Part I: Economics

Chapter 1

Output of the Healthcare Sector

OBJECTIVES

1. Describe the product *medical care* and its components.
2. Define the concepts of *risk* and *risk shifting* and show why they are relevant to medical care.
3. Describe health care and its components.
4. Describe the concept of *health outcome.*
5. Explain the theoretical relationship between health and medical care, and demonstrate the meaning of the term *flat-of-the-curve medicine.*

1.1 INTRODUCTION

In this chapter, we introduce the descriptive elements in the study of the healthcare system. This involves identifying the phenomena with which we are concerned, defining them so we can know their nature precisely, and measuring them so we can obtain an understanding of their magnitude. At this stage, we wish only to discover what phenomena exist, not what causes them (explanation) or in what quantities they should exist (evaluation).

The processes generated within the healthcare system can be looked at in two ways. The first approach is to directly examine factors that influence health. These health-influencing factors can be classified as lifestyle elements, such as diet, sleep, and other individual behaviors; environmental factors, such as air and water purification; genetic factors; and medical care, such as examinations and treatments. Section 1.2 focuses on the definition and measurement of medical care. It identifies and defines the phenomena associated with medical care and discusses measures that indicate how much medical care is provided. Section 1.3 describes another aspect of the healthcare system: risk shifting. Because most medical expenditures do not occur with certainty, individuals will place a value on buying insurance to cover possible losses. Risk shifting provides benefits to consumers and is an important output of the healthcare sector.

The second approach stems from the assertion that the true end of the healthcare sector is not the care itself, but rather the health that results

from this care. When measuring the output of health care, according to this approach, the measure should be how much health is being produced. If it is believed that the volume of medical care provided is not necessarily a good indicator of the benefits provided, a more fundamental approach would be to measure what medical care is ideally supposed to produce, that is, health. Section 1.4 examines issues of definition and measurement associated with health.

Section 1.5 focuses on the output of the healthcare system derived from the education of healthcare personnel. The healthcare system includes the training of the professionals who work within the system, and these individuals will produce output (health care) during their training and after it is completed. In economic terms, the output of the education and training production process is called "human capital."

1.2 MEDICAL CARE

Medical care is a process during which certain inputs, or factors of production (e.g., healthcare provider services, medical instrument and equipment services, and pharmaceuticals), are combined in varying quantities, usually under a physician's supervision, to yield an output. An individual visiting a physician's office receives an examination involving the services of the physician or a nurse practitioner, nurse, or medical technician, and the use of some equipment. The inputs vary from one visit to another. One patient may receive more friendly treatment than another, and healthcare providers vary in their thoroughness, knowledge, and technique. Thus, the quality of one visit may differ considerably from the quality of another.

Much of the difficulty in measuring the medical care process stems from the issue of quality. If physician care is measured by the number of patient visits to a physician's office, two cursory examinations count as two visits. But one cursory examination followed by a thorough examination involving a battery of tests also counts as two visits, even though more medical care was provided.

It should be stressed that *quality* is a very broad term, and its meaning is elusive (Donabedian, 1988). For example, organizations providing medical care can have substantially different characteristics. To begin with, they can differ in terms of structure, that is, the amount and type of training of the care providers and the type of medical equipment used. Further, differences in structure are associated with the use of different techniques in the provision of care. For example, a computerized axial tomography (CAT) scan machine that takes cross-sectional radiographs is generally considered to provide a higher quality product than a standard radiology machine (Sisk, Dougherty, Ehrenhaft, Ruby, & Mitchner, 1990). A second aspect of the quality of care involves the process of providing care, in particular, the amount of personal attention providers devote to consumers, and incorporates what is actually done in the provision and receipt of care. Examples of quality-of-care measures that reflect the degree of personal attention given to consumers include the volume of services performed per individual and patient evaluations of physician performance.

Another set of characteristics is associated with outcomes, or the effects of care on the health status of the individual or the populations. In this instance, the measure of outcomes deals with the accuracy of diagnoses and the effectiveness of treatments in producing health. Examples of measures reflecting this set of characteristics include hospital mortality rates adjusted for patient condition, the rates of other adverse events in hospitals, such as postsurgical infections, or the reduction in influenza because of immunizations.

All of these characteristics, as well as others, have been identified as aspects of quality. The challenge of measuring quality, then, derives from the fact that there are many ways of viewing quality and many different ideas as to what constitutes quality. For this reason, the raw measure "visits" should be only guardedly used as a measure of physician care.

The measurement of hospital care requires the same caution. Hospital output has frequently been measured by bed days or by the number of cases admitted to the hospital. Over time, however, the typical admitted patient receives a greater intensity of services as a result of advances in technology. To count an admission in 1965 as having the same output as an admission in 2011 (given the type of case) would be to neglect the greater intensity of services likely to be provided at the later date.

Despite these objections, physician visits as a measure of the output of medical care and hospital admissions or bed days as a measure of the output of hospital care have frequently been used because of their immediate availability. Recently, efforts have been made to develop additional measures that incorporate the changing quality of inputs per admission or per bed day.

