit level

Picture: https://nccih.nih.gov/health/yoga/introduction.htm

Case Studies

"You can teach physicians mindfulness and meditation techniques, but if you throw them back into the war zone, it's not going to work." - Mark Greenawald

1. APEX (Ambulatory Process Excellence)

Dept. of Family Medicine at the U of Colorado

The APEX system was introduced specifically to ***reduce burnout.***

"The chaos in exam rooms before APEX was akin to texting while driving"

– Corey Lyon, DO
Medical Director at the Family Medicine Center

Source: Alexi A. Wright, M.D., M.P.H., and Ingrid T. Katz, M.D., M.H.S. (2016). Beyond Burnout — Redesigning Care to Restore Meaning and Sanity for Physicians

Change in **Workflow**

- Transfer structured tasks to a medical assistant:
  - data collection
  - medication reconciliation
  - patient education
  - visit documentation

- The ratio of medical assistants to clinicians 1:1 → 2.5:1
- Rigorous training, structured protocols, new communication systems
- Free up the Primary Care Providers to focus on the exam and medical decision making

Picture source: https://www.irishtimes.com/news/education/technology-is-increasing-teachers-workload-survey-shows-1.2163907
https://www.healthcatalyst.com/ehr-vs-data-warehouse-7-points-to-ponder

Results after 6 months

- Burnout rates dropped from 53% to ***13%***
- Improvement in multiple preventive health measures (mammogram, colonoscopy and vaccination rates)
- Reduced wait times
- More patient visits per day (additional 3 per doctor)

- ***Cost-neutral*** despite adding more staff & training
  - Productivity increased
  - Less burnout, less turn-over

Primary Stakeholders

- Physicians (Primary Care Providers)
  - Less hours spent on non-medical tasks
  - Improved work satisfaction
- Patients
  - Reduced wait times
  - Better care
  - Improvement in preventive care
- Medical Assistants
  - More job opportunities

Image source: http://all-free-download.com

2. Time Bank - Stanford School of Medicine

Physician burnout costs Stanford at least

$7.75 million annually

Overworking, covering shifts, long hours spent on non-patient related tasks

Time Bank

A two-year, $250,000 pilot program, seeking to change an unforgiving culture that has traditionally rewarded long work hours.

Source: https://wire.ama-assn.org/life-career/stanford-physician-burnout-costs-least-775-million-year
Source: https://www.washingtonpost.com/news/inspired-life/wp/2015/08/20/the-innovative-stanford-program-thats-saving-emergency-room-doctors-from-burnout/?utm_term=.2900de1b8ac2
Source: Alexi A. Wright, M.D., M.P.H. and Ingrid T. Katz, M.D., M.H.S. (2016). Beyond Burnout — Redesigning Care to Restore Meaning and Sanity for Physicians

Change in **Processes** and **Incentives**

- Reward those activities that aren't typically recognized by medical centers
  - Examples: mentoring, serving on committees, stepping in to fill a shift at the last minute for a colleague who needs support

- A physician can receive time credits to be traded for:

Academic-support	*Home-support*
• Manuscript editing	• House cleaning
• Grant writing	• Meal delivery
• Lab management	• Dry cleaning

Change in satisfaction from pre- to post- intervention

Aspect	P-Value
Culture of Flexibility	0.020
Wellness	0.013
Understanding professional development opportunites	0.036
Institutional Satisfaction	0.020

Change in Individual Survey items	P-value
Increase in satisfaction with professional support to manage fit between work, long-term career aspirations & personal life	0.009
Decrease in postponing/avoiding vacation	<0.01
Decrease in avoiding health habits due to lack of time	0.043
Increase in timeframe projected for promotion	0.021
Increase in frequency which faculty step in to fill clinical service on short notice to help a colleague	0.028

Source: Fassiotto, M., Simard, C., Sandborg, C., Valantine, H., & Raymond, J. (2018). An Integrated Career Coaching and Time Banking System Promoting Flexibility, Wellness, and Success. Academic Medicine
& Supplemental Digital Content

Results: Wellbeing

- Number of physicians feeling ***supported*** doubled
- Share of female faculty members who felt Stanford supported their ***career development*** rose from 29% to **57%**
- ***Volunteering to cover shifts*** on short notice doubled to ~**83%**
- Proportion of faculty who had ***time to discuss science*** with colleagues increased from 9% to **55%**
- Improved work satisfaction and work-life balance

Results: Productivity

Awards & funding

- **Increased success rate** and **amount**

Fellows in the Department of Emergency Medicine:

"All our spots have been retained, there has been **no turnover***."*

Source: Fassiotto, M., Simard, C., Sandborg, C., Valantine, H., & Raymond, J. (2018). An Integrated Career Coaching and Time Banking System Promoting Flexibility, Wellness, and Success. Academic Medicine & Supplemental Digital Content

