Will Guideline Implementation Increase Rural Health Care Work Force Demand? The Case of Diabetes Mellitus

Working Paper Series

Barbara Yawn, M.D., M.S.
Michelle Casey, M.S.
Paul Hebert, B.A.

Rural Health Research Center
Division of Health Services Research and Policy
School of Public Health
University of Minnesota

Working Paper #20

December, 1997

Support for this paper was provided by the Office of Rural Health Policy, Health Resources and Services Administration, PHS Grant No. 000003-04-0.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Rural health care work force forecasting is difficult and uncertain. Three basic methods are used to predict current and future needs for rural health care clinicians: needs-based estimates, demand-based estimates and extrapolation from existing provider to population ratios. Although adjustments to these methods often include factors such as the aging of the population, most forecasting models assume that practice patterns will not change or that changes that will occur are not predictable.

Practice guidelines have been developed and widely accepted as an important and necessary method of changing physicians practice patterns. For chronic disease, guidelines outline a program of follow-up care aimed at maximizing control of disease symptoms and minimizing adverse effects and complications. This usually entails a list of regularly scheduled visits and clinical and laboratory assessments. Few medical practices, including those owned by or affiliated with HMOs, have successfully implemented more than a very few guidelines. Estimates of compliance with most guidelines reveal large numbers of patients who receive only a small percentage of recommended visits and procedures. However, most health plans and payers (including Medicaid and Medicare) hope to have guidelines widely implemented within the next decade.

Using guidelines developed by the American Diabetes Association (ADA) for the care of people with non-insulin dependent diabetes (NIDDM), this study projects the potential impact on rural work force needs of implementation of the ADA guidelines in a rural Medicare population.

A cohort of all rural Minnesota Medicare recipients over the age of 65 who have a diagnosis of NIDDM was identified from Medicare claims data (Part B and MedPar). All diabetes-related services for 1994 and 1995 for members of this cohort were recorded and compared to the services recommended by the ADA guidelines for care of persons with NIDDM.

The basic services recommended by the ADA guidelines include a yearly complete history and physical examination plus at least two other office visits to assess diabetic control; those visits should include laboratory assessment of diabetic control with a glycosylated hemoglobin or fasting blood sugar. In addition, screening for kidney and eye complications of diabetes is recommended, including a yearly microalbuminuria test and a yearly dilated eye examination.

During 1994 and 1995, compliance with the elements of the guidelines among rural Minnesota clinicians varied from fewer than 14 percent of Medicare beneficiaries having two or more glycosylated hemoglobin tests to 45 percent having a dilated eye examination. Twelve to 15 percent of this study's rural population did not have any recorded visits for diabetes during one or more years of the study.

The National Institutes of Health recently released recommendations for screening of all person over 45 years of age for NIDDM. It is estimated that screening would increase the known prevalence of NIDDM by 40 to 100 percent. These persons are unlikely to have received any of

the recommended services; serving them will further increase the office visits, laboratory tests and eye examinations that rural clinicians must provide for the treatment of diabetes.

When all the additional recommended laboratory tests, procedures and visits are taken into account, we estimate that treating diabetes alone would require the full-time attention of twenty additional primary care physicians and fourteen additional ophthalmologists in the rural regions of Minnesota. The number of additional physicians for each region varies with the size of the Medicare population in the region. For example, the least populated region, with 21,246 Medicare recipients would need 1.8 additional primary care physicians and 1.1 additional ophthalmologists. The most populated rural region of Minnesota, with 78,421 Medicare beneficiaries, would require 7.4 additional primary care physicians and 4.8 additional ophthalmologists. These projections assume that the additional clinicians would do nothing but provide the recommended services for Medicare patients with NIDDM. This is an increase of 3.4 percent (on average) in the rural primary care physician work force of each rural region of Minnesota and a 47 percent increase in the rural ophthalmologist work force required for the implementation of guidelines for a single condition. Diabetes guidelines recommend a modest number of tests and visits each year; guidelines for other chronic disease are similar. In rural regions where primary care clinicians are working to capacity, it is unlikely that the guidelines can be fully implemented by existing personnel. Implementing proposed guidelines for treating the many common chronic disease of the elderly could require a very significant increase in the numbers of rural primary care clinicians.

INTRODUCTION

Forecasting the current and future need for primary health care resources, especially rural primary care health professionals, is difficult and highly uncertain. Three basic methodologies are generally employed to make estimates: 1) provider-to-population ratios (Makuc et al., 1991), 2) needs-based assessment (Politzer et al., 1996), and 3) demand-based assessment (Pathman, 1991; Kindig and Ricketts, 1991; Capilouto and Ohsfeldt, 1996). For future forecasting, adjustments are often made for the aging of the population or changes in types of providers available (Feil, Welch and Fisher, 1993; Reuben, et al., 1993). All forecasting methods assume that no predictable changes in practice patterns will occur. However, practice guidelines have been developed and are being implemented with the explicit purpose of changing practice patterns (Herman and Dasbach, 1994; Eddy, 1990). Moreover, many of the changes that will occur for primary care physicians and other personnel are predictable (Greenfield, Audet, and Fold, 1990).

By comparing current practice patterns to practice patterns recommended by a single specific practice guideline, it should be possible to predict the changes in current resources needed if the guideline were implemented in a given rural area. This study illustrates the potential impact on the health care work force of implementing a practice guideline for care of people with non-insulin diabetes in one segment of the population (Medicare recipients over 65 years of age). In addition, it assesses an often overlooked outcome of the implementation of practice guidelines C the potential for increased demands on the rural health care system.

The specific aims of the project are to:

- Identify the cohort of rural Minnesota Medicare recipients over age 65 who have diagnosed NIDDM.

- Identify all current inpatient and outpatient services (visits and testing) provided to this population-based cohort of rural Medicare recipients with diagnosed NIDDM.

- Identify additional services necessary to meet the guideline recommendations for caring for patients with NIDDM by comparing the current services provided to each person in the identified cohort with the services required under the recommended care guidelines developed by the American Diabetes Association (ADA) for people with NIDDM.

- Estimate the numbers and types of health care personnel needed to provide the additional services identified in Aim 3.

- Estimate the changes in the current work force that would be required when implementing the ADA guidelines in rural Minnesota.

- Assess the impact of various levels of implementation of the guidelines.

BACKGROUND

Methods of Forecasting Rural Work Force Needs

Work force forecasting has recently received renewed attention. The growth of training programs for non-physician providers, the increasing dominance of managed care health plans and a recognition that the current primary care to specialty physician ratios may not encourage efficient care, have driven the renewed interest in work force prediction and planning. The three current methods of work force forecasting (extrapolation from existing provider-to-population ratios, needs-based assessment and demand-based assessment) have varying strengths and weaknesses (Pathman, 1991). While projections from needs- and demand-based assessment could include the implications of guidelines on either provider-assessed needs or consumer demands, they have not. Extrapolation-based projections have also failed to incorporate any modification for predicted practice pattern changes.

Many of the federal and state programs designed to address the inadequate supply of physicians in rural and inner city areas use physician-to-population ratios to determine shortage areas. These programs impute the need for providers in defined geographic areas based on provider-to-population ratios from an ideal or "adequately served" reference population. As Pathman (1991) has noted, this method is best used to identify potential areas of provider shortages or excesses. It has several limitations, including not accounting for differences across geographic areas in population demographics, barriers in access to care, and variations in physician productivity. For rural populations, the use of physician-to-population ratios is complicated by the fact that rural areas tend to have higher proportions of elderly than urban areas, and more widely dispersed populations (Feil, Welch, and Fisher, 1993). It is also difficult to determine ideal ratios for specialists such as ophthalmologists who should be accessible to rural populations, but not necessarily located in rural areas (Jackson, Lee, and Relles, 1994; Javitt, 1996; Crijns, Casparie, and Hendrikse, 1995; Johnston, 1990; Eger, 1985).

A needs-based approach to assessing future work force requirements requires defining a target population and determining the incidence and prevalence of diseases among that population. Expert opinion and, if available, scientific evidence are then used to generate standards of optimal care for acute disease, chronic disease, and preventive health care. Projections of the actual number of physicians needed to care for the population should be based on the total amount of morbidity, the number of encounters needed, physician work hours and productivity (Capilouto and Ohsfeldt, 1996). Thus far, predictions of number of encounters needed have not included encounters recommended in guidelines.

The landmark Graduate Medical Education National Advisory Committee (GMENAC) report used an “adjusted-needs” based approach (DHHS, 1981). A primary strength of the needs-based approach is its use of professional norms regarding necessary and appropriate care. Its weaknesses include the large amount of data it requires, which are frequently not available for rural populations. Also, professionally defined needs often do not translate well to actual patient visits, especially for rural populations facing travel and economic barriers to care (Pathman, 1991; Nuttall, 1983). Among the Medicare population, physician service utilization has been shown to vary significantly across geographic areas. Even after adjusting for the race, sex, and age of beneficiaries utilization of most health care services by rural beneficiaries is considerably less than utilization by urban beneficiaries (Miller, Holohan, and Welch, 1995). When projecting population work force requirements, needs-based assessment has not taken into account the implications of implementing practice guidelines.