Output measurements are usually conducted to make comparisons, either against other output measures or against some standard. There are two types of output comparisons: time series and cross-sectional comparisons. A time series comparison measures the output of the same good or service at different times. A cross-sectional comparison measures the output of the good or service among different groups at the same time (e.g., the medical care provided to consumers in different age groups, ethnic groups, or geographic areas, or with different diagnoses).

Medical care output can be measured at three sources:

1. The providers can be surveyed to determine how much medical care they have produced.
2. The payers for medical care can be surveyed to determine for how much medical care they have paid.
3. The consumers can be surveyed to determine the quantity of consumption or utilization.

With perfect measurement, all three sources will yield the same results; however, because of measurement difficulties, considerable differences will arise. A continuing source of data on medical care received by consumers is the National Health Interview Survey, an annual nationwide sample survey of households on health-related matters compiled for the U.S. Public Health Service. Much of the information from this survey is summarized in the Public Health Service's annual compendium of health-related data, *Health United States* (www.cdc.gov/nchs/hus.htm).

The National Health Interview Survey (www.cdc.gov/nchs/nhis.htm) is also the major source of data on medical care administered by physicians outside the hospital. This care is measured by the number of visits to physicians (the numbers of visits are often adjusted for the size of the relevant populations to yield utilization rates), with utilization defined as the amount of services consumed. As an illustration of the use of time series data, comparisons were made of physician's office visits per year for individuals in the 65 and over age group. For this group, visits per person were 4.5 in 1975, also 4.5 in 1985, 5.3 in 1995, and 6.9 in 2008. These numbers indicate that there was no increase in the output of physician office care for this group between 1975 and 1985, but that a marked increase did occur in the following decades (see U.S. Department of Health and Human Services, 1994, 1999, 2011). Also, one visit in 1975 was counted as the equivalent of one visit in 2008 because quality-difference adjustments were not made. It is very likely that quality did increase in this period because of new technology, better equipment, and better training. Unfortunately, this aspect of output is usually neglected in data collection efforts (Freiman, 1985).

An alternative way of measuring physician output is to focus on procedures or services. Procedures (e.g., an appendectomy) can be measured in a number of dimensions (e.g., average time of performance, complexity, overhead expenses), and based on these dimensions, comparable weights can be developed for each procedure (Hsiao & Stason 1979; Hsiao et al., 1992). This approach better captures the differences among various physician tasks.

There are several different measures of hospital output. One way of measuring output is to examine the number of admissions on a per-population basis. In 1964, there were 190 admissions per 1,000 population, while in 2007 there were 114 admissions. However, the length of stay per admission has changed radically in this time period, from 12 days per admission to 4.8 days. As a result, total days in hospital per 1,000 population fell from 2,292 to 540. The number of days is a better measure of resources used than admissions, but even days does not tell the whole story, as it leaves out the consideration of quality (U.S. Department of Health and Human Services, 1999, 2011).

Because of the vast differences in types of illnesses, in disease severity, and in medical treatment patterns (including quality of care), hospital output is difficult to characterize from an economic viewpoint. One method of doing so that captures a mixture of illness types and severities, as well as treatment patterns, is the diagnosis-related group (DRG) classification system. The DRG system has many variants, but all of them are simply patient classification systems. In the 1998 version of the DRG system, which was used by the Health Care Financing Administration to reimburse hospitals, hospital inpatient output was divided into 511 different groups based on the major reason for hospitalization, whether the case was medical or surgical, patient age, and the presence of significant complications and comorbidities (conditions in addition to the primary). In 2007, the Centers for Medicare and Medicaid introduced the Medicare Severity Diagnosis-Related Groups (MS-DRG), expanding the number of groups to 745. While the MS-DRGs do not measure quality, they do incorporate more data on the severity of illness of the patients within the diagnosis.

In a nationwide study of hospital costs conducted at the Agency for Health Care Policy and Research (AHCPR), average annual charges for specific DRGs were as follows: normal delivery, $3,094; craniotomy without complications, $32,594; liver transplant, $204,000 (Agency for Healthcare Research and Quality, 1997). Despite the fact that the DRG system develops average costs among groups, the range of costs within, as well as between, DRGs was considerable; this variation is reduced, but not eliminated, with the MS-DRG system.

DRGs do not measure "quality of care." To gather a picture of hospital product quality, we must look at data collected from hospitals. Hospital output data are available from *Vital and Health Statistics* (Series 13), published by the Public Health Service; *Hospital Statistics,* the annual compendium of the American Hospital Association (AHA), and various issues of *Hospitals: Journal of the American Hospital Association*. The Hospital Compare website (http://www.hospitalcompare.hhs.gov) provides another source of quality measures in hospitals, including patients' perceptions regarding their hospital stays.

The AHA formerly published a series of indexes that extensively covered the concept of measuring quality changes in hospital care over time (Phillip, 1977). This index attempted to measure the quality change of a day of care by changes in service intensity, which was defined as the quantity of real services that go into one typical day of hospitalization. The AHA's Hospital Intensity Index (HII) incorporated 46 services, including the number of dialysis treatments, obstetric unit worker hours, and pharmacy worker hours. A weighted average of these 46 services was calculated annually on data from a sample of hospitals to derive an average number of services per patient day offered during the year. With the calculation for 1969 as a baseline (the value for that year equals 100), the annual averages formed an index that measured changes in the service intensity component of output over time. Although these data are no longer published, they did provide an excellent illustration of how important service intensity is as a component of medical care output. While intensity of service has been associated with quality of hospital services, there is no evidence that increased intensity always results in increased quality of care. There are a number of other factors impacting actual quality of care delivered.