Stakeholders

- Physicians
  - Improved quality-of-life & work satisfaction
  - More support from colleagues and school
  - Better relationships with colleagues
- Stanford School of Medicine
  - More grants and funding
  - Lower turnover
- Patients

3. Carilion Roanoke Memorial Clinic

- 7 hospitals
- Medical school
- Brain science research institute
- 240 health care facilities
- > 12,000 employees

- 59% physicians
- 50% medical students, physician assistants, nurse practitioners
- 65% residents in specialty training

…experienced burnout in (2015)

Source: https://www.aafp.org/news/family-doc-focus/20180326fdf-greenawald.html
http://www.roanoke.com/business/columns_and_blogs/blogs/med_beat/u-s-news-stories-on-diagnosing-physician-burnout-feature-carilion/article_18d25cec-cde4-55e4-9bb3-aed50f07ae8f.html

Pilot Project:

- Systemwide improvements in effort to decrease burnout
- Build a network of local non-profit agencies to care for patients requiring simple care, to free up space in ER
  - "to address deep-seated social problems that affect patients' health and ratchet up demand for care"
- Provide comprehensive administrative support for primary care physicians, so they can focus their attention on their patients

Source: Sternberg, Steven (2016). Diagnosis: Burnout. https://www.usnews.com/news/articles/2016-09-08/doctors-battle-burnout-to-save-themselves-and-their-patients
Sternberg, Steven (2016). These Doctors are at the forefront of the Burnout Battle. https://www.usnews.com/news/articles/2016-09-08/carilion-clinic-doctors-are-at-the-forefront-of-the-burnout-battle

4. PICU Workflow

Children's Healthcare of Atlanta

Pediatric Intensive Care Unit Expansion has led to:

- Increased rounding duration
- Non-billable physician hours
- Trainee duty hour violations

Map the current state of the rounding process, and use ***lean techniques*** to streamline.

- Standardize rounding process
- Reduce of variation & waste in each step
- Focus on essential components
  - Removing non-value-added steps

Source: Vats, A. & H Goin, K. & Villarreal, M. & Yilmaz Gozbasi, T. & Fortenberry, J. & Keskinocak, P. (2012). The impact of a lean rounding process in a pediatric intensive care unit. Critical care medicine

Results

- Improve timeliness for patient care
- Enhance resident experience
- Reduce required resources
- Fewer non-billable attending hours
- Improved patient and provider satisfaction scores

Results & Stakeholders

Metrics	Results
▪ Transfers of Care ▪ Plan of Care Completion ▪ **Staff** Survey	▪ Eliminated extra transfers to/from resource ▪ 40% to 97% of **patients** by 10:00 a.m. ▪ Improved staff experience with rounding
▪ **Physician** Utilization ▪ Rounding Efficiency ▪ PICU LOS / Diversion	▪ Reduced total man hours by 48% ▪ Reduced rounding duration up to 1 hour ▪ Improved discharge order entry
▪ Teaching Time ▪ Duty Hours ▪ **Resident** Surveys	▪ Created formalized, didactic lectures ▪ N0 duty hour violations ▪ Improved experience

Example from a PICU

Over 5 years

- Increased patient volume (daily census 22.6 in 2008 and 24.1 in 2009)
- 4 → 9 attendings, 2 → 6 fellows, residents, 61 nurses and respiratory therapists, "resource" physician
- Trial and error efforts towards process improvement focusing on physicians and residents

- Move to a new space with state-of-the-art facilities
  - 22K sq ft → 33K sq ft
  - 21 beds → 30 beds
  - Low patient and staff satisfaction, long rounding time

Example from a PICU – Systems engineering approach

- Rounding time: 160 → 120 minutes
- Non-essential activities: 53 → 9 minutes
- # of patients rounded by 9:30: 40% → 80%
- Increased satisfaction by staff, learners, and patient families
- Time spent per patient did not decrease

Systems Engineering

- People, processes, resources (materials, information, technology, equipment, money)
  - → Design, implementation, improvement
  - → Shared goals

- Examples:
  - Manufacturing systems
  - Transportation systems
  - Service systems

"*… it is time to… establish a vigorous new partnership between engineering and health care and hasten a transition to a patient-centered 21st century health care system*"

Systems Engineering Approach

- Current state analysis
  - Identify the **symptoms** for "problem" areas
  - **Measure/quantify** the magnitude of the problems/symptoms
  - Identify potential **root causes** of the problems (bottlenecks)
- Roadmap towards an improved state
  - **Design interventions** for improvements in the system, or **redesign** the system with uncertainty
  - **Evaluate** the **potential impact** of proposed changes
    - Cost of care: Staff and resources efficiency and utilization
    - Quality of care: Treatment outcomes, medical errors, infection rates, patient satisfaction
    - Access to care: Patient volume trends, communities served

METHODS: Statistics, simulation, optimization, queuing models, ..

