

Occasional Notes

THE ECOLOGY OF MEDICAL CARE REVISITED

SINCE its publication in the *Journal* in 1961, “The Ecology of Medical Care,” by White et al.,¹ has provided a framework for thinking about the organization of health care, medical education, and research (Fig. 1). This conceptualization, inspired in part by careful reporting on the part of British general practitioners,² suggested that in a population of 1000 adults, in an average month, 750 reported an illness, 250 consulted a physician, 9 were hospitalized, 5 were referred to another physician, and 1 was referred to a university medical center. These data have been used repeatedly by investigators, authors of textbooks, task forces, and government agencies.³⁻⁹ The 1961 report was based on multiple sources of information, mostly from the United States and Britain, dating from 1928. Some of the estimates were subsequently characterized as “intelligent guesses,” with the truth unknown.¹⁰

In 1961, the number of general practitioners in the United States was in steep decline, and the overall number of physicians and the number of subspecialists were growing rapidly. Medicare and Medicaid had yet to be created. Much of the current medical armamentarium, such as computed tomography, organ transplantation, endoscopy, effective antidepressant drugs, and coronary-artery bypass surgery, had not been developed. Nurse practitioners, physician assistants, and the specialty of family practice did not exist.

Much has changed in medicine and in the organization and financing of health care since 1961. Some of these changes — such as new medications and forms of technology, increased expenditures, managed care, and changes in the medical work force — might be expected to have altered the ecology of medical care.¹¹⁻¹⁸ There have also been substantial improvements in the collection and reporting of data on health care in the United States.¹⁹⁻²¹ We have updated the 1961 report by White et al. and have also extended the original study to incorporate data on children and additional sites and types of health care services. Like White, who revised the model in 1973,²² and Thacker and colleagues, who used a longitudinal approach in applying it to a rural setting,²³ we found some variation but overall stability of the relationships proposed 40 years ago.

METHODS

Data

We used the 1996 Medical Expenditure Panel Survey because it contains the most recent, nationally representative data on most of the components of utilization included in the 1961 analysis. Reported data on households cover demographic characteristics, health conditions, health status, use of medical services, charges and

payments for services, access to care, satisfaction with care, health insurance coverage, income, and employment.²⁴ Of the respondents to the 1995 National Health Interview Survey who were selected for inclusion in the subsequent Medical Expenditure Panel Survey, 83.1 percent participated in the first round of data collection in 1996. Data in the survey can be adjusted with the use of weights to make inferences about national trends.²⁴ Although the survey is a remarkably comprehensive source of information on health care utilization, it did not meet all our needs. Consequently, we collected additional data using a short survey administered by the Gallup Organization.²⁵

The Gallup survey was based on telephone interviews with adults in 1001 households. This nationally representative sample was selected through random-digit dialing, with three attempts made to contact a potential respondent before another was chosen. Data were collected for 1001 adults and 480 children who resided in the surveyed households. Not more than two children per household, the youngest and oldest, were included. Interviews were conducted between April 23 and May 7, 2000. The Gallup survey was the primary source of data for estimating the number of people who had considered seeking health care in the previous month and who had received care from a complementary or alternative medical care provider, excluding use of alternative treatment without a visit to a provider.

The Gallup Organization provided weighting factors (to permit inferences to be made for the U.S. population) and estimates of sampling errors, making possible the calculation of national estimates and providing the range within which estimates might vary. The largest 95 percent confidence interval in this study was the ± 3 percent range for the estimate of the number of persons who had considered seeking health care in a one-month period. For estimates based on the Medical Expenditure Panel Survey, the largest 95 percent confidence interval was 211.6 to 222.4 for the number of persons per 1000 who had visited a physician's office in a one-month period.

We lacked a single reliable source of data for estimating the number of persons who have symptoms in a one-month period. Thus, we used prospective health-diary studies conducted in the United States between 1964 and 1991.²⁶⁻²⁹ The use of health diaries has been shown to increase the likelihood that respondents will report most of their symptoms.^{10,30} Few such studies have used the one-month reporting period chosen for this study, and we know of none that have used a nationally representative sample. Our estimate is based predominantly on two studies^{27,28} that involved relatively large samples and a reporting period of three weeks²⁸ or four weeks²⁷ staggered throughout the calendar year to avoid seasonal confounding. These studies are complementary in other ways. One sampled children and young adults,²⁷ and the other focused on adults over the age of 65 years.²⁸ One sample was urban and racially mixed,²⁷ and the other was predominantly rural and white.²⁸ Definitions of terms and data sources are summarized in the Appendix.

