Effect of Physician Specialty on Outcomes in Diabetic Ketoacidosis

CLARESA S. LEVETAN, MD
MAUREEN D. PASSARO, MD
KATHLEEN A. JABLONSKI, PHD
ROBERT E. RATNER, MD

OBJECTIVE — More than 100,000 people are hospitalized annually in the U.S. with diabetic ketoacidosis (DKA). Outcome differences have not been examined for these patients based on whether their primary care provider is a generalist or a diabetes specialist. The objective of this study was to investigate hospital charges and hospital length of stay (LOS) for patients with DKA according to the specialty of their primary care provider.

RESEARCH DESIGN AND METHODS — We investigated all patients with a primary diagnosis of DKA during a 3.5-year period (n = 260) in a large urban teaching hospital. Hospital charges and LOS were studied regarding the specialty of the primary care provider. Demographic factors, severity of illness, laboratory data, and readmission rates were compared.

RESULTS — Patients cared for by generalists and endocrinologists had a similar case mix and severity of DKA. The age-adjusted mean LOS for patients of generalists was 4.9 days (95% CI 4.5–5.4), and the mean LOS for patients of endocrinologists was 3.3 days (2.6–4.2) ($P <$ 0.0043). Mean hospital charges differed ($P < 0.0001$) with an age- and sex-adjusted mean for patients of endocrinologists of $5,463 ($4,179–7,141) and a mean for patients of generalists of $10,109 ($9,151–11,166). The additional charges incurred by generalists were due in part to patients undergoing more procedures. No differences in diabetes-related complications occurred during admission, but the endocrinologist-treated group had a lower readmission rate for DKA during the study period than the generalist-treated group (2 vs. 6%, respectively) ($P = 0.03$).

CONCLUSIONS — Endocrinologists provide more cost-effective care than generalists do when serving as primary care providers for patients hospitalized with DKA.

Diabetes Care 22:1790–1795, 1999

More than 60% of the direct U.S. health care costs for patients with diabetes (in excess of $65 billion annually) result from hospitalization (1–5). Each year, more than 100,000 patients in the U.S. who have diabetic ketoacidosis (DKA) require hospital admission for an annual total of almost 500,000 patient days (4–7).

As health care delivery in the U.S. evolves, medical care is increasingly delivered by primary care physicians instead of specialists (8–15). Replacing specialty care with primary care, however, may lead to worse outcomes for acutely ill patients (16–21). For example, patients hospitalized with acute myocardial infarction are significantly less likely to die within 1 year when their primary are provider is a cardiologist rather than a generalist (16,17). As the number of physicians training as specialists declines, evaluating the clinical settings in which care delivered by specialists may be most appropriate and cost-effective has become necessary (22).

Greenfield et al. (23) reported no meaningful differences in health outcomes by medical provider specialty in a population of 167 patients with type 2 diabetes who were cared for by general internists, family practitioners, and endocrinologists. Their study did not, however, evaluate hospitalization data or hospital care by provider specialty. Conversely, in an inpatient setting, we (24) previously reported a 56% reduction in hospital length of stay (LOS) among patients admitted with a principal diagnosis of diabetes who received consultation from a team led by endocrinologists. In the present study, we compare DKA patient outcomes and hospital resource utilization according to the specialty of the primary care provider.

RESEARCH DESIGN AND METHODS

— To identify patients with DKA, we evaluated data for all patients admitted to the Washington Hospital Center, Washington, DC, a 907-bed inner-city tertiary care teaching hospital, between 1 January 1993 and 31 July 1996. The records of patients who had been discharged with a principal diagnosis of DKA and whose medical care had been managed by interns and residents under the supervision of an attending physician were studied. Patients were initially identified by an *International Classification of Diseases, Ninth Revision* (ICD-9) code of 250.1X in the first discharge position. Each ICD-9 code represented a code assigned immediately after hospital discharge based on documentation by the primary care provider that DKA was the principal reason for the hospital stay. No attempt was made by the investigators to modify or correct possible misdiagnoses or coding errors made by the attending physician or medical records staff members.

