



INFORMATICS PROFESSIONALS. LEADING THE WAY.

2D: Health System Performance and Evaluation

Bimal R. Desai, MD, MBI, FAAP, FAMIA
Children's Hospital of Philadelphia

Clinical Informatics
Board Review Course

Clinical Informatics Subspecialty Delineation of Practice (CIS DoP)

Domain 1: Fundamental Knowledge and Skills (no Tasks are associated with this Domain which is focused on fundamental knowledge and skills)

Clinical Informatics

K001. The discipline of informatics (e.g., definitions, history, careers, professional organizations)
K002. Fundamental informatics concepts, models, and theories
K003. Core clinical informatics literature (e.g., foundational literature, principle journals, critical analysis of literature, use of evidence to inform practice)

K004. Descriptive and inferential statistics
K005. Health Information Technology (HIT) principles and science
K006. Computer programming fundamentals and computational thinking

K007. Basic systems and network architectures
K008. Basic database structure, data retrieval and analytics techniques and tools

K009. Development and use of interoperability/exchange standards (e.g., Fast Health Interoperability Resources [FHIR], Digital Imaging and Communications in Medicine [DICOM])
K010. Development and use of transaction standards (e.g., American National Standards Institute X12)

K011. Development and use of messaging standards (e.g., Health Level Seven [HL7] v2)

K012. Development and use of ancillary data standards (e.g., imaging and Laboratory Information System [LIS])
K013. Development and use of data model standards

K014. Vocabularies, terminologies, and nomenclatures (e.g., Logical Observation Identifiers Names and Codes [LOINC], Systematized Nomenclature of Medicine –Clinical Terms [SNOMED-CT], RxNorm, International Classification of Diseases [ICD], Current Procedural Terminology [CPT])
K015. Data taxonomies and ontologies

K016. Security, privacy, and confidentiality requirements and practices
K017. Legal and regulatory issues related to clinical data and information sharing

K018. Technical and non-technical approaches and barriers to interoperability

K019. Ethics and professionalism

The Health System

K020. Primary domains of health, organizational structures, cultures, and processes (e.g., health care delivery, public health, personal health, population health, education of health professionals, clinical research)

K021. Determinants of individual and population health
K022. Forces shaping health care delivery and considerations regarding health care access

K023. Health economics and financing

K024. Policy and regulatory frameworks related to the healthcare system

K025. The flow of data, information, and knowledge within the health system

Domain 2: Improving Care Delivery and Outcomes

K026. Decision science (e.g., Bayes theorem, decision analysis, probability theory, utility and preference assessment, test characteristics)

K027. Clinical decision support standards and processes for development, implementation, evaluation, and maintenance
K028. Five Rights of clinical decision support (i.e., information, person, intervention formats, channel, and point/time in workflow)

K029. Legal, regulatory, and ethical issues regarding clinical decision support

K030. Methods of workflow analysis

K031. Principles of workflow re-engineering

K032. Quality improvement principles and practices (e.g., Six Sigma, Lean, Plan-Do-Study-Act [PDSA] cycle, root cause analysis)

K033. User-centered design principles (e.g., iterative design process)

K034. Usability testing

K035. Definitions of measures (e.g., quality performance, regulatory, pay for performance, public health surveillance)

K036. Measure development and evaluation processes and criteria

K037. Key performance indicators (KPIs)

K038. Claims analytics and benchmarks

K039. Predictive analytic techniques, indications, and limitations

K040. Clinical and financial benchmarking sources (e.g., Gartner, Healthcare Information and Management Systems Society [HIMSS] Analytics, Centers for Medicare and Medicaid Services [CMS], Leapfrog)

K041. Quality standards and measures promulgated by quality organizations (e.g., National Quality Forum [NQF], Centers for Medicare and Medicaid Services [CMS], National Committee for Quality Assurance [NCQA])

K042. Facility accreditation quality and safety standards (e.g., The Joint Commission, Clinical Laboratory Improvement Amendments [CLIA])

K043. Clinical quality standards (e.g., Physician Quality Reporting System [PQRS], Agency for Healthcare Research and Quality [AHRQ], National Surgical Quality Improvement Program [NSQIP], Quality Reporting Document Architecture [QRDA], Health Quality Measure Format [HQMF], Council on Quality and Leadership [COL], Fast Health Interoperability Resources [FHIR], Clinical Reasoning)

K044. Reporting requirements

K045. Methods to measure and report organizational performance

K046. Adoption metrics (e.g., Electronic Medical Records Adoption Model [EMRAM], Adoption Model for Analytics Maturity [AMAM])

K047. Social determinants of health

K048. Use of patient-generated data

K049. Prediction models

K050. Risk stratification and adjustment

K051. Concepts and tools for care coordination

K052. Care delivery and payment models

Domain 3: Enterprise Information Systems

K053. Health information technology landscape (e.g., innovation strategies, emerging technologies)

K054. Institutional governance of clinical information systems

K055. Information system maintenance requirements

K056. Information needs analysis and information system selection

K057. Information system implementation procedures

K058. Information system evaluation techniques and methods

K059. Information system and integration testing techniques and methodologies

K060. Enterprise architecture (databases, storage, application, interface engine)

K061. Methods of communication between various software components

K062. Network communications infrastructure and protocols between information systems (e.g., Transmission Control Protocol/Internet Protocol [TCP/IP], switches, routers)

K063. Types of settings (e.g., labs, ambulatory, radiology, home) where various systems are used

K064. Clinical system functional requirements

K065. Models and theories of human-computer (machine) interaction (HCI)

K066. HCI evaluation, usability engineering and testing, study design and methods

K067. HCI design standards and design principles

K068. Functionalities of clinical information systems (e.g., Electronic Health Records [EHR], Laboratory Information System [LIS], Picture Archiving and Communication System [PACS], Radiology Information System [RIS] vendor-neutral archive, pharmacy, revenue cycle)

K069. Consumer-facing health informatics applications (e.g., patient portals, mobile health apps and devices, disease management, patient education, behavior modification)

K070. User types and roles, institutional policy and access control

K071. Clinical communication channels and best practices for use (e.g., secure messaging, closed loop communication)

K072. Security threat assessment methods and mitigation strategies

K073. Security standards and safeguards

K074. Clinical impact of scheduled and unscheduled system downtime

K075. Information system failure modes and downtime mitigation strategies (e.g., replicated data centers, log shipping)

K076. Approaches to knowledge repositories and their implementation and maintenance

K077. Data storage options and their implications

K078. Clinical registries

K079. Health information exchanges

K080. Patient matching strategies

K081. Master patient index

K082. Data reconciliation

K083. Regulated medical devices (e.g., pumps, telemetry monitors) that may be integrated into information systems

K084. Non-regulated medical devices (e.g., consumer devices)

K085. Telehealth workflows and resources (e.g., software, hardware, staff)

Domain 4: Data Governance and Data Analytics

K086. Stewardship of data

K087. Regulations, organizations, and best practice related to data access and sharing agreements, data use, privacy, security, and portability

K088. Metadata and data dictionaries

K089. Data life cycle

K090. Transactional and reporting/research databases

K091. Techniques for the storage of disparate data types

K092. Techniques to extract, transform, and load data

K093. Data associated with workflow processes and clinical context

K094. Data management and validation techniques

K095. Standards related to storage and retrieval from specialized and emerging data sources

K096. Types and uses of specialized and emerging data sources (e.g., imaging, bioinformatics, Internet of things [IoT], patient-generated, social determinants)

K097. Issues related to integrating emerging data sources into business and clinical decision making

K098. Information architecture

K099. Query tools and techniques

K100. Flat files, relational and non-relational/NoSQL database structures, distributed file systems

K101. Definitions and appropriate use of descriptive, diagnostic, predictive, and prescriptive analytics

K102. Analytic tools and techniques (e.g., Boolean, Bayesian, statistical/mathematical modeling)

K103. Advanced modeling and algorithms

K104. Artificial intelligence

K105. Machine learning (e.g., neural networks, support vector machines, Bayesian network)

K106. Data visualization (e.g., graphical, geospatial, 3D modeling, dashboards, heat maps)

K107. Natural language processing

K108. Precision medicine (customized treatment plans based on patient-specific data)

K109. Knowledge management and archiving science

K110. Methods for knowledge persistence and sharing

K111. Methods and standards for data sharing across systems (e.g., health information exchanges, public health reporting)

Domain 5: Leadership and Professionalism

K112. Environmental scanning and assessment methods and techniques

K113. Consensus building, collaboration, and conflict management

K114. Business plan development for informatics projects and activities (e.g., return on investment, business case analysis, pro forma projections)

K115. Basic revenue cycle

K116. Basic managerial/cost accounting principles and concepts

K117. Capital and operating budgeting

K118. Strategy formulation and evaluation

K119. Approaches to establishing Health Information Technology (HIT) mission and objectives

K120. Communication strategies, including one-on-one, presentation to groups, and asynchronous communication

K121. Effective communication programs to support and sustain systems implementation

K122. Writing effectively for various audiences and goals

K123. Negotiation strategies, methods, and techniques

K124. Conflict management strategies, methods, and techniques

K125. Change management principles, models, and methods

K126. Assessment of organizational culture and behavior change theories

K127. Theory and methods for promoting the adoption and effective use of clinical information systems

K128. Motivational strategies, methods, and techniques

K129. Basic principles and practices of project management

K130. Project management tools and techniques

K131. Leadership principles, models, and methods

K132. Intergenerational communication techniques

K133. Coaching, mentoring, championing and cheerleading methods

K134. Adult learning theories, methods, and techniques

K135. Teaching modalities for individuals and groups

K136. Methods to assess the effectiveness of training and competency development

K137. Principles, models, and methods for building and managing effective interdisciplinary teams

K138. Team productivity and effectiveness (e.g., articulating team goals, defining rules of operation, clarifying individual roles, team management, identifying and addressing challenges)

K139. Group management processes (e.g., nominal group, consensus mapping, Delphi method)