Demand-based approaches to assessing work force needs rely on recent utilization data to determine a population’s future physician requirements. Future health services utilization is projected using current utilization which is then adjusted for anticipated changes in population demographics, the health and disease status of a population, and anticipated changes in the health care system, e.g., growth in technology. Demand-based methods reflect actual patient use of health services. However, like the needs-based models, these methods require data that may not be available for defined rural populations; nor do they take into consideration unmet health care needs, which may be especially significant among rural populations (Pathman, 1991; Osterweis, et al., 1996).

A variation of the demand-based model that recently has been used to project future health care work force needs involves application of HMO staffing patterns to the general population of providers (Weiner, 1991, 1994). The basic theoretical framework of this approach assumes that observed HMO staffing levels are appropriate for meeting the health needs of the general population and are representative of future practice patterns.

Weiner (1991) has acknowledged that HMO staffing patterns should be adjusted upward when projecting work force needs for non-HMO populations, to compensate for differences between the demographic and health status characteristics of populations served by HMOs and non-HMO populations, differences in the organizational structure of HMO practice settings, and out-of-plan care obtained by HMO enrollees (Hellinger, 1995). More recently, Weiner concluded that standards for physician requirements in non-metropolitan areas should be equivalent to staffing levels recommended for IPAs (non-staff model HMOs), since rural populations are likely to be served by either fee-for-service medicine or IPAs. The recommended IPA staffing levels suggest that an increase of about 35 percent is needed over the current supply of physicians in non-metropolitan areas (Weiner, 1994). The HMO staffing patterns used as a basis for the estimates included HMOs with relatively few practice guidelines in place.

Researchers have recently combined work force projection methodologies to estimate the future number of physicians needed to care for the elderly population (Reuben et al., 1993). These authors used secondary data from national studies on health care utilization; physician productivity and supply; visit data; primary data from a national survey of physicians; and opinions of a panel of experts. They assessed the influence on future physician needs of differing assumptions regarding population growth, per capita physician visit rates, the prevalence of functional impairment in the elderly population, and physician productivity. The authors concluded that increased numbers of functionally impaired older adults with multiple medical conditions could result in increased duration of physician visit times, thereby having a profound impact on productivity and thus on the supply of physicians needed to care for the elderly. They did not include any estimates of the impact of guideline implementation.

Some recent estimates of future work force needs have attempted to account for differences between rural and urban health care delivery systems, while others have examined the impact of likely changes in the characteristics of the elderly population (Weiner, 1991; Kindig and Ricketts, 1991; Feil, Welch, and Fisher, 1993). These studies contribute to our understanding of multiple factors that may influence the future need for primary care providers to care for older rural populations. However, these studies have not taken into account specific changes in practice patterns that may result from implementation of practice guidelines.

Whatever system of forecasting is used, it should be adjusted for the changes in the patterns of health care practice that can be predicted. Currently, it is quite difficult to predict what new pharmacological, technological or preventive measures may be available in the future, and their possible impact on the health status and medical care utilization needs of the population. However, it is possible to predict how the utilization of services might change with the implementation of guidelines.

As a popular current strategy for reducing the wide variability in physicians' practices related to specific diseases, guidelines are being aggressively promoted. The Omnibus Budget Reconciliation Act of 1989 authorized the first federal guideline development within the Agency for Health Care Policy and Research (U.S. Congressional Record, 1989). Most guidelines apply to chronic conditions such as diabetes mellitus, hypertension, depression, urinary incontinence, and low back pain. Chronic disease occurs disproportionally in the elderly or Medicare population, and the elderly represent a disproportionally large share of rural primary care practice. Therefore, the impact of guideline adoption and implementation could have a major impact on rural health care delivery and rural health work force needs. This impact is likely to be most easily observed in the treatment of chronic conditions among the rural elderly.

Practice Guidelines for Diabetes Mellitus

Diabetes is a common condition in America. The Center for Disease Control and Prevention (CDC) estimated that 3.2 million Americans over 65 had a diagnosis of NIDDM in 1993 (CDC, 1995). An estimated 13.4 percent of Medicare beneficiaries in Iowa, Alabama and Maryland had a diagnosis of NIDDM (Weiner et al., 1995). NIDDM had a 15.5 percent prevalence rate among U.S. Healthcare HMO Medicare members in 1994 (Hanchak et al., 1996). The 1987 NHIS self-reported prevalence rates of NIDDM were higher in rural residents compared to those living in metropolitan areas (31.6 per 1,000 versus 26.7 per 1,000) (OTA, 1990), and both rural and metropolitan self-reported rates were much higher than those identified from medical indexes and administrative databases. As many as 40 percent of persons with diabetes may remain undiagnosed (Worrall 1991; Engelgau et al., 1995; Herman et al., 1995; Singer et al., 1988).

Guidelines or recommendations for the care of people with NIDDM have been developed by several organizations, including professional medical societies, private medical groups, researchers and the American Diabetes Association (AACE, 1992; Hurwitz, Yudkin, and Hyland, 1992; American College of Physicians, 1992; Position Statement - American College of Physicians, 1983; IDC, 1995; Kerr, 1995; Position Statement - American Diabetes Association, 1994; Clark and Kinney, 1992; Lasker, 1993; Worrall, 1994) (Tables 1 and 2). These guidelines vary in the number and frequency of recommended laboratory tests and visits to a health care professional, but most agree on the types of tests and visits that should be provided. Based on a combination of scientific evidence and expert opinion, the guidelines embody current recommendations for management of NIDDM. As stated in these guidelines, the recommendations for care can be divided into two basic categories: those for immediate care and

Table 1

Guidelines for Prevalence Cases

Follow-up Yearly	**AACE[1]**	**ACP[2]**	**ADA[3]**	**KERR[4]**	**IDC[5]**	**RCGP[6]**
Provider Visit: Complete History & Physical			x1		x1	
Provider Visit: Re-evaluations	x4	x1	x2	x1	x2	x1
Foot examination	x1	x	x1	x	x3	x1
Dilated Eye Exam	x1	x1	x1	x1	x1	x1
Random Blood Sugar (BS)	x4					x2
Fasting Blood Sugar (FBS)			x2		x3	x2
Glycosylated Hemoglobin (HbAlc)	x4		x2	x2	x3	x1
High Density Lipoproteins (HDL)	x1		x1	x1	x1	
Total Cholesterol	x1		x1	x1	x1	
Triglycerides	x1		x1	x1	x1	
Serum Creatinine				x1	x1	
Microalbuminuria – Urine Albumin			x1	x1	x1	
Dipstick protein – Urine Albumin						x1
Electroardiogram (ECG)			x1	x1	x1	
Education or Dietician Visit	x1		x1	x1	x1	

1. American Association of Clinical Endocrinologists, 1992
2. American College of Physicians, 1992
3. American Diabetes Association, 1992-3
4. Kerr, 1995
5. Mazze, Strock, Etzwiler, 1995
6. Royal College of General Practitioners (Hurwitz, 1992; CDA, 1992)

Table 2

Guidelines for Incidence Cases

Follow-up Yearly	**AACE[1]**	**ACP[2]**	**ADA[3]**	**KERR[4]**	**IDC[5]**	**RCGP[6]**
History and Physical (extensive)	x		x		x	
Foot examination	x		x		x	x
Dilated Eye Exam	x		x		x	
Random Blood Sugar (BS)	x					
Fasting Blood Sugar (FBS)	x		x		x	x
Glycosylated Hemoglobin (HbAlc)	x		x		x	
High Density Lipoproteins (HDL)	x		x		x	x
Total Cholesterol	x		x		x	x
Triglycerides	x		x		x	x
Electrolytes	x				x	x
TSH	x		x		x	
Creatinine	x		x		x	x
Urine Analysis	x		x		x	x
Microalbuminuria	x		x		x	
Dip stick						
Culture			x			
Creatinine Clearance (CrCl)	x				x	
Electrocardiogram (ECG)	x		x		x	x
Education or Dietician Visit	x		x		x	x

1. American Association of Clinical Endocrinologists, 1992
2. American College of Physicians, 1992
3. American Diabetes Association, 1992-3
4. Kerr, 1995
5. Mazze, Strock, Etzwiler, 1995
6. Royal College of General Practitioners (Hurwitz, 1992; CDA, 1992)

evaluation of incident cases (Table 1), and those for the yearly follow up of prevalence cases (Table 2).

