Chapter 2
The U.S. Health System

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Learning Objectives

This chapter will provide the reader with a basic understanding of the history and current structure of the U.S. Health System. It provides a system level context for the field of Clinical Informatics, and describes how clinical informatics fits into the complex health care delivery system. After reading this chapter individuals will be able to:

- describe components of the health care delivery system
- summarize the state of health care delivery in the United States
- explain the role of data in health system planning and policy making

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Core Content

The following core competencies are covered in this chapter:

- 1.2. The Health System
  - 1.2.1. Determinants of individual and population health
  - 1.2.2. Primary domains, organizational structures, cultures, and processes
    - 1.2.2.1. Health care delivery
    - 1.2.2.2. Public health
    - 1.2.2.3. Clinical research
    - 1.2.2.4. Education of health professionals
    - 1.2.2.5. Personal health
  - 1.2.5. Health Economics and financing
  - 1.2.6. Forces shaping health care delivery
  - 1.2.7. Institute of Medicine quality components
    - 1.2.7.1. Safety
    - 1.2.7.2. Effectiveness
    - 1.2.7.3. Efficiency
    - 1.2.7.4. Patient-centeredness
    - 1.2.7.5. Timeliness
    - 1.2.7.6. Equity

Case Vignette

A 48 year old, Caucasian male presents in the emergency department of a level I trauma hospital in a major metropolitan area. He is complaining of flu-like symptoms. The patient reports his personal and health insurance related registration information to a patient access representative in a triage room while waiting to be seen. The patient has never been to this hospital before, but the representative is able to find his electronic medical record (EMR) in their electronic health record (EHR) system, because he has been seen at the critical access hospital near his house, which is in the same network. She opens the administrative section of his EMR to verify and update the previous information. At this time she has the patient sign a consent for treatment form. After she types the patient's updated information into the computer, she logs out and explains that she needs to step out for a moment to make copies of the signed form, ID and insurance cards that the patient provided. Shortly, she re-enters the room with a barcoded wristband for the patient. She returns the patient's ID and insurance cards, and a copy of the consent, which now has a label imprinted with a barcode and the patient's name, date of birth (DOB) and unique identifier number. Then, as she looks at the wristband, she asks the patient to verify his name and birthdate. Satisfied, she places the wristband on the patient, puts extra patient labels next to the computer, and leaves again. Soon a nurse enters the room.

She introduces herself, asks the patient his name, and logs into the computer. She begins asking the patient to describe the symptoms he has been experiencing. As he talks, she enters the information he shares into his EMR. He describes having nausea, vomiting and a headache since the day before, that have all gotten much worse, quickly. The nurse is prompted to ask the patient whether he has been travelling recently as she enters these symptoms into the EMR. The patient shares that in fact, he just returned from Nigeria last week. As the nurse enters this into the computer, she is prompted to ask a series of questions specific to exactly where he travelled and why, and whether others that he was around were sick. He shares that he was travelling for pleasure and he was not aware of anyone being sick that he was around. The nurse then takes his temperature by pointing an infrared thermometer at his forehead. She comments that he has a fever and asks if he has noticed this earlier. He says no. She enters his temperature into the EMR and stares at the screen for a few moments. Her patient has just been flagged as potentially having a deadly and highly contagious disease. She calmly tells the man that based upon his symptoms, they will be implementing some special precautions as they perform more tests to see what might be wrong. She lets him know that she will be back shortly with the doctor.

The patient is moved into a special isolation room where he is hooked up to a variety of monitors to track his vital signs, and the doctor suits up to perform a complete assessment. The doctor notes that the patient also has a stiff neck and as his headache has grown worse, he has begun complaining about the lights being on in his room. After finishing his exam, the doctor documents his new findings in the EMR and reviews the patient's past medical history, current medications (verified earlier with the patient by the inpatient pharmacist), and checks for any allergies entered earlier by the nurse. Based upon these findings, the doctor locates the appropriate Order Set for working up his patient, and looked through the list of testing options, leaving all of them checked—multiple types of bloodwork, a spinal tap and a few other tests. He then looks at the choices of pain medications listed in the order set and chooses one for now and a stronger dose, if needed. He leaves the rest of the orders as they are written for the nurses to follow in their daily care of the patient. He thinks of how good it is that they now have these standardized Order Sets created, so that they know they are delivering consistent, evidence-based medicine.

As the doctor is finishing up, the nurse hears the pneumatic tube station signal a delivery. She finds the pain medication ordered for the patient, and sent up from the inpatient pharmacy. She suits up and enters the room, letting the patient know she has pain medication for him. She picks up the barcode scanner that has been placed in a sealed wrapping and dedicated to stay in his isolation room, and scans the barcode on the patient's wrist ID. She then scans the barcode label on the medication sent up from the pharmacy. Then she scans the barcode on the patient's wristband, and gives him the medication. It doesn't take long for him to relax and drift off to sleep.

Early the next morning, the inpatient lab calls the charge nurse and pages the patient's physician. The patient is negative for Ebola, positive for meningococcal meningitis. Isolation protocols are downgraded slightly and the appropriate treatment protocol is initiated. The patient seems less responsive than on the previous day.

In the background, the National Electronic Disease Surveillance System (NEDSS) is activated, and the State Health Department is informed that the patient has a "notifiable" disease per the Centers for Disease Control (CDC) National Notifiable Diseases Surveillance System (NNDSS). Per protocol, the State Health Department then notifies the CDC of this patient through the same electronic tracking system.

Late in the afternoon, the patient becomes unresponsive and a neurology consultation is placed. The neurologist orders an MRI. After it is completed that evening, the neurologist reviews the images and the interpretation of the neuroradiologist remotely, from her home. She then places an order for continuous video EEG monitoring, with real-time viewing of the patient and brainwave data (Neurotelemetry) for the next 24–48 h. A nurse brings the video EEG machine into the room and begins talking with a neurodiagnostic specialist (neuro tech) who is remotely connected to the machine from their home office. The nurse glues small recording leads to many places on the patient's head, using a special template that shows where they should go. She then performs various types of stimulation on the patient while the neuro tech watches the brainwaves. The neuro tech lets the nurse know there were no significant events, and they will call her after the remote neurologist reads the initial brainwave recordings. She leaves the EEG machine on so that the neuro tech can continuously monitor the patient's brain activity.