Knowledge Statements from the DoP

- K021. Determinants of individual and population health
- K022. Forces shaping health care delivery and considerations regarding health care access
- K024. Policy and regulatory frameworks related to the healthcare system
- K035. Definitions of measures (e.g., quality performance, regulatory, pay for performance, public health surveillance)
- K036. Measure development and evaluation processes and criteria
- K037. Key performance indicators (KPIs)
- K038. Claims analytics and benchmarks
- K040. Clinical and financial benchmarking sources (e.g., Gartner, Healthcare Information and Management Systems Society [HIMSS] Analytics, Centers for Medicare and Medicaid Services [CMS], Leapfrog)
- K041. Quality standards and measures promulgated by quality organizations (e.g., National Quality Forum [NQF], Centers for Medicare and Medicaid Services [CMS], National Committee for Quality Assurance [NCQA])
- K042. Facility accreditation quality and safety standards (e.g., The Joint Commission, Clinical Laboratory Improvement Amendments [CLIA])
- K043. Clinical quality standards (e.g., Physician Quality Reporting System [PQRS], Agency for Healthcare Research and Quality [AHRQ], National Surgical Quality Improvement Program [NSQIP], Quality Reporting Document Architecture [QRDA], Health Quality Measure Format [HQMF], Council on Quality and Leadership [CQL], Fast Health Interoperability Resources [FHIR] Clinical Reasoning)
- K044. Reporting requirements
- K045. Methods to measure and report organizational performance
- K047. Social determinants of health
- K048. Use of patient-generated data
- K049. Prediction models
- K050. Risk stratification and adjustment
- K051. Concepts and tools for care coordination
- K052. Care delivery and payment models
- K069. Consumer-facing health informatics applications (e.g., patient portals, mobile health apps and devices, disease management, patient education, behavior modification)
- K084. Non-regulated medical devices (e.g., consumer devices)
- K085. Telehealth workflows and resources (e.g., software, hardware, staff)



Topics

- Definition of healthcare quality and the IOM Quality domains
- How well does the US healthcare system perform?
- Healthcare Equity
- Health of Individuals and Populations (SDOH, Pop Health)
- Sources of Data and Benchmarking
- Quality Standards and Measures
- Facility accreditation and safety
- Public Health Reporting
- Access and Utilization
- Definition of Measures
- Claims Analytics and Benchmarks
- Patient-Generated Data and Innovative Care Models



Definition of Quality in Healthcare

“The degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge.”

<https://www.nap.edu/read/25152/chapter/1>



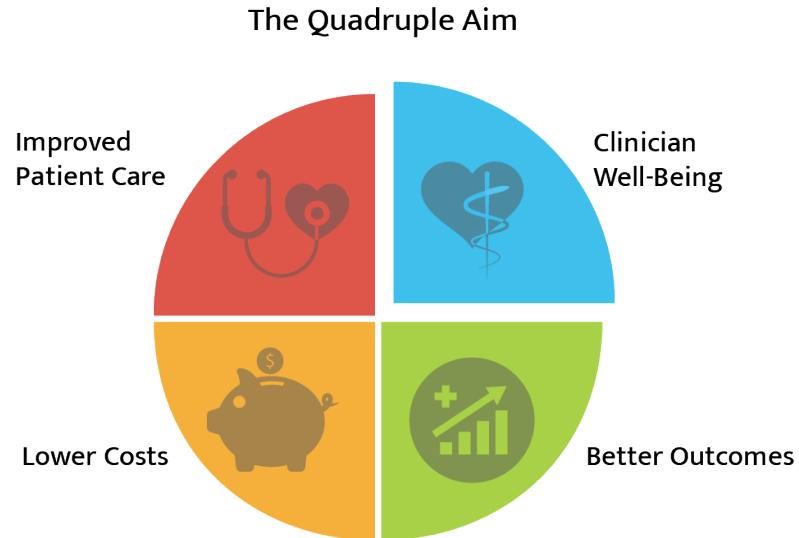
Triple/Quadruple Aim

IHI Triple Aim

- Better Health (Outcomes)
- Better Care (Experience)
- Lower Cost (Higher Value)

Proposed Fourth Aim (and beyond)

- Health Equity
- Joy in Work (Clinician Well-being)
- Organizational Readiness/Preparedness



[Image credit: AMA](#)



IOM (NAM)* Quality Domains

Safe

- 1st IOM Report “To Err is Human” (1999):
1M injured, 44K-98K die annually

Effective / Reliable

- Care is evidence-based; benefits outweigh risks
- Care is consistent – patients receive the same standard of care regardless of where, when, and from whom

Patient-centered

- Meet individual needs, incorporates values/preferences
- Tailored to language, level of education
- Focus on emotional support, pain relief, attention to suffering, family support

Efficient

- Avoid wastefulness and redundancy, match access to demand

Timely

- Avoid long waits, scheduling delays, barriers to care

Equitable

- At population and individual level
- Reduce disparities attributable to age, gender, race, education, disability, sexual orientation, etc.



*Institute of Medicine was renamed National Academy of Medicine in 2015

US Healthcare is Unsafe

Medical errors are harmful and costly

- Early estimates of 98,000 deaths and 1 million injuries annually, at a cost of \$29 billion (IOM, “To Err is Human” 1999)

But these estimates have been disputed

(Source: <https://psnet.ahrq.gov/perspectives/perspective/221/Measuring-and-Responding-to-Deaths-From-Medical-Errors>)

- Soon after report, estimates drew criticism
- 2016 BMJ article placed estimates at 250K per year, which would make medical error the 3rd leading cause of death in the US
- Critique of BMJ and earlier studies include:
 - High variability in attribution of errors
 - Population estimates were extrapolated from a small number of individual studies with few deaths.
 - Studies were not designed to determine if deaths were due to preventable adverse events
 - AHRQ believes “the toll is clearly in the tens of thousands of deaths per year, perhaps more”



US Healthcare is Unsafe

- Two seminal works
 - IOM 1999, "To Err is Human"
 - IOM 2001, "Crossing the Quality Chasm"
- Impact of ADEs
 - \$3.6 Billion in additional expenses due to hospital ADEs
- Adverse Drug Events (ADE)
 - Hospital Adverse Drug Events:
 - Classen 1997: "380,000 preventable adverse drug events annually"
 - Bates 1995: "450,000 preventable ADEs"
 - Long-term Care Facilities
 - Gurwitz 2005: "800,000 ADE's annually"
 - Outpatient Care
 - Gurwitz 2003: "Among Medicare patients alone, 530,000 ADEs"



IOM Types of Errors

Diagnostic

- Error or delay in diagnosis
- Failure to employ indicated tests
- Use of outmoded tests or therapy
- Failure to act on results of monitoring or testing

Treatment

- Error in the performance of an operation, procedure, or test
- Error in administering the treatment
- Error in the dose or method of using a drug
- Avoidable delay in treatment or in responding to an abnormal test
- Inappropriate (not indicated) care

Preventive

- Failure to provide prophylactic treatment
- Inadequate monitoring or follow-up of treatment

Other

- Failure of communication
- Equipment failure
- Other system failure

Leape LL, Lawthers AG, Brennan TA, et al. **Preventing Medical Injury.** Qual Rev Bull. 19(5):144-149, 1993. [[Abstract](#)]



Delivers Inconsistent Value

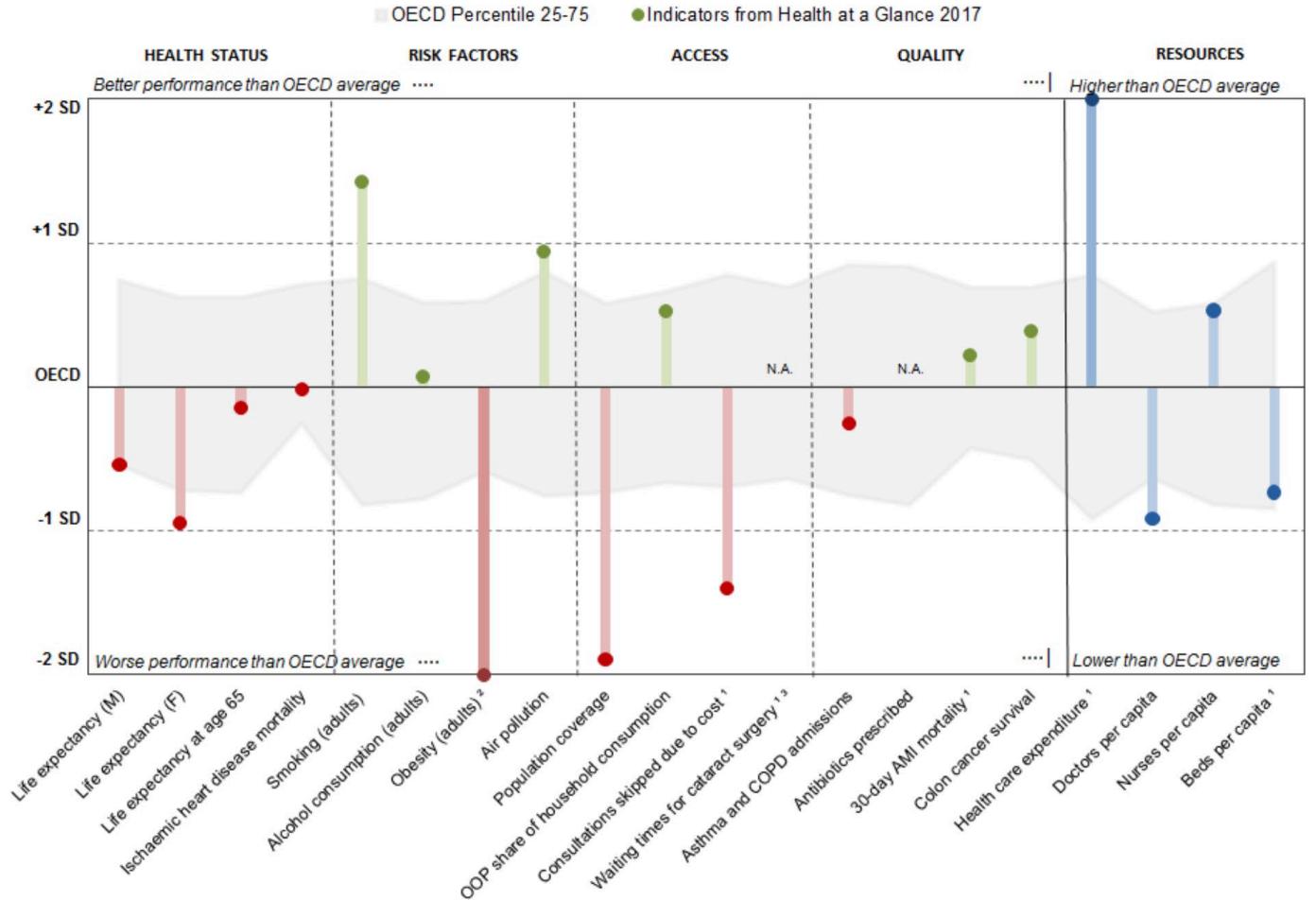
Value = Quality / Cost

- Care can have poor value if it either delivers poor quality or has excess cost (or both)