Evaluation was conducted on two different datasets: *1*) data extracted from the hospital's information system including patient demographic data, all ICD-9 diagnostic codes, procedure codes, and hospital charges and *2*) the medical records of the hospital admission including physician notes, medical orders, and laboratory data pertaining to DKA. To avoid reviewer bias, the data were extracted from the medical record by diabetes educators who were blind to the purpose of the study. The chart review was supervised by an investigator who did not admit patients to the hospital during the study period and was unfamiliar

From the MedStar Research Institute, Washington, DC.
Address correspondence and reprint requests to Dr. Claresa Levetan, MedStar Research Institute, 650 Pennsylvania Ave. SE, Suite 50, Washington, DC 20003-4393. E-mail: levetan@juno.com.
Received for publication 19 March 1999 and accepted in revised form 12 July 1999.
Abbreviations: CABG, coronary artery bypass graft; DKA, diabetic ketoacidosis; GEE, general estimating equation; GLM, generalized linear model; ICD-9, *International Classification of Diseases, Ninth Revision*; LOS, length of stay.
A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

Table 1—*Demographics of primary care providers*

	Endocrinologists	Generalists	*P*
Physicians (*n*)	15	92	—
Patients with DKA (*n*)	28	184	—
Average age of physician (years)	49.6 ± 6.8	47 ± 8.1	0.10*
Board certification (%)	100	97	0.648†
Subspecialty board certification (%)	86	44‡	0.003†

Data are means ± SD, %, or *n*. *Student's *t* test; †Fisher's exact test; ‡other than endocrinology (e.g., cardiology).

with the physicians caring for the patients or the physicians' areas of specialty.

All data were evaluated according to the specialty of the primary care provider based on information obtained from the hospital's credentialing office. Physicians completing an endocrinology fellowship were classified as endocrinologists. Demographics of the primary care providers were also obtained from their hospital credentials. All baseline laboratory values including pH, bicarbonate, and serum glucose were recorded during a comprehensive medical chart review. The medical orders were reviewed to determine for how long patients received intravenous insulin, how long the initial glucose level took to fall to <11.1 mmol/l (200 mg/dl), and how long the patient spent taking sliding-scale regular insulin without definitive intermediate- or long-acting insulin treatment. Metabolic complications of DKA were documented, including the development of nonanion gap hyperchloremic acidosis (Cl > 110 mmol/l), hypokalemia (K < 3.2 mmol/l), hypophosphatemia (PO_4 < 1.8 mmol/l), and the number of hypoglycemic episodes (glucose < 3.3 mmol/l).

Case mix was established by using two different methodologies. The first was the Disease Staging Scale, a comprehensive case-mix diagnosis-based system designed to predict inpatient mortality (25,26). The Disease Staging Scale generates a comorbidity index abstracted from computerized diagnostic discharge data in which all of the diagnostic codes assigned to a given patient are weighted. A comorbidity index is assigned to a given patient based on the weighting of all ICD-9 codes and is scored by stages 1, 2, and 3 and substages according to both acute and chronic diagnoses. Stage 1 indicates conditions with minimal severity, stage 2 indicates conditions of increasing severity, stage 3 indicates multisystem involvement with a poor prognosis, and stage 4 indicates death. Case mix also was established via independent assignment by two physicians of each patient's ICD-9 codes to one of the following categories: acute comorbid complications (e.g., myocardial infarction, sepsis), chronic comorbid conditions (e.g., nephropathy, neuropathy), medical complications intrinsic to DKA (e.g., dehydration, hypokalemia), medical conditions unlikely to affect LOS (e.g., cataracts), and procedure codes (e.g., magnetic resonance imaging, computed tomography).

Parametric (i.e., Student's *t* tests), nonparametric (i.e., median tests), and contingency table analyses (i.e., Fisher's exact test) were used to detect difference in demographics and laboratory assignment variables between patients cared for by each of the two physician groups.