By midnight, the nurse has received a couple of routine calls from the neuro tech, just to update her and let her know that no significant brainwave events have occurred. Then around 1:00 a.m. she receives another call from the neuro tech saying that they have just paged the on-call neurologist to confirm subclinical seizures from the brainwave recordings. Soon, the neurologist calls the nurse, to confirm that the patient is having seizures and to be connected to the physician caring for the patient. The nurse puts him in touch with the physician and a treatment protocol for seizures is initiated. The nurse communicates with the neuro tech through the night to titrate the patient's medications until the seizures are decreasing in frequency.

By the next day, the seizures appear to be under control and the patient is somewhat responsive again. The patient continues to improve and the brainwave monitoring is discontinued late the second day. The rest of the patient's stay in unremarkable. He improves steadily and he is eventually discharged to home.

As the nurse is preparing him to be discharged, she goes over a set of post-discharge instructions with him. Then, she asks him if he is familiar with the patient personal health portal that is available for him within the EHR. He is not sure, so she shows him how to set up his account, and get logged in, then she goes over how to send secure messages to his caregivers, look at past lab results, radiographs, and other diagnostic tests. She also shows him how to review and download summaries of his clinic visits and hospital stays if he needs them for future doctor visits out-of-network or for other reasons. She reminds him that as a part of his follow-up instructions he is to schedule an appointment with his primary care provider in clinic in 2 weeks. She shows him a scheduling tool in the portal where he can do this on-line if he would like. She also lets him know now that he is signed up for the portal, he will get an email reminder to schedule his appointment if he hasn't done so in a week.

Throughout the patient's stay, charges for all of the testing, supplies, and daily care he received from the hospital were entered into the hospital's billing system through his EMR. At the end of his stay, these charges were submitted electronically to the insurance company on file. The summary data from his hospital stay was copied to the hospital's data warehouse, to be utilized for quality review and other internal projects, and it was copied to the state Health Information Exchange (HIE), to make it available to physicians at out-of-network hospitals who might treat the patient in the future.

Introduction

The U.S. Health System is composed of a highly complex network of organizations, institutions, and resources focused on the monitoring, maintaining, and improving the health of individuals and populations. Health care delivery, public health, clinical research, education and health professionals, and personal health are all domains of the health system. Health information has a specific and important role in each of these, as do health policies and economics. Understanding the basic structure and function of the health system and the flow of information (data) within and between its various domains is critical to the field of clinical informatics. This chapter will examine the various domains of the health system and serve as a foundation to understanding the role of clinical informatics in this intricate and complex system. We begin by considering the concept of health as an individual and population characteristic in order to provide a frame of reference for studying the health system.

Health

Health is a defining human characteristic and integral to the human experience. As health care providers, we often think of health in the context of organ systems, disease states, and functioning status. In reality, health is a much broader concept. The widely accepted World Health Organization (WHO) definition, established in 1946, describes health as 'a state of complete physical, mental, and social well-being and not merely the absence of disease.' A myriad of factors play a role in health. Contributing factors are commonly referred to as the 'determinants of health,' and generally include (1) social environment, (2) physical environment, (3) genetics, (4) medical care, and (5) behavior. Health may be conceptualized as a state that results from 'exposure' to multiple determinants [1].

The determinants of health do not exist within a vacuum, they are intertwined and interdependent. Genetics are the foundation of human health. Genes are responsible for basic level of health at birth and determine risk for certain diseases [2]. Beyond genetics, however, individual and environmental factors also have a large influence on human health. Poverty, for example, is a social factor commonly associated with health and also related to physical environment, another determinant of health. People living in poverty are more likely to reside in low-income communities where health care resources are scarce and difficult to access.

Regardless of their genetics, poor individuals living in low-income communities are more likely to experience barriers to access health care services than their more affluent counterparts. This simple example illustrates the complex nature of human health and those dimensions beyond the bounds of health care delivery.

Individual Versus Population

Health may be measured at the individual and population levels. Individuals exist within populations, and their unique characteristics are woven into the fabric of the population. Whereas individuals have a unique set of characteristics contributing to their health, populations are comprised of groups of individuals which generally share some defining characteristics, demographic, geographic, or social. Population health then is a reflection of the health of individuals within a defined group.

Health information is used to evaluate and monitor trends in individual and population health. At the individual level, health information generally summarizes as a set of characteristics or outcomes relating to health. At the population level, health information includes the distribution of characteristics and outcomes within a specific group [3].

Individual health information has been part of health care delivery from its start, as a tool for practitioners to document and monitor the patient health. Historically, data were documented in record books by hand. Handwritten records evolved into patient charts, which are now health information systems employing sophisticated technologies. Health care providers gather health information to determine patient's health status and inform diagnoses and treatment planning, but individuals are increasingly monitoring their own health. New and emerging technologies empower individuals to collect and monitor their health. These technologies and their role in personal health are explored later in the chapter.

Population health information has also been recorded for many years. The earliest population health information includes mortality records and recordings of major epidemics that occurred throughout history. The 'Bill of Mortality' from 1665 depicted in Fig. 2.1 demonstrates how early data on cause of death were recorded and reported. The first documented recording of population health data to monitor trends in health and disease to determine the source or causation were done by the British physician John Snow. Snow, a nineteenth century anesthesiologist from London, England, is credited with systematically studying a cholera epidemic in his community and identifying polluted drinking water as the source. This study of an epidemic and subsequent intervention, removal of the water pump handle to the contaminated drinking water supply, were successful in stopping the cholera epidemic [4].

John Snow is widely considered to be the father of modern epidemiology [4]. **Epidemiology**, *the branch of medicine concerned with the incidence, distribution, and possible control of disease and factors relating to health, is a science based upon the analyses of population health data.* As we explore later, population health data are critical to the public health system, but they also play an important role in modern health care delivery, where individual patient health information is now aggregated within large health care organizations/systems for clinical decision sup-