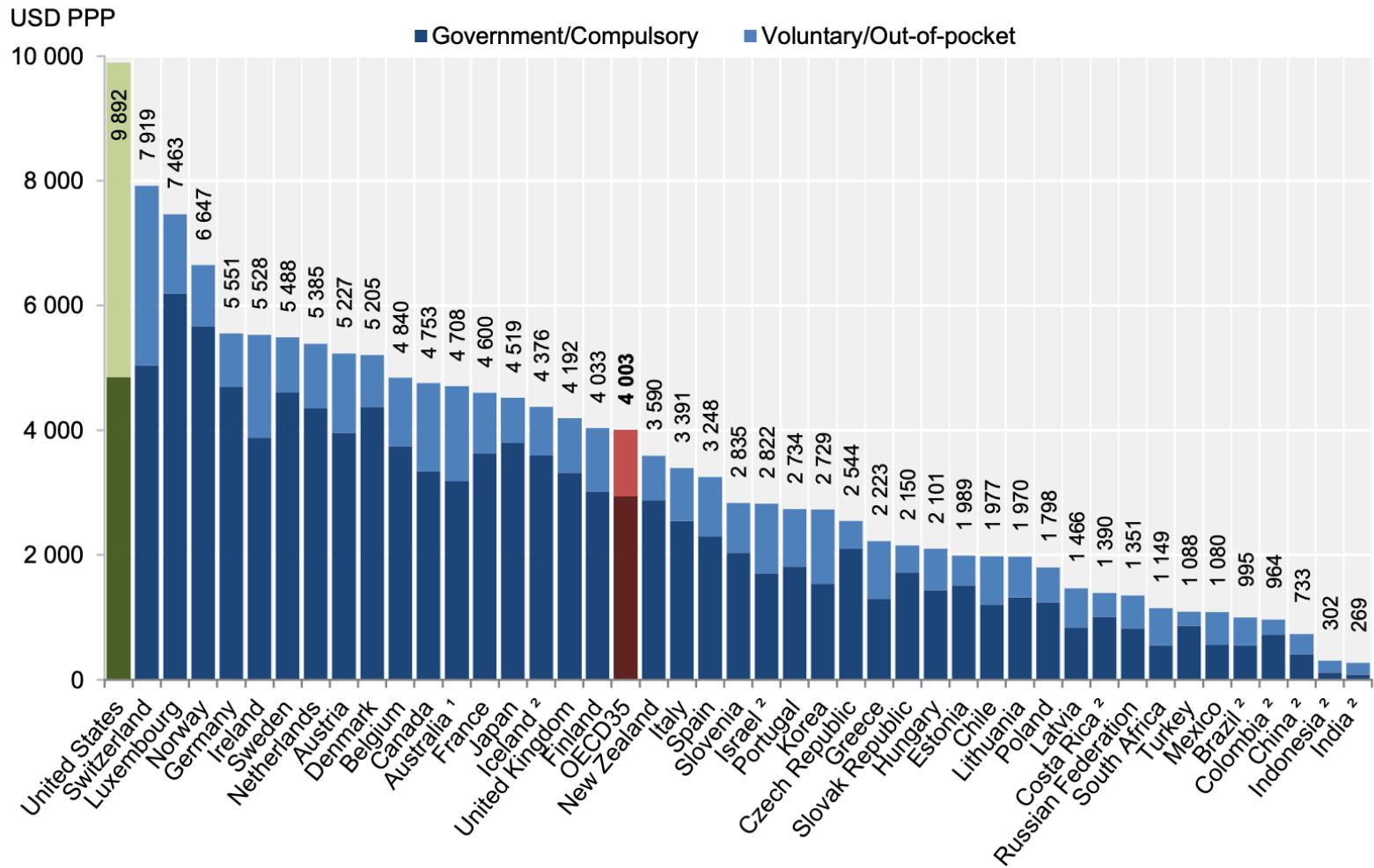
Compared to other developed countries, US healthcare system lags in many markers of healthcare value



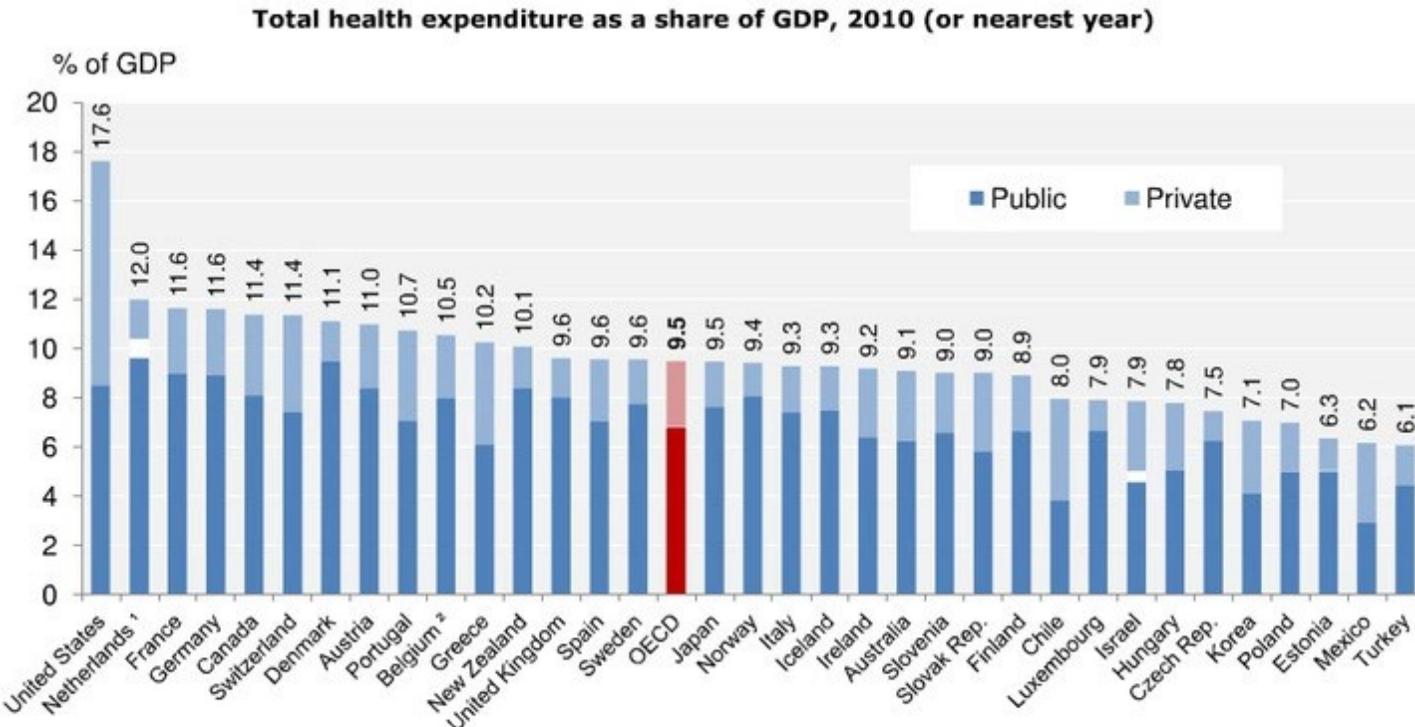
United States – Relative performance compared to the OECD average



Health expenditure per capita, 2016 (or nearest year)



At 17.6% of GDP in 2010, US health spending is one and a half as much as any other country, and nearly twice the OECD average