- Assess the impact of proposed changes after implementation

Better Health Care and Lower Costs through **Systems Engineering**

"Systems engineering has been widely used in other industries, such as manufacturing and aviation, to improve efficiency, reliability, productivity, quality, and safety of systems. It has begun to be used to good effect in health care … United States would benefit from more widespread adoption."

"The benefits of systems engineering can be realized at the community level … engaging public and private community entities in improving the delivery of care and/or promoting health can enhance the quality of care and the health of communities."

"… the need for the United States to build a health-care workforce that has the necessary "know-how," … systems engineering concepts should be embedded in education and training for a wide variety of people involved in health care, from clinicians to administrators to public-health officials."

Source: White House PCAST Report
https://www.whitehouse.gov/blog/2014/05/29/new-pcast-report-says-systems-engineering-can-improve-health-care

Systems Engineering Approach to Healthcare

- Complex system with multiple (competing) objectives, limited resources, and interactions between units
  - Need for modeling & analytics
- Optimizing individual units ≠ Optimizing system
- Systems engineering can lead to improvements across multiple metrics:
  - Effectiveness: Using services that provide the most benefit
  - Timeliness (Efficiency): Reduce waiting times and delays, avoid waste of resources
  - Access/Equity
  - Quality of care & safety
  - Patient/staff satisfaction

Synergistic collaborations between healthcare professionals and systems engineers → improved/transformed healthcare delivery

ADDITIONAL SLIDES

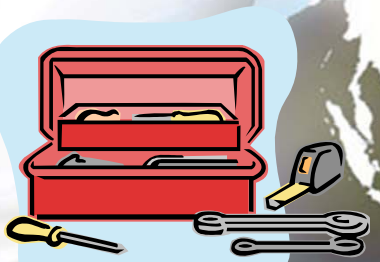
When errors occur …

Traditional approach	Systems approach
Inadequate knowledge or skill (Expecting flawless performance from human beings)	Poorly designed systems; most accidents result from multiple, smaller errors in environments with serious underlying system flaws
Corrective efforts on punishment or remediation	Identify situations or factors likely to give rise to human error, and change the underlying systems

Adapted from https://psnet.ahrq.gov/primers/primer/21/systems-approach

What Tools?

- Methods from the mathematical, physical, and social sciences together with systems approaches to specify, optimize, predict, and/or evaluate the results obtained from systems
  - Optimization with mathematical modeling
  - Simulation of systems with uncertainty
  - Statistics and probability
  - Economics and financial analysis
  - Human factors



Healthcare decisions

Policy Level

- Disease modeling, prevention, and treatment (e.g., screening/vaccination policies)
- Education, health and wellness programs
- Access to services such as primary care
- Payment rules and mechanisms

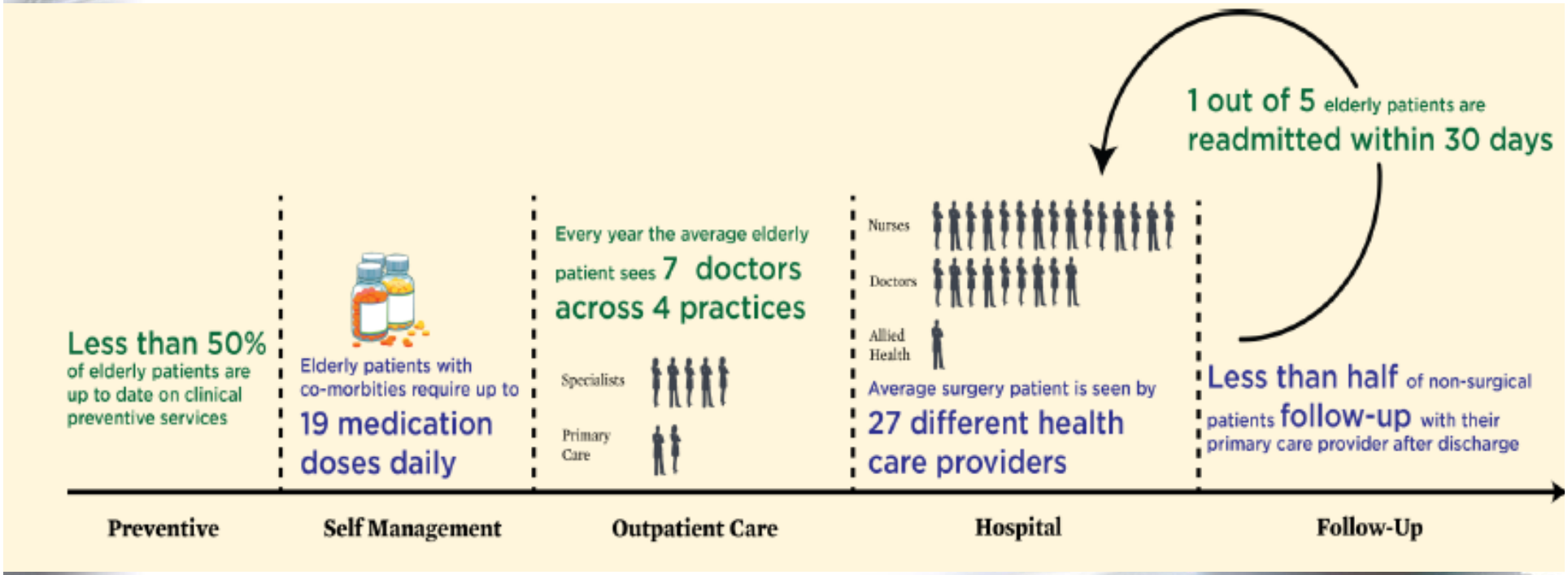
System Level

- Design of care networks (what services to provide, where, and by whom)
- Resource allocation