In Table 1-1, national data are shown for three components of hospital utilization between 1980 and 2007. The three general measures are hospital patient days per 10,000 population, hospital discharges per 10,000 population, and average lengths of stay (ALOS) in days. These three categories are then presented as crude rates and as age-adjusted rates. The crude rates are simply numbers of events that occurred. The age-adjusted rates are statistical calculations to adjust the population to a "standard" distribution. Age-adjusted rates enable better comparisons among populations with different age distributions, which is particularly important in health care, because there are substantial differences in health simply because of the aging process. For example, if there is interest in comparing hospital utilization across different areas, and one area has a high rate of younger individuals (possibly because of a college town within its borders), compared to another area with an older population, the age-adjusted rate can be used to reduce the confounding impact of age differentials.

Table 1-1 Output in Short-term, Acute Care Hospitals in the United States

	Days of Care per 10,000		Discharges per 10,000		Average Length of Stay	
Year	*Crude*	*Age Adjusted*	*Crude*	*Age Adjusted*	*Crude*	*Age Adjusted*
1980	12,166.8	15,027.0	1,676.8	1,746.5	7.3	7.5
1985	9,576.6	10,017.9	1,484.1	1,522.3	6.5	6.6
1990	7,840.5	8,188.3	1,222.7	1,252.4	6.4	6.5
1995	6,201.7	6,386.2	1,157.4	1,180.2	5.4	5.4
2000	5,546.5	5,576.8	1,128.3	1,132.8	4.9	4.9
2005	5,620.9	5,541.7	1,174.4	1,162.4	4.8	4.8
2007	5,538.4	5,404.1	1,143.9	1,124.0	4.8	4.8

Data Source: Adapted from Table 99. NCHS (2011). Health, United States, 2010: With Special Feature on Death and Dying. Hyattsville MD. NCHS. CDC/NCHS: National Hospital Discharge Survey.

As can be seen in Table 1-1, the utilization of hospitals has been declining since 1980. The decline was large in the 1980s and early 1990s, and has leveled off somewhat in recent years, especially in terms of the length of stay of individuals admitted to hospitals. The age-adjusted number of days of care per 10,000 population in 2007 was only about 40% of what it was in 1980. The decline in days of care reflect both a decrease in the number of times individuals were admitted/discharged from the hospitals and the average length of time they stayed in the hospital once admitted.

1.3 RISK SHIFTING AND HEALTH INSURANCE

Another type of healthcare sector output is risk shifting through the purchase of health insurance. Illnesses are often unexpected and accompanied by monetary losses. These losses can be in the form of medical expenses, lost earnings from work, and other expenses. Individuals can be said to face a *risk* of losing some of their wealth, which means that the existence of the loss and its amount are uncertain. This risk creates concern on the part of the consumers, and they are usually willing to pay something to avoid the risk.

One way of dealing with the risk is to shift it to someone else. Insurers are organizations that specialize in accepting risk. When an insurer accepts a large amount of risk, the average loss to the insurer becomes predictable. Of course, there are costs of operating such a risk-sharing organization. These include the administrative expenses associated with determining probabilities, setting prices, selling policies, and adjudicating claims. The owners also expect a return on their investment (profits). These expenses and profits are included in the fee (called a *premium*) that each individual must pay to obtain insurance. The essential point here is that, in its own right, risk shifting is an additional output that is distinct from the output called *medical care*. Someone can

obtain medical care without risk shifting (by paying for it when the product is received). Such an individual is still faced with the risk of incurring losses, but has done nothing to shift the risk. It is the *additional* activity of shifting the risk in advance—taking action to reduce the loss should illness occur—that is the output.

There are a variety of ways in which risk can be shifted. It can be done privately, by the purchase of insurance. Insurance organizations, such as Blue Cross Blue Shield, Prudential, and Aetna, sell health insurance policies, either directly to individuals (individual policies) or through groups, such as employers and professional associations (group policies). In addition, health maintenance organizations (HMOs) act as both insurers and providers of care. The government also acts as a payer of healthcare bills for large numbers of individuals, although, strictly speaking, it is not an insurer; most of its revenues are in the form of taxes, not premiums, and often the covered individuals are not the ones who pay these taxes. Thus, the government does not manage its healthcare related expenditures on an insurance (risk assessment) basis. Government-style risk sharing is referred to as *risk pooling*.

Health insurance can cover all an individual's expenses. Full insurance has become quite costly, and so insurers have come to resort to "cost-sharing" provisions, in which insured persons pay a portion of their healthcare bills and the insurer covers the rest. These provisions allow the insurers to limit expected payouts and charge the insured persons lower premium rates. In cost-sharing arrangements, the risk shifting is not complete.

