

Effects of Providing Comprehensive Ambulatory Services to Children With Chronic Conditions

Gregory S. Liptak, MD, MPH; Christine M. Burns, MBA, MEd; Philip W. Davidson, PhD; Elizabeth R. McAnarney, MD

Objective: To document the effects of a comprehensive program of care on the resource utilization and cost of care for children with chronic conditions.

Design: Descriptive study of 10 715 admissions between 1984 and 1995 with analyses of costs based on charges. Comparisons were made with data from a national consortium of academic medical centers and from a national survey of hospitals. A 2-week survey of staff was conducted to identify their use of time in the care of these patients.

Patients: Children aged birth through 18 years meeting *International Classification of Diseases, Ninth Revision, Clinical Modification* criteria for chronic conditions. Patients with acute conditions were used as controls.

Intervention: A program of expanded care funded since 1989 by a regional insurance company.

Results: Between 1984 and 1995, mean length of stay for children with chronic conditions decreased from 83.9

to 10.6 days; mean annual admissions decreased from 2796 to 1622. Median hospital inpatient charges, adjusted for cost of living, decreased from \$26.1 to \$14.6 million. A \$77.7 million savings occurred for inpatient care, with total expenditures from the insurance program of \$3.6 million (a 21:1 ratio). Almost half the professional activities provided for these children were for services that could not be reimbursed in a fee-for-service model. Median adjusted inpatient charges were lower in Rochester, NY (\$8746) than in other academic medical centers (\$12 773) or in a national survey of hospitals (\$12 462), and fewer children were readmitted within 30 days in Rochester (12.7%) than in other academic medical centers (15.0%).

Conclusions: An investment of funds by a regional insurance company was associated with reduced costs, admissions, and lengths of stay for children with chronic conditions, and resulted in significant savings for the company. This model may be applicable to other centers.

Arch Pediatr Adolesc Med. 1998;152:1003-1008

Editor's Note: There are many good reasons to keep children (and everyone else) out of the hospital—saving money is only one of them.

Catherine D. DeAngelis, MD

DATA FROM the 1988 National Health Interview Survey¹ indicate that 30% of children younger than 18 years have at least 1 chronic health condition. One third of these children (10% of the childhood population) have a significant chronic condition such as congenital heart disease, cerebral palsy, or leukemia, with an additional 2% having a severe developmental disability. These children have annual health care costs that are more than 5 times that of healthy children.² The care re-

quired to optimize their health and functioning is expensive and difficult to coordinate.³ In the past, the intricate and sophisticated care required by these children typically was provided in the inpatient setting by trained specialists. Because children function better at home than in the hospital,⁴ some child health systems have begun to provide their care in the ambulatory setting.

Comprehensive ambulatory care for persons with special health needs, including developmental disabilities, can improve outcomes by reducing secondary complications and thereby reduce costs.⁵⁻¹¹ But managed care options for the financing of health care, which are designed to improve care by enhancing primary care and service coordination, may threaten the quality of care provided to children with chronic conditions because some plans

From the Children's Hospital at Strong, University of Rochester Medical Center, Rochester, NY.

SUBJECTS, MATERIALS, AND METHODS

SETTING

The Children's Hospital at Strong, located in Rochester (metropolitan statistical area population of 1.1 million), provides tertiary and quaternary level pediatric services in central western New York State. Fifteen of the 17 pediatric subspecialties at CHAS provide care for children and adolescents with chronic disabilities and the hospital serves as a regional referral site. More than 6000 children are seen each year for management of a wide range of chronic conditions including chronic lung disease, malignant neoplasms, pediatric acquired immunodeficiency syndrome, congenital heart disease, neuromuscular diseases, arthritis, genetic diseases, renal disease, liver disease, and neurodevelopmental disorders. In 1980, Strong Memorial Hospital, the hospital of the University of Rochester Medical Center, had switched from fee-to-service to reimbursement based on diagnosis related groups (DRGs).

INTERVENTION

In 1985, CHAS began hiring additional personnel, including nurses, social workers, psychologists, nutritionists, physical therapists, occupational therapists, special educators, play therapists, and speech and language pathologists, to expand ambulatory care coordination (case management) and "wraparound" services to children with chronic conditions. Personnel were located within each subspecialty program and were part of the teams that provided care for the children.