We chose to use the ADA guidelines to project the work force impact of implementing chronic disease management guidelines. Although not universally accepted, the ADA guidelines are the most widely disseminated NIDDM guidelines and are the basis for many managed care organizations' guidelines, as well as recent HEDIS quality monitors (Morrissey, 1996). Therefore, they provide an adequate, if not scientifically perfect, basis for assessing the impact of changing patterns of practice due to guideline implementation. The ADA guidelines target both the prevention of known adverse acute complications of NIDDM such as ketoacidosis and severe hypoglycemia and early recognition of long term complications of diabetes such as nephropathy, retinopathy and neuropathy.

The guidelines are based on a combination of scientific evidence and expert opinion. The strength of evidence varies from element to element within the guideline. For example, no studies are available to determine the proper frequency of visits or testing to prevent or decrease the incidence of diabetic ketoacidosis or marked hypoglycemia (Petitti and Grumbach, 1993). In the absence of data, expert opinion has determined that measuring either blood glucose or its proxy, glycosylated hemoglobin (hemoglobin A1c or HgbA1c), one to four times per year is appropriate. The impact of this testing on long-term outcomes of diabetes mellitus is unclear.

Screening for early signs of the complications of NIDDM allows medical intervention which can reverse or slow the progression of some long term complications (CDC, 1996; American College of Physicians, 1992; Kentucky Diabetic Retinopathy Group, 1989; Javitt et al., 1991; Javitt et al., 1994; Lee et al., 1995; Singer et al., 1992; Borch-Johnson, 1993; Herman et al., 1993; LaPlante, 1992; Neil et al., 1993; Earle et al., 1992). For example, the use of a class of medications called "ACE inhibitors" has recently been shown to slow the progression of early diabetic nephropathy in some people with NIDDM (Cooper, 1996; Ganesvoort, de Zeeuuw, and de Jong, 1996). Micro-albuminuria testing appears to be an adequate screening test for early diabetic nephropathy (Neil et al., 1993; LaPlante, 1992) and therefore can be used to identify the group of people who may benefit from ACE inhibitors. However, the best timing for micro-albuminuria screening (i.e., annual, bi-annual) has not been identified.

The development and progression of diabetic retinopathy has been well documented (ACP, 1993). The use of dilated and undilated ophthalmoscope and fundus photography have been carefully studied as tools to identify early abnormalities consistent with diabetic retinopathy. Treatment of early diabetic retinopathy has been shown to successfully prevent progression and vision loss secondary to retinopathy (Javitt et al., 1994; Singer et al., 1992). The exact frequency of examinations to identify retinopathy sufficiently early to prevent adverse outcomes has not been determined. Both yearly and semi-annual examinations have been shown to be cost effective. Yearly eye examinations have been incorporated into most NIDDM guidelines (ACP, 1992).

While the medical literature provides some scientific basis for the use of screening tests for people with NIDDM, most of the guidelines for timing intervals of screening and examinations for NIDDM are the result of expert consensus panels that combine clinical experience and some studies of natural history of NIDDM complications with common sense.

Previous Research on Implementation of Diabetes Practice Guidelines

Guidelines are designed to improve the quality of care a person receives by decreasing both over- and under-utilization of health care resources (Greco and Eisenberg, 1993; Schroth et al., 1992). However, few experts suggest that guidelines are likely to decrease primary care resource utilization. Preliminary information from the Physician Payment Review Commission and the RAND Corporation suggests that, for several common diagnoses, Medicare patients are receiving only 30 percent to 60 percent of the minimum health care services recommended for ongoing monitoring of their chronic diseases (unpublished data, Physician Payment Review Commission, Washington DC, April, 1995).

Previous research confirms that NIDDM guidelines are a good proxy for all guidelines. The compliance with diabetes guidelines is very limited in all practices and groups of people with NIDDM that have been studied. The rate of compliance with guidelines for the management of other chronic conditions is similarly low. (Kenny, et al., 1993; Brechner, et al., 1993; Fain and Melkus, 1994; Weiner, et al., 1995; Hanchak, et al., 1996; GAO, 1997a; Lawler and Viviani, 1997; Worrall, 1994; Hiss, Anderson, and Hess, 1994. Hiss, 1996; Jacques, et al., 1991; Pringle, et al., 1993; Siebert, et al., 1993; Wedig, Mitchell, and Cromwell, 1989; Worrall, et al., 1997). Kenny et al. (1993) surveyed a national sample of primary care physicians (n = 1,434) regarding their adherence to recommended clinical and laboratory treatments for patients with diabetes. Self-reported adherence to recommended treatments was high (> 70 percent) for eye exams, blood pressure measurements, neurological and circulatory exams, and blood laboratory tests; it was low (< 40 percent) for exams of teeth and gums, foot exams, and urine laboratory tests. Reported adherence rates varied by specialty, with internists generally having the highest self-reported adherence rates and pediatricians the lowest. The rates of compliance decreased with physician age. Physicians reported greater adherence to guidelines for treating IDDM patients than NIDDM patients.

Brechner et al. (1993) surveyed a national sample of adults 18 years and older who reported a diagnosis of diabetes on the 1989 National Health Interview Survey (n = 2,405) to assess whether or not these individuals were receiving recommended eye examinations for detection of diabetic retinopathy. Less than half (49 percent) reported having a dilated eye examination in the past year. The likelihood of having a dilated eye exam increased with patient age. Of those 65 years and over, 57 percent of NIDDM patients treated with insulin and 50 percent of NIDDM patients not treated with insulin reported having an exam. Urban or rural location was not associated with having had an eye exam.

Fain and Melkus (1994) evaluated the extent to which the diabetes care practice patterns of nurse practitioners (NPs) in an urban ambulatory care center were consistent with ADA standards of care. Chart reviews were conducted for 78 patients cared for by six NPs to evaluate care in four areas: referrals for ophthalmic examinations and ECGs, glucose evaluations, nutrition counseling, and foot care. Results showed that 50 percent of patients were not being properly referred for ophthalmic examinations and/or ECGs; 23 percent had not had HbA1c tests; and 27 percent had no documented dietary interventions. The NPs documented comprehensive foot examinations for 23 percent of patients, with a 54 percent referral rate to podiatrists.

Weiner et al. (1995) used Medicare Part B claims data to evaluate the performance of recommended procedures for Medicare beneficiaries with a diagnosis of diabetes in three states (n = 97,388). Three procedures were considered to be part of general standards of care and were expected to be performed annually for all patients with diabetes: HgbA1c measurement, ophthalmology examination, and total cholesterol measurement. Only 16 percent of patients with diabetes received a HgbA1c measurement; 46 percent had an ophthalmology exam and 55 percent had a total cholesterol measurement. Rates of all procedures except ophthalmology exams were significantly lower in rural areas.

Hanchak et al. (1996) reported data on quality of care measures for U.S. Healthcare HMO Medicare members. Results indicated that 73 percent of Medicare members with diabetes received an annual HgbA1c test in 1994, while 54 percent received an annual retinal eye exam (defined as any visit or procedure by an eye care professional).

A study by the GAO (1997a and b) found that the provision of preventive and monitoring services for a national sample of Medicare beneficiaries with diabetes was below recommended levels in both the fee-for-service system and HMO plans. While 94 percent of fee-for-service beneficiaries with diabetes visited their physicians at least twice during 1994, only 42 percent received an eye exam, only 21 percent received at least two glycosylated hemoglobin tests, and just over half (53 percent) had a urinalysis. The use of these services varied by state, and utilization rates for urban beneficiaries were "slightly but consistently higher" than those of rural beneficiaries.

None of the studies revealed good (> 85 percent) or even adequate (> 75 percent) compliance (as defined by HEDIS standards) with the most basic recommendations for care of people with diabetes. The spread of managed care into rural areas and the demand for report-card like assessments of quality of care from all providers may force increased compliance with basic care guidelines for NIDDM and other chronic medical conditions. And increased compliance appears to imply increased use of services.

An increase in needed services, both testing and visits, may have the greatest impact in inner city and rural regions where local clinicians often work to full capacity and therefore are unable to provide even moderate increases in required services. In some rural areas, distances to non-rural providers may not allow substitution of metropolitan providers for rural providers for these primary care services.

Specific Rural Concerns

Statewide estimates of the number of people with diabetes and the frequency of some screening tests were made for three states by Weiner et al. (1995). These estimates were divided into estimates for rural and urban residents. Such data are a useful first step in assessing the impact of diabetes guidelines on the rural work force. However, population is not evenly distributed throughout the state or amongst provider service areas. Therefore, more local or regional level data are necessary to capture variation in provider-to-patient ratios as well as variation in NIDDM prevalence rates within regions of any state. To provide a more detailed picture of the impact of guidelines on work force requirements, the services needed by people with NIDDM should be compared with the health professionals available to provide these services within a geographic or medical care region for non-metropolitan areas. This is particularly important for the rural regions of states that have low population densities and often lack transportation systems that allow people to move long distances to receive primary care services. Within metropolitan areas, it may be possible to assess increases for an entire metropolitan region, but no one would assume that all metropolitan areas can be served by the same providers. Similarly it should not be assumed that a rural provider is equally accessible to all rural residents.