A P value of 0.05 was considered significant. Outcomes analyses were adjusted by confounding variables that were statistically significant in the analysis. Because the distribution of the two outcome variables (LOS and hospital charges) was considerably skewed, the log of each variable was taken to approximate a normal distribution. Generalized linear models (GLMs) were used to test for mean differences in LOS and hospital charges between the two groups. A full model was tested by using age, race, sex, and group assignment as independent variables for each outcome variable. A reduced model was designed with 95% CIs calculated to adjust for significant covariates. Because several patients were admitted many times, general estimating equations (GEEs) as defined by Nelder and Wedderburn (27), were used to confirm the results obtained from the GLMs. GEE models adjust for the correlation between admissions for patients who were admitted many times.

RESULTS — Of the 260 patients admitted with a principal diagnosis of DKA during the study period, 257 had medical records available for evaluation. A total of 15 endocrinologists were the primary care providers for 33 (13%) of the admissions, and 92 physicians who did not have special training in diabetes or endocrinology were the primary care providers for 224 (87%) of the admissions. The demographic characteristics of these primary care providers are shown in Table 1. No differences in age, years of clinical practice, or primary board certification were found among primary care providers.

The mean LOS for all patients was 4.6 days. Patients managed by the endocrinologists were an average of 6 years younger and were more likely to be female than patients managed by the generalists (Table 2). The case mix, established with the Disease Staging Scale (25,26), demonstrated no statistically significant differences between groups regarding severity of illness (P < 0.27) (Fig. 1). Similarly, there were no statistical differences between groups based on the number of acute comorbidities, chronic comorbidities, or conditions intrinsic to DKA (Table 2). Similar baseline pH, admission glucose, and admission bicarbonate levels (Table 2) also indicated equivalent severity of illness between groups. Factors that may represent barriers to care, including alcohol and drug use, were evaluated, but no statistically significant differences between groups were found (P = 0.60).

There were no significant differences between groups regarding the time spent taking sliding-scale regular insulin without definitive therapy. The amount of time the initial glucose value took to fall to <11.1 mmol/l (200 mg/dl) was not significant (Table 2), although the plasma glucose of the generalist-treated patients took longer to fall to <11.1 mmol/l (200 mg/dl) (Table 2). There were no significant differences between groups regarding the amount of time patients received intravenous insulin (P = 0.18) or the number of patients requiring intensive care (P = 0.08).

There were no significant differences between the percentages of patients in each group who had metabolic complications during hospitalization such as hyperchloremic acidosis (P = 0.45), hypokalemia (P = 0.27), hypophosphatemia (P = 0.27), and the number of hypoglycemic episodes (P = 0.26). No deaths occurred in either group, and no statistically significant differences were found in early patient readmission rates (within 30 days of discharge) between patients of endocrinologists and patients of generalists (3 vs. 6%, respectively) (P = 0.50). However, the endocrinologist-treated group had a lower readmission rate for DKA during the 3.5-

Table 2—*Characteristics of patients admitted with DKA*

	Endocrinologists	Generalists	*P*
Age (years)	38 (13–53)	44 (17–90)	0.0003*
Race (% African-American)	66	89	0.0001†
Sex (% male)	21	54	0.0001†
pH	7.3 (7.0–7.4)	7.3 (6.9–7.6)	0.38*
Glucose (mg/dl)‡	385 (160–741)	458 (76–1,885)	0.34*
HCO_3 (mEq/l)	16	16	0.73*
Patients undergoing procedures (%)	24	49	0.0008†
Time until glucose was <11.1 mmol/l (h)	6 (0–79)	13 (0–179)	0.13*
Time on sliding scale insulin (days)	2 (0–11)	2 (0–50)	0.74*
Acute comorbidities (e.g., sepsis) (%)	39	46	0.58†
Chronic comorbidities (e.g., hypertension) (%)	61	71	0.23†
Conditions intrinsic to DKA (e.g., hypokalemia) (%)	48	44	0.71†

Data are medians (ranges) or %. *Median test; †Fisher's exact test (two-tailed); ‡six patients (three in each group) had initial glucose values that were above the reportable range on admission.

year study period than the generalist-treated group (2 vs. 6%, respectively) ($P = 0.03$).