Although the intervention had begun in 1985 without outside funding, in 1989 a formal agreement was reached with a regional insurance carrier to provide direct funds for those professionals for whom direct billing was not reimbursable, such as social workers and nurses. The annual revenues from this grant, adjusted to the 1990 consumer price index for medical care, averaged \$450 000. In turn, CHAS allocated these funds to the subspecialty divisions serving children with chronic conditions to pay for the additional support personnel (approximately 11 full-time equivalents). Each division used the funds in a discretionary way to pay for services necessary for its own activities. All patients with chronic conditions, regardless of insurance status, had access to these additional personnel and services.

DATA

Data on hospital admissions and outpatient visits were obtained for all children 18 years and younger who were

admitted to CHAS between January 1, 1984, and June 30, 1996. Children's diagnoses were classified according to the *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)*¹⁴ codes for 25 selected categories of chronic conditions such as cardiac, pulmonary, and endocrine; these are listed in **Table 1**. These categories were based on the subspecialty structure of the CHAS at the time of the study. Admissions for 3 acute conditions—appendicitis, bronchiolitis, and fractures—from 1984 to 1996 and admissions for acute "discretionary" conditions¹⁵ such as diarrhea and dehydration, fever in an infant, and lower respiratory infections (primarily bronchiolitis) from 1991 to 1996 were used as controls. If a child ever had a primary diagnosis from the list (eg, cystic fibrosis) during the 12-year period, all admissions for that child were recorded even if the primary diagnoses for subsequent or previous admissions were different (eg, pneumonia).

Data on admissions, lengths of stays, charges, and readmissions from Rochester were obtained from the Clinical-Administrative Data Service of the Association of American Medical Colleges, Washington, DC, and compared with data from a consortium of 18 US academic tertiary medical centers,¹⁶ including the University of Rochester Medical Center. Data from these centers are available only since 1989. Unique identifiers such as unit number were not available. Therefore, data on individual patients were not obtainable.

Frequency and charges associated with CHAS pediatric ambulatory services and procedures for the 25 chronic illnesses and the 3 acute conditions between 1993 and 1995 (the only years for which such comprehensive data were available) were ascertained. Charges were used as an estimate for cost for several reasons. First, estimates of cost were available only in Rochester. Second, although charges clearly are different from costs,^{17,18} no uniformly accepted method of estimating costs is available.¹⁹ Data were not available on home care services provided during the study period.

Lengths of stay and charges from 1993 were compared with the Nationwide Inpatient Sample of 1993.²⁰ The hospitals in this sample represent all hospitals in the United States and are not limited to tertiary centers. Charges were adjusted for the consumer price index for medical goods with 1990 used as the base year.²¹

Costs and effort associated with personnel involved in the coordination of care were projected from a survey conducted for 14 days during 1995 (7 days in March and 7 days in April). In this survey we used self-reported work sampling, a standard method to track productivity that is frequently used in studies of health care providers.²²⁻²⁴ Physicians, nurses, therapists, social workers, and other health-related workers were asked to record the nature of their activities during 15-minute intervals for both direct and indirect patient care on formatted survey instruments.

may try to save resources by limiting access to services (such as equipment), subspecialists, or procedures. If the managed care of children is to succeed, new models of care must be found that *both* reduce costs and maintain quality.^{12,13}

In 1985, the Children's Hospital at Strong (CHAS) of the University of Rochester Medical Center, Rochester, NY, established a program to expand ancillary ser-

vices for children with chronic conditions. In 1989, a capitation agreement was made with a regional insurance company in the Rochester area to support the annual costs of this program. The premise of the agreement was that major savings in charges from diminished inpatient services would be realized. The purpose of this study was to evaluate the effects of the ambulatory care coordination program on health care utilization and costs. The

Table 1. ICD-9-CM Codes for Selected Chronic and Acute Conditions*

Category	ICD-9-CM Codes
Asthma	493.00-493.91
Bronchopulmonary dysplasia	770.7
Cardiac	745.00-747.49; 425.00-425.70; 425.90; 759.30
Leukemia/childhood cancers	140.0-208.91, V58.0-V58.1
Epilepsy	345.00-345.91
Other CNS dysfunction	330.0-330.9; 331.0-331.2; 331.8-344.9
Thalassemia	282.4
Other hemoglobinopathies	282.7
Agranulocytosis	288.0
Sickle cell anemia	282.5; 282.60-282.69
Rheumatologic and musculoskeletal disorders	711.00-716.99; 732.00-732.99; 733.40-733.49
Other complications of care	996.00-996.1; 996.30-999.9
Spina bifida	741.00-741.99; 742.0
Cystic fibrosis	277.00-277.01
Congenital nervous system anomalies	742.1-742.9; 331.3; 331.4
Ventriculoperitoneal shunt malfunction	996.2
Congenital musculoskeletal disorders	754.30-754.89
Scoliosis	737.0-737.9; 754.2