The Diseases and Casualties this year

Abortive and Stillborn	617	Executed	21	Murthered and Shot	9
Aged	1545	Flox and Small-pox	653	Overlaid and Starved	45
Ague and Feaver	5257	Found dead in streets, fields etc	20	Palsie	30
Apoplexie and Suddenly	116	French Pox	84	Plague	68596
Bedrid	10	Frighted	23	Plannet	6
Blasted	5	Gout and Sciatica	27	Plurisie	15
Bleeding	16	Grief	46	Poysoned	1
Bloudy Flux, Scowring and Flux	185	Griping In The Guts	1288	Quinsie	35
Burnt and Scalded	8	Hanged and Made away themselves	7	Rickets	557
Calenture	3	Headmouldshot and Mouldfallen	14	Rising Of The Lights	397
Cancer, Gangrene and Fistula	56	Jaundices	110	Rupture	34
Canker and Thrush	111	Imposthume	227	Scurvy	105
Childbed	625	Kild by several accidents	41	Shingles and Swine Pox	2
Chrisomes and Infants	1258	King's Evil	86	Sores, Ulcers, broken limbs	82
Cold and Cough	68	Leprosie	2	Spleen	14
Collick and Winde	134	Lethargy	14	Spotted Feaver and Purples	1929
Consumption and Tissick	4808	Livergrowne	29	Stopping Of The Stomach	332
Convulsions and Mother	2036	Meagrom and Headach	12	Stone and Stangury	98
Distracted	5	Measles	7	Surfet	1251
Dropsie and Timpany	1478			Teeth and Worms	2614
Drowned	50			Vomiting	51
				Wenn	1
				Total	97306

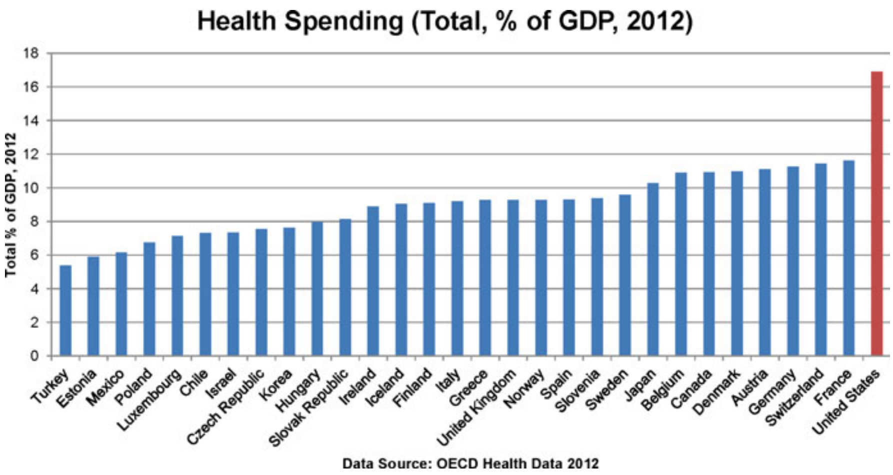
Fig. 2.1 Bill of mortality from 1665. The 'Bill of Mortality' from 1665 demonstrates how early data on cause of death were recorded and reported

port and quality improvement and between systems through Health Information Exchanges (HIE). Such high resolution health information on populations provides new perspectives on health and its determinants. Ultimately, these data have an important role in transforming the United States health system.

The Right to Health

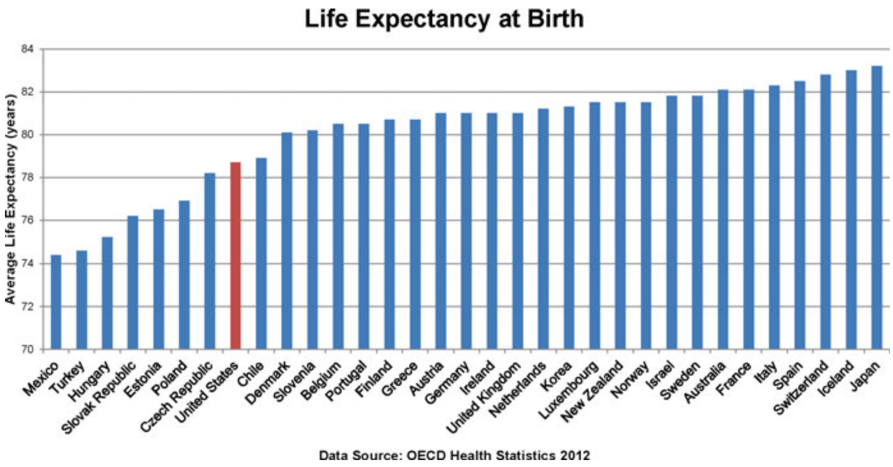
Health is not only a human characteristic; enjoyment of the highest attainable standard of health is also considered a fundamental human right [5]. In international human rights laws, the 'right to health' includes assuring access to health care, as well as addressing the underlying determinants of health. A large amount of resources are required to ensure this right. Many countries, including the United States, grapple with assuring the health of its population.

Although the United States expenditures for health are significantly higher than other developed countries, it ranks poorly in commonly reported population health indicators, such as life expectancy at birth [6]. Comparative country-level data are available through the Organization for Economic Co-operation and Development (OECD). OECD is a global organization focused on promoting policies that improve the economic and social well-being of people around the world. Country-level data



Data Source: OECD Health Data 2012

Fig. 2.2 Health spending among OECD (Organization for Economic Co-operation and Development) countries. This figure shows the United States' health care spending relative to other OECD countries (Data source: OECD Health Data 2012)



Data Source: OECD Health Statistics 2012

Fig. 2.3 Life expectancy at birth for OECD (Organization for Economic Co-operation and Development) countries. This figure shows the United States' life expectancy relative to other OECD countries (Data source: OECD Health Statistics 2012)

from OECD on life expectancy at birth (See Fig. 2.2) and percent of GPD associated with health care expenditures (See Fig. 2.3) for 32 developed countries are alarming. In 2012, the United States expended an estimated 16.9 % of its GDP on health care, and reported a life expectancy of 78.8 years from birth. That same year, average GDP expenditures for health care among the other OECD countries were 9.3 %, and average life expectancy at birth was 80.2 years.

OECD data suggest that higher health care spending has not led to better health for America's population. The structure and organization of the United States health system, or rather the lack thereof, is a major contributor to the high cost and poorer health outcomes of Americans.

Summary

Health is a defining human characteristic and a basic human right. Many factors interact and influence health, including genetics, social and physical environments, medical care, and behavior. The 'right to health' is almost universally recognized. Although the United States reports the highest percentage of GDP is spent on health care, its population lags behind other developed countries in life expectancy and other population health measures. Contributing to this is an inefficient disease focused health system.

Health information is used to assess the health of individuals and population within the health system and drive activities within the system. At the individual level, patient health information has historically been collected and analyzed as a part of patient care. At the population level, health information is collected and analyzed to determine distribution and patterns of disease, and to inform health policies. Individual health information is being aggregated into large population health information systems with the capacity to inform health policy and drive health system change.