Hospital/Clinic Level

- Facility design and layout, patient flow management
- Capacity/resource allocation
- Care practices
- Workforce management

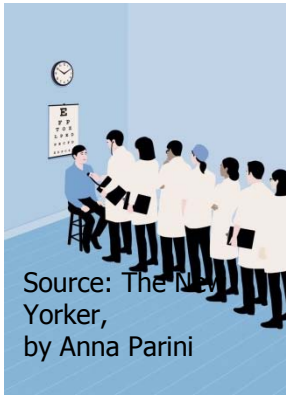
Representative timeline of a patient's experiences in the U.S. health care system



Source: http://www.nationalacademies.org/hmd/~/media/Files/Activity%20Files/Quality/LearningHealthCare/Release%20Slides.pdf

Is all of this "care" necessary?

Low-value (or no-value) care



- Medicare beneficiaries commonly receive care leading to minimal or no benefit
  - EEG for an uncomplicated headache
  - CT or MRI scan for low-back pain in patients without any signs of a neurological problem
  - coronary-artery stent in patients with stable cardiac disease
- Low-value care may affect 25-42% of Medicare beneficiaries

→ Overtesting, Overdiagnosis, Overtreatment

Observations based on recent study published in JAMA Internal Medicine
Source: http://archinte.jamanetwork.com/article.aspx?articleid=1868536, and http://www.newyorker.com/magazine/2015/05/11/overkill-atul-gawande

2006 – "Health" overview

- Hospital costs for potentially preventable conditions totaled ~$30.8 billion
- 4.4 million hospital stays could possibly have been prevented with better ambulatory care, improved access to effective treatment, or patient adoption of healthy behaviors
- 1 in 5 (18%) Medicare admissions was for a potentially preventable condition.
- Most common reasons for potentially preventable hospitalizations: congestive heart failure and bacterial pneumonia. $15.6 billion in hospital costs
- Among children, pediatric asthma ($293 million) and pediatric gastroenteritis (133 million admissions) were in the lead

Missed Opportunities

Source: http://www.nationalacademies.org/hmd/~/media/Files/Activity%20Files/Quality/LearningHealthCare/Release%20Slides.pdf