Analytic Strategy

We estimated the number of persons per 1000 members of the civilian, noninstitutionalized U.S. population in 1996 who had experienced the health care events shown in Figure 2 during a one-month period. We used data from the Medical Expenditure Panel Survey to calculate the numbers of persons who had visited a physician's office, an emergency department, or an outpatient clinic; had received home health care; or had been hospitalized. For each survey participant, we computed the number of months in which each type of event occurred, divided this number by 12, and multiplied this quotient by the survey weight. The product was summed for all records, multiplied by 1000, and divided by the number of persons in the U.S. population in 1996.

To estimate the number of persons who had visited a primary care physician, we first calculated the proportion of all visits to a physician's office reported in the 1996 National Ambulatory Medical Care Survey that involved family physicians, general practitioners, general internists, and general pediatricians. We then

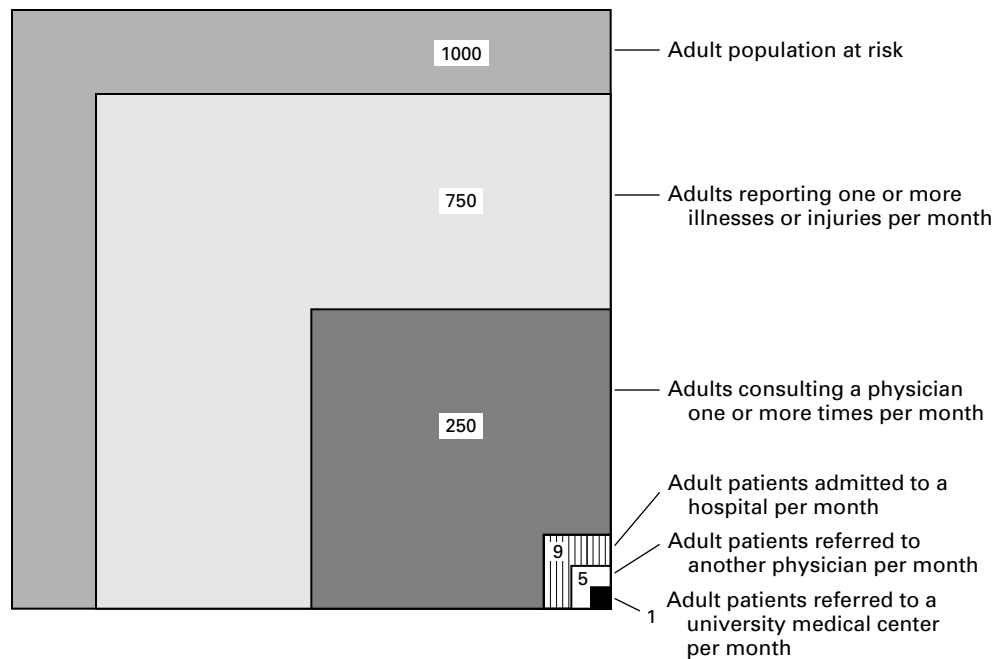


Figure 1. Monthly Prevalence Estimates of Illness in the Community and the Roles of Physicians, Hospitals, and University Medical Centers in the Provision of Medical Care.

Data are for persons 16 years of age and older. Reprinted from the 1961 report by White et al.¹