*ICD-9-CM indicates International Classification of Diseases, Ninth Revision, Clinical Modification¹⁴; CNS, central nervous system.

hypotheses of the study were that providing ambulatory, coordinated care would (1) decrease hospitalizations and length of stay; (2) increase ambulatory visits; and (3) yield savings for insurers from reductions in charges for inpatient services.

RESULTS

INPATIENT AND AMBULATORY PATTERNS IN ROCHESTER

A total of 10 715 admissions with the selected codes occurred in Rochester between 1984 and 1995. The mean length of stay for children with chronic conditions admitted to CHAS decreased from 83.9 to 10.6 days ($R^2 = 0.83$, $P < .001$); annual admissions decreased from 2796 to 1622 ($R^2 = 0.82$, $P < .001$).

Figure 1 shows that the linear regression trend line for admissions for chronic conditions was steeper ($t_{20} = 2.9$ for the difference between the slopes of the 2 linear regression lines, $P < .01$) than the similar line for acute admissions ($R^2 = 0.08$, $P = .45$), suggesting that the changes were specific to children with chronic conditions and did not apply to children with acute conditions. Admissions for discretionary acute conditions totaled 1020 in 1991 and 1019 in 1995 and were stable in between.

Adjusted hospital inpatient charges for chronic conditions, shown in **Table 2**, fell from \$26.2 million to \$14.6 million. A dramatic decrease in charges was noted in 1990 (either adjusted or unadjusted by consumer price index). Although some of this decrease probably represents the effect of the chronic illness program, some likely represents statistical variation in admissions. No other

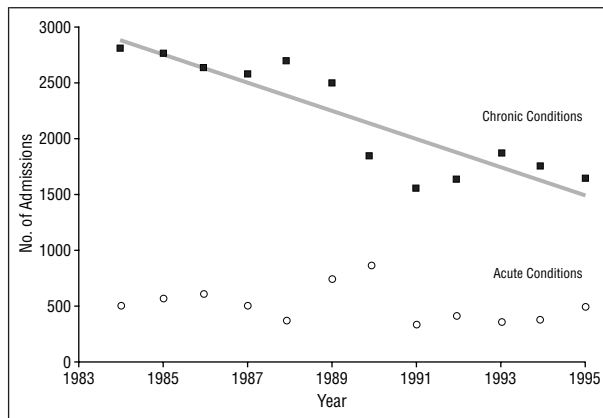


Figure 1. Linear regression analysis of admissions for chronic and acute conditions, Children's Hospital at Strong, Rochester, NY.

Table 2. Summary of Annual Adjusted* Inpatient Charges for Selected Chronic Conditions at Children's Hospital at Strong, Rochester, NY

Year	\$(in Millions)	
	Charges	Difference From 1989
1984	26.2	...
1985	29.8	...
1986	26	...
1987	25.3	...
1988	29.5	...
1989†	28.1	0
1990	11.3	16.8
1991	15.3	12.8
1992	15	13.1
1993	18	10.1
1994	16.8	11.3
1995	14.6	13.5
Total		77.7

*Adjusted for consumer price index for medical care: 1990 = 100.

†Chronic illness grant first funded.

known significant changes had occurred in CHAS in that year. The cumulative diminution in these charges since 1989 was \$77.7 million. Given the total expenditure of \$3.6 million for this program, the ratio of savings to expenditures was 21:1 (irrespective of the patient's insurance status). Adjusting for the 50% segment of the patient population covered by the sponsoring regional insurance company and its affiliates, \$38.9 million in savings were realized from this \$3.6 million investment. This represents a savings to the insurer of \$10.50 for every \$1 invested.