The interactions from fitting the full model in testing age, race, sex, and group assignment were not statistically significant in testing the dependent variable LOS. In the reduced model that adjusted for significant covariates, only age ($P < 0.0001$) and group assignments ($P < 0.0043$) were statistically significant. The age-adjusted geometric mean LOS for the endocrinologist-treated group was 3.3 days (95% CI 2.6–4.2); the corresponding geometric mean LOS for the generalist-treated group was 4.9 days (4.5–5.4) (Fig. 2).

There were no statistically significant differences between groups regarding age, race, or sex in testing the dependent variable hospital charges. In the reduced model, age ($P < 0.0001$), sex ($P = 0.018$), and group ($P < 0.0001$) were statistically significant. The age- and sex-adjusted geometric mean hospital charge for the endocrinologist group was $5,463 ($4,179–7,141); the corresponding geometric mean hospital charge for the generalist group was $10,109 ($9,151–11,166) (Fig. 2).

According to ICD-9 procedure codes, only 24% of the endocrinologist-treated patients underwent one or more procedures compared with 49% of the generalist-treated patients (Table 2). There were no significant differences between groups regarding patients receiving intensive care during their hospital admission (Table 2).

CONCLUSIONS — We found that patients hospitalized for DKA who had an endocrinologist as their primary care provider had shorter hospital stays and incurred lower hospital charges than did patients with comparable severity of illness whose primary care provider did not have subspecialty training in diabetes. Although we have reported results from an individual hospital, we believe our results are generalizable. The LOS for our study population as a whole was 4.6 days, which is comparable to the national average of a 5-day LOS for patients hospitalized with a principal diagnosis of DKA during our study period (4–7). Nationally, 10% of patients with diabetes receive their primary care from endocrinologists. This is comparable to our study population in which 13% of patients had endocrinologists as their primary care provider (28).

Improved cost outcomes when endocrinologists care for patients with DKA have been described in both urban and community-based hospitals (24,29–31). May et al. (29) reported shorter hospital stays with lower costs and resource utilization at Vanderbilt University Hospital when care for patients with DKA involved diabetes specialists. Analogous to our findings in an urban setting, Alsever (30) reported that the average charges for patients with DKA treated by generalist physicians were 1.8 times higher than those for patients with DKA treated by endocrinologists in a community-based hospital in Colorado (30).

We evaluated our patient population according to whether the primary care provider had specialty training in endocrinology. Two methodologies were used to determine comorbidity. Both were diagnosis-based systems with inherent limitations, but neither methodology demonstrated significant differences between the two patient groups. These findings are consistent with those of patient groups with similar metabolic alterations on admission and a similar number of acute and chronic comorbidities. Most patients in both groups studied were African-Americans, which reflects the urban community served by the hospital. Analysis of variance found no differences between patient groups regarding race or sex. Although age affected LOS and hospital charges, the age-adjusted

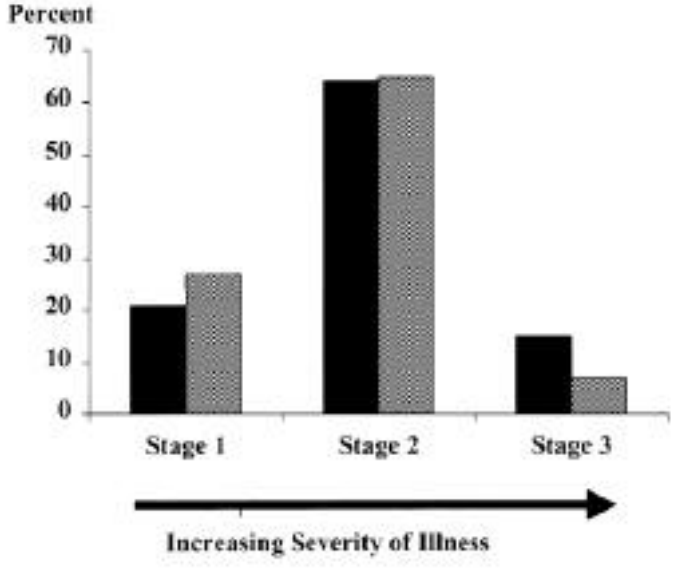

Figure 1—*Case mix determined using the Disease Staging Scale. Values for endocrinologists (■) and generalists (■) represent the percentage of ICD-9 codes at each stage. There were no statistical differences in severity of illness between the two study groups (P = 0.27).*