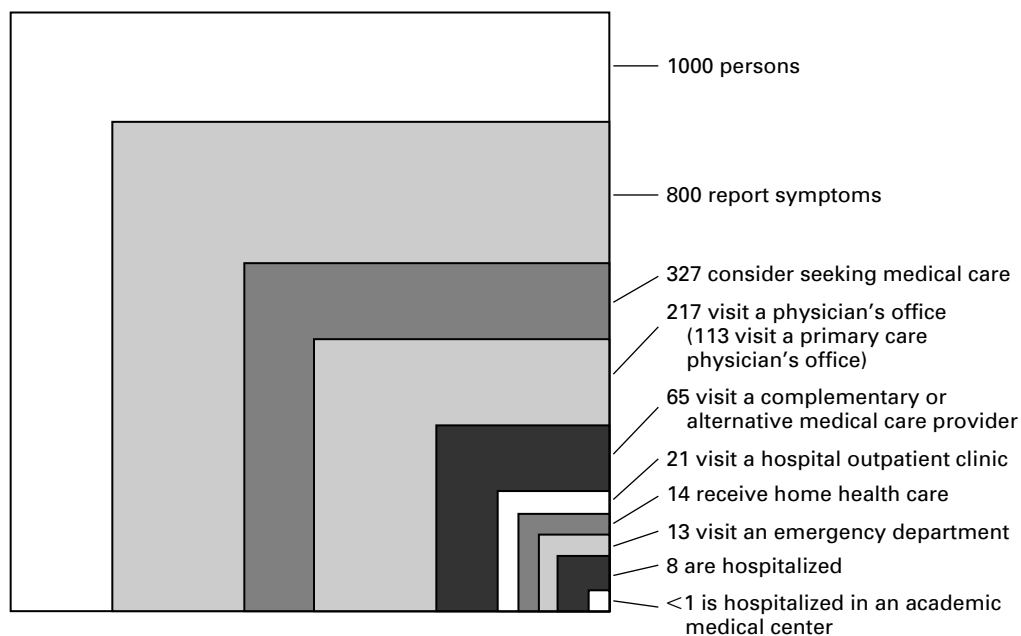


Figure 2. Results of a Reanalysis of the Monthly Prevalence of Illness in the Community and the Roles of Various Sources of Health Care.

Each box represents a subgroup of the largest box, which comprises 1000 persons. Data are for persons of all ages.

multiplied this proportion by the number of persons per 1000 who had visited a physician's office. Similarly, we calculated the proportion of all hospital admissions that were accounted for by academic medical centers, using data for 1996 from the American Hospital Association. This proportion was multiplied by the number of persons per 1000 who had been hospitalized during a one-month period (calculated from the Medical Expenditure Panel Survey) in order to estimate the number of persons per 1000 per month who had been hospitalized at an academic medical center. These procedures for estimating the number of persons visiting a primary care physician and having an inpatient stay at an academic-medical-center hospital are based on the assumption that the number of persons is independent of the number of visits or inpatient stays.

The Gallup survey weights were summed for all persons who had considered seeking health care and who had received care from a complementary or alternative medical care provider. The resulting number was multiplied by 1000 and then divided by the U.S. population for the year 2000.

Roghmann and Haggerty found that 77 percent of young adults and children report one or more symptoms in a four-week period,²⁷ and Stoller and Forster found that 83 percent of older adults report symptoms in a three-week period.²⁸ Two other diary studies involving adults^{26,29} have shown that older persons report more symptoms than do younger persons. To estimate the number of persons with symptoms, we assumed that the results of these studies represent the range for the numbers of persons experiencing symptoms of illness or injury within an average month. We took the midpoint of the range as a point estimate.

RESULTS

Of 1000 men, women, and children in the United States, we estimated that on average each month, 800 experience symptoms, 327 consider seeking medical care, 217 visit a physician in the office (113 visit a primary care physician and 104 visit other specialists), 65 visit a professional provider of complementary or alternative medical care, 21 visit a hospital-based outpatient clinic, 14 receive professional health services at home, 13 receive care in an emergency department, 8 are hospitalized, and less than 1 (0.7) is admitted to an academic-medical-center hospital (Fig. 2). These

results are not nested (i.e., they are not subgroups of one another); all are based on a denominator of 1000.

Table 1 illustrates how the relations in the ecology model can vary. It shows that the number of persons receiving care each month in different settings varies according to age, sex, and race. More adults than children, more women than men, and more whites than blacks receive care in physicians' offices and hospital outpatient clinics. More adults than children and more women than men receive care in their homes. Similar numbers of whites and blacks receive care at home or in the hospital. Use of the emergency department does not vary according to age, sex, or race.

DISCUSSION

As White et al. reported in 1961, we found that each month a large portion of the population of the United States has health problems. Almost 25 percent visit a physician's office, and approximately one third that number visit a complementary or alternative medical care provider. The number of persons who receive professional care at home is similar to the number who receive care in an emergency department. Less than 1 person in 1000 is admitted to an academic-medical-center hospital.