1. In the Netherlands, it is not possible to clearly distinguish the public and private share related to investments.

2. Total expenditure excluding investments.

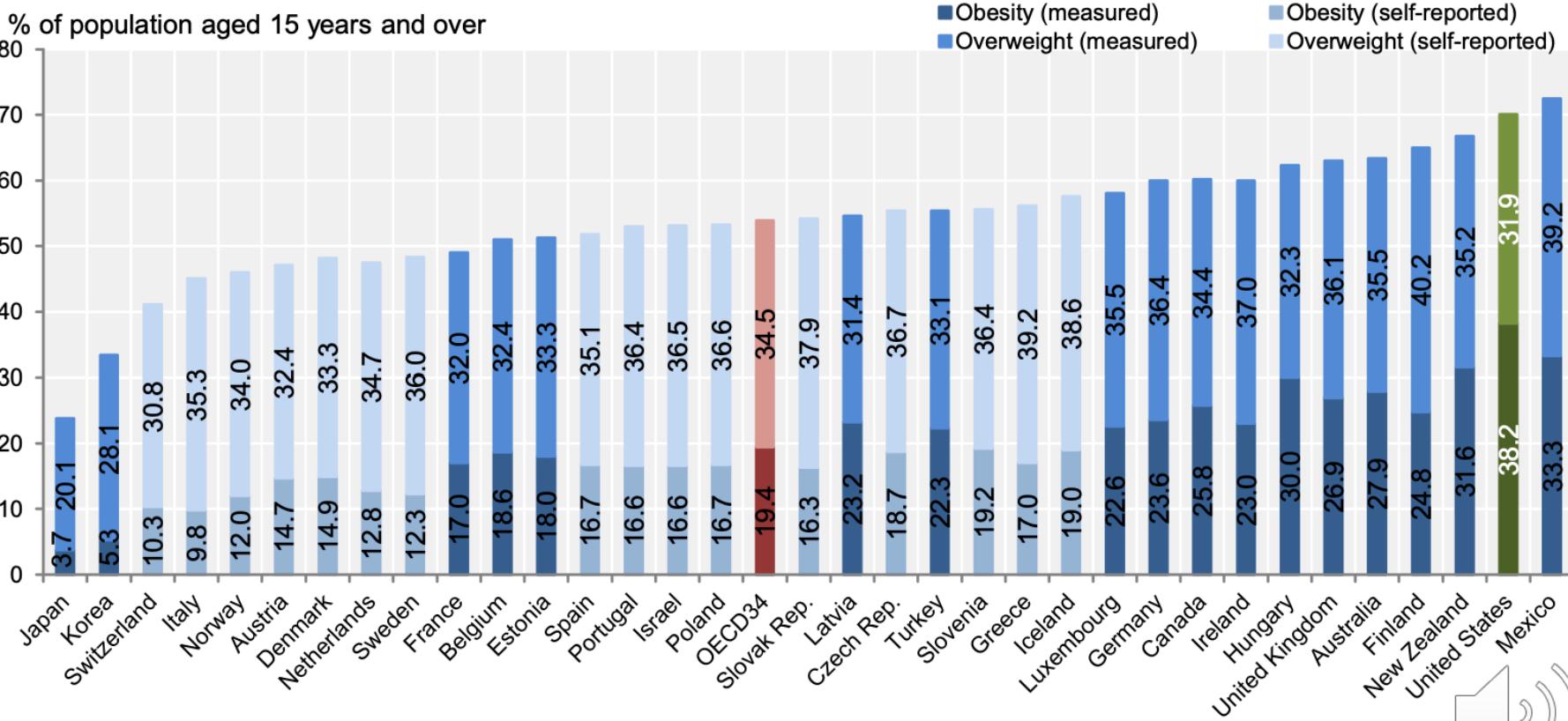
Information on data for Israel: <http://dx.doi.org/10.1787/888932315602>.

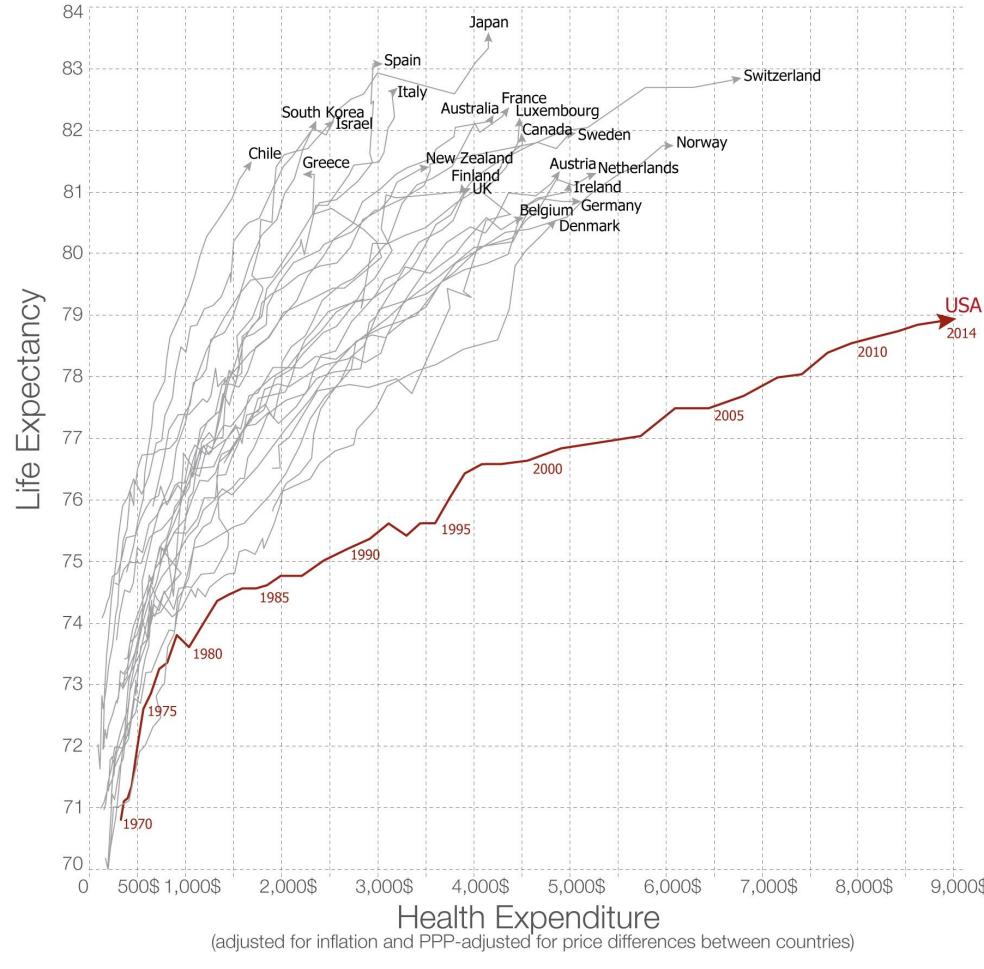
Source: OECD Health Data 2012.



Overweight including obesity among adults, 2015 (or nearest year)

% of population aged 15 years and over



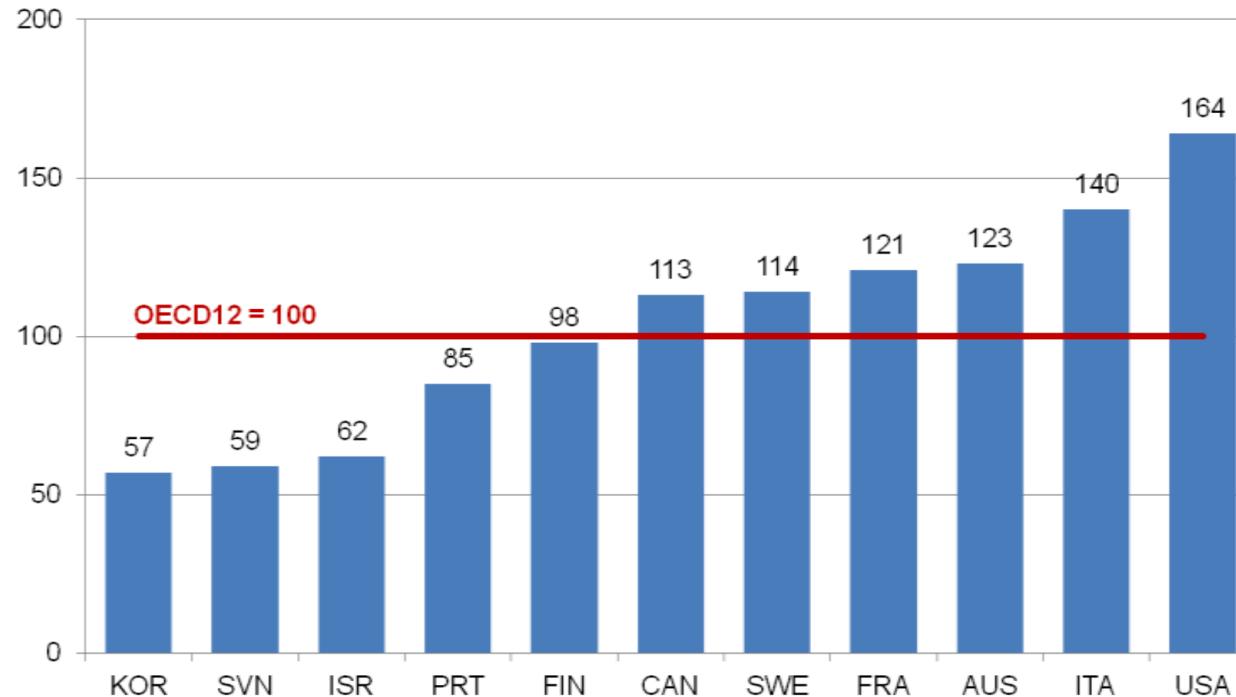


Source: https://commons.wikimedia.org/wiki/File:Life_expectancy_vs_healthcare_spending.jpg



US prices for a set of hospital services are over 60% higher than the average of 12 OECD countries

Comparative price levels for total inpatient hospital services, 2007

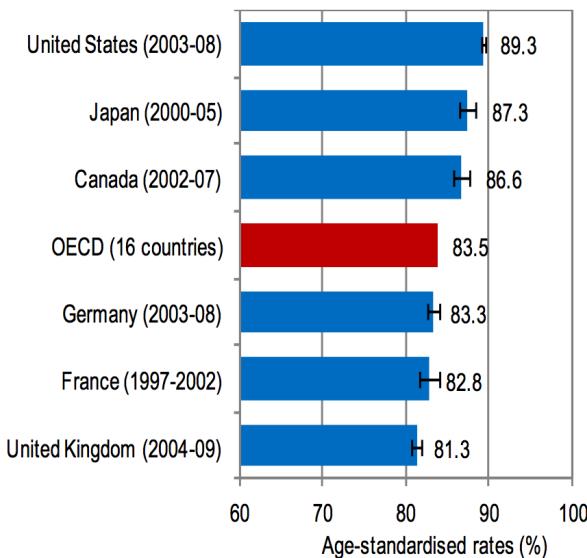


Source: Koechlin et al. (2010).