This study will evaluate the changes in need for primary care services that would occur with the successful (80 to 100 percent) implementation of a single practice guideline (NIDDM). Changes in the number of providers needed for various levels of compliance with NIDDM guidelines will be calculated for each of five rural health care regions of Minnesota. These results demonstrate the impact of guideline implementation on current and future rural provider needs and suggest an important adjustment to current methods used to estimate the need for rural primary care providers. Estimating the impact in five separate rural regions of a single state also provides an opportunity to see how the impact may vary across rural regions.

METHODS

This study used administrative data files available from HCFA (Part B and MedPar) for rural Medicare recipients over the age for 65 in the state of Minnesota. Services received by this population in 1994 and 1995 are compared to the services recommended in ADA guidelines for care of persons with NIDDM.

To determine the potential impact of guidelines on future work force needs, we estimate the number of additional services that would be required if guidelines for a single condition, NIDDM, were implemented. Estimates of the additional burden on currently available providers, or the number of additional providers needed are calculated.

Data Collection

Data were collected from the Part B and MedPar Medicare files of all persons > 65 years old living in rural Minnesota (non-MSA counties). Those persons enrolled in an HMO were excluded since encounter-level data are available for HMO participants. This 100 percent sample of rural Minnesota Medicare beneficiaries 65 years and older who are not enrolled in an HMO does not represent all persons with NIDDM, but is the best available resource for developing population-based estimates of disease in a major segment of the population known to be at high risk of NIDDM. Penetration of Medicare HMOs into rural Minnesota is very low, representing less than two percent of the rural population. Therefore, excluding them had little effect on estimates of compliance or of work force predictions.

Persons with previously diagnosed NIDDM (a prevalence cohort) were identified using information from 1992 and 1993 Medicare billing files. Any person with a diagnosis (ICD-9 or

CPT code) of diabetes mellitus, a complication of diabetes mellitus (e.g., diabetic nephropathy) or a procedure for a diabetes-related problem (e.g., amputation for diabetes-related gangrene) for any ambulatory or hospital service was considered to be a prevalent case. A person was considered to have a diagnosis of NIDDM if he or she had a face-to-face service with a provider that was associated with any diabetes related code. (Appendix B contains a list of the codes used to identify persons with NIDDM.) The diagnosis cohort required both a single diabetes-related encounter during 1992 and 1993 and requiring two or more diabetes-related encounters. An incidence cohort was assembled from all persons with a diagnosis of diabetes or a diabetic complication in 1994, but who had received no diabetes-related services in the two previous years. All incidence cases and those prevalence cases not specifically designated IDDM were considered to be NIDDM.

The diabetes screening and follow-up services used by the prevalent cases (those known to be alive January 1, 1994) were assessed for both 1994 and 1995. In addition, the 1994 and 1995 services used by all incident cases of NIDDM in the cohort were tabulated for the two months before the first diagnosis of NIDDM and for the 12 months after the first diagnosis of NIDDM. Persons dying during 1994 or 1995 were included in the cohort for assessment of recommended yearly services only if they were alive at least six months of the year. Data were tabulated separately for persons who lived < 6 months in either 1994 or 1995 since those living less than six months could not be considered to require all services required multiple times in a single year.

The services assessed as diabetes-related for the prevalence cohort were:

- Fasting blood sugar (FBS);
- Glycosylated hemoglobin (HgbA1c) (a measure of diabetic control over the previous three months);

- Micro-albuminuria (a measure of kidney damage);
- Electrocardiogram (ECG);
- Eye examination;
- History and physical examination related to NIDDM;
- Any ambulatory visit or hospital admission in which NIDDM or a complication of NIDDM was the first diagnosis;
- And, patient education or registered dietician visits.

Thyroid testing and urinalysis were considered as diabetes-related for those in the incidence cohort.

Data Analysis

We compared numbers and types of tests and visits recommended by the NIDDM guidelines with those recorded for each person in the NIDDM prevalence and incidence cohorts. The comparison was performed at the individual level to allow calculation of repeated need for the same test or visit type. For example, a person may have only one FBS or HgbA1c laboratory evaluation during a 12-month period and would require at least one additional HgbA1c that year to comply with the guidelines. Alternatively, one person might have seven diabetes-related visits, reaching 100 percent compliance with this aspect of the guideline. However, if calculations were simply done using the total number of visits (i.e., diabetes-related visits) divided by the total number of persons in cohort, the five "extra" visits would appear to increase compliance for other persons who had fewer than the recommended number of visits.

Using data on individual cohort members aggregated over the region, it was possible to calculate both the number of persons in current compliance with guideline recommendations as well as the additional tests and examinations necessary for individuals to meet various levels of compliance (80 percent, 90 percent, 100 percent) with the guidelines. We then aggregated the numbers of individual requirements by rural region. The ADA guidelines were used as the basic reference. No adjustments for decreases in services were made for people who had more services than the recommended number since the ADA guidelines are considered minimum care guidelines (ADA, 1993).

In addition to the simple calculations of unmet needs, adjustments in the estimates of needed services were made for the presumed number of people with undiagnosed NIDDM. No adjustments were made for additional services required by persons with NIDDM-related complications. Nor were adjustments made for any decreases in services that might result from the prevention of a complication due to increased use of routine care (i.e., prevention of nephropathy) since no information on the efficacy of the guidelines in preventing complications was available in the literature (with the exception of blindness prevention from regular eye exams).

Calculations for needed additional services were performed individually for the five rural health services regions of Minnesota. Since it is unlikely that any primary care provider would be able to provide services in multiple regions of the state, statewide estimates, except as the sum of the regional needs, were not made. Health services regions are the State of Minnesota's attempt to define provider service regions or markets. Such regions conform to basic referral patterns as well as existing rural regional networks and political boundaries.

The estimated of number of additional providers needed is based on the amount of time estimated to be needed to complete the additional examinations and test interpretations required under the guidelines, divided by the average number of ambulatory practice hours per week for rural Minnesota physicians, nurse practitioners and physician assistants (Kephart, 1993; AAPA, 1996). Separate calculations were completed in each region for primary care clinicians and eye care professionals (optometrists and ophthalmologists). It was assumed that all eye exams would be performed by eye care professionals. A physical examination (complete) was assumed to require 45 minutes of physician time (including paper work). Our calculations allowed 20 minutes for repeat visits, and seven minutes for each interpretation and reporting of lab results, except EKGs which were assumed to require 15 minutes. Estimates are based on the work of Hsaio and others who developed such estimates during their basic work on the development of the Relative Value Resource Based System (RBRVS). All providers were assumed to be physicians in the base case calculations.

Calculations for additional hours of primary care physicians required by region =
Additional number of complete physical examination x 45 minutes

+ additional number of recheck visits x 20 minutes
+ additional number of (HgA1C+BG+Urine tests) x 7 minutes
+ additional number of EGCs x 15 minutes

Calculations for additional number of hours of eye care by region =
Additional number of eye examinations x 30 minutes

The number of hours of additional service was translated into the number of physician FTEs using data from a survey completed by the Minnesota Academy of Family Physicians (67 percent response rate) (Kephart, 1993). The average Minnesota rural family physician spent 42 hours each week in ambulatory practice. According to the AMA survey of specialists (American Medical Association, 1994) ophthalmologists spend 34 hours each week seeing ambulatory patients. Optometrists see only ambulatory patients and are therefore assumed to spend 40 hours per week in ambulatory care service. Nurse practitioners and physicians assistants were assumed to spend 20 percent more time than physicians in completing each task (Kindig and Ricketts, 1991; AAPA, 1996). Physicians assistants were assumed to spend 34 hours each week seeing patients in ambulatory practice and nurse practitioners, 30 hours per week (AAPA, 1996).

RESULTS

Of the 192,994 eligible Medicare recipients alive on January 1, 1994, 20,905 (10.8 percent) were included in the 1994 prevalence cohort for NIDDM. Another 2,798 persons (1.8 percent) were first recorded as having a diabetes related encounter in 1994 and therefore considered incident cases. Of the 191,100 Medicare recipients alive on January 1, 1995 19,918 (10.4 percent) were included in the 1995 prevalence cohort. Prevalence and incidence percentages were very similar across the rural regions of Minnesota (Table 3). Within-region prevalence was slightly lower in 1995, but there was no statistically significant difference between 1994 and 1995 values, except in Region 1 ($p = 0.05$ for Region 1) (Table 3).

Lack of compliance with guidelines varied by the element in the guidelines that was considered. Tables 4 and 5 present the number and percentage of the prevalence cohort who did not have any record of each of the recommended services in 1995. (The corresponding tables for 1994 are in Appendix A). The calculations were done separately for those living less than six months and those living six months or longer in the year of interest. This was done in recognition of the possible differing clinical needs and goals of care for persons with diabetes who are near death. Tables for those living less than six months are not presented The tables are presented as non-compliance rates since the purpose of this study is to define the nature and extent of services not provided.