Remarkably, with children included in the analysis, the estimated proportions of persons reporting symptoms, visiting a physician, receiving care in a hospital, and receiving care in an academic medical center have changed little in 40 years. This lack of change may represent stability of these proportions, perhaps because the interactions between people and the health care system are driven by preferences and needs that persist despite changes in the organization of health care. It is also possible that various developments in the health care system have had offsetting effects. For example, an

TABLE 1. MEDICAL ECOLOGY IN TERMS OF TYPE OF CARE ACCORDING TO AGE, SEX, AND RACE.*

VARIABLE	OFFICE VISIT	OUTPATIENT CLINIC VISIT	HOME HEALTH CARE VISIT	EMERGENCY DEPARTMENT VISIT	HOSPITAL STAY
	no./1000 (95% CI)				
Age†					
<18 Yr	167.3 (161.0–173.6)	8.2 (7.0–9.4)	2.2 (1.4–3.0)	12.8 (11.7–13.9)	3.5 (2.7–4.3)
≥18 Yr	234.8 (229.0–240.6)	25.8 (24.0–27.6)	17.7 (15.6–19.8)	13.0 (12.2–13.8)	10.3 (9.6–11.0)
Sex‡					
Male	179.3 (173.4–185.2)	17.5 (16.0–19.0)	8.7 (7.0–10.4)	12.5 (11.6–13.4)	7.5 (6.7–8.3)
Female	252.6 (246.1–259.2)	24.6 (22.5–26.7)	18.1 (15.7–20.5)	13.3 (12.4–14.2)	9.5 (8.7–10.3)
Race§					
Black	150.7 (142.3–159.1)	15.5 (12.5–18.5)	14.9 (10.8–19.0)	13.0 (11.3–14.7)	7.9 (6.3–9.5)
White	230.9 (225.0–236.8)	22.7 (21.1–24.3)	13.6 (11.8–15.4)	13.1 (12.3–13.9)	8.7 (8.0–9.4)

*Data are for persons who made at least one visit or were hospitalized at least once in a one-month period. CI denotes confidence interval.

†Data are for males and females of all races.

‡Data are for all races and all ages.

§Data are for males and females of all ages.

increase in the proportion of older persons with chronic diseases may have resulted in more office visits and hospital stays, but cost containment by hospitals and the shifting of care to outpatient departments and patients' homes may have moderated these effects.

The inclusion in the ecology model of children and additional settings provides a broader, still useful framework for thinking about the organization of health care, medical education, and research. For example, most measures of the quality of health care that are currently in use were developed for hospital settings, and much of the recent interest in medical errors has focused on the safety of patients in hospitals.^{31,32} The ecology model makes apparent the opportunities that would be missed by limiting quality and safety programs to hospitals. It highlights the need for comprehensive medical-information systems that span all sites of care. The model also shows the need for alternative types of research laboratories, such as practice-based research networks,³³ which allow the study of patients where they receive their care.

There are important limitations of the ecology model and the methods we used for this analysis. The model may appear to be nested, leading to the misinterpretation that a small box is derived from an adjacent, larger box. Our estimates have not been adjusted for the effects of age, race, ethnic group, or other variables. The model does not establish causal pathways. We did not estimate the frequency of referral to specialists because of limited data and current ambiguities in how a referral is defined.

Unlike other results calculated from contemporary, nationally representative data sets, our estimate of the number of persons who have symptoms per month is based on the best health-diary data we could locate that could be organized into a monthly time frame. The usable studies spanned decades and had different sampling frames. Errors may also have arisen from the use of data on office visits and admissions to estimate the number of persons who visit a primary care physician's office and the number hospitalized in an academic medical center, respectively. Although the public data used were averaged over the entire calendar year 1996, so that there was no need for seasonal adjustment, the data from the Gallup survey lacked seasonal adjustment.