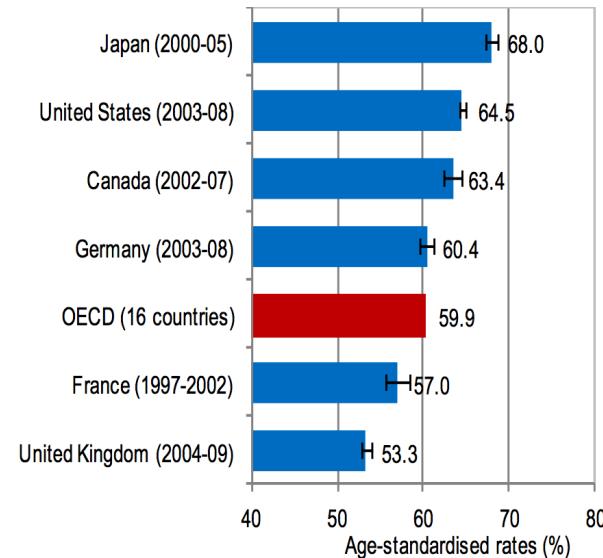


Cancer system is generally performing well

Breast cancer, 5-year survival rate



Colorectal cancer, 5-year survival rate



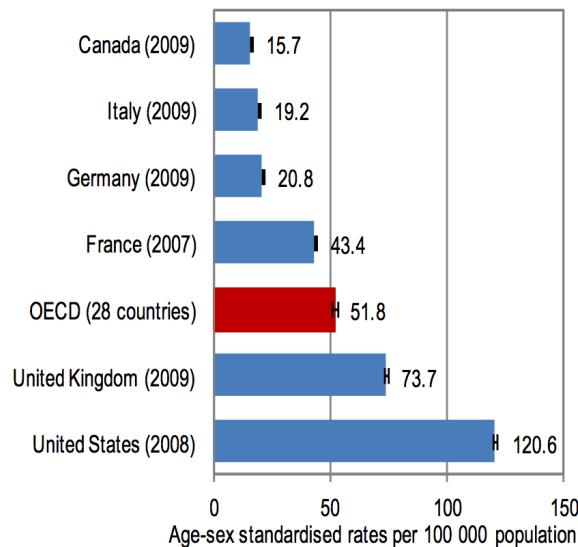
Note: 95% confidence intervals are represented by H.

Source: OECD Health Data 2012.

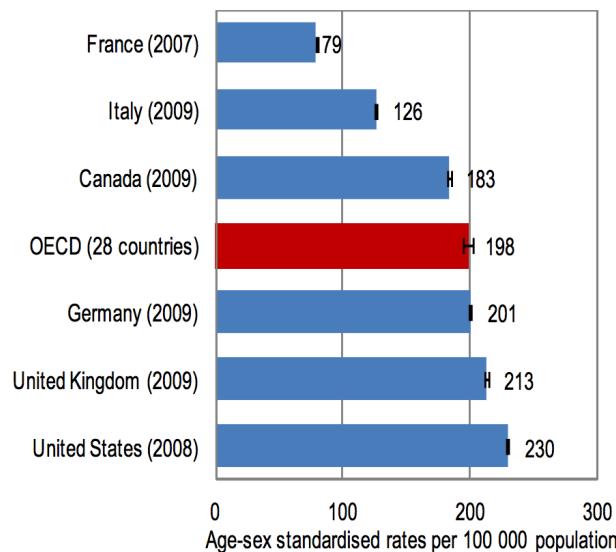


Primary care sector is not performing so well

Asthma hospital admission



COPD hospital admission



Note: 95% confidence intervals are represented by H.

Source: OECD Health Data 2012.



US Healthcare is Inequitable

- Healthcare **disparity** – difference in health outcomes between populations
- Healthcare **inequity** – disparity due to difference in social, economic, environmental, or resource-related causes
 - Healthcare may be inequitable due to explicit/extrinsic or implicit/intrinsic bias and structural differences
 - Ex: Explicit / structural inequity: lack of healthy food choices or quality schools in poor neighborhoods
 - Ex: Implicit: providers are [nearly 3x less likely to use opioids](#) to treat appendicitis pain in black children compared to white children
- Healthcare disparities (population-specific differences in quality and access to health care services) between 2003 and 2006 cost us \$229 billion
 - Infants born to African-American women have [1.5-3x higher infant mortality rate](#)
 - African-American men >2x as likely to [die of prostate cancer](#)
 - Hispanic women >2x as likely to be [diagnosed with cervical cancer](#)
 - In pediatric and adult cancer care, distance from care associated with [later diagnosis, worse outcomes](#)



clipart credit: opfiliation.com

Health Equity & Informatics

- Informatics/Analytics tools have the potential to either improve or worsen bias
 - Make disparities visible: for any dashboard measuring clinical performance, [stratify results by race, SES, preferred language](#)
 - Be cautious of either [inclusion or omission of race in clinical algorithms](#) that could introduce bias
 - Ex: surgical risk calculator that adds points to score for black patients → higher risk may discourage black patients from getting necessary surgery
 - Attention to potential bias in [data](#) and [interpretation/implementation](#) of digital interventions, including AI algorithms
- Emerging challenges and opportunities
 - "[Digital Divide](#)" (telemedicine, patient portal, remote monitoring)
 - Broadband access – FCC [investing in projects](#) to provide rural areas with internet access
 - Device / Internet access – Pew survey suggests smartphone may be [only form of internet access for many](#) low-income households
 - [Language-concordant care](#) is an important determinant of health – are digital tools language-concordant & patient-centered?
 - Digital Connectivity has been described as the "[Sixth Vital Sign](#)", as chronic disease management strategies via telemedicine, remote-patient-monitoring, hospital-at-home, and biosensors become more prevalent.



Social Determinants of Health

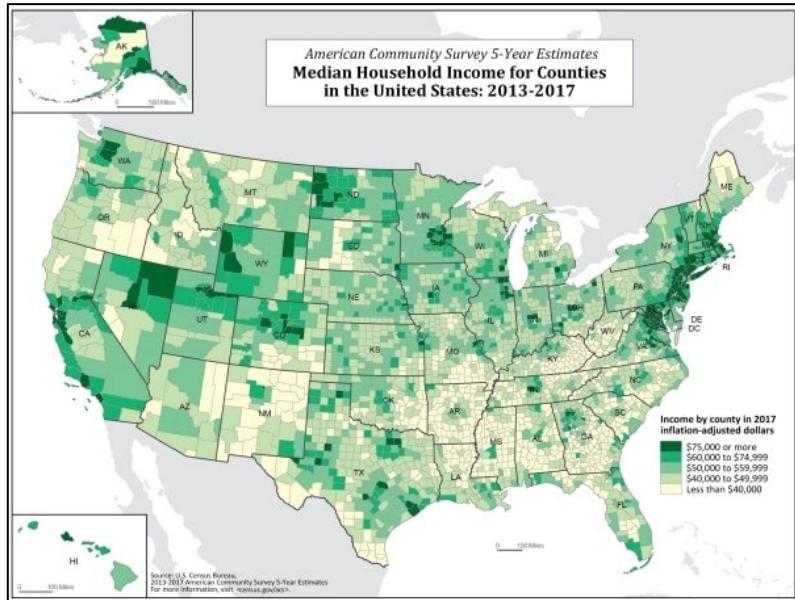
- Social, economic, physical environment influence health, quality of life, access to health care resources, risk for disease, and sense of safety.
- Five generally accepted domains:
 - Economic stability (food insecurity or housing instability)
 - Education access and quality
 - Health care access and quality
 - Neighborhood and built environment (clean water, clean air)
 - Social and community context (interpersonal safety, intimate partner violence)
- Healthy People 2030 is an HHS initiative to improve health of populations. [Website includes overview of baseline statistics and goals for specific populations.](#)
 - Ex: HC/HIT-05 "Increase the proportion of adults with broadband internet"
 - Ex: NWS-02 "Eliminate very low food security in children"
 - Ex: AHS-04 "Reduce proportion of people who can't get medical care when they need it"



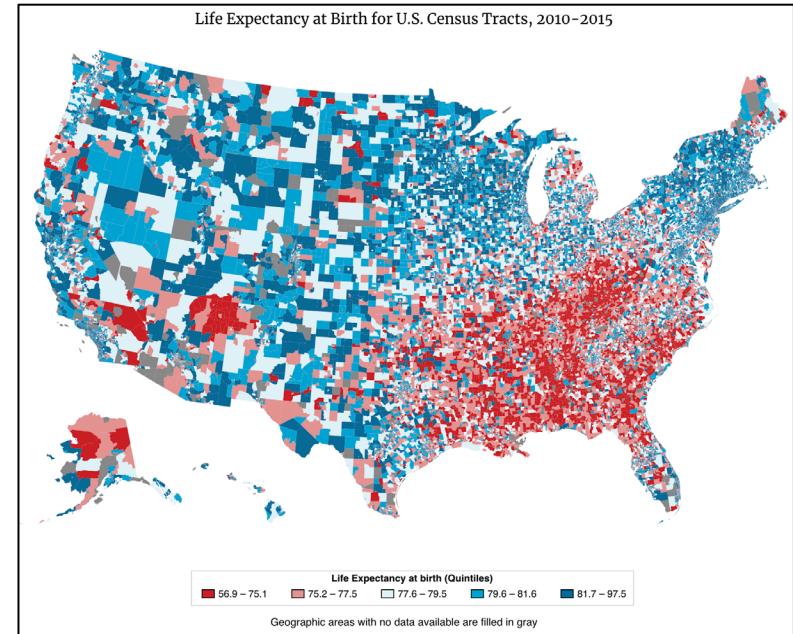
Credit: Healthy People 2030, U.S. Department of Health and Human Services,
Office of Disease Prevention and Health Promotion.
Retrieved 7/30/2021 from <https://health.gov/healthypeople/objectives-and-data/social-determinants-health>



Association Between Social Determinants and Longevity



Median Household Income by Census Tract
Source: [Census.gov](#)

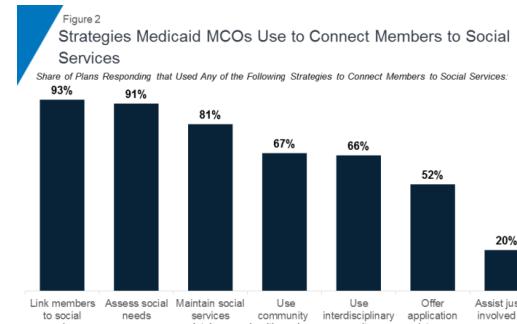
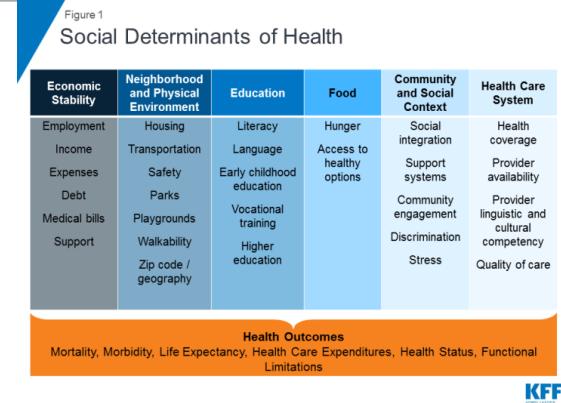