Of the persons in the diabetes prevalence cohort who lived at least six months of 1994, 2,493 (12.0 percent) of 20,806 persons did not have any visit in which diabetes was recorded as a diagnosis during 1994. Similarly, 2,558 (12.8 percent) of the 19,918 persons in the 1995 prevalence cohort had no diabetes-related visits recorded in 1995. For actual assessment of the compliance with ADA guidelines it is necessary to break the number of visits down into more

Table 3

Prevalence and Incidence of NIDDM in Rural Minnesota Medicare Recipients

Region	Prevalence 1994 n=20,806 (10.8)	Prevalence 1995 n=19,918 (10.4)	Incidence Cohort n=2,989
1	2,303 (10.9)	2,178 (10.4)	277 (1.3 percent)
2	1,794 (10.5)	1,733 (10.3)	292 (1.6 percent)
3	4.484 (11.0)	4,261 (10.8)	595 (1.3 percent)
5	7,964 (10.2)	7,582 (10.1)	1,017 (1.3 percent)
6	4,261 (10.5)	4,164 (10.3)	621 (1.5 percent)

Table 4

Prevalent Cases 1995§
Number of Persons with NIDDM Not Having Any Claims of Each Type in 1995 for the listed Services

Region n=19,918	Complete H&P	DM Related Visits (Not H&P)*	Dilated Eye Exams	Specialty Visits	Diabetic Education Visits
1 n=2,178	1,201 (55.1%)	308 (14.1%)	1,282 (58.9%)	1,867 (85.7%)	2,178 (100.0%)
2 n=1,733	867 (50.0%)	264 (15.2%)	1,151 (66.4%)	1,503 (86.7%)	1,733 (100.0%)
3 n=4,261	2,388 (56.0%)	504 (11.8%)	2,584 (60.6%)	3,775 (88.6%)	4,258 (99.9%)
5 n=7,582	4,249 (56.0%)	912 (12.0%)	4,161 (54.9%)	6,568 (86.6%)	7,577 (99.9%)
6 n=4,164	2,144 (51.5%)	570 (13.7%)	2,575 (61.8%	3,548 (85.2%)	4,153 (99.7%)

§Does not include data on the 980 people with NIDDM that survived less than six months in 1995.
*See Table 6 for persons with 1, 2, 3, 4 and more of these services in 1995.

Table 5

Prevalent Cases 1995§
Patients with NIDDM Not Having Any of the Listed Laboratory Tests

Regions n=19,918	Blood Glucose	HbgA1c*	Serum Cholesterol	Serum Creatinine	Urine Protein (Includes Microalbuminuria)
1 n=2,178	1,467 (67.4%)	1,256 (57.5%)	1,849 (84.9%)	2,116 (97.2%)	2,163 (99.3%)
2 n=1,733	1,288 (70.9%)	934 (53.9%)	1,556 (89.8%)	1,686 (97.3%)	1,721 (99.3%)
3 n=4,261	2,768 (65.0%)	2,419 (56.8%)	3,569 (83.9%)	4,143 (97.0%)	4,207 (98.7%)
5 n=7,590	4,700 (63.1%)	4,312 (56.8%)	6,700 (88.3%)	7,345 (96.9%)	7,475 (98.6%)
6 n=4,164	2,737 (65.7%)	2,065 (49.6%)	3,578 (85.9%)	3,952 (94.9%)	4,069 (97.7%)

§Does not include the 980 people with NIDDM that survived less than six months in 1995.
*See Table 6 for persons with 1, 2, 3, 4 and more of these services in 1995.

detailed groups than either the presence or absence of a visit. For example, the 1995 prevalence cohort also contained 2,206 (11.1 percent) persons who had only one NIDDM-related visit, and 15,154 (76.1 percent) who met the ADA criteria of two or more visits during the year.

The compliance in 1995 with visits and laboratory tests recommended more than once a year is presented in Table 6. Only data for those living more than six months of the year are presented. Data for 1995 are similar with slightly lower rates (75.5 percent) of people with NIDDM having two or more diabetes-related visits. Overall, lack of compliance was highest for diabetic education visits and lowest for a single complete history and physical in which NIDDM was coded as a diagnosis (Table 4)

The guidelines for incidence cases include several additional services such as a urine culture, a test for thyroid stimulating hormone (TSH) and a creatinine clearance. Compared with prevalence cases, the compliance with guidelines for incidence cases is lower for the extended services such as TSH but higher for the core of services such as HgbA1c (Table 7).

While the compliance vs. non-compliance data are interesting, their major functions is the foundation for the calculations that are the aim of this study: to assess the additional hours and personnel needed to reach various levels of compliance with the guidelines. Additional personnel needed were estimated from the additional provider visits and laboratory tests required to increase compliance with the guidelines to the desired level. Most additional visits needed are in the category of revisits for evaluation of diabetes management or identification of complications. From the low prevalence of specialty visits it is clear that almost 85 percent of these patients receive all their diabetic care from primary care physicians. It is therefore reasonable to assume that missed visits are visits that would have been provide by primary care clinicians. The most common missed laboratory evaluation is the assessment of proteinuria. In each region the

Table 6

Frequency of NIDDM-Related Visits and Glycosylated Hemoglobin in Prevalent Cases in 1995 Recommended More than Once Each Year§

Region n=19,918	No DM Related Visits	Only 1 DM Related Visit	Only 2 DM Related Visits	Only 3 DM Related Visits	4 or More DM Related Visits
1 n=2,178	308 (14.1%)	247 (11.3%)	244 (11.2%)	249 (11.4%)	1,130 (51.9%)
2 n=1,733	264 (15.2%)	210 (12.1%)	195 (11.2%)	192 (11.1%)	872 (50.3%)
3 n=4,261	504 (11.8%)	451 (10.6%)	456 (10.7%)	427 (10.0%)	2,423 (57.1%)
5 n=7,582	912 (12.0%)	781 (10.3%)	829 (10.9%)	812 (10.7%)	4,248 (56.0%)
6 n=4,164	570 (13.7%)	517 (12.4%)	496 (11.9%)	444 (10.7%)	2,137 (51.3%)

Region n=19,918	No HgbA1c	Only 1 HgbA1c	Only 2 HgbA1c	Only 3 HgbA1c	4 or More HgbA1c
1 n=2,178	1,256 (57.7%)	459 (21.1%)	269 (12.4%)	117 (5.4%)	71 (3.4%)
2 n=1,733	934 (53.9%)	422 (24.3%)	226 (13.6%)	103 (5.9%)	48 (2.3%)
3 n=4,261	2,419 (56.8%	840 (19.7%)	546 (12.8%)	258 (6.1%)	198 (4.6%)
5 n=7,582	4,312 (55.6%)	1,680 (22.2%)	960 (12.7%)	404 (5.3%)	226 (3.0%)
6 n=4,164	2,065 (50.0%)	1,046 (25.1%)	565 (13.6%)	308 (7.4%)	180 (4.3%)

§Does not include 980 people with NIDDM who survived less than six months in 1995.

Table 7

Incidence Cases: Number of Additional Visits and Laboratory Tests Necessary to Meet ADA Guidelines

Region n=2,989	Complete H&P (0.75 Hr.)	Diabetes Recheck Visits (0.33 Hr.)	Eye Exams (0.6 Hr.)	Diabetes Education Visits (1.0 Hr.)
1	154	301	172	277
2	193	251	184	288
3	367	781	348	594
5	722	1,449	578	1,017
6	430	687	392	620

Region	Glucose (0.05 Hr.)	HgbA1c (0.05 Hr.)	Lipids (0.05 Hr.)	Serum Creatinine (0.05 Hr.)	Urine Protein (0.05 Hr.)
1	417	451	226	263	276
2	393	412	247	270	286
3	916	1,117	471	570	595
5	1,448	1,501	830	963	1,002
6	763	806	466	586	616

Region	Urine Culture (0.05 Hr.)	TSH (0.05 Hr.)	Creatinine Clearance (0.05 Hr.)	Electrolytes (0.05 Hr.)	ECG (0.05 Hr.)
1	238	200	275	240	198
2	238	221	285	249	212
3	486	475	593	515	512
5	869	721	1,009	896	783
6	618	418	618	546	554

number of additional tests and visits needed (e.g., Table 7) can be translated into additional hours of provider services needed (Table 8), using the assumptions and formulas presented in the methods section. Data are presented for both incidence and prevalence cases, and for all visits and tests. All tests and visits except diabetic education visits and eye visits are grouped under primary care visits. Due to concerns about the ability of administrative data to portray accurate information on diabetic education visits, these visits are not included in the calculations for either primary care or eye care clinicians but presented as a separate category.