Where genetics are the foundation of human health, information is the foundation of the health system. The next sections of this chapter review the major domains of the U.S. health system and explores the flow of data throughout it.

The United States Health System

From the 'mile-high' view, a **Health System** may be *described as sum of organizations, institutions, and resources focused on health*. The health system may be thought of as a network of diverse entities and cutting across multiple sectors. This section presents background information on five domains (health care delivery, public health, clinical research, education of health professionals, and personal health) of the United States health system pertinent to the field of clinical informatics. A basic understand of this system and its key domains is required to appreciate the role and flow of data within and throughout the health system. We explore each major component of the health system in this section.

Health Care Delivery

Health care delivery *generally refers to the resources and processes which enable people to receive health care services* [7]. The United States has the most expensive, highly complex system of health care delivery in the world. Its complexity may be summarized into four broad components: providers, payers, suppliers, and regulators.

Health Care Delivery: Providers

Providers refer to all organizations, services, and resources (including the workforce) that directly deliver or facilitate the delivery of health care services to patients. At the organizational level, providers include vast array of organizations and services. Acute care hospitals, primary care physician offices, dental offices, rehabilitation facilities, home health services, tele-medicine, and numerous other organizations and services are considered providers within the health care delivery system.

In addition to organizations, the workforce of health professionals that deliver health care services is also a major component of health care providers. This workforce includes licensed health professions such as physicians, nurses, dentists, therapists, and many other health professionals. In addition to the professionals traditionally thought of as "health care providers," many others professionals support the delivery of health care services. Community health workers, for example, are increasingly being used to support health care delivery and build additional capacity or manage care and care transitions, especially among vulnerable populations [8]. In addition, practitioners in clinical informatics may also be considered a provider as they play a critical role in health care delivery process. This is especially true as newer health care delivery models which rely heavily on clinical information technologies, such as tele-medicine, are more widely utilized.

As the point of intersection between medical sciences and health care delivery, the healthcare workforce has a large role in the health care system. This workforce oversees the collection and recording of patient health information and leverages it to inform patient care. Additional information on the education of health professionals is explored later in the chapter.

Health Care Delivery: Payers

Organizations (public and private) that finance health care services, such as government sponsored health insurance programs (Medicaid and Medicare), as well as commercial insurance carriers, managed care organizations, and self-insured employers are commonly referred to as **payers**. Although healthcare payers are typically larger organizations or entities, *individuals directly paying for their services are also considered to be a payer* within the health care delivery system.

Health insurance is the foundation of the health care financing in the United States and is also the most common mechanism. Insurance is grounded in two basic principles: Risk Spreading and Cost Sharing. **Risk spreading** is *the process of minimizing the chance of major losses to the payer*. This is typically accomplished by setting insurance premiums concordant with a patients, risk level, selectively denying coverage based on risk, or increasing the rate of cost sharing. **Cost sharing** is *a financial risk-management strategy that requires patients to share in a portion of* *healthcare costs*. Common cost sharing mechanisms include premiums, deductibles, copayments, coinsurance, or benefit limits. Due to the high costs, few individuals pay the entire cost of health care services out of pocket. This system of health care financing is unique to the United States, represents a major source of inefficiency, and is a threat to equity within the system. Understanding how this system evolved is important.

Although health insurance is the primary mechanism for financing health care today, this was not always the case. Health insurance has only been in existence since the mid-twentieth century when major automotive manufacturers began to offer health benefits to employees as an incentive to offset the cost of health care [9]. Employer-based health insurance expanded throughout the latter half of the twentieth century and became a major recruiting incentive for employers. During this same time period, incredible advancements in medical science were also being made. Advancements led to the development of technologies and treatments for many conditions that were previously untreatable and/or incurable. These innovations came with a high price tag, but patients were largely unaware of the cost as most services were reimbursed, on their behalf, through their health insurance program. Cost-sharing, described earlier, was introduced more recently as an effort to increase patient awareness regarding the cost of health care.

The advent of health insurance and availability of new health services acted to increase health care utilization and costs in the United States. As costs and utilization increased, the system evolved to become heavily dependent upon financing through health insurance. It became increasingly difficult for individuals without health insurance to access health services.

Financing of heath care in the United States largely determines who has access to health care and who does not [10]. **Access** *refers to the ability of an individual to obtain health care services when needed* [7]. Individuals typically must be able to finance health care through one of the following mechanisms in order to have access to care.

1. They must have health insurance through their employer
2. They must be covered under a government health care program
3. They must be able to afford to buy insurance with their own private funds
4. They must be able to pay for services privately [7].

The ability to finance health care services through one of these means does not guarantee access. In addition to the ‘ability to pay’ for health care, an adequate supply of health care providers (organizations and professionals) is needed to ensure access to health care services. Unfortunately, health care providers are not evenly distributed across the population.

Health care financing has a large influence on the supply and distribution of health care services. Health care providers are clustered in metropolitan areas with high population densities in which greater proportions of the population have health insurance coverage. Rural communities with small populations and low-income urban communities with less robust financing mechanisms are more likely to experience shortages of health care providers and associated health services.

In addition to its influence on the geographic supply and distribution, financing has also had a large role in shaping providers in the current health care delivery system. For example, historically **fee-for-service** (FFS) **payments***, or payment of a fee for each specific health care service or visit,* were the major form of reimbursement to health care providers. FFS payments are issued to providers retrospectively after the service is provided. Advanced and specialty health care services requiring greater expertise and more resources were reimbursed at higher FFS rates while primary health care services focused on disease prevention and health promotion were reimbursed at lower rates. Under FFS reimbursement, health care providers are incentivized to increase the volume of specialty services. Over time, the culture favoring high cost specialty services became embedded into the fabric of health care delivery in the United States.

Health Care Delivery: Suppliers

Healthcare suppliers are *organizations which provide resources to the health care delivery system*, such as pharmaceutical companies and medical equipment manufactures. Suppliers are a diverse group ranging from large pharmaceutical firms and durable medical equipment manufacturers to small companies that produce hospital linens and medical uniforms. In addition to organizations that supply medications and materials, organizations that supply services such as biohazardous waste disposal companies, medical laboratory courier, and health information technology companies are also included in this category. Basically, any industry or organization that provides goods, materials, or services which directly or indirectly support health care delivery are considered suppliers.