Life Expectancy by Census Tract
Source: [CDC NCHS](#)



Strategies to Screen and Address SDOH

- There are recommended tools for screening SDOH, like PRAPARE, EveryONE, and AHC-HRSN
- Of course, screening without having a plan to intervene/refer would be ineffective, unethical
- Can be implemented in EHRs, linked to resources referral agencies such as Healthify, AuntBertha, NowPow
- Federal healthcare activity to address SDOH is largely through grants and incentive programs
 - Medicaid Delivery System Reform Incentive Payment (DSRIP) incentivize SDOH innovation
 - E.g. NY invested in supportive housing
 - E.g. TX bought insulin refrigerators for homeless shelters
 - Medicaid Managed Care Contracts may include SDOH strategies
- Health Systems are increasingly addressing SDOH barriers directly
 - Hospital or civic partnerships to reduce food insecurity / healthy food access.
 - Partnerships to remediate homes, reduce asthma triggers



NOTES: Plans were asked "In the Past 12 months, has your Medicaid MCO used any of the following strategies to connect members with social services?" "Other" responses (4% of plans) not shown.
SOURCE: Kaiser Family Foundation Survey of Medicaid Managed Care Plans, 2017.



The Health of Populations

- **Public Health** protects / improves health of communities through policy, education, outreach, research
- **Population Health** is the “[health outcomes of a group of individuals, including the distribution of such outcomes within the group](#)” [Kindig & Stoddart, 2003]
- Common use today (especially in informatics) is to describe “population-based disease management” or “population health management” (**PHM**, coined by David Nash)
 - Focus on prevention, care coordination, agency/self-efficacy, personalization of care, cost-effectiveness
- Health System / Informatics approach to PHM:
 - **EHR-defined cohort** based on identifiable criteria (ICD-10 codes, encounter types, procedure codes, demographics, payer)
 - Definition of a **registry** that is either manually or automatically updated for that cohort (e.g. all children with recent new diagnosis of diabetes)
 - Definition of **key performance indicators** to demonstrate consistent delivery of care (e.g. timely screening, vaccination, Rx rates)
 - Definition of **risk indicators** to identify outliers or patients who need additional attention (e.g. # missed visits, cardiac risk score)
 - Definition of **clinical/health-status indicators** to demonstrate outcomes of care (e.g. HgbA1c)
 - Infrastructure and “efferent arm” to monitor a **population dashboard**, identify patients that need personalized care/intervention, and escalate as necessary. Often requires a dedicated population health management team (case managers, SW, nursing, etc.)



Case Study: The Camden Coalition

- Program founded by Philadelphia physician Dr. Jeffrey Brenner
- Worked with city of Camden, NJ, to identify **supers utilizers** using a technique known as **hot spotting**.
- Post-discharge, patients are assigned nurses, social workers, community health workers to coordinate outpatient care, link patients to social services.
- Early results were promising, showing reduction in readmission by 40%
- But a [2020 RCT](#) suggests that patients who received routine care had similar readmission rates to Camden cohort
- Does that mean PHM doesn't work?
 - Systematic reviews find [more studies that demonstrate benefit than not](#)
 - However, PHM may not reduce total healthcare spending – savings may not offset cost of program/interventions.
 - Bottom line: while we explore and understand models of PHM effectiveness, [health systems should invest in PHM because it provides health benefits at the same cost, not because it will save money](#)



Tools & Concepts for Care Coordination

- Patient-Centered Medical Home ([PCMH](#))
 - Model of care delivery that emphasizes role of primary care site as coordinator of physical/mental health services for patients
 - Team-based approach that includes physician, APN, PA, nurse, pharmacist, nutritionist, social worker, educators, coordinators
 - Patient-Centered = understands and takes into account needs, culture, values, preferences of the patient; emphasizes partnership
 - Focus on coordination of care between specialists, hospitals, home health, community/support services
 - Focus on accessibility (phone or portal access at all times) and alternate methods of communication (email, phone, SMS, portal)
 - Goal to improve quality and safety – accountable via data sharing
- Accountable Care Organization ([ACO](#))
 - Group of doctors, hospitals, other providers who coordinate high quality care for Medicare patients
 - Medicare offers several [ACO Programs](#)
- Care Management
 - Identify populations with modifiable risk, align CM services to needs of population, identify personnel to provide those services.



Quality Standards & Organizations

CMS – Center for Medicare & Medicaid Services

- Have published clinical quality measures (CQMs) that define appropriate use of EHR technology to support clinical practice
- Submitting CQM data is required in order to receive Meaningful Use incentive in Stage 1 and Stage 2
- Derived from NQF measures
- Administers the EHR Incentive Program, total funds ~ \$21 billion

NQF – National Quality Forum

- Collects and standardizes quality measures in a tool known as QPS or Quality Positioning System
- Each NQF-endorsed measure has an NQF number, defined steward, and update / revision cycle



Quality Standards & Organizations

NCQA – National Committee for Quality Assurance

- Publish and maintain Health Effectiveness Data and Information Set (HEDIS) performance measures
- Intent is to allows consumers to benchmark health plans
- Process of physician and hospital accreditation
- HEDIS measures are required of CMS “Medicare Advantage” subcontractors, like HMOs

ONC – Office of the National Coordinator for Healthcare IT

- Established in 2004 by legislative order, mandated in 2009 in the HITECH Act (Title XIII of ARRA, “the stimulus package”)
- Oversees national activities to promote HIT and healthcare information exchange
- Established certification criteria for EHR
- Established HIE standards



Quality Standards & Organizations

Joint Commission

- Non-profit that accredits US healthcare organizations
- Established National Patient Safety Goals (NPSG)
 - Ex: reduction of MDRO, catheter-related bloodstream infections, surgical site infections

Leapfrog Group

- Voluntary program that described “4 leaps” that would improve safety and quality of US healthcare system
 - CPOE – recommend a list of CPOE functions/safeguards
 - Evidence-based hospital referral – recommend referring complex cases to high volume and high-quality health care facilities
 - ICU Physician Staffing – recommend staffing ICU with intensivists
 - Leapfrog Safe Practice Score (a list of NQF-endorsed safe practices)

The Council on Quality and Leadership (CQL, not to be confused with Clinical Quality Language)

- Accredits organizations that care for patients with intellectual, psychiatric, and developmental disabilities



Different Types of Quality Measures

- Donabedian categories: Structure, Process, Outcomes
- Sources of Quality Measures: administrative, medical records, patient surveys, patient feedback/comments, standardized clinical data
- Categories of Quality Measures:
 - Quality Performance - eClinical Quality Measures ([eCQM](#))
 - Regulatory – CMS Conditions of Participation, Joint Commission
 - [CMS](#): ePrescribing, Prescription Drug Monitoring Program (PDMP), HIE, eCQM
 - [JC](#): ORYX reports, including eCQM
 - Pay-for-Performance ([P4P](#)) aka “value-based care”
 - Incentives for higher performance; disincentives for readmissions, avoidable harm
 - Public Health Surveillance – local, state, and federal reporting of specific conditions or outcomes
 - Ex: CDC National Healthcare Surveillance Network ([NHSN](#)) for reportable conditions and hospital-acquired infections
 - Hospital association benchmarking
 - Ex: [Children's Hospital Association](#) benchmarks peer hospitals on quality, sepsis, safety, outcomes



clipart library.com

Measure Development & Evaluation

National Quality Forum ([NQF](#))

- Sets standard for quality measures via NQF-endorsed measures
- Recommends which measures are used for payment / public reporting
- Advances electronic measurement through Health IT initiatives

NQF [develops and validates measures](#) through a rigorous process, taking into account many factors:

- Standardization, comparability, availability, timeliness, relevance, validity
- Experience, stability, evaluability, distinguishability, credibility



NQF Example

NQF #0002 – Appropriate Test for Children with Pharyngitis

- Measure Steward – NCQA
- Measure description – “percentage of children 2-18 who received a diagnosis of pharyngitis, had strep testing, and received abx”
- Numerator – “a group A strep test was performed in the 7 day period from 3 days before to 3 days after index episode”
- Denominator – “children age 2 to 18 as of 6mo prior to measurement period who had an outpatient or ED visit with only a diagnosis of pharyngitis”
- Exclusions
- Risk Adjustment
- Additional Classifications (condition, care setting, data source, etc)



Key Performance Indicators (KPI)

Set of quantifiable measures that an organization uses to gauge performance over time

Examples of **operational KPIs** for a health system

- Average occupancy, time to discharge, average LOS

Example of **clinical KPIs**

- Acute MI: time to reperfusion, rate of prescription of ACE/ β -blocker/statins at discharge, rates of intervention for smoking cessation

Often displayed, trended, and tracked on a KPI Dashboard – can also be used in datamarts, population health tools, care manager dashboards, etc.