Enrollment of children with chronic conditions in individual practice associations and health maintenance organizations increased from 1% to 58% of all payers between 1984 and 1995. Between 1993 and 1995, the only years for which valid data were available, total enrollees in the ambulatory programs increased from 4168 to 4693. Ambulatory visits for direct billable care by a health care provider increased from 6623 to 8888, while procedures, such as urinalyses or electrocardiograms, increased from 6686 to 8305.

Table 3. Top 10 Primary ICD-9-CM Codes for Chronic Conditions in Rochester, NY, Compared With 17 Other Academic Centers*

ICD-9-CM Code	Condition	Discharges in Rochester	Discharges in Other Centers	Rank Order in Other Centers
493.91	Asthma with status asthmaticus	1029	1566	3
493.90	Asthma without status asthmaticus	382	1902	2
V58.1	Maintenance chemotherapy	140	2214	1
737.30	Idiopathic scoliosis	110	509	13
593.7	Vesicoureteral reflux	99	883	6
996.2	Malfunction neurological device/graft	99	777	9
250.91	Juvenile diabetes with complications	98	511	12
753.2	Congenital ureteral obstruction	88	432	14
307.1	Anorexia nervosa	74	270	21
282.62	Hemoglobin-S disease with crisis	72	372	16

*ICD-9-CM indicates International Classification of Diseases, Ninth Revision, Clinical Modification.¹⁴ Data are from the Academic Medical Consortium, 1995.

COMPARISON WITH OTHER INSTITUTIONS

Table 3 shows the 10 most frequent primary ICD-9-CM codes in 1995 in Rochester, the number of discharges represented by each one, and the rankings by frequency of each code in the other 17 centers of the Academic Medical Consortium. Children hospitalized at CHAS with chronic conditions had lower median adjusted inpatient charges (\$8746 [95% confidence interval (CI), \$7379-\$10 113] vs \$12 773 [95% CI, \$11 931-\$13 615]) and fewer children readmitted within 30 days (12.7% [95% CI, 10.4-14.0] vs 15.0% [95% CI, 14.2-15.7]) than did the other centers. Median lengths of stay were 6.6 (95% CI, 5.7-7.6) days in Rochester and 7.0 (95% CI, 6.6-7.4) days in the other institutions. Data from the 1993 national survey of hospitals revealed an average median total charge of \$12 462 (95% CI, \$12 402-\$12 520) and a median length of stay of 6.2 days (95% CI, 6.1-6.2) for children with chronic conditions. Both of these were significantly greater than the averages in Rochester.

Rates of admissions could not be calculated because neither the number of children present in the catchment areas of each of the medical centers nor a measure of the referral pattern was available to use as a denominator. The number of admissions for appendicitis was used as a proxy to evaluate rates of admission.^{25,26} As a rule, the incidence of appendicitis is constant in pediatric populations, and virtually all children who have appendicitis are admitted to the hospital. **Figure 2** and **Figure 3** illustrate the ratio of the number of admissions for acute and chronic conditions to the number of admissions for appendicitis. The higher this ratio, the greater the rate of admissions per unit of population. For acute condi-

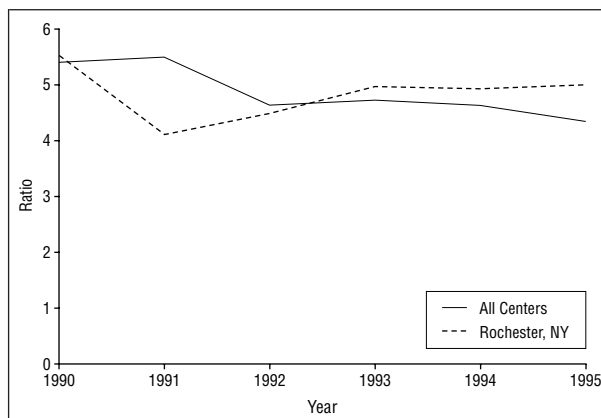


Figure 2. Ratio of admissions for bronchiolitis and fractures to admissions for appendicitis.