Health Care Delivery: Regulators

Because of its substantial impact on human health, health care delivery is the most regulated industry in the world. Regulation occurs at all levels within the health care delivery system. **Regulators** primary responsibility is to *direct or influence the actions, behaviors, or decisions of the providers, suppliers, and payers of the health system to ensure safety and to balance the objectives of enhancing quality, expanding access, and controlling costs* [11]. Currently, the majority of regulation occurs within the various sectors (providers, supplier, and payers) through governmental and private agencies that develop and oversee guideline and policies around cost, access, and quality. Table 2.1 summarizes the regulation occurring within each healthcare delivery sector and provides examples of the most prominent regulators within those sectors. It is important to understand that many of these regulators span multiple or all of the healthcare delivery sectors although their primary responsibility may lay within one of the three sectors. Although a large number of entities are engaged in regulation, their efforts are not currently coordinated. Ensuring access to high quality, low cost care in the United States requires system level and

Table 2.1 Summary of key regulators within various sectors of health care delivery

Sector of healthcare delivery	Scope and purpose of regulation	Examples	Role of regulators	Examples of regulators
Provider	Direct delivery or facilitating delivery of health services. Collecting and recording patient health information.	Physician offices Hospitals Rehabilitation facilities Tele-medicine Health care workforce	Ensure safety, quality, and access to health services.	HIPAA[a] Agency for Healthcare Research and Quality (AHRQ) Joint Commission on Accreditation of Healthcare Organizations (JCAHO) National Committee for
Payer	Financing health care services.	Medicare Medicaid Private insurers Self-pay	Regulate cost of healthcare against services provided.	Department of Health and Human Services (HHS) Centers for Medicare and Medicaid (CMS)
Suppliers	Provide resources to the health care delivery system.	Pharmaceutical companies Biohazard waste disposal Health information technology	Ensure quality of health care resources.	Centers for Disease Control and Prevention (CDC) Federal Drug Administration (FDA) United States Agency for Toxic Substances and Disease Registry (ATSDR)

[a] Health Insurance Portability and Accountability Act of 1996

coordinated regulation. Unfortunately, previous efforts to implement health planning at the system level have failed.

At the system level, **health planning** processes, where the *government develops a plan to align and distribute health care resources with the intention of achieving desired health outcomes* [7]. Through health planning efforts, there have been several regulation initiatives that aimed to ensure an equitable supply and distribution of health care throughout the United States. In 1974, the federal Health Planning and Resource Development Act was enacted, which provided incentives and penalties that would encourage states to adopt certificate-of-need (CON) legislation [12]. A CON is a control exercised by a government planning agency over expansion of medical facilities [7]. CON statutes were enacted through adoption of policies at the state level. These statutes required that health care facilities receive approval for expansion of existing, or building of new, health care facilities. The approval of CONs was largely based on demonstrated need for additional services or supply within specific communities. In 1986, the Health Planning and Resource Development Act was repealed as the federal government moved away from health planning.

More recently, as a result of implementation of the Affordable Care Act (ACA), community health needs assessments (CHNA) and implementation strategies are

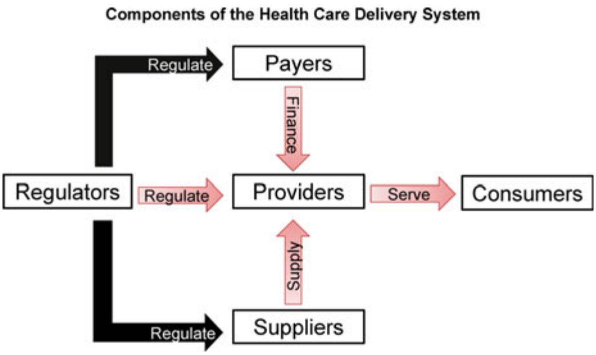


Fig. 2.4 Components of the United State health care delivery system. This figure identifies the relationship between the four major components of the health care delivery system: Payer Providers, Regulators, and Supplies

now required of tax-exempt hospitals much like CONs prior to 1986. CHNAs help to ensure that hospitals and other health care facilities have the information required to make informed decisions regarding what services to provide to their respective community. These efforts aim to improve the health of communities by using data to identify areas of need within communities. Once again, clinical informatics practitioners are an important component of community health needs assessments as health data at the patient, community, and population levels are the driving forces behind CHNAs, which directly influence supply initiatives within the U.S. Health System.

Regulators are largely responsible for patient safety and health system quality and efficiency. Unfortunately, health care delivery and its regulation is disorganized and fragmented between and within the various sectors. Figure 2.4 illustrates how the sectors are regulated and work together within the delivery system to finance, supply, and serve the health care needs of consumers.

Forces Shaping Health Care Delivery

Over the years, health professionals have recognized the need to improve the quality of the health system while increasing access and reducing costs. However, the complexity of the health system continues to grow and can be “characterized by more to know, more to do, more to manage, more to watch, and more people involved than ever before” [13]. As a result population health and health outcomes in the United States have been largely impacted by poorly organized and uncoordinated health care delivery. In 2001, The Institute of Medicine released a report that stated, “bringing state-of-the-art care to all Americans in every community will require a fundamental, sweeping redesign of the entire health system” [13]. IOM’s identifies six aims of quality components necessary for improvement of the health system in the report, which are summarized in Table 2.2.

In order for the United States health system to make substantial improvements the system must be safe, effective, patient-centered, timely, efficient, and equitable. Therefore, these fundamental quality components are significant forces shaping health care delivery today.

Table 2.2 Summary of Institute of Medicines (IOM) six aims of quality components

Institute of Medicine: Six aims of quality components [13]	
Quality component	Specific aim
Safety	Avoiding injuries to patients from the care that is intended to help them
Effective	Providing services based on scientific knowledge to all who could benefit, and refraining from providing services to those not likely to benefit
Patient-centered	Providing care that is respectful of and responsive to individual patient preferences, needs, and values, and ensuring that patient values guide all clinical decisions
Timely	Reducing waits and sometimes harmful delays for both those who receive and those who give care
Efficient	Avoiding waste, including waste of equipment, supplies, ideas, and energy
Equitable	Providing care that does not vary in quality because of personal characteristics such as gender, ethnicity, geographic location, and socioeconomic status

A Culture Change

As illustrated throughout this chapter, the Health System is made up of several sectors that all play a fundamental role in health care delivery and ultimately determine the system's ability to provide affordable, high quality care to everyone. Therefore, a fundamental redesign of the health system that aims to improve the six quality components identified by the Institute of Medicine must be supported by a commitment to change from all sectors of the health system: Providers, Payers, Suppliers and Regulators.