Cost sharing can be done in several ways. The insurance policy can require the individual to cover the first dollars of expenses—a deductible—and the insurer then pays all, or a portion, of the rest. For example, the individual might be required to pay a deductible of $100 before the insurer begins to kick in. The insurer can also specify a limit above which payments will cease. For example, it might cover expenses up to a lifetime limit of $1,000,000. Beyond that, the individual would again bear the risk. So-called catastrophic insurance can be obtained to cover very large losses.

The amount and type of insurance coverage is inextricably tied to the workings of the medical care market. Thus, although insurance and medical care should be thought of as separate products, they do affect one another. In the case of insurance coverage, distribution issues have arisen as a cause for concern. In the United States in 2010, some 18.5% or roughly 49.1 million people under age 65 were uninsured (CDC, 2011). Among those lacking insurance were a number of children (8.2% of those under 10), a fact that has generated a considerable amount of concern.

This number of uninsured children is much lower than previously, mainly the result of the implementations of the SCHIP (State Children's Health Insurance Program). Additionally, many employed individuals have no insurance. Because employment is the traditional source of health insurance in the United States, the lack of insurance among workers is viewed as a worrisome development (Monheit & Short, 1989).

The mere possession of some sort of coverage does not guarantee adequate risk protection. Medicare is a government plan that covers hospital expenses and (optionally) medical and drug expenses for individuals age 65

and older. Because of the cost-sharing arrangements incorporated into the program, many of those who are covered under Medicare still face a substantial financial risk should they become ill. Indeed, 70% of those who are age 65 and older now purchase private supplemental insurance plans, also called "Medigap" policies, to cover the risk resulting from the cost-sharing elements (Health Care Financing Administration, 1998).

At the same time, it also should be pointed out that a complete absence of risk on the part of insured individuals (the shifting of the entire risk onto insurers) has its problems as well. A totally riskless policy may be very expensive, because individuals are more prone to demand care when it has a zero price (as under full insurance coverage). The costs of such care must still be covered by the insurer, and so premiums must increase to cover these costs.

1.4 HEALTH STATUS

1.4.1 Concepts

The concept of health seems so familiar to us that we can almost reach out and touch it. It seems easy to distinguish the 97-pound weakling from the bodybuilder who kicks sand in his face at the beach or to recognize a radiant complexion when we see one in a facial soap commercial on television. More precise measures, however, are hard to obtain. The categories "healthy" and "unhealthy" are not exact. The main reason for this is that we have not defined health precisely. Lacking such a definition, two observers can have different opinions as to whether one person is healthier than another. An essential task of the scientific method is to obtain widespread agreement about the nature of a phenomenon. If we lack an operational definition, we can hardly expect two independent observers to reach agreement about the status of the phenomenon. A definition is useful if it helps pinpoint the characteristics of the phenomenon we are trying to describe and eventually measure.

Health is not an easy concept to define with any degree of precision. As the English epidemiologist Sir Richard Doll remarked concerning the concept of health, "Positive health seems to be as elusive to measure as love, beauty, and happiness" (Doll, 1974). Yet, in an effort to give some hold on the concept, the World Health Organization (2000) has defined health as "a complete state of physical, mental and social well-being, and not merely the absence of illness or disease." This is a very broad definition, and the characteristics of health suggested by it are not easy to pinpoint and measure. The definition stresses that there are three components of health, and even if a person is physically healthy, he or she can still be lacking in the other categories.

1.4.2 Measures of Individual Health

For many years, health was identified by the presence of disease (morbidity) or by death (mortality). Individual measures, such as the diagnosis rates for certain conditions or rates of hospitalization, were used as indicators for morbidity. Mortality was usually adjusted for such population factors as age and gender. More recently, mortality has been addressed in terms of premature

mortality, with the difference between expected age of death and the actual age of death being forwarded as a measure of life-years lost prematurely. Thus, if the expected age of death for a male aged 20 is 75, then a 20-year-old man who dies in a car accident is considered to have lost 55 years of life.

Researchers have been looking for other measures of health with a more positive focus. Attempts at identifying and measuring health have focused on certain characteristics we would expect in a healthy person. These characteristics include the physical functioning of the individual's body in relation to some norm, the physical capability of the individual to perform certain acts (e.g., getting up or dressing), the social capabilities of the individual (i.e., how well he or she interacts with others), and how the individual feels. These characteristics are, by no means, distinct from one another, a fact that has led to much disagreement among researchers who have tried to invent a unique measurement of health status. Different research efforts have focused on clinical characteristics; on individual capabilities (Boyle & Torrance, 1984; Culyer, 1976); on the physical functioning of people's bodies in relation to some norm (Kass, 1975; Williamson, 1971); and on a mixture of physical, mental, and social characteristics (Breslow, 1972).