It is likely that persons with diabetes who remain undiagnosed have not received any of the services suggested in the ADA management guidelines. Their inclusion in the calculations therefore increased the number of additional FTEs required for 100 percent compliance with the guidelines. The time required for these additional services to be provided to Medicare beneficiaries with undiagnosed diabetes is added to the time required for additional services needed for the diagnosed cases of NIDDM in the final section of Table 8.

The numbers of additional hours of services required could be divided among the known current providers in each region. The additional number of hours may seem small to those not practicing in rural regions. However, over 95 percent of rural Minnesota physicians state they are working too many hours and are attempting to recruit help to continue to provide the current level of services. (Kephart, 1993) More importantly, the additional hours reported here are for compliance with only one set of guidelines in one chronic condition.

If the services are assumed to be provided by new clinicians, an additional twenty new primary care physicians and fourteen ophthalmologists would be needed in rural Minnesota. The number of primary care physicians needed for each region varies from only two in the least populated region, to seven in the most populated region. Table 9 summarizes the increased

Table 8

All Tests* & Visits* Translated to Hours
Average 1994 and 1995

	Prevalent and Incident Cases			Prevalent, Incident and Undiagnosed Cases		
Region	**Primary Care Provider**	**Eye Care Provider**	**Education**	**Primary Care Provider**	**Eye Care Provider**	**Education**
1	3,178.3	1,494.75	3,134	4,633.5	2,185.5	4,055
2	2,238.4	1,242.75	2,658	3,371.3	1,780.5	3,375
3	4,792.9	2,962.5	6,263	7,624.3	4,306.5	8,055
5	8,503.5	5,044.2	11,011	13,534.2	7,432.2	14,195
6	4,586.9	2,867.1	6,115	7,276.1	5,556.3	7,817

*Additional tests and visits required to meet 100 percent compliance with guidelines.

number of primary care providers needed for each region if all new providers were 1) primary care physicians, 2) physician assistants or 3) nurse practitioners. Primary care physicians were assumed to provide ambulatory care 40 hours each week, 48 weeks each. Nurse practitioners and physicians were assumed to provide ambulatory services 32 hours, 48 weeks per year. The table also shows the results of the sensitivity analysis for 80 percent and 90 percent compliance with the ADA guidelines.

The projected number of additional physicians required for 100 percent compliance varies by rural region. Region 2 is the least populated, with only approximately 21,000 rural Medicare recipients and a need for 1.8 new physicians to meed the diabetes care requirements. Region 5 has the largest rural Medicare population and the largest calculated need (7.4 new physicians) (Table 10). For compliance rates of less than 100 percent, the projected needs are smaller. For example, Region 1 has a projected need of 2.5 physicians for 100 percent compliance, but 2.1 and 2.4 respectively for 80 percent and 90 percent compliance. Similarly, the projected need of 7.4 physicians in Region 5 drops to 6.8 and 7.1 for 80 percent and 90 percent compliance with the ADA guidelines.

Mixed models of both physician and mid-level providers could be developed but were not included here. Instead Table 9 presents the additional number of providers needed if all new providers were of the type in the column heading (physicians, nurse practitioners or physician assistants). The increases in primary care physicians represent a two to three percent increase for each region. The percent increase in eye care providers is about 25 percent for each region for ophthalmologists (Table 10).

Table 9

Actively Practicing Primary Care Providers in Minnesota Counties by Region
(Additional Providers Need to Comply with Guidelines
[Additional Providers for 80% and 90% Compliance]

	Physicians: Family Practice, General Practice, and General Internal Medicine		Physician Assistants: Family Practice and General Internal Medicine		Nurse Practitioners: Adult, Family, and Gerontology	
Region	Current Number of MDs (Additional Needed)	Additional Needed for [80%, 80% Compliance]	Current Number of PAs (Additional Needed)	Additional Needed for [80%, 80% Compliance]	Current Number of RNPs (Additional Needed)	Additional Needed for [80%, 80% Compliance]
1	85 (2.5)	[2.1, 2.4]	11 (3.5)	[2.7, 3.0]	5 (5.0)	[4.2, 4.7]
2	93 (1.8)	[1.6, 1.7]	10 (2.5)	[2.1, 2.4]	9 (3.6)	[3.2, 3.8]
3	161 (4.2)	[3.8, 4.0]	16 (5.9)	[5.1, 5.7]	25 (8.4)	[6.7, 7.3]
5	275 (7.4)	[6.8, 7.1]	36 (10.4)	[9.2, 9.6]	57 (14.8)	[12.1, 13.4]
6	158 (4.0)	[3.4, 3.7]	10 (5.6)	[5.1, 5.4]	17 (8.0)	[6.9, 7.3]

Data Source: Office of Rural Health, Minnesota Department of Health, 1995.

Table 10

Actively Practicing Eye Care Providers in Minnesota Counties by Region (Additional Providers Need to Comply with Guidelines)

	Ophthalmologists		Optometrists	
Region	**Rural**	**Urban**	**Rural**	**Urban**
1	6 (1.4)	2	24 (1.1)	14
2	2 (1.1)	14	12 (0.9)	20
3	10 (2.8)	7	38 (2.2)	41
5	16 (4.8)	0	84 (3.9)	0
6	15 (3.5)	27	35 (2.9)	14

Data Sources: Office of Rural Health, Minnesota Department of Health, and Minnesota Board of Optometry

DISCUSSION

In rural Minnesota, compliance with the various elements of the ADA guidelines ranges from less than 14 percent to more than 64 percent for various elements of the ADA recommended care of people with NIDDM. The high prevalence of NIDDM (> 10 percent) and the relatively low compliance with recommended services leads to requirement for additional providers' services if compliance with ADA guidelines is to reach even 80 percent. The creation of community programs to diagnose the estimated additional 40 percent of persons with NIDDM who remain unidentified would increase this projected need by approximately 50 percent, adding significantly to current and future work force projections of needed rural primary care and eye care professionals.

The compliance data that are the foundation of our estimates of required additional work force personnel are very similar to those reported in the literature. Using statewide Minnesota Medicare data, the GAO (1997a and 1997b) recently reported that 41.2 percent of all people with diabetes had at least one eye examination in 12 months. Our regional rural rates of eye examination are slightly lower, ranging from 33.2 percent to 41.9 percent. Other studies report rates of 46 percent (Weiner et al., 1995) to 54 percent (Hanchak et al., 1996). When comparisons are available, most studies report lower rates in the rural population compared to state averages.

Rates of at least one glycosylated hemoglobin test ranged from 28.4 percent in Minnesota (GAO , 1997) to 16 percent of Medicare recipients in Iowa, Maryland and Kentucky (Weiner et al., 1995). This is similar to our regional levels of 19.7 percent to 25.1 percent.

The GAO (1997b) data on diabetes-related visits and cholesterol measurements are the only reported data that can be compared to our data. The GAO study identified much higher rates of a serum cholesterol test within 12 months (58.9 percent versus 15.7 percent) and a slightly higher rate of at least one primary care visit for diabetes (91.5 percent versus 89.1 percent). From the similarity in most compliance rates, it would appear that the assumptions on which we based our calculation of additional tests and visits required are consistent with data in the medical literature.

Taken out of context, the additional requirements for rural physicians may seem small — only two to eight primary care physicians per region. However, these numbers represent an increase of two percent to four percent in the current number of health care clinicians to provide care for a single disease entity in only a limited segment of the population. The consideration of even four or five more guidelines for the management of other chronic diseases could increase this need for additional providers to a 5 to 15 percent increase. It must also be remembered that these calculations assume the new providers will provide no other care than that required to comply with the guidelines.

It is unlikely that full compliance with guidelines will ever be achieved. Even rates of 80 percent to 90 percent require great effort in staff model managed care organizations (Pringle, 1993; Wedig, 1989; Hanchak et al., 1996). However, the use of electronic medical records and chronic disease registries, specialized nurse run outreach clinics and other automated recall and reminder systems could increase compliance rates significantly. Evan with such assistance, any increase in compliance translates to an increase in needed primary care provider services and, in the case of NIDDM, eye care providers.

Certain efficiencies could decrease the actual number of extra visits or the time spent in providing the services during visits that already occur. It is not possible to make any informed estimates for the impact of these efficiencies in reducing the number of FTEs required to meet the additional service needs. However, the average number of minutes a rural primary care physician spends with a patient during a routine care check is only 9.5 minutes (Mainous, Ramsbottom-Lucier, and Rich, 1994). It is difficult to guess how much more assessment and testing can be incorporated into such a streamlined visit.

Not all services need to be provided by a physician. Both nurse practitioners and physician assistants provide care to persons with chronic diseases, including management and routine follow up of NIDDM. In rural Minnesota expecting NPs or PAs to provide all the additional services would result in a 33 to 80 percent increase in the NP or PA work force just for compliance with NIDDM guidelines.