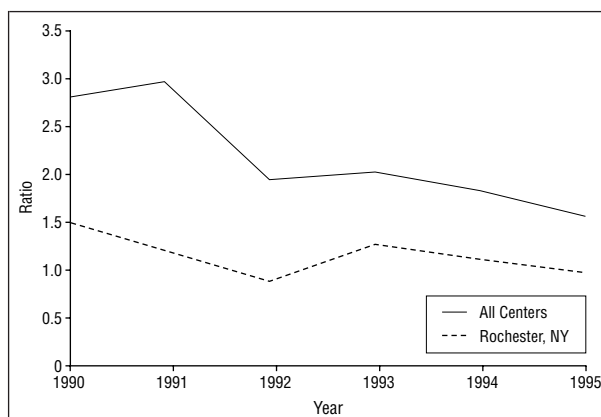


Figure 3. Ratio of admissions for chronic conditions to admissions for appendicitis.

tions (bronchiolitis and fractures) (Figure 2), the ratios for Rochester and the 17 consortium hospitals were similar. However, for the chronic conditions (Figure 3), the ratio of admissions for children at CHAS was significantly less than the ratio for the hospitals of the consortium ($t_8 = 4.7$ [statistic for the difference in intercepts], $P < .01$), implying a lower admission rate per capita for children in Rochester. This finding is consistent with previous research comparing Rochester with New Haven, Conn, and Boston, Mass.^{25,26}

ACTIVITIES WITHIN CHAS RELATED TO PATIENT CARE

During the time and motion study, information on 7122 encounters by 1717 patients was recorded. The results of the survey were extrapolated to a 1-year period and compared with data from billing records to evaluate their validity. Billing records indicated 19 313 direct encounters; the extrapolated data predicted 20 702 direct encounters (only 7% more), verifying that the survey was a valid cross-section.

The professionals surveyed spent a mean of 17.5 minutes on each inpatient encounter and 22.8 minutes on each outpatient encounter. Professionals spent a mean of 10.9 minutes on triage, 27.1 minutes on screening, 24.7 minutes on providing treatment, and 16.6 minutes on fol-

low-up. During this survey 3122 encounters were classified as “face-to-face” (and thus billable) with a mean time of 30.4 minutes; 958 encounters were telephone encounters with a mean time of 13.1 minutes; and 2792 encounters were classified as indirect (those without direct contact with a patient, such as telephoning a pharmacy or discussing the patient with a colleague) with a mean time of 11.0 minutes. Thus, 24.1 of a total of 54.5 minutes (44%) were spent in encounters that were not billable under most fee-for-service models.

COMMENT

The care of children with chronic conditions has been shifting from inpatient to ambulatory services. As more families enroll in managed care programs, integrating primary and specialty care to assure appropriate use of higher-cost health services becomes more challenging. Mechanisms to ensure the payment of a care coordinator who knows the patient, his or her condition, the family, and available resources are critical. In addition, as the scope of care at home broadens and more patients are treated at home or in ambulatory settings, the patients who are admitted will have more severe or complex illnesses. For instance, children admitted with asthma were sicker in Rochester than in New Haven or Boston.¹⁰ Therefore, it is even more important that health care providers who treat these children in hospitals receive special training to optimize their care. Specialized centers of care, where these providers are concentrated, may be more efficient in providing care to these children than nontertiary centers.

Whereas most services provided to hospitalized children can be billed, many services provided in the ambulatory setting, such as nursing and social work, are not easy to bill under fee-for-service mechanisms. In this study, 44% of the activities of CHAS professionals providing chronic illness care, such as consulting with community providers or discussing insurance issues with the family on the telephone, were indirect and thus not considered billable. Programs that want to optimize the care that chronically ill children receive should provide reimbursement for these indirect services.

These results show that a comprehensive, coordinated program was associated with absolute decreases in numbers of admissions (2796 to 1622), lengths of admissions (84 to 11 days), and inpatient charges (\$26 million to \$15 million) for children with chronic conditions. Relative decreases in these parameters were present when compared with children in Rochester who had acute conditions, implying that the factors responsible for the changes affected admissions for chronic conditions more than acute conditions. If the chronic illness program was the major factor leading to such changes, then for every \$1 invested by the insurance company \$10.50 in savings occurred in inpatient charges for children enrolled in the insurance program. When admissions to acute care hospitals decrease, some costs are shifted to alternate sources of care, including ambulatory and home-based services. No pediatric rehabilitation services were available in the Rochester community during the study, and data on the frequency of home-based services were not obtained. Thus, these savings represent the maximum savings experienced by the

insurance company—some of the potential savings could have been shifted to pay for more home-based care. Also, if children are cared for at home instead of in the hospital, costs are shifted to families in terms of missed days at work and more expensive child care.