Despite the considerable difficulties in arriving at widely accepted indexes of health status, the importance of the topic ensures that researchers will keep trying. One widely used measure is the 15-D (for 15 health dimensions), which categorizes health status into 15 groups, as shown in Table 1-2. These groups include breathing, hearing, moving, and so on. Subjects rate each dimension on a 5-point scale. For the breathing dimension, for example, a "1" would indicate normal breathing, and a "5" would indicate that the individual experiences breathing difficulties almost always. Within each dimension, each point on the scale is assigned a value, which scores the functioning level. For example, normal breathing is scored as 1.0000, and level 5 breathing is scored as 0.0930. The 15-D investigators have assigned a second set of weights to each of the 15 dimensions. These weights were obtained from community surveys and reflect the importance of each dimension. Example weights are shown in Table 1-2. For example, breathing has an importance weight of 0.0805. The 15 importance weights sum to 1.0000.

Investigators can use instruments such as the 15-D to provide measures of an individual's quality of life. Further, a time dimension can be added to provide a measure of quality-adjusted life years, or QALYs. Investigators often standardize these measures, with a score of 1.0000 being the highest level of health and 0.0000 being the lowest (or perhaps even death). Thus, for example, a group of patients with asthma had an average overall 15-D score of 0.89 (out of a maximum possible score of 1.00) (Kaupinnen et al., 1998). If the condition persisted for 1 year, then the average patient's quality of life index would be 0.89 QALYs for the period. The individual would have lost 0.11 QALYs due to his asthmatic condition. The figure 0.11 represents the loss of full health over the year. If the condition persisted over 2 years, then the individual would have experienced 1.78 QALYs during that period.

The translation of health-related quality of life (HRQOL) measures into QALYs has one very convenient benefit. By evaluating death as 0.0000, one can compare interventions, some of which result in death. For example, if one

Table 1-2 Health Dimensions in the 15-D Health-related Quality of Life Index

Dimension	Importance Weight
Breathing	0.075
Mental functioning	0.044
Speech	0.065
Vision	0.075
Mobility	0.046
Usual activities	0.057
Vitality	0.074
Hearing	0.104
Eating	0.040
Eliminating	0.033
Sleeping	0.090
Distress	0.079
Discomfort/symptoms	0.072
Sexual activity	0.084
Depression	0.062
Total	1.000

Source: Adapted from H. Sintonen. The 15D Instrument of Health-related Quality of Life: Properties and Applications, *Annals of Medicine 33*: 328–335, ©2001.

person lived for 5 years at a QALY value of 0.5 rather than being dead (QALY value of 0.0000), then the difference in QALYs would be 2.5000–0.0000, or 2.5 QALYs. Of course, there are conceptual problems with placing a 0.0000 value on death; death is beyond the conscious experience of people, and so they may have great difficulty comparing different levels of health with death.

The 15-D weights can be used both to assess the HRQOL of an individual over time or to compare different individuals or groups. For example, women with breast cancer can take different forms of chemotherapy. The 15-D can measure differences in health-related quality of life among the interventions. There are several general HRQOL measures in use (Bowling, 1995); those used mostly by economists include the Euroquol 5D (Kind, 1996) and the Health Utilities Index (Feeny et al., 1996). In addition, there are a large number of HRQOL measures for specific diseases (Bowling, 1995).

1.4.3 Population Health Measures

The most commonly used population health measures have been mortality rates and morbidity (usually hospitalization) rates. Mortality, or death rates, are standardized by age and sometimes gender and can be expressed for the entire

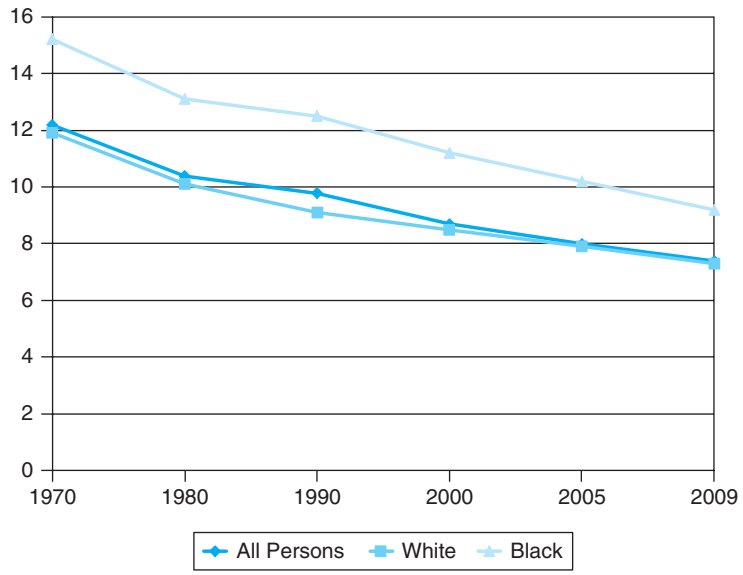

Figure 1-1 Age-adjusted Death Rates by Group, United States, 1970–2009 (Deaths per 100,000 Residents).

Source: 1970–2005 data from U.S. Census (2010). Statistical Abstract of the United States, 2010, Table 107; Table A: National Center for Health Statistics, National Vital Statistics Reports, Deaths: Preliminary data for 2009.

population or for subgroups, such as Whites and Blacks. In Figure 1-1, we show the trends in death rates for the total population and for Whites and Blacks from 1970 to 2009 in the United States. All rates have been falling, but the death rate for Blacks is substantially above that for Whites. Death rates are also used for subgroups; for example, the neonatal mortality rate, which expresses deaths up to the first 28 days of life as a percentage of total live births, was 4.5 in 2006. For the White and Black populations, the respective rates were 3.7 and 9.1 (U.S. Department of Health and Human Services, 2011).