The culture of the United States health system has historically been that of diagnosis and treatment of disease. In recent years, the U.S. has recognized the inefficiencies of the system and their impact on population health. The culture within the system is currently moving away from one that is focused on diagnosis and treatment and now emphasizes the importance of patient-centered and managed care, which is able to promote disease prevention and population health. Figure 2.5 illustrates the change in culture within the health system by demonstrating how health professionals have begun to shift their understanding of a few fundamental concepts in health care.

Public Health Systems

Public health plays a large role in heath, but is generally lesser understood than health care delivery. Whereas the health care delivery systems, primary focus is on restoring the health of individual patients, the public health system focuses on ensuring the health of populations. Defined in 1920 as 'the art and science of preventing disease, prolonging life, and promoting health and efficiency through organized effort' [14], public health focuses on prevention and health promotion, and is

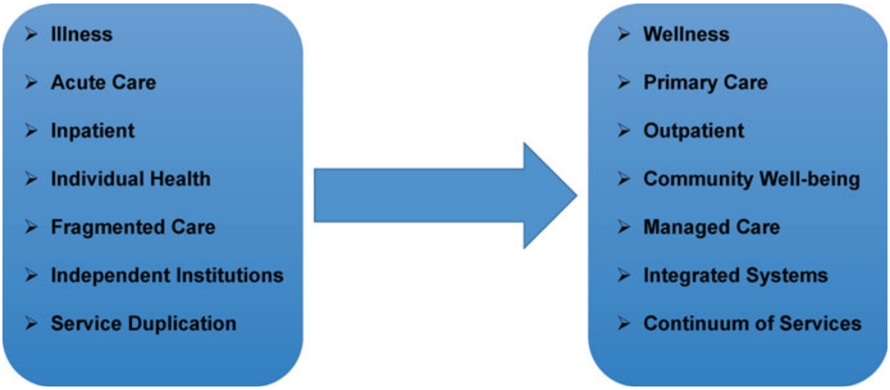


Fig. 2.5 A shift in thinking and culture: moving health care delivery from treating acute conditions to prevention and health promotion. This figure illustrates the change in culture within the health system by demonstrating how health professionals have begun to shift their understanding of a few fundamental concepts in health care

concerned with the broader social and environmental determinants of health, described earlier in this chapter. In the United States, the public health system is comprised of official government public health agencies, other public-sector agencies, (such as schools, Medicaid, and environmental protection agencies) and private-sector organizations whose actions have 'significant consequences' for the health of the public [15]. However, it is important to note that in other countries the activities of public health are carried out by a Ministry of Health that also oversees health care administration.

Population health information is the driver of public health. In a landmark 1988 report, the Institute of Medicine recognized assessment, policy development, and assurance as the three core functions of public health [16]. Monitoring, or assessing, population health is one of the primary functions of the public health system. The system of monitoring population health is commonly referred to as public health surveillance and is often referred to as the cornerstone of public health practice [17].

John Snow's work documenting Cholera in the mid-nineteenth century, mentioned earlier in this chapter, represents early public health surveillance work where cases were manually identified and recorded. More recently, administrative data and national surveys have been used for public health surveillance. Claims databases contain information on health care utilization and have been widely used for public health surveillance because they are relatively inexpensive and available in electronic formats [18]. Unfortunately, no one administrative data set includes the entire United States population, making these data sets limited. National surveys, such as the National Health and Nutrition Examination Survey (NHANES) and the Behavioral Risk Factor Surveillance System (BRFSS) collect information from representative samples of the population to determine health status as well as prevalence of health behaviors and risk factors.

Whereas patient level information is used to drive clinical decision making within health care delivery settings, population level health information is used to drive public health policies which contribute to the environment where health care delivery occurs. However, as data are integrated across the health systems clinical information is becoming increasingly important and will likely play a large role in public health decision making, as described in the vignette.

Clinical Research

Clinical research is the domain of the health system that determines the safety and effectiveness of medications, devices, diagnostic products and treatment regimens intended for use in individuals and populations. Traditionally research has been conducted using randomized controlled trials (RCTs) or otherwise controlled experiments in which an intervention was compared to "usual care." Evidence that a given intervention is "better" than usual care, or another intervention, should prompt clinical providers to change practice. However, it has been observed that the gap between published research and a change in clinical practice requires, on average, approximately 17 years [19]. Additional details on research methods and the development of evidence-based medicine (EBM) guidelines to influence clinical practice can be found in Chap. 5 of this book.

Clinical informaticians are responsible for ensuring that EHR systems and other health information technologies enable clinicians, allied health professionals, and organizations to provide the best possible care to patients. Currently clinical organizations predominantly use two methods for providing front line staff in a health system with access to the latest evidence from clinical research. First, organizations provide frontline staff with direct access to scholarly journals and scientific publications. Users can access resources from the U.S. National Library of Medicine (NLM), such as MEDLINE or PubMed, which search for available evidence across a wide range of publications. Alternatively, EHR systems can include "infobuttons" that enable frontline staff to directly link to relevant evidence when browsing a patient's chart [20]. For example, a primary care physician might desire more information about a medication prescribed by a specialist because he or she does not typically prescribe it. The infobutton in the EHR would directly link the PCP out to a website that would describe the medication, its indications, and its side effects. A second method for implementing research-derived evidence is through clinical decision support (CDS). With CDS, the EHR system could remind the clinician to perform a task considered a "best practice" in a given context. For example, the PCP might be reminded to order a glycosylated hemoglobin test for a patient with diabetes because the EHR system detected no such test for this person within the past 13 months. Available evidence-based clinical guidelines recommend that people with diabetes should have their glycosylated hemoglobin tested once every 12 months. Additional information on research and evidence-based guidelines as well as their implementation through CDS can be found in Chaps. 5 and 6 of this book.

Personal Health

Although public health is primarily concerned with improving and maintaining the health of families, communities, and entire populations, its success is largely dependent on personal health. Personal health may be best described through *The Six Dimensions of Wellness Model* developed in 1976 by Bill Hettler, co-founder of the National Wellness Institute (NWI). This model explains personal health as a function of six domains of health: Occupational, Physical, Social, Intellectual, Spiritual, and Emotional Health [21].