The method of assessment used in our analysis has limitations. The identification of the cohort was based on the coding practices of providers. For a person to be recognized as a diabetes case, he or she had to receive care with diabetes mellitus coded as a diagnosis. Many studies have demonstrated the limitations of using administrative data sets to identify specific services for the individual patient (Lauderdale et al., 1993; Whittle et al., 1991; Jollis et al., 1993). We know less about the accuracy of identifying a cohort of persons with a chronic disease from administrative data. Unlike the patient who may have only a single visit for an acute problem or given diagnostic test, patients with chronic disease are likely to have multiple visits and procedures related to their chronic disease. Information from the Rochester Epidemiology Project medical index, which relies on the coding practices of over 2,000 physicians, nurse practitioners and physician assistants, suggests that the sensitivity and specificity of identifying diagnosed cases that receive medical care increase with the period of time used to identify cases (Kurland and Molgaard, 1981; Melton, 1996). Using two years of information from both outpatient care and hospitalizations provides a very broad window of opportunity to identify the diagnosis of NIDDM. The use of a single face-to-face encounter over the 1992-93 period provided us with a prevalence rate of NIDDM of approximately eleven percent in this population of Medicare recipients 65 and older. This is similar to prevalence rates identified in other population-based studies using other methods to assemble a cohort (CDC, 1995). The requirement of two face-to-face encounters lowered the perceived prevalence rate to only seven percent, which is significantly lower than anticipated. That is why the cohort based on a single face-to-face encounter was used in this study.

Some of the recommended elements of the NIDDM guidelines can not be assessed using administrative data. Foot care and examinations are rarely if ever recorded separately unless the care is provided by a podiatrist or involves the evaluation or treatment of a foot ulcer or amputation. Diabetic education sessions are rarely coded separately and, in this data set, education completed by the primary care provider during a visit was never recorded. This may be due to the very low rates of reimbursement from Medicare for educational activities (Fore, 1994).

It is therefore impossible to comment on the rates of compliance, number of additional services needed or the number of providers necessary to supply such services as foot exams and diabetic education. It is very likely that most foot care can be incorporated into routine visits for assessment of diabetic management and the presence of complications of NIDDM without adding to the time needed to complete the visits (Reiber, 1992; Position Statement, ADA, 1995). However, diabetic education is often a time-consuming process that may be occurring but is not recorded. If performed with the very limited frequency suggested by these data, adequate diabetic education would greatly increase the need for additional rural providers who can serve the patient's educational needs.

The ADA guidelines represent one of the most extensive guidelines for care of people with NIDDM (Position Statements, ADA, 1993, 1994). The number of diabetes-related visits and tests are the same or greater than found in any other NIDDM guideline. The lowest levels of recommended care are in the British guidelines which have no basis in evidence but rather are financially driven by the payer (Hurwitz, 1992). Conversely, guidelines from health care professional groups have little foundation in evidence and may be financially driven from the payee's perspective (Kerr, 1995; Position Statement, ACP, 1983; AACE, 1992). Until sufficient evidence can be developed, guidelines from the ADA, which include expert opinion from the payer, the payee and the patient, seem a reasonable compromise for the purpose of illustrating the potential impact of guideline implementation.

The choice not to adjust any of the estimates downward in the expectation that guideline compliance could prevent complications of diabetes could be criticized. However, no longitudinal or clinical trial data exist to estimate either the extent to which complications could be prevented or the impact of that prevention on the volume of care provided by primary care providers (Diabetes Control and Complication Trial Research Group, 1993). In this cohort, even the persons with complications did not receive the minimal services recommended. Therefore, it does not appear that those persons would have a greatly reduced service need even if their complications were prevented. Indeed, prevention of complications may allow the persons with NIDDM a longer life span and therefore create a continued need for services for several years beyond what they currently require. Due to this lack of data, it is not possible to incorporate directly decreased needs into the estimation of current or future work force needs.

CONCLUSIONS

Compared to the number of providers currently in practice in rural Minnesota, the number of additional providers needed to comply with guidelines for a single condition is significant. NIDDM is only one of several common chronic conditions that may require significant additional visits and laboratory evaluations to meet recommended care guidelines. As with diabetes, additional evaluation and secondary prevention services for other chronic conditions may identify complications earlier, and decrease the rate of progression to end stage complications, but will not necessarily decrease the need for primary care services. Preventing or slowing the progression of complications may even increase the number of years of primary care required for individuals with enhanced longevity and less complicated disease management.

We conclude that health workforce forecasting methods should consider adding an adjustment for the changes in practice patterns that will occur with the implementation of practice guidelines for chronic diseases. The exact magnitude of this adjustment will require additional study.

REFERENCES

American Academy of Physician Assistants. *Physician Assistants: Statistics and Trends, 1991 - 1996.* Alexandria, VA: author, 1997.

American Academy of Physician Assistants. *1996 AAPA Physician Assistant Census Report*. Alexandria, VA: author, 1996.

American Association of Clinical Endocrinologists. *Guidelines for the Management of Diabetes Mellitus*, Chicago, IL: author, 1992.

American College of Physicians, American Diabetes Association, American Academy of Ophthalmology. "Screening Guidelines for Diabetic Retinopathy." *Annals of Internal Medicine* 116:683-685, 1992.

American College of Physicians, American Diabetes Association, American Academy of Ophthalmology. "Screening Guidelines for Diabetic Retinopathy," *Diabetes Care* 16S:16-18, 1993. (Revised in 1993 by the American Diabetes Association). Guidelines of the American Diabetes Association, American College of Physicians and American Academy of Ophthalmology.

American Diabetes Association. "National Standards for Diabetes Patient Education and American Diabetes Association Review Criteria." *Diabetes Care* 16S:113-118, 1993. Reprinted from *Diabetes Care* 9:36-40. 1986, American Diabetes Association.

American Medical Association. *Physician Survey*. Chicago, Illinois: AMA Publications, 1994.

Borch-Johnson E. "Is Screening and Intervention for Microalbuminuria Worthwhile in Patients with Insulin-dependent Diabetes?" *British Medical Journal* 306:1722-1725, 1993.

Brechner, R., Cowie, C., Howie, L., Herman, W., Will, J., and Harris, M. "Ophthalmic Examination among Adults with Diagnosed D.M." *Journal of the American Medical Association* 270:1714-1718, 1993.

Canadian Diabetes Association. "Clinical Practice Guidelines for Diabetes Mellitus in Canada." *Canadian Diabetes* 5:1-4, 1992.

Capilouto, E. and Ohsfeldt, R. "Health Work Force Modeling: Lessons from." *US Health Work Force: Power, Politics and Policy.* M. Osterweis et al. (eds). Association of Academic Health Centers: Washington DC, pp. 277-282, 1996.

Centers for Disease Control. National diabetes fact sheet: National estimates for release on November 3, 1995. WorldWideWeb address http://www.cdc.gov/nccdphp/ddt/facts.htm#prev (CDC Diabetes Home Page).

Clark Jr., C. and Kinney, E. "Standards for the Care of Diabetes. Origins, Uses and Implications for Third-party Payment." *Diabetes Care* 15S:10-14, 1992.

Cooper, M. "Renal Protection and Angiotensin Converting Enzyme Inhibition in Microalbuminuric Type I and Type II Diabetic Patients." *Journal of Hypertension* 14:S11-S14, 1996.

Crijns, H., Casparie, A., and Hendrikse, F. "Future Need of Eye Care for Patients with Diabetes Mellitus, Costs and Effectiveness." *Nederlands tijdschrift voor Geneeskunde*. 139:1336-1341, 1995.

Diabetes Control and Complication Trial Research Group. "The Effect of Intensive Treatment of Diabetes on the Development and Progression of Long-term Complications in Insulin-dependent Diabetes Mellitus." *New England Journal of Medicine* 1329:977-986, 1993.

Earle, K., Walker, J., Hill, C., and Viberti, G. "Familial Clustering of Cardiovascular Disease in Patients with Non-insulin Dependent Diabetes and Neuropathy." *New England Journal of Medicine* 326:673-677, 1992.

Eddy, D. "Clinical Decision Making: from Theory to Practice. Practice Policies --guidelines for Methods." *Journal of the American Medical Association* 263:1839-1844, 1990.

Eger, M. "Survey Results: Manpower in Eyecare." *Journal of the American Optometry Association.* 56:360-362, 1985.

Engelgau, M., Thompson, T., Smith, P., Herman, W., Aubert, R., Gunder, E., Wetterhall, S., Sous, E., and Ali, M. "Screening for Diabetes Mellitus in Adults. The Utility of Random Capillary Blood Glucose Measurements." *Diabetes Care* 18:463-466, 1995.

Fain, J., and Melkus, G. "Nurse Practitioner Practice Patterns Based on Standards of Medical Care for Patients with Diabetes." *Diabetes Care* 17:879-881, 1994.