2006 – "Disparities" overview

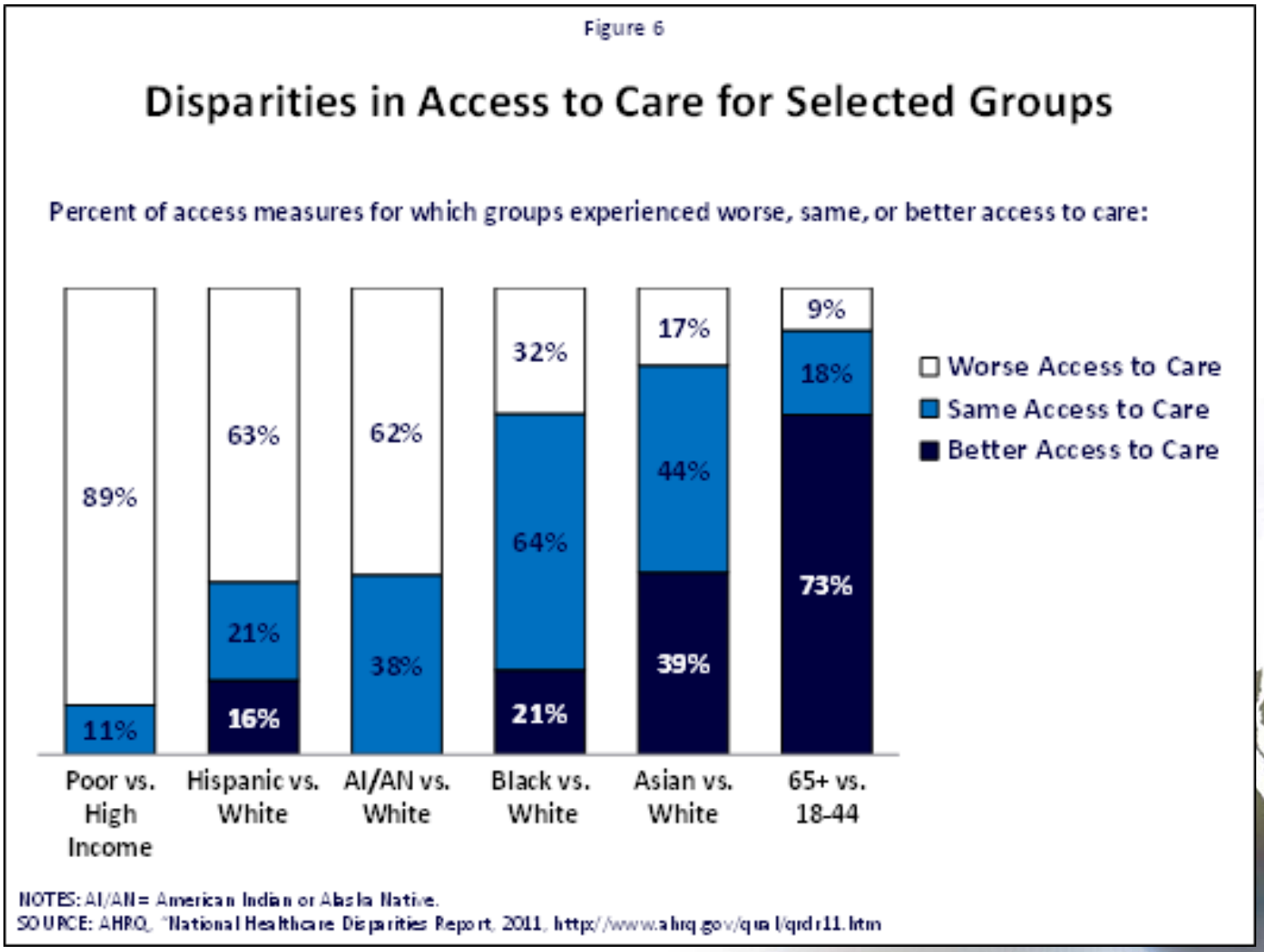
- Hospitalization rates for potentially preventable conditions were highest among residents in poorer communities but lowest among residents from wealthier communities.
- Hospital admission rates for diabetes without complications was more than 400 percent higher in the poorest communities than the rate in the wealthiest communities

Trends (2005-2010)

- Good news
  - Number of potentially preventable hospital admissions (-6.2%) for adults and children (-40%)
  - For children, preventable hospital admission rates for gastroenteritis (-64%) and pediatric urinary tract infection (-19%). Related costs -55% and -21%, resp.
- Not so good news
  - Potentially preventable hospital admissions for short term diabetes complications (+23%) and hypertension (+33%). Total hospital costs +32% and +62%, resp.

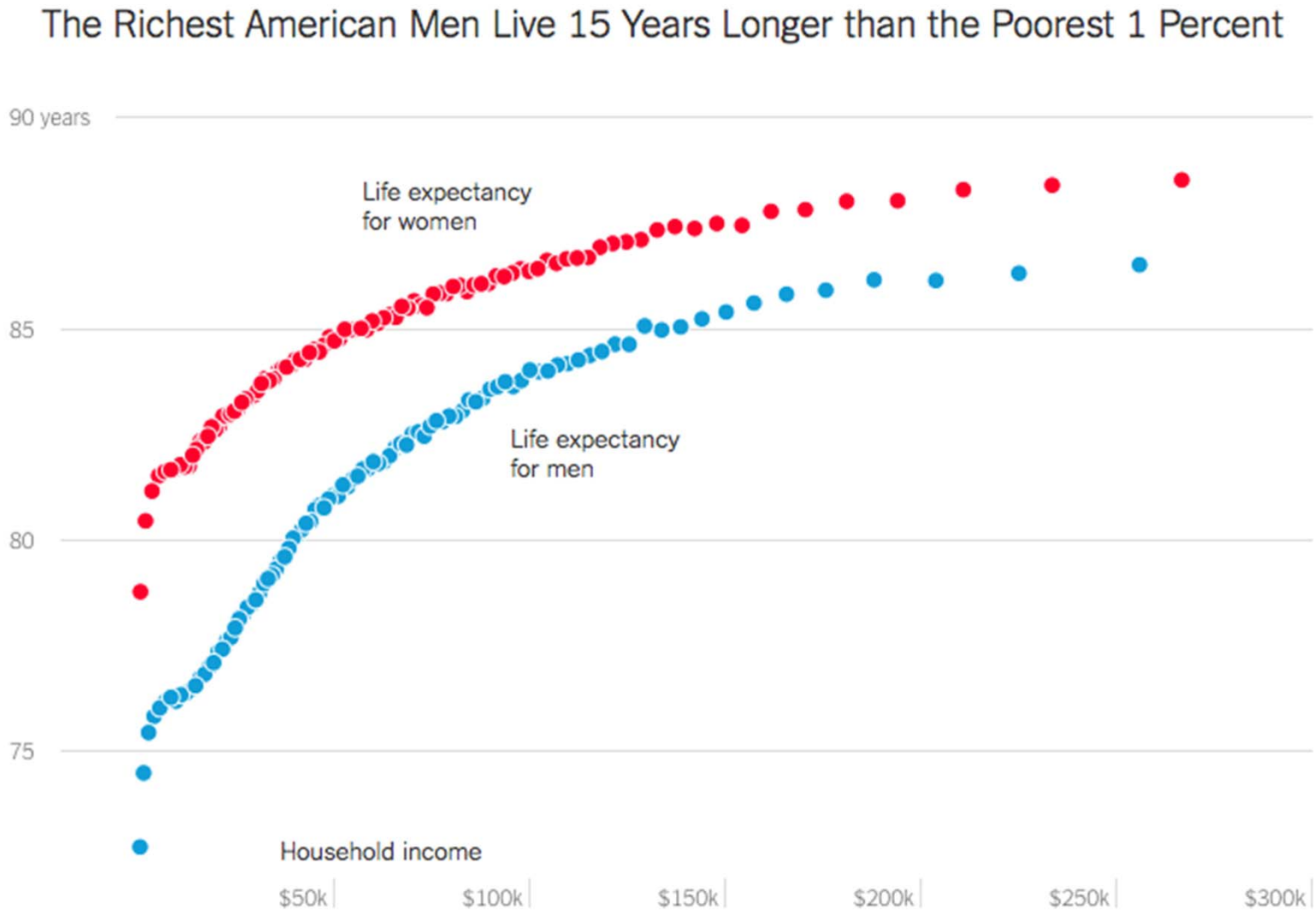
https://www.hcup-us.ahrq.gov/reports/statbriefs/sb151.pdf