Occupational Health – *recognizes the personal satisfaction and enrichment in one's life through work and its impact on overall personal health and wellness*

Physical Health – *recognizes the importance of the overall physical condition of one's body and its impact on overall personal health and wellness*

Social Health – *recognizes the interdependence between others as well as nature and its impact on overall personal health and wellness*

Intellectual Health – *recognizes one's creative stimulating mental activities and their contributions to overall personal health and wellness*

Spiritual – *recognizes how the search for meaning and purpose in the human experience impacts overall personal health and wellness*

Emotional – *recognizes awareness and acceptance of one's feelings and its influence on overall personal health and wellness*

The United States healthcare system has historically been focused on physical disease, but it is important to understand that health at the individual level is not simply the absence of disease. In fact, the major strength of *The Six Dimensions of Wellness Model* is its understanding and emphasis of the interconnectedness of each dimension of personal health and how they play key roles in achieving and maintaining health and wellness [21]. In order for individuals to achieve high levels of overall health and wellness they must actively work to improve or maintain health in all six domains.

As the U.S. healthcare delivery system continues to realize its vision of patient-centered primary care, patient activation has become increasingly important. **Patient activation** *refers to a patient's knowledge, skills, ability, and willingness to manage his or her own health and care* [22]. One important factor that influences a patient's ability to manage his or her personal health by working with healthcare providers to personalize care is the patient's ability to collect personal health data and maintain comprehensive personal health records that may be used to inform treatment plans and health strategies. A **personal health record** (PHR) *is an electronic, lifelong resource of health information used by individuals to make decisions related to their personal health.* PHRs contain various types of personal health information (PHI) and are typically a combination of individual records and data collected from healthcare providers. **Personal health information** or protected health information primarily *refers to personal data such as demographic information, medical history, diagnostic results, insurance information or any other data that is collected by a health care professional to identify an individual and determine what type of care that individual should receive* [23].

In recent years, these data have become more accessible to individuals in large part due to the advances in information technology and clinical informatics as well as the emergence of mobile health (mHealth). The World Health Organization (WHO) defines mHealth as "an area of electronic health and is medical or public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal data assistants (PDAs), and other wireless devices [24]. With the advances in clinical informatics and mobile technology which have facilitated the rise of mHealth, people are able to collect vast amounts of personal health data on a daily basis such as blood pressure, body temperature, glucose levels, and heart rates. Personal health data may not only be valuable to treatment decisions related to personal health, but can many times be aggregated at the community or population level and leveraged to enhance and inform clinical research that is so vital to the advancement of medicine and public health.

The Flow of Data, Information and Knowledge within the Health System

Understanding the Flow of Data

In the vignette in Part I, there were obvious examples of how the flow of data through the electronic medical record and within the electronic health system were critical to the care and treatment of the patient during the hospital stay. The vignette also revealed the many other ways that the electronic flow of data is now utilized to maximize multiple aspects of healthcare delivery related to efficiency, quality, and even public health. When the patient's registration information was already on file in the EHR because he had visited another in-network hospital, this saved time for the patient and allowed all of the information from his past visits to be available in his pre-existing EMR. His list of current medications was available, and only needed to confirmed and updated by his current caregivers. Even summaries of his records from out-of-network care were available through the state HIE, giving his current care providers a much broader and more accurate past medical history. Order Sets were utilized to promote the delivery of standardized practices and evidence-based medicine, and archives of his completed hospital stay were stored in a data repository for aggregated patient quality analyses and internal outcomes tracking. Public health needs were addressed through the activation of the NEDSS so that the appropriate agencies could track, assess and minimize the potential threat to public health posed by introduction of the disease into the community. To understand the true depth of the complexity efficiency and impact of electronic data flow in a fully integrated health system today, see Fig. 2.6, which illustrates the flow of data for the patient vignette detailed in Part I. While examining the illustration in Fig. 2.6, keep in mind that this complexity is the domain of the clinical informatician as he/she is generally tasked with sorting out information flows and implementing systems to improve care using redesigned health care delivery workflows.