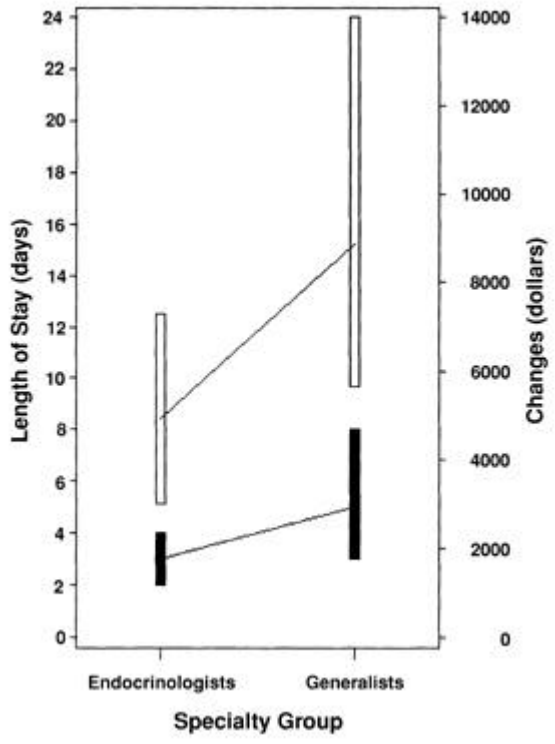

Figure 2—*LOS and hospital charges by specialty group. ■, The 25th to 75th percentile for LOS; □, the 25th to 75th percentile for hospital charges. The line connecting the bars indicates the median of each group. There were statistically significant differences between study groups regarding LOS (*P *= 0.0043) and hospital charges (*P *= 0.0001) by specialty group.*

LOS and hospital charges remained significantly different between the generalist- and endocrinologist-treated groups.

The ethical and political considerations of mandating or withholding specialty care precluded conducting randomized controlled trials that evaluate outcomes of patients treated by generalists versus endocrinologists. Our findings that endocrinologists serving as primary care providers incur lower hospital charges and perform fewer diagnostic procedures can be explained by endocrinologists' greater experience, more narrow area of focus, and the time these specialists dedicate to continuing education in the field of diabetes.

Because endocrinologists have additional training in and familiarity with the management of DKA, they may be more confident than generalists in their medical management and may not need to order as many diagnostic procedures. For example, patients with DKA commonly present with symptoms that mimic an acute abdomen. For these patients, physicians who are less familiar with DKA may be more likely to include more comprehensive testing such as abdominal computed tomography or ultrasonography in the initial battery of tests. The greater number of procedures and diagnostic studies performed by the generalist group could account for the longer LOS and the higher charges. Additionally, endocrinologists may be more comfortable discharging patients earlier and caring for recently hospitalized diabetic patients in an outpatient setting, which also results in reduced LOS. Although we could not identify differences between groups regarding the type of insulin therapy used, there was variability within both groups regarding the frequency and timing of plasma glucose levels and modalities of insulin delivery, which made direct comparisons between practice patterns in the two groups difficult.

Limited information in the literature exists that compares practice behaviors of physicians by specialty. We previously reported that, among patients with recent-onset diabetes, hyperosmolar state, or DKA who were hospitalized under the care of a generalist, the patients who received an endocrinology consultation had a significantly shorter LOS (23).