Increasingly, analysts have been focusing on survival time as an indicator of health status. They choose survival-time indicators because these place emphasis on the duration component of health status; a person's well-being is a function of the time spent in each health state, not merely the health state at a given moment in time. Measures that look at survival time adopt this important dimension of health. One such measure is that of potential years of life lost (PYLL) before a target age. The analyst selects a target age below which most individuals are expected to live. Deaths that occur at an age earlier than the target age are considered to be premature. The measure of premature deaths is considered to be one of the best population-level indicators of health. This indicator for Whites and Blacks in the United States is shown in Table 1-3. The PYLL for males, expressed in terms of 100,000 persons, is almost 14,000 life years, while for females it is only about half that, at 7,400. The number for Blacks, on the other hand, is almost 18,000 compared to Whites at less than 10,000.

Table 1-3 Years of Potential Life Lost before Age 75, per 100,000 Population under 75 Years of Age, United States, Selected Years (Age Adjusted)

Year	Total	Males	Females	White	Black
1980	10,448.4	13,777.2	7,350.3	9,554.1	17,873.4
1990	9,085.5	11,973.5	6,333.1	8,159.5	16,593.0
2000	7,578.1	9,572.2	5,644.6	6,949.5	12,897.1
2005	7,299.8	9,206.1	5,425.7	6,775.6	11,890.7
2007	7,083.5	8,919.9	5,274.2	6,614.2	11,259.8

Source: Adapted from National Center for Health Statistics, *Health, United States, 2010, Table 25*. Department of Health and Human Services, 2011.

Of course, mortality rates do not take quality of life into account. In an effort to incorporate both mortality and quality of life into a single index, analysts at the World Health Organization have developed an index called *healthy adjusted life expectancy* (HALE) (WHO, 2010), which reflects the average number of years an individual can expect to live in "good health." To estimate HALE, the investigators determine the prevalence of both fatal and nonfatal conditions in each country and adjust life years in light of disability rates due to diseases and injuries. The results for selected countries are displayed in Table 1-4. This table shows the life expectancy for males and females in seven countries, including the United States, both adjusted (2007) and unadjusted

Table 1-4 Life Expectancy at Birth and Healthy Life Expectancy (HALE) at Birth, Selected Countries

	Life Expectancy at birth, 2008			Healthy Life Expectancy (HALE) at birth, 2007		
Country	*Total*	*Males*	*Females*	*Total*	*Males*	*Females*
Argentina	76	72	79	67	64	69
Australia	82	79	84	74	72	75
Japan	83	79	86	76	73	78
New Zealand	81	78	83	73	72	74
Switzerland	82	80	84	75	73	76
United Kingdom	80	78	82	72	71	73
United States	78	76	81	70	72	68

Source: Reprinted with permission from: World Health Organization. World Health Statistics, 2010. Geneva Switzerland. Accessed April 19, 2012 from http://www.who.int/whosis/whostat/EN_WHS10_Full.pdf and http://www.who.int/whosis/whostat/EN_WHS2011_Full.pdf.

(2008) for disability. For the United States, the life expectancy at birth was 78 years before adjusting for disability. After making disability adjustments, this figure was reduced to 70 years. The difference (8 disability-adjusted years) is the reduction in quality of life of those who survived. The greater the gap between the two figures, the poorer the measure of health of the surviving population. For those countries shown in the table, the gap is between 7 and 9 disability years.

1.4.4 Outcome

The final output of the healthcare sector is health. If there is a close relationship between health and medical care, then indicators of *medical care* output can be used as indicators of the true output of the healthcare sector. It has been contended that there is not necessarily such a correspondence, and that the quantity of medical care utilized is, therefore, not a good indicator of output.

The true output of the healthcare sector is measured by the net change in health produced by the medical care provided. That is, output is measured not by the level of the health index (e.g., by the infant mortality rate) but rather by the *change* in the index due to the medical care, in other words, the effects of the care. For example, if the infant mortality rate fell from 12 to 10 deaths per 1,000 births subsequent to a program to introduce a new drug, the output of the program would be that proportion of the reduction in infant mortality that was due to the program. It may be that other factors, such as the mothers' diets, also contributed to the change in infant mortality. The presence of such confounding factors creates difficulties in finding an accurate measure of output; medical care is seldom the only factor contributing to changes in health status. Other factors may be difficult to identify (e.g., changes in personal behaviors) and equally difficult to measure.

In addition to the identification of confounding factors, there is the problem of measuring changes in health status. The previous discussion illustrates how many difficulties are posed in trying to measure levels of health status. The measurement of changes in health status merely adds to these problems. For example, assume that an individual with a gastrointestinal disorder will have a quality-of-life index of 0.5 for a seven-week period in the absence of any treatment. She can be treated using one of two different drugs. With the less effective drug, Treatment A, the individual will have a quality-of-life index of 0.7 for two weeks, of 0.8 for an four additional weeks, and 1.0 for the seventh week (see Figure 1-2). With Treatment B, the individual will have a quality of life of 0.8 for two weeks and will be completely cured after that. Over the entire seven week period, the individual would have a total quality-of-life measure of 3.5 quality-adjusted weeks with no treatment, 5.6 quality-adjusted weeks ($[2 \cdot 0.7] + [4 \cdot 0.8] + 1.1.0$) with Treatment A, and 6.6 weeks with Treatment B.