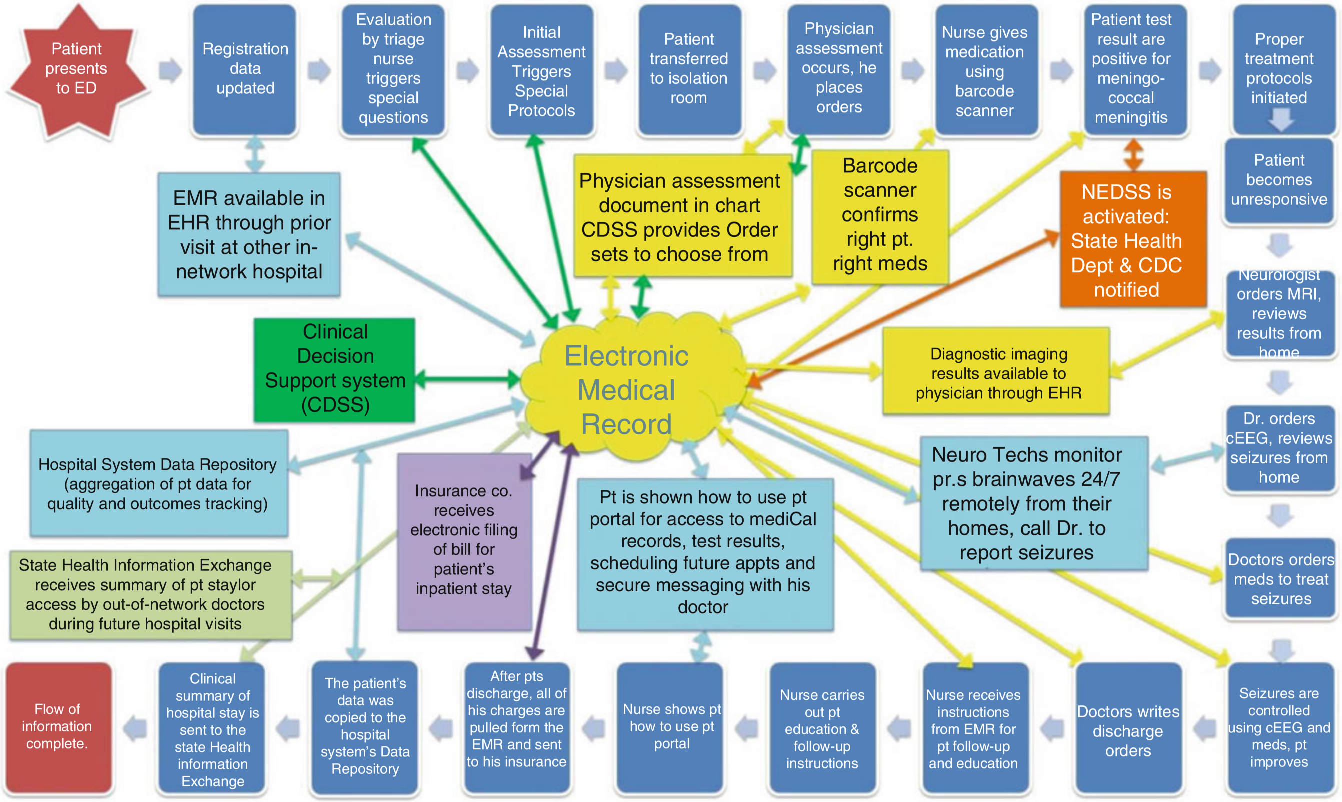


Fig. 2.6 Flow of data and information within the health system. This figure shows the flow of patient data and information within the health system by tracking the data from the beginning of a patient visit. The figure also shows that electronic medical records and clinical informatics is at the center of this complex process

Clinical Informatics: Unifying the Health System

As shown through the previous demonstration of the electronic flow of patient information, the field of clinical informatics is unifying our system of health care. With the patient's electronic medical record at the center:

- information flows throughout in-network and out-of-network health systems for easier access of patient information to providers, allowing them to deliver better patient care;
- clinical decision support engines and guidelines based order sets drive standardized, evidence-based best practices;
- barcode scanning of everything from medications and patient supplies to paper documents scanned into the EMR reduces medical errors and increases charting and billing accuracy;
- electronic notifications to state health departments and the CDC inform them of threats to public health;
- electronic remote viewing and monitoring of patient data by off-site care providers allows more timely and effective care delivery;
- patient access to their medical records and test results on-line, with the ability to securely send messages to their care provider, access assigned patient education, schedule upcoming appointments and pay their bills, gives them much more control and ability to influence their own health and healthcare;
- electronic submission of billing claims to insurance companies improves efficiency and accuracy of claims submissions; and
- submission of the patient's data to the health system's data repository allows the system to run multiple types of analyses of aggregated patient data to improve the quality, efficiency and overall outcomes of care for the patients that they serve.

Emerging Trends in Clinical Informatics: An Effort to Improve Quality

The United States Census Bureau reported in 2011 that 48.6 million Americans, or 15.7 %, did not have health coverage [25]. As a result, health reform has been a hot topic in the United States and was perhaps the most debated issue in both the 2008 and 2012 Presidential elections. In 2000, the World Health Organization (WHO) released the World Health Report, which ranked the U.S. Healthcare System 37th in the world due to its overall performance (15th) and overall health expenditure per capita (1st) [26]. On March 23, 2010, President Obama signed the Patient Protection and Affordable Care Act (ACA) into law. The purpose of the ACA legislation is to assure that all Americans have access to affordable health insurance. However, with the new legislation, health organizations as well as the system have had to adapt to new policies and regulations. As a result of the implementation of ACA, and the move to a value-based health system, several trends have emerged.

ACA & Accountable Care Organizations

The ACA seeks to improve access to high quality and affordable health care for all Americans. One mechanism in which the ACA seeks to reduce health care costs is through the promotion of provider networks, called Accountable Care Organizations (ACO), that coordinate patient care and are effective in delivering care more efficiently. An **ACO** *is a network of doctors and hospitals that share financial and medical responsibility for providing coordinated care to patients in hopes of limiting unnecessary spending* [27]. In order for ACOs to be effective in providing health care efficiently and improving health outcomes, ACOs rely on comprehensive patient data. The use of aggregated patient data and connected, interoperable electronic health systems to drive improved quality of care are ideal for utilization by ACOs and Patient-Centered Medical Homes. Similar to ACOs, **The Patient-Centered Medical Home** *is a care delivery model aimed at providing coordinated health care services through a primary care provider to ensure they have access to health services when and where they need it*. Clinical informatics, once again, is a vital component to the development, implementation, and management of systems capable of population health tracking and patient information management. These systems require the use and the continuing refinement of these information management systems grounded in clinical informatics.

Learning Health System and Electronic Health Records

Another trend that has emerged in recent years is the development and implementation of **electronic health records** (**EHR**) which are "*digital versions of a patient's paper chart. EHRs are real-time, patient-centered records that make information available instantly and securely to authorized users*" [28]. With the adoption and use of EHR systems, it is now possible to learn or infer patterns of evidence from the vast amounts of information captured during routine clinical care. This observation led the Institute of Medicine to propose the notion of a Learning Health System in which health care providers not only seek to provide care in accordance with established clinical guidelines based on evidence from clinical research but also in accordance with evidence they infer from their EHR system [29]. Because clinical informaticians are chiefly responsible for the implementation and use of health information technologies within their organization, they are responsible for ensuring that the EHR not only captures data that can inform care delivery processes but that actionable insights are found and applied. This activity is generally referred to as analytics or business intelligence.

The aggregation of patient data through the use of electronic health records has also allowed for an evolution of research into areas of study that were not previously possible. Now scientists can look at EHR level data to track historic data on disease outcomes with branching factors of complications and treatment decisions.

Researchers have begun to tie genomic data and social determinants of health into this equation as well. This use of "Big Data" is aimed at the goal of allowing a care provider or even a patient to input all of the known variables of the patient and then be shown the odds of the various most likely outcomes given specific treatment and life choices.

Chapter Summary

As the U.S. Health System aims to improve overall population health by improving the effectiveness of and efficiency of the system, clinical informatics has and will continue to play an integral role on the path to a coordinated health system that is effective in improving health outcomes by delivering high quality and affordable health care to all Americans.

Application Exercise/Questions for Discussion

1. What is the difference between individual and population health?
    (a) Compare and contrast the determinants of each.
    (b) How are they monitored differently?
2. How are insurance costs determined?
3. How will the shift in health system culture (from treating acute problems to promoting wellness) impact health care delivery?
4. How does clinical informatics support the U.S. health system?
5. How will health reform likely impact the flow of information through the health system?

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