Although not designed to directly compare generalists to specialists, other studies have reported potential differences in knowledge, treatment patterns, and outcomes between generalists and specialists who care for patients with diabetes (32–38). Tuttleman et al. (32) evaluated the practice patterns of 1,082 family practice, general practice, and internal medicine physicians and their attitudes toward tight blood glucose control in type 1 diabetes. The authors concluded that generalists were not fully aware of the recommended criteria for intensive management of blood glucose in type 1 diabetes, and, even among those who were knowledgeable, practice behaviors were less than optimal. Larme and Pugh (33) reported that, among primary care providers, diabetes was rated as significantly more difficult to treat than five other chronic conditions, including angina and congestive heart failure.

The settings in which specialists provide more cost-effective care is a critically important one. This study was limited to outcomes for patients hospitalized primarily for DKA. In general, hospitalizations of patients with diabetes are longer and incur greater charges than hospitalizations of patients with similar conditions who do not have diabetes (4–7,39–41). Recognition of the differences between providing outpatient care and delivering care to an acutely ill hospitalized patient has given rise to a new medical specialist known as the "hospitalist" (42). As data emerge on the positive effect of the hospitalist on patient outcomes, the potential role of physicians with specialty training who serve as the primary care provider in the hospital setting for specific acute illnesses becomes evident (43). The role of diabetes specialty care in the hospital setting may also be beneficial for patients whose diabetes is a secondary medical problem. For example, mortality rates after coronary artery bypass graft (CABG) surgery have been significantly reduced as a result of an endocrinologist-led intervention before surgery by using intravenous insulin infusions (44). Similar findings of improved survival and reductions in deep sternal wounds have resulted from aggressive glycemic control in patients with myocardial infarction and CABG surgery (45–48).

Patients with DKA represent a small (<3%) but expensive subset of hospitalized patients with diabetes. Our data and others suggest that hospital stays can be shortened and hospital charges reduced when specialists provide the primary medical care for these patients. As the incidence of diabetes

rises by nearly 10% each year in the U.S., there has been a corresponding decline in the number of physicians entering training fellowships in endocrinology (23,49). The challenge remains how to most effectively use specialty physicians. Further study is needed to determine if an acute medical problem requiring hospitalization, such as DKA, may be better managed by a physician with expertise in that specialty.

Acknowledgments — This study received grant support from the MedStar Research Institute.

The authors thank Karen Dawn, Janet Lauer, Sepidah Sami, and Carol Coloma for their timely chart reviews; Freddie Lee, Vanessa Dean, Crystal Willis, Darlene Merryweather, and Jacqueline Ennis for their assistance in obtaining the medical records and information systems data; Ellen Shair for editing the manuscript; Beverley Antoine and Judith Chiostri for assistance in manuscript preparation; and Larry Hochberger and Barbara Howard for their unending support of this project.