The outcome measure will depend on what the alternative is. If the alternative is no care, then the outcome for Treatment A is 2.1 quality-adjusted weeks, and for Treatment B, it is 3.1 quality-adjusted weeks. That is, the outcome is the difference in the value of the index between the two treatments (Williams, 1985).

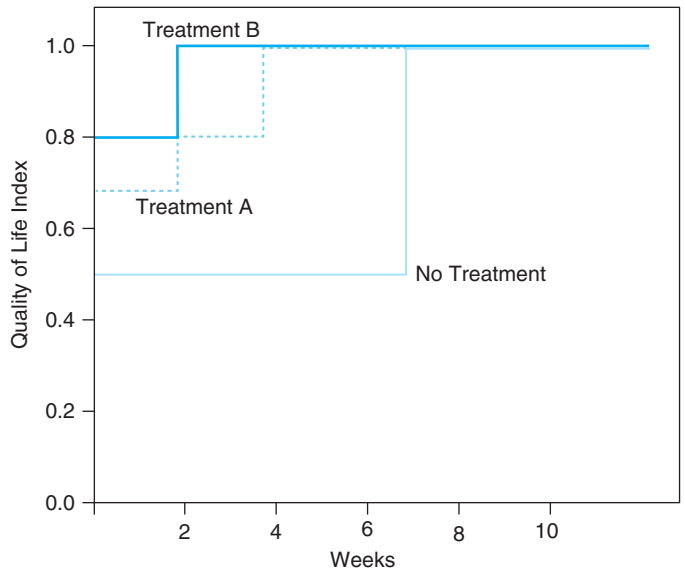

Figure 1-2 Quality of Life Indexes under Three Alternative Treatment Options. With no treatment (see thin solid line), the individual has a quality of life index of 0.5 over 7 weeks and then recovers fully (quality of life level 1.0). Under Treatment A (broken line), the quality of life index is 0.7 for 2 weeks, 0.8 for the next two weeks, and 1.0 thereafter. Under Treatment B (darker solid blue line), the quality of life index is 0.8 for 2 weeks and full recovery (1.0) thereafter.

It has been contended that, in general, there is a limit to how much good medical care can do; as more medical care is provided (to the same individuals), the additional output becomes less. This is illustrated in Figure 1-3, in which health is shown on the vertical axis and the quantity of medical care on the horizontal axis. The medical care "outcome" curve, showing the relation between health and medical care, is drawn to indicate that there would be some level of health without any medical care (H_0) and that additional levels of medical care make some contribution to health. However, the additional (marginal) contribution declines as the quantity of medical care increases. Such an output curve assumes all other factors (environmental, genetic, personal) are held constant and only medical care varies. The additional output is expressed as $\Delta H/\Delta M$, where ΔM is the additional medical care and ΔH is the additional health. Note that, because of the way the curve is drawn, $\Delta H/\Delta M$ declines in value as more medical care (M) is provided. This eventual flattening of the output curve has given rise to the expression "flat-of-the-curve medicine" (Enthoven, 1980). Drawing the curve in this way geometrically illustrates that, as medical care provision is increased, the additional effectiveness of medical care declines.

Researchers have attempted to establish the relationship between medical care and health in different ways. Several early studies attempted to identify a statistical relationship between mortality rates and various measures of medical input per capita using state data (Auster et al., 1969) and national data (Stewart, 1971). Both studies found a small relationship or none at all. One explanation

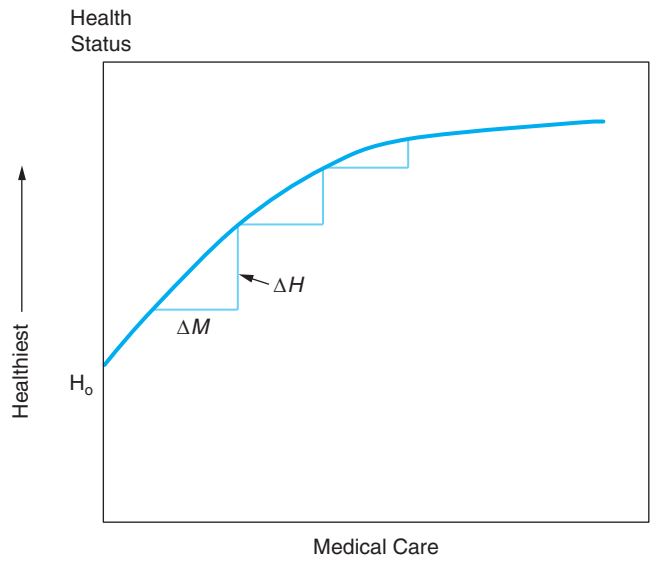

Figure 1-3 Hypothesized Relationship between Health and Medical Care. In this figure, additional units of medical care have a diminishing impact on health; eventually, a situation of low medical productivity, termed "flat-of-the-curve medicine," is reached.

given was that we may have reached the leveling-out point on the curve. Furthermore, it was estimated that the self-care components of health care (e.g., quitting smoking, eating right, getting exercise) may, indeed, be more important than the medical care components (Newhouse & Freidlander, 1979). However, subsequent statistical research that examined specific groups, such as infants, did find significant evidence of the impact of medical care (Hadley, 1982).