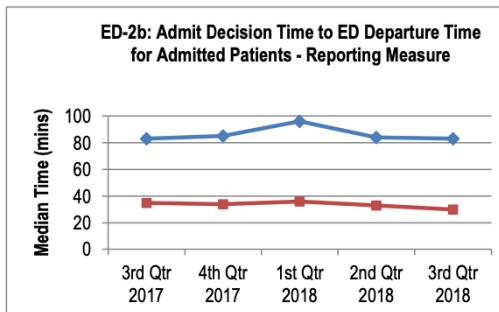
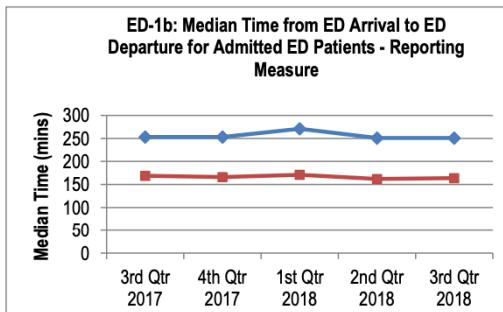
Claims Analytics & Benchmarks

- Claims data are a robust (but imperfect) source for healthcare analytics
- Includes rich set of patient- and encounter-level data (diagnoses, treatments, billed/paid amounts), EHR data.
- Challenges: data quality, missing data, integration from multiple sources
- Can be used to infer if a provider followed national recommendations for care (e.g. patients with diabetes → did they receive quarterly exams, did they have an eye exam for retinopathy, were they admitted to hospital)
- Can be used to predict outcomes or classify risk
- Can be used to benchmark providers and organizations
- Can be used to link to other external data sources (US Census, cancer registry, VA, Medicaid, provider information)
- Additional thoughts on strengths/limitations of CMS claims data as analytics source



Clinical & Financial Benchmarking

- [Gartner](#) – IT, supply chain, digital innovation, and more; Magic Quadrant; Hype Cycle; insight on industry trends, comparisons across industry
- [HIMSS Analytics](#) – EMR adoption model (EMRAM), Analytics (AMAM), Continuity of Care Maturity Model (CCMM), Supply Chain (CISOM), Digital Imaging (DIAM), Infrastructure (INFRAM), Outpatient EMR (O-EMRAM)
- [CMS](#) – publish “Achievable Benchmarks of Care” (ABC), both inpatient and outpatient
- [Leapfrog](#) – non-profit organization dedicated to improving safety, quality, affordability of healthcare. Publishes a safety score for participating health systems with transparent grading



[Source](#). Example CMS benchmark for median duration in ED and median time to decision to admit for ED patients who were admitted.



Example Leapfrog Report from a “D” Grade Hospital

Infections



Safety Problems



Practices to Prevent Errors



Doctors, Nurses, and Hospital Staff



Problems with Surgery



Hospital Performs Below Average



Average



Facility Accreditation & Quality/Safety Standards

CMS

- Conditions of Participation ([CoP](#)) & Conditions for Coverage ([CfC](#))
- Clinical Laboratory Improvement Amendments ([CLIA](#))

Joint Commission (JC)

- Chart-abstracted data for ORYX quality initiative, aligns measures with CMS
- Ex: Acute care hospitals must submit 4 eCQM (related to labor and delivery, postnatal care) and 4 other eCQM of their choosing for 2 self-selected quarters

CLIA

- Clinical Laboratory Improvement Amendments, established by CMS, regulates all lab testing on humans in the US (except research)
- Certification of Waiver (COW), Compliance (COC), Accreditation (COA)



Clinical Quality Standards & Reporting Formats

PQRS – Physician Quality Reporting System, encourages providers to report specific quality measures through incentive payments

AHRQ – Agency for Healthcare Quality & Research

NSQIP – National Surgical Quality Improvement Program, risk-adjusted, validated program to improve surgical care quality → 27% reduction in mortality, 45% reduction in morbidity in VA hospitals from 1985-1994

Relevant Standards (channeling my inner Bill Hersh)

- QRDA – Quality Reporting Document Architecture for eCQIs, based on HL7 clinical document architecture (CDA)
- HQMF – Healthcare Quality Measure Format, standards-based representation of quality measure as an XML document.
- CQL – Clinical Quality Language is the expression logic used in HQMF. An HL7 Standard for Trial Use (STU), CQL replaces the logic expressions in QDM (Quality Data model) and is now the standard for logic representation in eCQM
- FHIR Clinical Reasoning module –represents / encodes clinical knowledge for use in systems. Permits sharing of CDS rules, ordersets, protocols, quality measures. Allows systems like CDSHooks to evaluate clinical knowledge in context provide CDS, assess metrics, etc.

A technical deep dive into the use of these standards is beyond the scope of this review, but [here's a good overview](#).



CQL in Action – Risk Score and an eCQM

```
define "Needs eGFR Lab":  
    "eGFR Lab is Overdue"  
        or ("eGFR Lab Frequency" is not null and "Last eGFR Lab Result" is null)  
  
define "eGFR Lab Frequency":  
    case  
        when "CKD Stage" >= 4  
            then 3 months  
        when "CKD Stage" >= 3  
            then 6 months  
        when "Has CKD or Diabetes"  
            then 12 months  
        else null  
    end  
  
define "eGFR Lab is Overdue":  
    "Last eGFR Lab Result" Result  
    return  
    case  
        when Result.effective is null  
            then true  
        when Result.effective is dateTime  
            then (Result.effective.value + "eGFR Lab Frequency") < Today()  
        when Result.effective is Period  
            then (end of PeriodToInterval(Result.effective) + "eGFR Lab Frequency") < Today()  
        else false  
    end
```

()

CQL representation of a [chronic kidney disease risk score](#)

```
valueset "Asthma": '2.16.840.1.113883.3.117.1.7.1.271'  
valueset "Asthma Management Plan": '2.16.840.1.113883.3.117.1.7.1.131'  
valueset "Home Discharge Disposition": 'TBD'  
valueset "Doctor": 'TBD'  
  
parameter MeasurementPeriod default Interval[DateTime(2013, 1, 1, 0, 0, 0), DateTime(2014, 1, 1, 0, 0, 0))  
  
context Patient  
  
define "In Demographic":  
    AgeInYearsAt(start of MeasurementPeriod) >= 2 and AgeInYearsAt(start of MeasurementPeriod) <= 17  
  
define "Asthma Encounters":  
    ["Encounter": "Asthma"] E  
    where E."class" = 'inpatient'  
    and E."length" <= 120 days  
    and E."hospitalization"."dischargeDisposition" in "Home Discharge Disposition"  
    and E."period" ends during MeasurementPeriod  
  
define "Asthma Encounters with Plan":  
    "Asthma Encounters" E  
    with ["CommunicationRequest"] C  
    such that (C."encounter" as "Encounter")."id" = E."id"  
    and exists ((C."reason") R where R in "Asthma Management Plan")  
    and exists (((C."sender" as "Practitioner")."practitionerRole") R where R."role" in "Doctor")  
    and (First(C."recipient") as "Patient")."id" = (C."subject" as "Patient")."id"  
  
define "In Initial Patient Population":  
    "In Demographic" and exists ("Asthma Encounters")  
  
context Population  
  
define "Denominator": "Asthma Encounters"  
  
define "Numerator": "Asthma Encounters with Plan"
```

CQL representation of a CQM: does the patient have an asthma action plan ([CMS26](#))?

For a more detailed overview of how FHIR is used to represent eCQM using CQL, [click here.](#)

<https://ecqi.healthit.gov/sites/default/files/FHIR-101-Cooking-with-CQL-508.pdf>



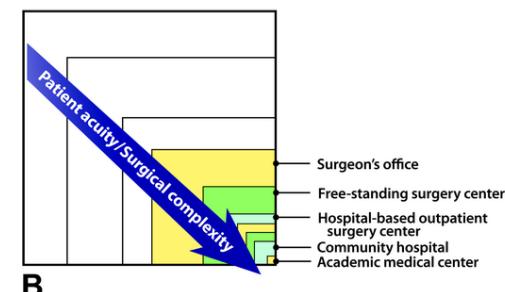
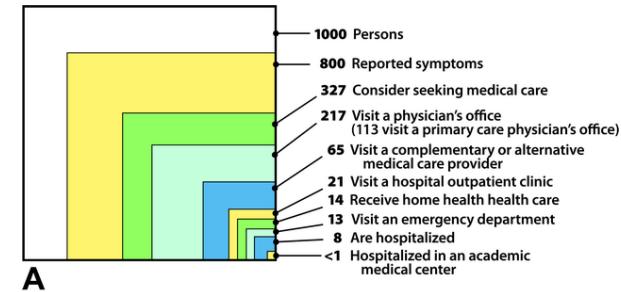
Risk Adjustment & Stratification

Risk Adjustment

- Predicts future healthcare expenditure of individuals based on diagnoses and demographics.
- Reimbursement strategies in ACO, bundled payment and value-based contracts shift risk to provider (e.g., if your patients have worse outcomes than expected, you get reimbursed less)
- So Risk Adjustment, which depends on accurate coding of co-morbidities, takes that into account, reduces "penalty" for caring for sicker patients.

Risk Stratification

- Segments patients into distinct groups of similar complexity.
- Used to determine resource allocation, direct care resources. [Useful in population health management.](#)
- Resource allocation follows Pareto rule:
 - 20% of population accounts for 80% of healthcare expenditure
 - 5% of the population accounts for nearly 50% of US health expenditure
 - Health expenditure for patients with 5 or more chronic conditions is 17x higher than those with zero chronic conditions



Source: [Green et al. NEJM, 2001](#).