References

1. American Diabetes Association: Economic consequences of diabetes mellitus in the U.S. in 1997. *Diabetes Care* 21:296–309, 1998
2. Currie CJ, Kraus D, Morgan CL, Gill L, Stott NC, Peters JR: NHS acute sector expenditure for diabetes: the present, future, and excess in-patient cost of care. *Diabet Med* 14:686–692, 1997
3. Rubin RJ, Altman WM, Mendelson DN: Health care expenditures for people with diabetes mellitus 1992. *J Clin Endocrinol Metab* 78:809A–809F, 1994
4. Graves EJ, Owings MS: *1995 Summary: National Hospital Discharge Survey: Advance Data 291: Vital and Health Statistics*. Hyattsville, MD, National Center for Health Statistics, 1997, p. 6
5. Graves EJ, Gillum BS: Detailed diagnoses and procedures: National Hospital Discharge Survey, 1994: National Center for Health Statistics. *Vital Health Stat* 13 (no. 128), 1997
6. Graves EJ, Gillum BS: Detailed diagnoses and procedures: National Hospital Discharge Survey, 1995: National Center for Health Statistics. *Vital Health Stat* 13 (no. 133), 1997
7. Graves EJ: Detailed diagnoses and procedures: National Hospital Survey, 1993: National Center for Health Statistics. *Vital Health Stat* 13 (no. 122), 1995
8. Greer DS, Bhak KN, Zenker BM: Comments on the AAMC policy statement recommending strategies for increasing the production of generalist physicians. *Acad Med* 69:245–260, 1994
9. Cohen JJ: Generalism in medical education: the next steps. *Acad Med* 70:S7–S9, 1995
10. Rivo ML: Internal medicine and the journey to medical generalism. *Ann Intern Med* 119:146–152, 1993
11. AAMC policy on the generalist physician. *Acad Med* 68:1–6, 1993
12. Lee PR: Health system reform and the generalist physician. *Acad Med* 70:S10–S13, 1995
13. Cohen JJ, Whitcomb ME: Are the recommendations of the AAMC's task force on the generalist physician still valid? *Acad Med* 72:13–16, 1997
14. Cohen JJ: Transforming the size and composition of the physician work force to meet the demands of health care reform. *N Engl J Med* 329:1810–1812, 1993
15. Clement DG, Retchin SM, Brown RS, Stegall MH: Access and outcomes of elderly patients enrolled in managed care (Erratum). *JAMA* 271:1487–1492, 1994
16. Thiemann DR, Coresh J, Oetgen WJ, Powe NR: The association between hospital volume and survival after acute myocardial infarction in elderly patients. *N Engl J Med* 340:1640–1648, 1999
17. Jollis JG, DeLong ER, Peterson ED, Muhlbaier LH, Fortin DF, Califf RM, Mark DB: Outcome of acute myocardial infarction according to the specialty of the admitting physician. *N Engl J Med* 335:1880–1887, 1996
18. Schreiber TL, Elkhatib A, Grimes CL, O'Neill WW: Cardiologist versus internist management of patients with unstable angina: treatment patterns and outcomes. *J Am Cardiol* 26:577–582, 1995
19. Ayanian JZ, Hauptman PJ, Gaudagnoli E, Antman EM, Pashos CL, McNeil BJ: Knowledge and practices of generalist and specialist physicians regarding drug therapy for acute myocardial infarction. *N Engl J Med* 331:1136–1142, 1994
20. Vollmer WM, O'Hollaren M, Ettinger KM, Stibolt T, Wilkins J, Buist AS, Linton KL, Osborne ML: Specialty differences in the management of asthma: a cross-sectional assessment of allergists' patients and generalists' patients in a large HMO. *Arch Intern Med* 157:1201–1208, 1977
21. Fowles J, Schoenwetter W, Pheley A: Measuring the severity and outcomes of asthma care by the generalists and allergists (Abstract). *J Allergy Clin Immunol* 85:195, 1990
22. The National Study for Graduate Education in Internal Medicine and the National Study of Internal Medicine Manpower from 1975–1995. *Perspectives* Fall/Winter:2, 1997/1998
23. Greenfield S, Rogers W, Mangolich M, Carney MR, Tarlov AR: Outcomes of patients with hypertension and non-insulin dependent diabetes mellitus treated by different systems and specialties: results of the Medical Outcomes Study. *JAMA* 274:1436– 1444, 1995
24. Levetan CS, Salas JR, Wilets IF, Zumoff B: Impact of endocrine and diabetes team consultation on hospital length of stay for patients with diabetes. *Am J Med* 99:22–28, 1995
25. Gonnella JS, Hornbrook MC, Louis DZ: Staging of disease: a case-mix measurement. *JAMA* 251:637–644, 1984
26. Markson LE, Nash DB, Louis DZ, Gonnella JS: Clinical outcomes management and disease staging. *Eval Health Prof* 14:201–227, 1991
27. Nelder JA, Wedderburn RWM: Generalized linear models. *J R Stat Soc* 135:370–384, 1972
28. Harris MI: Testing for blood glucose by office-based physicians in the U.S. *Diabetes Care* 13:419–426, 1990
29. May ME, Young C, King J: Resource utilization in treatment of diabetic ketoacidosis in adults. *Am J Med Sci* 306:287–294, 1993
30. Alsever RN: Specialist versus primary care: not an easy question. *Physician Executive* 21:49–51, 1995
31. Moss JM: Diabetic ketoacidosis: effective low-cost treatment in a community hospital. *Southern Med J* 80:875–881, 1987
32. Tuttleman M, Lipsett L, Harris MI: Attitudes and behaviors of primary care physicians regarding tight control of blood glucose in IDDM patients. *Diabetes Care* 15:765–772, 1993
33. Larme AC, Pugh JA: Attitudes of primary care providers toward diabetes: barriers to guideline implementation. *Diabetes Care* 21:1391–1396, 1998
34. Ho M, Marger M, Beart J, Hip I, Shekelle P: Is the quality of diabetes care better in a diabetes clinic or in a general medicine clinic? *Diabetes Care* 20:472–475, 1997
35. Hellman R, Regan J, Rosen H: Effects of intensive treatment of diabetes on the risk of death or renal failure in NIDDM and IDDM. *Diabetes Care* 20:258–264, 1997
36. Hellman R, Regan J, Rosen H: Intensive therapy program for diabetes management: effect on cardiac-specific mortality. *Cardiol Rev* 15:30–33, 1998
37. Koprowski J, Pretto Z, Poretsky L: Effects of an intervention by a diabetes team in hospitalized patients with diabetes. *Diabetes Care* 20:1553–1555, 1997
38. Kalin MF, Salas JR, Zumoff B: Brief intensive in-patient intervention in uncontrolled diabetes unresponsive to out-patient treatment: update at 540 days. *Endocrinol Pract* 4:251–258, 1998
39. American Diabetes Association: *Direct and Indirect Cost of Diabetes in the United States in 1992*. Alexandria, VA, American Diabetes Association, 1993
40. Harris MI: Diabetes-related hospitalization and utilization. In *Diabetes in America*. 2nd ed. Aubert RE, Geiss LS, Ballard DJ, Cocanougher B, Herman WH, Eds. Washington, DC, U.S. Govt. Printing Office, 1995,