Our findings are supported by similar estimates based on different sources. For example, data from the 1996 National Health Interview Survey indicated that there were 7.9 and 8.1 admissions per 1000 persons for 30-day and 31-day periods, respectively; these estimates are consistent with our estimate of 8 persons hospitalized per 1000, which is based on data from the Medical Expenditure Panel Survey. Also on the basis of data from the National Health Interview Survey, 6.9 persons per 1000 (the same for adults and children) used the emergency department during a two-week period. Our estimate of emer-

gency-department use during a one-month period, based on data from the Medical Expenditure Panel Survey, was 13 per 1000 for both adults and children. Of the respondents who reported acute conditions in the 1996 National Health Interview Survey, 68.8 percent sought care in physicians' offices. Of the Gallup-survey participants who considered seeking medical care during a one-month period (327 per 1000), 66.4 percent actually visited a physician's office.

In conclusion, there have been marked changes in the organization and financing of medical care since the 1961 study by White et al.¹ Substantial progress in the collection and reporting of health-related data has made it possible to update and expand the study, with the use of data only from the United States. The new estimates are remarkably similar to the estimates made 40 years ago.

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REFERENCES

1. White KL, Williams TF, Greenberg BG. The ecology of medical care. *N Engl J Med* 1961;265:885-92.
2. Horder J, Horder E. Illness in general practice. *Practitioner* 1954;173:177-85.
3. White K. The ecology of medical care: origins and implications for population-based healthcare research. *HSR Health Serv Res* 1997;32:11-21.
4. Godwin M, Grzybowski SC, Stewart M, et al. Need for an institute of primary care research within the Canadian Institutes of Health Research. *Can Fam Physician* 1999;45:1405-9, 1417-21.
5. DeFriese GH. A brief symposium: in honor of Kerr L. White. *HSR Health Serv Res* 1997;32:3-4.
6. McWhinney IR. An introduction to family medicine. New York: Oxford University Press, 1981.
7. Rakel RE. The family physician. In: Rakel RE, ed. *Essentials of family practice*. 2nd ed. Philadelphia: W.B. Saunders, 1998:3-20.
8. Putting research into practice: report of the Task Force on Building Capacity for Research in Primary Care. Bethesda, Md.: Agency for Health Care Policy and Research, August 1993.
9. The National Primary Care Conference: executive summary. Rockville, Md.: Health Resources and Services Administration, 1992.
10. Verbrugge L. Health diaries. *Med Care* 1980;18:73-95.
11. Fuchs V. The health sector's share of the gross national product. *Science* 1990;247:534-8.
12. Aaron H, Schwartz WB. Rationing health care: the choice before us. *Science* 1990;247:418-22.
13. Marcille J. The coming boom in primary care. *Manag Care* 1994;3:22-4, 26-28.

14. Council on Graduate Medical Education. Fifth report: women & medicine. Rockville, Md.: Health Resources and Services Administration, July 1995. (DHHS publication no. HRSA-P-DM-95-1.)
15. Kuttner R. The American health care system: health insurance coverage. *N Engl J Med* 1999;340:163-8.
16. Bodenheimer T. The American health care system: physicians and the changing medical marketplace. *N Engl J Med* 1999;340:584-8.
17. Iglehart JK. The American health care system: expenditures. *N Engl J Med* 1999;340:70-6.
18. Council on Graduate Medical Education. Sixth report: managed health care: implications for the physician workforce and medical education. Rockville, Md.: Health Resources and Services Administration, September 1995. (DHHS publication no. HRSA-P-DM-95-2.)
19. Inter-university Consortium for Political and Social Research. Guide to resources and services, 1995-1996. Ann Arbor, Mich.: Inter-university Consortium for Political and Social Research, 1996.
20. Mullner RM, Byre CS. Inventory of U.S. health care data bases, 1976-1983. Rockville, Md.: Health Resources and Services Administration, May 1984. (DHHS publication no. (HRSA) HRS-P-OD 84-5.)
21. Monheit AC, Wilson R, Arnett RH III, eds. Informing American health care policy: the dynamics of medical expenditure and insurance surveys, 1977-1996. San Francisco: Jossey-Bass, 1999.
22. White K. Life and death and medicine. *Sci Am* 1973;229:23-33.
23. Thacker SB, Greene SB, Salber EJ. Hospitalizations in a southern rural community: an application of the 'ecology model.' *Int J Epidemiol* 1977;6:55-63.
24. MEPS: household component event files. Rockville, Md.: Agency for Healthcare Research and Quality, March 2001. (See <http://www.meps.ahrq.gov/>.) (See NAPS document no. 05597 for 6 pages, c/o Microfiche Publications, 248 Hempstead Tpke., West Hempstead, NY 11552.)
25. Family medical care: prevalence of physician visits among adults and children. Princeton, N.J.: Gallup Organization, May 2000.
26. Verbrugge L, Aschione FJ. Exploring the iceberg: common symptoms and how people care for them. *Med Care* 1987;25:539-69.
27. Roghmann KJ, Haggerty RJ. The diary as a research instrument in the study of health and illness behavior: experiences with a random sample of young families. *Med Care* 1972;10:143-63.
28. Stoller EP, Forster LE. Patterns of illness behavior among rural elderly: preliminary results of a health diary study. *J Rural Health* 1992;8:13-26.
29. Hickey T, Akiyama H, Rakowski W. Daily illness characteristics and health care decisions of older people. *J Appl Gerontol* 1991;10:169-84.
30. Kooiker S. Exploring the iceberg of morbidity: a comparison of different methods for assessing the occurrence of everyday illness. *Soc Sci Med* 1995;41:317-32.
31. Quality Interagency Coordination Task Force. Doing what counts for patient safety: federal actions to reduce medical errors and their impact. Washington, D.C.: Department of Health and Human Services, February 2000.
32. Institute of Medicine. To err is human: building a safer health system. Washington, D.C.: National Academy Press, 1999.
33. Green LA, Hames CG Sr, Nutting PA. Potential of practice-based research networks: experiences from ASPN. *J Fam Pract* 1994;38:400-6.