Patient-generated Health Data

- Health-related data created, recorded, or gathered by/from patients or caregivers
 - Ex: health history, treatment history, symptoms, lifestyle, SDOH, biometric data, patient-reported outcomes
 - Ex: manually entered blood-pressure, depression questionnaire submitted via portal (like [PHQ-9](#)), image of wound uploaded to EHR
- ONC certification rule for EHR and CMS Quality Payment Program require that EHR product must enable users to “identify, record, and access information directly and electronically shared by a patient”
- ONC sees PGHD as a key tool to improve engagement, care delivery, and research



Care Delivery & Reimbursement Models

MACRA = Medicare Access and CHIP Reauthorization Act of 2015

- New payment program that incentivizes value and patient-centered care

Starting in 2019, physicians began to receive payments either through MIPS or APMs

- **MIPS** = Merit Based Incentive Payment System
- **APM** = Alternative Payment Models

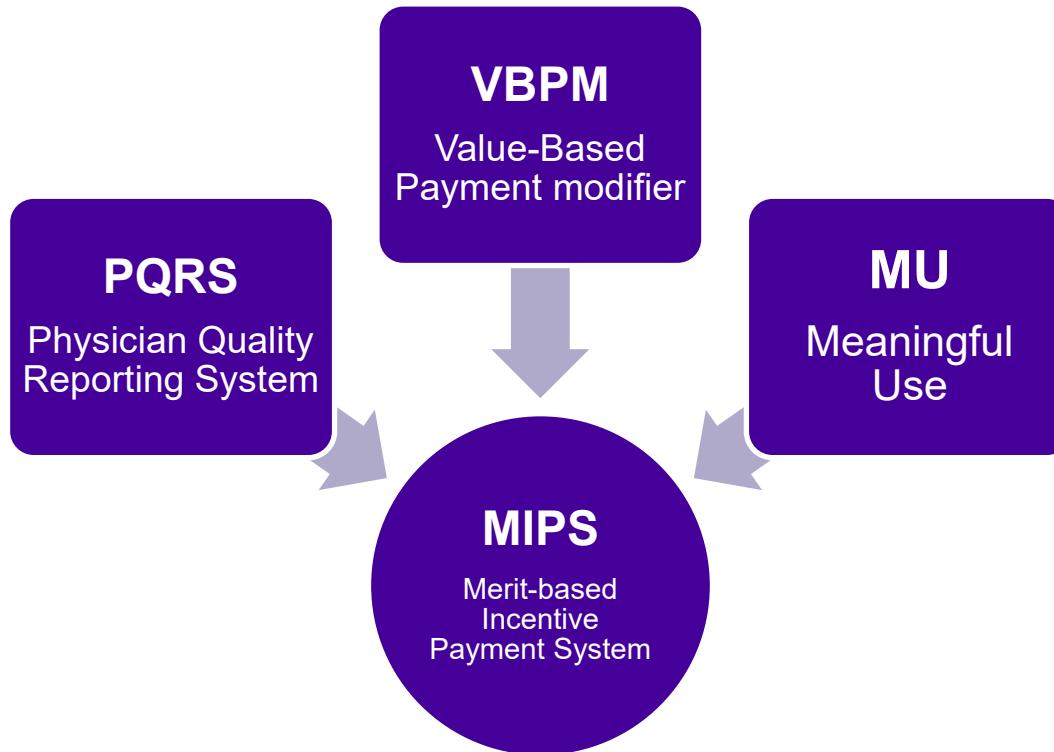
MACRA rates physicians based on **NCQA** quality measures, including **HEDIS** performance scores, as well as **PCMH** (Patient Centered Medical Home), **PCSP** (Patient Centered Specialty Practice) designation, and **MU** (Meaningful Use)

Link: [2021 Core Set of Adult HCQM for Medicaid](#)

Link: [2021 Core Set of Child HCQM for Medicaid and CHIP](#)



MIPS Consolidation



MIPS Composite Score

MIPS performance category weights in 2020:

Quality



45% of MIPS Score

Cost



15% of MIPS Score

Improvement Activities



15% of MIPS Score

Promoting Interoperability



25% of MIPS Score

Please note that for MIPS APM participants, scored under the APM Scoring Standard, the performance categories have the following weights:

50% Quality

0% Cost

20% Improvement Activities

30% Promoting Interoperability

Source: CMS [MIPS Quick Start Guide \(PDF\)](#)



Telehealth Terminology & Models

Four Telehealth Technology Models ([reference](#)): live, asynchronous, remote patient monitoring, and mHealth

Three Telehealth Service Models ([reference](#)):

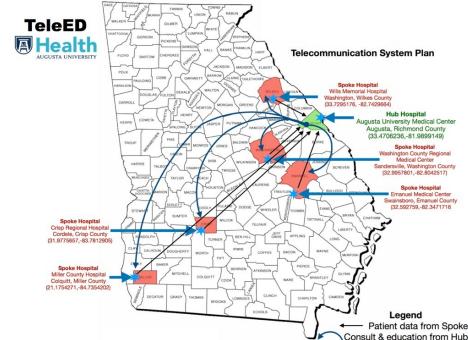
1. Hub & Spoke – e.g. telestroke, where a tertiary care site is the remote hub and serves many originating sites, such as a group of rural health systems
2. Network of Networks – extend telehealth to community health settings, private practice, schools, and other traditional/non-traditional settings.
3. Fully Distributed Network – direct to consumer, includes home as originating site, "virtual care"

Originating Site: location of the patient at the time the service is being provided. Can submit claim for services provided.

Distant/Remote Site: location of the provider at the time the service is being provided. Can submit claim for facility fee.

mHealth: use of smartphones and tablets for care delivery

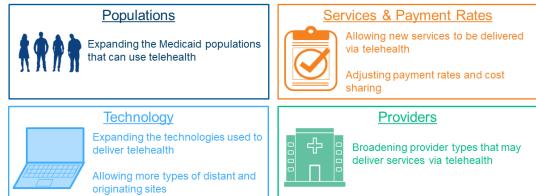
Of note, during pandemic, it was clear that telehealth [improves provision of healthcare delivery](#)



Source: [Augusta University, Medical College of Georgia](#)

Figure 1

In response to COVID-19, states are expanding telehealth in Medicaid by making adjustments to key areas:



SOURCE: Centers for Medicare and Medicaid Services (CMS). [State Medicaid & CHIP Telehealth Toolkit](#); April 2020, as well as KFF analysis of Medicaid telehealth guidance posted to state websites.

Source: [Kaiser Family Foundation, 2](#)



New and Innovative Care Models

- **Telemedicine:** Video Visit (synchronous), eVisit (asynchronous or store-and-forward) - originating site is the patient
- **Teleconsultation:** Video consult (synchronous), eConsult (store and forward) - originating site is another provider
- **Remote Patient Monitoring:** automatically transmitted data from devices and biosensors
- **Remote Therapeutic Monitoring:** non-physiologic data, patient-reported data
- **Remote Care Management**
- **"Hospital at Home":** continuous, real-time monitoring of patients via connected devices
- **Home-based therapies**, such as home dialysis, chemotherapy infusion, bisphosphonate infusion
- **Home-based services:** mobile phlebotomy, mobile radiology, direct delivery of pharmaceuticals
- **Theme:**
 - Use of patient portals, mobile applications, behavioral economics or "nudges", wearable devices, and more
 - Blurring of lines between "home" and "health system", also a better understanding of choosing the right intervention for the right condition.
 - Shift from **episodic care of illness** (clinic, hospital) to **chronic support of health and wellbeing** (remote monitoring)
- There are now reimbursable CMS codes for RPM/RTM as well as Care Management



clipart library.com

Non-Regulated Medical Devices

FDA classification of "Medical Devices"

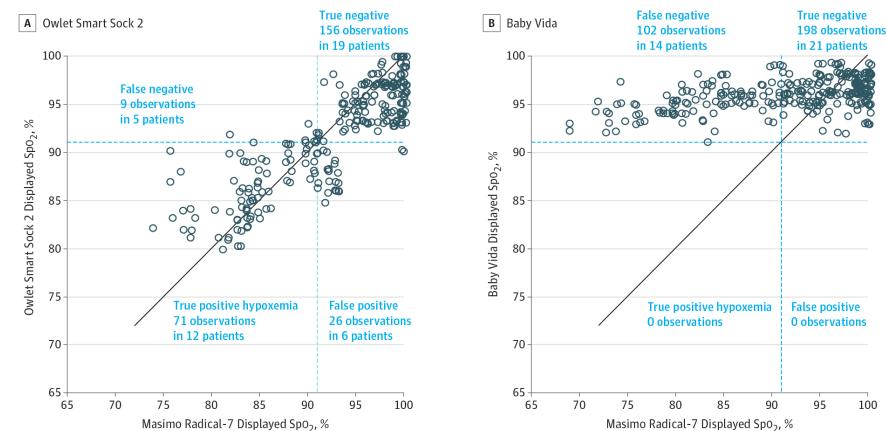
- Class I: General controls (bandages, gloves, forceps)
- Class II: GC + special controls like labeling, performance standards, post-marketing surveillance (wheelchairs, infusion pumps, surgical drapes)
- Class III: GC + SC insufficient to assure safety, effectiveness (heart valves, implantable cerebellar stimulators)

FDA Clearance vs. Approval

- Approval required for devices that may have risk of injury/illness, but may also benefit patients
- Class I and Class II devices usually require clearance as "substantially similar" to existing devices in the market. E.g. if a new device has a pulse oximeter, obtaining 510(k) clearance from FDA is sufficient to market in the US.
- Ex: AppleWatch is FDA cleared, not approved, as a Class II device
- Ex: Many infant monitors based on pulse-oximetry are neither cleared nor approved and have disclaimers re: "for peace of mind" or "not intended to diagnose, evaluate, or treat and medical condition"

What's the Risk?

- Manufacturer claims, patient interpretation/application, and medical veracity may be inconsistent.
- What is our obligation to incorporate these data? How do we interpret and use in clinical practice?
- Ex: with published sensitivity & specificity of Apple's A-Fib detection algorithm, you can estimate that PPV in a low risk population is about 15%, which means 85% of the time, an alarm will be a false alarm.



Source: [Bonafide CP, Localio AR, Ferro DF, et al. Accuracy of Pulse Oximetry-Based Home Baby Monitors. JAMA. 2018;320\(7\):717–719. doi:10.1001/jama.2018.9018](#)



End of Lecture



Clinical Informatics
Board Review Course

Pop Quiz!

You wish to implement a new CMS-endorsed eCQM in FHIR. Which standard do you use for the clinical logic / content?

- A. HQMF – Healthcare Quality Measure Format
- B. Arden Syntax
- C. QDM – Quality Data Model
- D. CQL – Clinical Quality Language

Answer

- A. HQMF – Healthcare Quality Measure Format
- B. Arden Syntax
- C. QDM – Quality Data Model

D. CQL – Clinical Quality Language

Explanation: The correct answer is “D” Clinical Quality Language (CQL) is the expression logic used in HQMF. It replaces the Quality Data Model for CMS eCQMs. Arden Syntax is a standard format for expressing clinical decision support logic, but is not used in the Healthcare Quality Measure Format.