Disparities in Access to Care



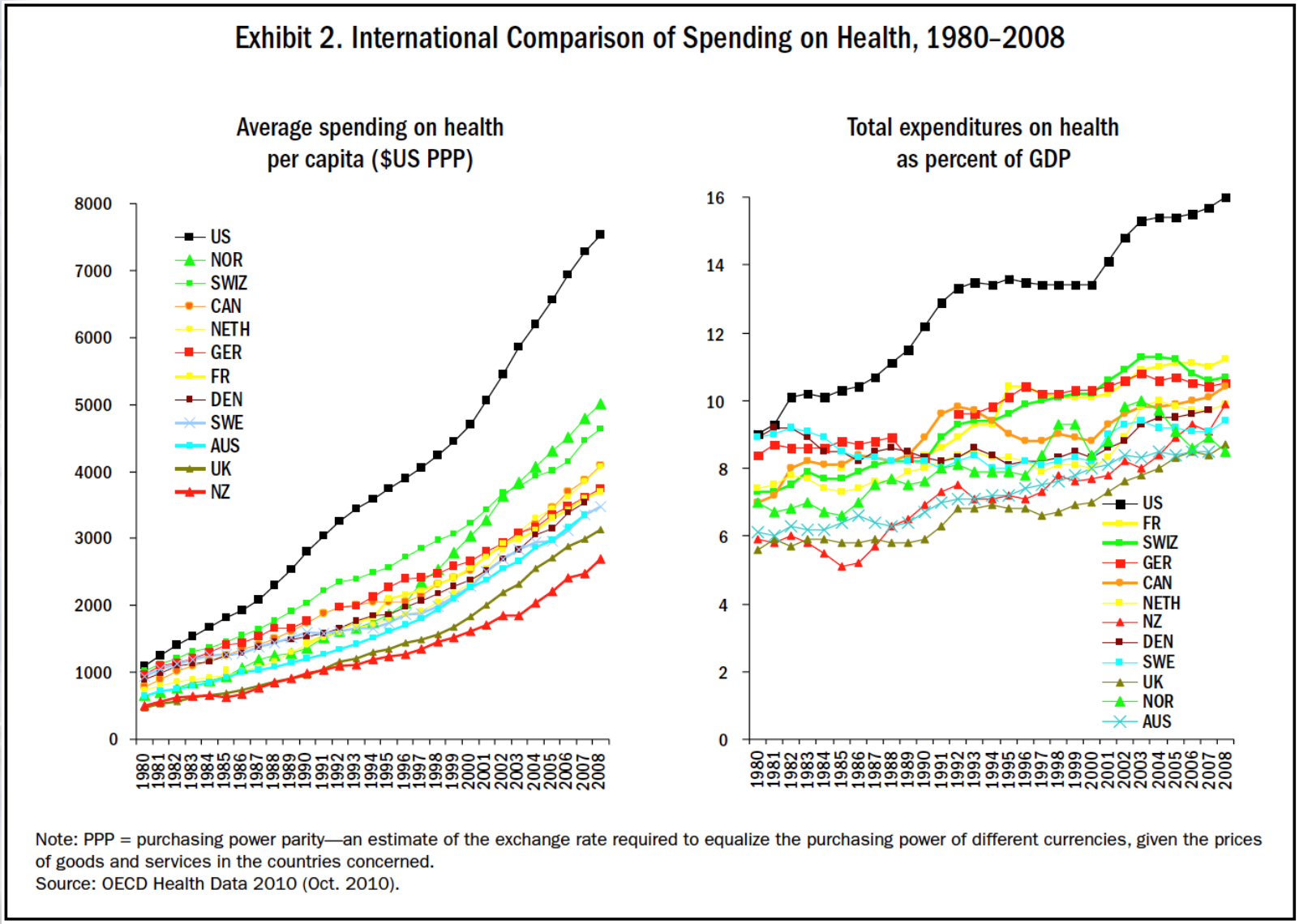
Source: http://kff.org/disparities-policy/issue-brief/disparities-in-health-and-health-care-five-key-questions-and-answers/