APPENDIX. DEFINITIONS OF TERMS AND SOURCES OF DATA.

TERM	DEFINITION	SOURCE OF DATA
Final estimate	The number of persons per 1000 who had each type of event	Medical Expenditure Panel Survey, Gallup survey, National Ambulatory Medical Care Survey, American Hospital Association data base
Person	A civilian, noninstitutionalized member of the U.S. population, regardless of age, sex, race, or ethnic group	U.S. Census Bureau
Month	Each of the months in calendar year 1996, or the 30 days immediately preceding interviews conducted in April and May of 2000	Medical Expenditure Panel Survey, Gallup survey
Symptom	Any discomfort, illness, or injury	Journal articles
Considered seeking health care	For adults, an affirmative response to the question, "In the last 30 days, have you considered or thought about seeking medical care for any health problem, even though you may not have actually visited a health care professional?" For children, an affirmative response by a parent or guardian to the question, "In the last 30 days, have you considered or thought about seeking medical care for your child for any health problem, even though you may not have actually visited a health care professional?"	Gallup survey
Visit to a physician's office	A visit to the office of any doctor of medicine or osteopathy, including the 3.5 percent of reported visits that were actually telephone calls	Medical Expenditure Panel Survey
Visit to a primary care physician's office	A visit to the office of a family physician, general practitioner, general internist, or general pediatrician	Medical Expenditure Panel Survey, National Ambulatory Medical Care Survey
Visit to a complementary or alternative medical care provider	For adults, an affirmative response to the question, "In the last 30 days, did you receive any alternative medical treatment, such as chiropractic care, acupuncture, massage therapy, or some other type of alternative medical care?" For children, an affirmative response by a parent or guardian to the question, "In the last 30 days, did your child receive any alternative medical treatment, such as chiropractic care, acupuncture, massage therapy, or some other type of alternative care?"	Gallup survey
Emergency department visit	A visit to the emergency department	Medical Expenditure Panel Survey
Outpatient clinic visit	A visit to a hospital outpatient department	Medical Expenditure Panel Survey
Home health care	Health care services provided at a person's home by a health care professional	Medical Expenditure Panel Survey
Inpatient hospital stay	A stay of any duration after admission to a facility licensed or registered as a hospital by a state to provide diagnostic and therapeutic services for a variety of medical conditions, both surgical and nonsurgical	Medical Expenditure Panel Survey
Inpatient stay at an academic-medical-center hospital	A stay of any duration after admission to a hospital owned by or affiliated with a university that has an allopathic or osteopathic medical school and a school or training program for at least one other profession, as defined by the Association of American Medical Colleges	Medical Expenditure Panel Survey, American Hospital Association data base