Ambulatory services in the chronic illness program in Rochester increased as inpatient visits decreased. Compared with other academic institutions between 1990 and 1995 and general hospitals in the United States in 1993, children hospitalized in Rochester had lower average charges and fewer readmissions within 30 days. The median length of stay was lower but not statistically different from that of the other institutions. Although the rates of admission per total eligible children were not available, when appendicitis was used as a proxy to estimate rates of admission children in Rochester had a lower ratio of admissions than children in the other academic centers. Therefore, the lower median charges are unlikely to reflect the admission of more children with mild to moderate illnesses to Rochester. Since 1992, the difference between Rochester and the other centers has become less marked.

POTENTIAL LIMITATIONS

This intervention was carried out only in Rochester and, because each community is unique, there is no true comparison site. As Table 3 presents, the relative frequency of admissions is somewhat different in Rochester from other programs. This may reflect differences in referral patterns as well as different practices regarding which patients should be admitted. The changes documented in this study could have been the result of other factors in the community besides the chronic illness initiative, such as the switch to reimbursement using DRGs. If this were the case, the factor(s) affected the children who had chronic conditions significantly more than those who had acute conditions. Because Strong Memorial Hospital initiated the DRG system of reimbursement prior to the onset of data collection, it is unlikely that DRGs affected the rate of admission since 1985.²⁷ However, prior to 1985, some decreases in the rates of admissions for chronic conditions were noted; thus, some community factors, including the institution of DRGs in 1980, could have been affecting admission rates.

Rochester's practices in the mid 1980s may have been conservative relative to the rest of the country and the reductions in utilization could have been the result of bringing practices in line with those of other communities. This explanation is not consistent with the findings of earlier studies comparing Rochester with Boston and New Haven.^{26,28} It also would not explain the favorable comparisons between Rochester and the other academic centers.

This study did not use actual rates of admission per population at risk, but instead used the rate of appendicitis as a proxy. Because the catchment areas of a tertiary medical center are often difficult to define and may differ for separate conditions (eg, children who have cardiac conditions may come from a larger geographic area than those who have asthma), valid estimation of the denominator used to compute rates of admissions would

be difficult to obtain for each condition and each institution evaluated. Finally, the issue of quality was not addressed. Although moving patient care from an inpatient to an ambulatory setting may be less expensive, little is known of the effect on the functional status of the children and the perceived quality of their care.

CONCLUSION

This study suggests that directing financial resources to ambulatory, comprehensive care teams seems to have reduced admissions for children with chronic conditions and reduced the average length of stay. Hospital inpatient charges fell significantly, resulting in a savings to insurers of \$10.50 for every \$1 invested. Such an investment creates a system that allows health care providers to assure that only the children who need hospitalization are admitted for inpatient care. It also assures (1) the presence of the wide variety of professional disciplines with the knowledge and skills required to address the complexity of these chronic conditions; (2) the opportunity for effective communication among providers of care, which leads to efficient use of patient services; and (3) the opportunity for educating patients and families about management of the condition. The alternative of distributing the care of children with chronic conditions across a broad pool of primary care providers without providing a care coordination team or special training would lead to additional costs to the primary care provider and specialists as well as the potential for delayed or missing care, which is necessary to prevent hospitalization.

Models of care that support the efficient use of pediatric subspecialty services and maintain high-quality health outcomes for children with chronic conditions must be considered in the design of managed care models. Models that adhere to these principles could minimize the risk that future health care services for these children would be too expensive, incomplete, or duplicative. When providers and payers can work together effectively, sharing economic risks and benefits, they will be able to manage the finances for the most costly group of pediatric patients without compromising the health and well-being of these children.

Accepted for publication May 28, 1998.

Corresponding author: Gregory S. Liptak, MD, MPH, Children's Hospital at Strong, University of Rochester Medical Center, 601 Elmwood Ave, Rochester, NY 14642-8671 (e-mail: Gregory_Liptak@urmc.rochester.edu).