Disparities based on income



Source: "The Association Between Income and Life Expectancy in the United States, 2001-2014", The Journal of the American Medical Association, 2016

US Leads in Per Capita Health Spending

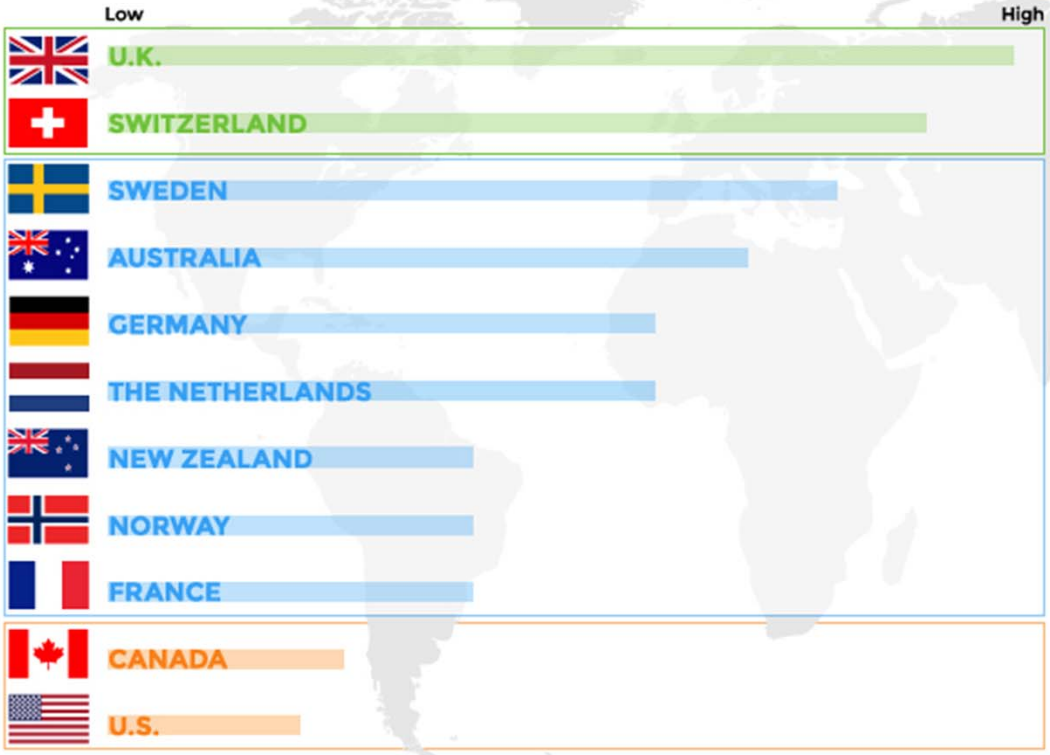


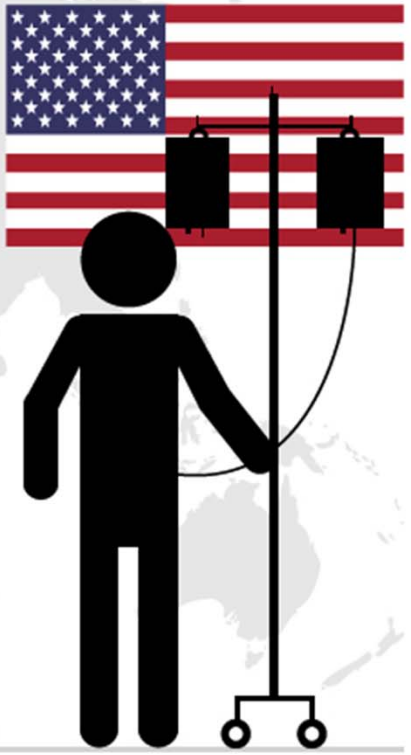
Source: Squires. Commonwealth Fund. 2011

U.S. HEALTH CARE RANKS LAST AMONG WEALTHY COUNTRIES

A recent international study compared 11 nations on health care quality, access, efficiency, and equity, as well as indicators of healthy lives such as infant mortality.