p. 553–569 (DHHS publ. no. 95-1468)
41. Rice DP, Hodgson TA, Kopstein AN: The economic costs of illness: a replication and update. *Health Care Financ Rev* 7:61–80, 1985
42. Wachter RM, Goldman L: The emerging role of hospitalists in the American health care system. *N Engl J Med* 335:514–517, 1996
43. Diamond HS, Goldberg E, Janosky JE: The effect of full-time faculty hospitalists on the efficiency of care at the community teaching hospital. *Ann Intern Med* 129:197–203, 1998
44. Kalin MF, Tranbaugh RF, Salas J, Zumoff B: Intensive intervention by an endocrinologist-directed diabetes team diminishes excess mortality in patients with diabetes who undergo coronary artery bypass graft (Abstract). *Diabetes* 47 (Suppl. 1):A87, 1998
45. Zerr KJ, Furnary AP, Grunkemeier GL, Bookin S: Glucose control lowers the risk of wound infection in diabetics after open heart operations. *Ann Thorac Surg* 63:356–361, 1997
46. Furnary AP, Zerr KJ, Grunkemeier GL, Kanhere V, Starr A: Continuous intravenous insulin infusion reduces the incidence of deep sternal wound infection in diabetic patients after cardiac surgical procedures. *Ann Thorac Surg* 67:352–360, 1999
47. Malmberg K, Ryden L, Efendic S, Herlitz J: Randomized trial of insulin-glucose infusion followed by subcutaneous insulin treatment in diabetic patients with acute myocardial infarction (DIGAMI Study): effects on mortality at 1 year. *J Am Coll Cardiol* 26:57–65, 1995
48. Malmberg K, for the DIGAMI (Diabetes Insulin Glucose Infusion in Acute Myocardial Infarction) Study Group: Prospective randomized study of intensive insulin treatment on long-term survival after acute myocardial infarction in patients with diabetes mellitus. *BMJ* 314:1512–1515, 1997
49. Centers for Diabetes Control and Prevention: *National Diabetes Fact Sheet: National Esti - mates and General Information on Diabetes in the United States*. Atlanta, GA, Centers for Disease Control and Prevention, 1997