REFERENCES

- Newachek PW, Taylor WR. Childhood chronic illness: prevalence, severity, and impact. *Am J Public Health*. 1992;82:364-371.
- Hoffman C, Rice D, Sung HY. Persons with chronic conditions: their prevalence and costs. *JAMA*. 1996;276:1473-1479.
- Pless IB, Satterwhite B, VanVechten D. Division, duplication and neglect: patterns of care for children with chronic disorders. *Child Care Health Dev*. 1978; 4:9-19.
- McConnochie KM, Roghmann KJ, Kitzman HJ, Liptak GS, McBride JT. Ensuring high-quality alternatives while ending pediatric inpatient care as we know it. *Arch Pediatr Adolesc Med*. 1997;151:341-349.
- Kaufman BA, Terbrock A, Winters N, Ito J, Klosterman A, Park TS. Disbanding a multi-disciplinary clinic: effects on the health care of myelomeningocele patients. *Pediatr Neurosurg*. 1994;21:36-44.
- Sperber K, Ibrahim H, Hoffman B, Eisenmesser B, Hsu H, Corn B. Effectiveness of a specialized asthma clinic in reducing asthma morbidity in an inner-city minority population. *J Asthma*. 1995;32:335-343.
- Bindman AB, Grumbach K, Osmond D, et al. Preventable hospitalizations and access to health care. *JAMA*. 1995;274:305-311.
- Bean P, Waldron K. Readmission study leads to continuum of care. *Nurs Manage*. 1995;26:65-68.
- Schroeder C. Nursing's response to the crisis of access, costs, and quality in health care. *Adv Nurs Sci*. 1993;16:1-20.
- Patterson T, Higgins M, Dyck DG. A collaborative approach to reduce hospitalization of developmentally disabled clients with mental illness. *Psychiatr Serv*. 1995;46:243-247.
- Criscione T, Kastner TA, Walsh KK, Ruth N. Managed health care services for people with mental retardation: impact on inpatient utilization. *Ment Retard*. 1993; 31:297-306.
- Ireys HT, Grason HA, Guyer B. Assuring quality of care for children with special needs in managed care organizations: roles for pediatricians. *Pediatrics*. 1996; 98:178-185.
- Neff JM, Anderson G. Protecting children with chronic illness in a competitive marketplace. *JAMA*. 1995;274:1866-1869.
- International Classification of Diseases, Ninth Revision, Clinical Modification*. Washington, DC: Public Health Service, US Dept of Health and Human Services; 1988.
- McConnochie KM, Roghmann KJ, Liptak GS. Socioeconomic variation in discretionary and mandatory hospitalizations of infants: ecologic analysis. *Pediatrics*. 1997;99:774-784.
- Witter DM Jr. *The Clinical-Administrative Data Service (CADS)*, Association of American Medical Colleges. Available at: <http://www.cads.rhigroup.com/>. Accessed July 21, 1998.
- Finkler SA. The distinction between cost and charges. *Ann Intern Med*. 1982;96: 102-109.
- Eddy D. Clinical decision making, from theory to practice: applying cost-effectiveness analysis. *JAMA*. 1992;268:2575-2582.
- Shwartz M, Young DW, Siegrist R. The ratio of costs to charges: how good a basis for estimating costs? *Inquiry*. 1995;32:476-481.
- Agency for Health Care Policy and Research. *The Health Care Cost and Utilization Project: HCUP-3 Nationwide Inpatient Sample, Release 2, 1993*. Rockville, Md: Agency for Health Care Policy and Research; 1996.
- US Department of Commerce. *Statistical Analysis of the United States, 1996: The National Data Book*. 116th ed. Washington, DC: US Dept of Commerce; 1996:483.
- Hagerty BK, Chang RS, Spengler CD. Work sampling: analyzing nursing staff productivity. *J Nurs Admin*. 1985;15:9-14.
- Perez CA, Kobeissi B, Smith BD, et al. Cost accounting in radiation oncology: a computer-based model for reimbursement. *Int J Radiat Oncol Biol Phys*. 1993; 25:895-906.
- Pedersen A. A data-driven approach to work redesign in nursing units. *J Nurs Admin*. 1997;27:49-54.
- Bindman AB, Grumbach K, Osmond D, et al. Preventable hospitalizations and access to health care. *JAMA*. 1995;274:305-11.
- Perrin JM, Homer C, Berwick D, Woolf AW, Freeman JH, Wennberg JE. Variations in rates of hospitalization of children in three urban communities. *N Engl J Med*. 1989;320:1183-1187.
- Phelps CE. *Health Economics*. New York, NY: Harper & Row; 1992.
- Homer CJ, Szilagyi P, Rodewald L, et al. Does quality of care affect rates of hospitalization for childhood asthma? *Pediatrics*. 1996;98:18-23.