Overall Health Care Ranking

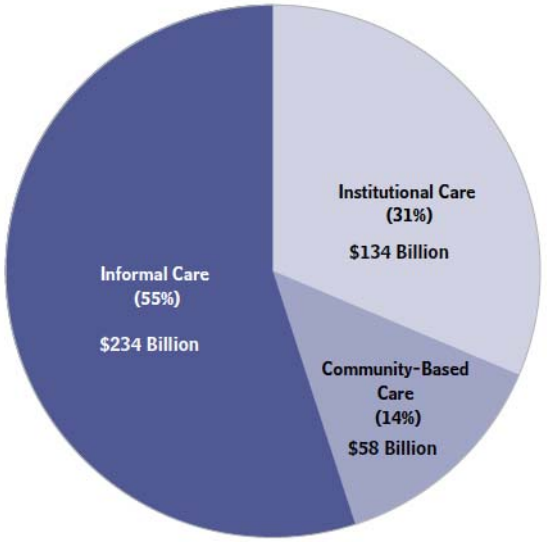




Source: K. Davis, K. Stremikis, D. Squires, and C. Schoen, *Mirror, Mirror on the Wall: How the Performance of the U.S. Health Care System Compares Internationally, 2014 Update*, The Commonwealth Fund, June 2014.

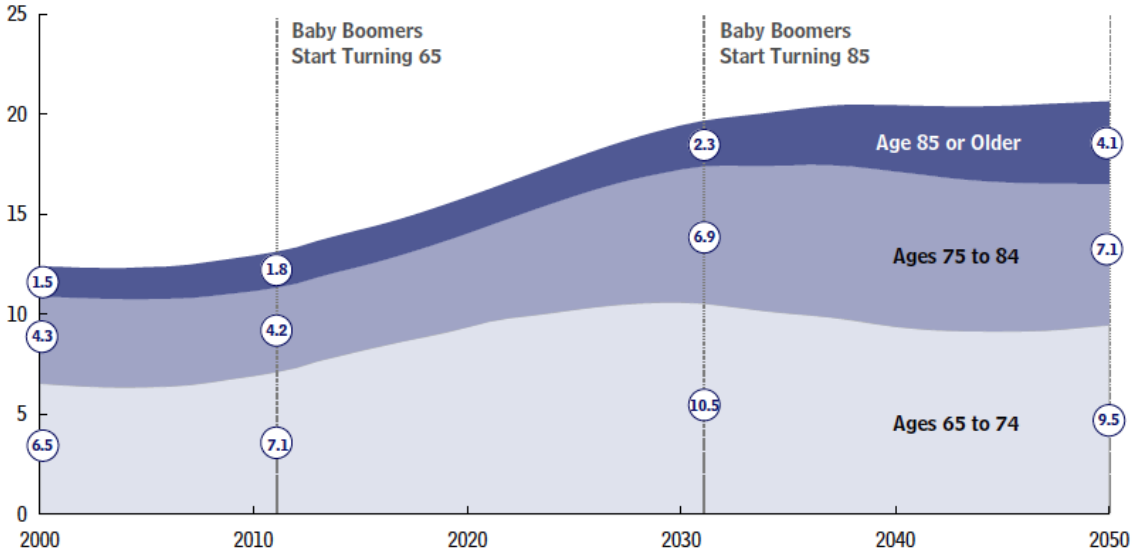
The COMMONWEALTH FUND

Aging Population and Care Needs



Elderly Adults As a Share of the U.S. Population, 2000 to 2050

(Percent)



Source: Congressional Budget Office tabulations based on population projections reported in *The 2012 Long-Term Budget Outlook* (June 2012), www.cbo.gov/publication/43288.

Note: Members of the baby-boom generation (people born between 1946 and 1964) started turning 65 in 2011 and will turn 85 beginning in 2031.

Source: Congressional Budget Office. Rising Demand for Long-Term Services and Supports for Elderly People. June 2013.

The challenges underlying the disparities in the use of clinical preventive services are complex and reach beyond the traditional heath care arena of patient-provider interactions. Combining forces of the public health infrastructure, aging services network, community-based organizations, and linking to health systems affords a real opportunity to make a difference.

CDC Report: Enhancing the Use of Clinical Preventive Services Among Older Adults (CPS): Closing the Gap
http://www.cdc.gov/aging/help/dph-aging/clinical-preventive-services.html

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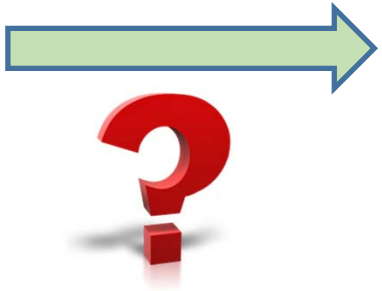
Source: White House PCAST Report
https://www.whitehouse.gov/blog/2014/05/29/new-pcast-report-says-systems-engineering-can-improve-health-care

Fix when it breaks

Fragmented care

Systems

engineering



Integrative health