Because such studies are so broadly focused, their results are often difficult to interpret, and it may be that health output is more reasonably measured only by experimental means. Setting up clinical trials, in which one group receives a certain treatment and another group with similar characteristics (a control group) does not, is an experimental method of establishing output. The difference in cure rates, if any, between the two groups could be taken as a measure of the output produced by the resources (Cochrane, 1972). In a number of instances, less aggregated studies have sometimes failed to turn up evidence that certain medical practices impact health (e.g., no relationship was found between appendicitis death rates and appendectomies performed) (see Enthoven, 1980, chap. 2). However, such findings should not automatically be generalized (Angell, 1985). Although it may have some analytic appeal, a broad-brush approach may pass over many situations in which we are not on the "flat of the curve."

1.5 CONSUMPTION AND INVESTMENT OUTPUT

The production of any output requires the use of inputs, including services and supplies. These inputs themselves have to be produced. Many of them are capital inputs, which means that they are durable and last for fairly

long periods of time. The totality of resources at any point in time is called a *stock*. In contrast, the amount of activity that occurs during a given time period is called a *flow*.

An output is measured over a given period of time, such as a year. Outputs fall into two classes: those that serve current wants, such as the treatment of patients; and those that serve future wants, such as the production of capital inputs. The use of output for current wants is called *consumption* activity. In health care, much of the output is used up as soon as it is produced. Curing a common cold using drugs is a consumption activity, because the treatment is brief. The production of capital resources is called *investment* activity; the effects themselves are designed to last for several years or more.

Capital inputs can be of the physical variety (radiological equipment) or the human variety (trained radiologists and radiology technicians). Physical capital is the stock of physical means of production. Examples include equipment and buildings. Human capital is the stock of talents, skills, and knowledge embodied in individuals. An example of investment in physical capital is the production of radiology machines. Undergraduate and postgraduate medical education is an example of investment in human capital.

One feature of the healthcare sector is that much of the human capital investment activity is a by-product of medical care consumption activity. Much undergraduate medical education and most postgraduate medical education occur in hospitals and clinics. In many cases, education and patient care activities are inseparable, physically and financially. For many years, teaching hospitals have relied on labor from medical interns and residents for patient care. Because the supply of physicians, including the ratio of specialists to primary care physicians, has become such an important issue in the United States, much attention is being paid to the process by which physicians and specialists are produced.

There is a distinct relationship between capital and production activities. Imagine a given stock of capital at the beginning of 2010 (e.g., magnetic resonance imaging [MRI] machines). Net new investment is the additional stock added during the year (new machines produced minus any machines retired). The stock at the beginning of 2011 is the original capital stock plus the net new investment in MRIs. Important related concepts include the capacity of the capital equipment, actual production, and the percent utilization (or occupancy) rate. If there are 1,000 MRIs in existence, and it takes one hour to produce one image, then the daily capacity is 24,000 images and the yearly capacity is 8.76 million images. If, in any year, 2 million images were produced, the utilization rate would be 23%.

Measures of capacity have a particular importance in the healthcare field. Some analysts believe that the supply of resources directly influences the demand. Commonly used terms and sayings such as "supplier-induced demand" and "an available bed is a filled bed" reflect this view. One of its implications is that, in order to control consumption activity, the investment of capital inputs must be controlled.

EXERCISES

1. Distinguish among three different views of the quality of medical care and provide examples of types of care that would be considered indicators of quality by each view.
2. What is risk and how can people reduce it? Is it costless to do so?
3. What is the difference between morbidity and utilization? Identify an indicator that has been used to measure both, and state a reason why it is not an ideal measure of morbidity.
4. What is the World Health Organization's definition of health? How does this differ from the concept of utilization? Why is it important to distinguish between these two concepts?
5. What is a health-related quality-of-life index? What is the difference between "social importance" weights and "level values" in constructing such indexes?
6. What is a quality-adjusted life year? How can it be used to compare differences in health status between someone who is healthy and someone who is not? Can it be used to compare health outcomes of someone who is ill with someone who has died?
7. What is the weakness of using an unadjusted mortality rate as an indicator of population health status?
8. Which issues in the measurement of population health do potential years of life lost (PYLL) and disability-adjusted life expectancy (DALE) address?
9. Specify a hypothesized relationship between medical care and health. How does flat-of-the-curve medicine fit in with this concept?
10. Indicate at which point flat-of-the-curve medicine is experienced in the following example (imagine that antibiotics have been prescribed for a given population of 1,000 elderly persons).

Number of Prescriptions	Hospitalizations for Community Acquired Pneumonia
0	60
100	50
200	40
300	32
400	28
500	28

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