Feil, E., Welch, H., and Fisher, E. "Why Estimates of Physician Supply and Requirements Disagree." *Journal of the American Medical Association* 269:2659-2663, 1993.

Fore, W. "Reimbursement for Diabetes Self-care Training." [Commentary] *Diabetes Care* 17:608-610, 1994.

Ganesvoort, R., deZeeuuw, D., and de Jong, P. "ACE Inhibitors and Proteinuria." *Pharmacy World Science*. 18:204-210, 1996.

General Accounting Office. *Most Beneficiaries with Diabetes Do No Receive Recommended Monitoring Services.* Publication #HEHS-97-48, March 29, 1997a.

General Accounting Office. (Testimony of Bernice Steinhardt, Director of Health Services Quality and Public Health Issues, before the Subcommittee on Health and Environment, House

Committee on Commerce). *Medicare: Provision of Key Preventive Diabetes Services Falls Short of Recommended Levels.* Publication #T-HEHS-97-113, April 11, 1997b.

Greco, P. and Eisenberg J. "Changing Physicians' Practice." *New England Journal of Medicine*. 329:1271-1273, 1993.

Greenfield, S., Audet, A., and Fold, M. "Medical Practice Guidelines; Current Activity and Future Directions." *Annals of Internal Medicine* 113:709-714, 1990.

Hanchak, N., Harmon-Weiss, S., McDermott, P., Hirsch, A., and Schlackman, N., "Medicare Managed Care and the Need for Quality Measurement." *Managed Care Quarterly* 4:1-12, 1996.

Hellinger, F. "Selection Bias in HMOs and PPOs: a Review of the Evidence." *Inquiry* 32:135-142, 1995.

Herman, W., and Dasbach, E. "Diabetes, Health Insurance and Health-care Reform." *Diabetes Care* 17:611-613, 1994.

Herman, W., Prior, D., Yassine, M., and Weder, B. "Nephropathy in NIDDM is Associated with Cellular Markers for Hypertension." *Diabetes Care* 16:815-818, 1993.

Herman, W., Smith, P., Thompson, T., Engelgau, M., and Aubert, R. "A New and Simple Questionnaire to Identify People at Increase Risk for Undiagnosed Diabetes." *Diabetes Care* 18:382-387, 1995.

Hiss, R. "Barriers to Care in Non-insulin-dependent Diabetes Mellitus: The Michigan Experience." *Annals of Internal Medicine* 124:146-148, 1996.

Hiss, R., Anderson, R., and Hess, G. "Community Diabetes Care - a 10-year Perspective." *Diabetes Care* 17:1124-1134, 1994.

Hurwitz, B., Yudkin, J., and Hyland, K. "Diabetes Mellitus, Chapter 2." In *Occasional Paper, Royal College of Physicians* 58:7-13, 1992.

International Diabetes Center (IDC). *Staged Diabetes Management, Decisionpaths*. Park Nicollet Medical Foundation, Minneapolis, MN, 1995

Jackson, C., Lee, P., and Relles, D. "Eye Care Manpower Estimates for the 21st Century." [Abstract] *AHSR & FHSR Annual Meeting Abstract Book* 11:136-137, 1994.

Jacques, C., Jones, R., Houts, P., Bauer, L., Dwyer, K., Lynch, J., and Casale, T. "Reported Practice Behaviors for Medical Care of Patients with Diabetes Mellitus by Primary-care Physicians in Pennsylvania." *Diabetes Care* 14:712-717, 1991.

Javitt, J. "The RAND Manpower Study: Retire, Refract or Re-educate?" [Editorial] *Archives of Ophthalmology* 114:476-477, 1996.

Javitt, J., Aiello, L., Bassi, L., Chiang, Y., and Canner, J. "Detecting and Treating Retinopathy in Patients with Type I Diabetes Mellitus." *Ophthalmology* 98:1565-1574, 1991.

Javitt, J., Aiello, L., Chiang, Y., Ferris III, F., Canner, J., and Greenfield, S. "Preventive Eye Care in People with Diabetes Is Cost-saving to the Federal Government. Implications for Health-care Reform." *Diabetes Care* 17:909-917, 1994.

Johnston, E. "Optometry's 'Manpower' Data Shortage." *Journal of the American Optometry Association* 61:518-519, 1990.

Jollis, J., Ancukiewicz, M., DeLong, E., Pryor, D., Muhlbaier, L., and Mark, D. "Discordance of Databases Designed for Claims Payment Versus Clinical Information Systems." *Annals of Internal Medicine* 119:844-850, 1993.

Kenny, S., Smith, P., Goldschmid, M., Newman, J., and Herman, W. "Survey of Physician Practice Behaviors Related to Diabetes Mellitus in the U.S.: Physician Adherence to Consensus Recommendations."*Diabetes Care* 16:1507-1510, 1993.

Kentucky Diabetic Retinopathy Group, The. "Guidelines for Eye Care in Patients with Diabetes Mellitus: Results of a Symposium." *Archives of Internal Medicine* 149:769-770, 1989.

Kephart, K., Kaemmerer, C., and Brown, S. "Family Medicine in Minnesota: Office Costs and Productivity." *Family Practice Research Journal* 13:323-330, 1993.

Kerr, C. "Improving Outcomes in Diabetes: a Review of the Outpatient Care of NIDDM Patients." *Journal of Family Practice* 40:63-75, 1995

Kindig, D. and Ricketts, T. "Determining Adequacy of Physicians and Nurses for Rural Populations: Background and Strategy." *Journal of Rural Health* 7:313-326, 1991.

Kurland, L., and Molgaard, C. "The Patient Record in Epidemiology." *Scientific American* 245:54-63, 1981.

LaPlante L. "Detecting Microalbuminuria in Your Office." *Can J Diagn* Feb:127-134, 1992.

Lasker, R. "The Diabetes Control and Complications Trial: Implications for Policy and Practice." *New England Journal of Medicine* 328:1676-1685, 1993.

Lauderdale, D., Furner, S., Miles, T., and Goldberg J. "Epidemiologic Uses of Medicare Data." *American Journal of Epidemiology* 15:319-327, 1993.

Lawler, F. and Viviani, N. "Patient And Physician Perspectives Regarding Treatment of Diabetes: Compliance With Practice Guidelines." *Journal of Family Practice* 44:369-373, 1997.

Lee, P., Whitcup, S., Hays, R., Spritzer, K., and Javitt, J. "The Relationship Between Visual Acuity and Functioning and Well-being among Diabetics." *Qualitative Health Research* 4:319-323, 1995.

Mainous III, A., Ramsbottom-Lucier, M., and Rich, E. "The Role of Clinical Workload and Satisfaction with Workload in Rural Primary Care Physician Retention." *Archives of Family Medicine* 3:787-792, 1994.

Makuc, D., Haglund, B., Ingram, D., Kleinman, J., and Feldman, J. "The Use of Health Service Areas for Measuring Provider Availability." *Journal of Rural Health* 7:347-356, 1991.

Mazze, R., Strock, E., and Etzwiler, D. *Staged Diabetes Management™ Reference Manual*. Minneapolis: International Diabetes Center, Institute for Research and Education Health Systems Minnesota. 1995.

Melton III, L. "History of the Rochester Epdemiology Project." *Mayo Clinic Proceedings.* 71:266-274, 1996.

Miller, N., Holahan, J., and Welch, W. "Geographic Variation in Physician Service Utilization." *Medical Care Research and Review* 52:252-278, 1995.

Minnesota Department of Health, Health Economics Program. *Minnesota Health Care Market Report, 1995.* St. Paul, MN: Minnesota Department of Health, 1995.

Morrissey, J. "Feedback Prompts HEDIS Revisions." *Modern Healthcare*, October 21, 1996.

Neil, A., Hawkins, M., Potok, M., Thorogood, M., Choen, D., and Mann, J. "A Prospective Population-based Study of Microalbuminuria as a Predictor of Mortality in NIDDM." *Diabetes Care* 16:996-1003, 1993.

Nuttall, N. "Capability of a National Epidemiological Survey to Predict General Dental Service Treatment." *Community Dentistry and Oral Epidemiology* 11:296-301, 1983.

Osterweis, M., McLaughlin, C., Manasse Jr., H., and Hopper, C. (eds). *The U.S. Health Work Force: Power, Politics and Policy*. Washington DC: Association of Academic Health Centers, 1996.

Pathman, D. "Estimating Rural Health Professional Requirements: an Assessment of Current Methodologies." *Journal of Rural Health* 7:327-346, 1991.

Petitti, D. and Grumbach, K. "Variation in Physician's Recommendation about Revisit Interval for Three Common Conditions." *Journal of Family Practice* 37:235-240, 1993.

Politzer, R., Gamliel, S., Cultice, J., Bazell, C., Rivo, M., and Mullan, F. "Matching Physician Supply and Requirements: Testing Policy Recommendations." *Inquiry* 33:181-194, 1996.

Position Statement. "Screening for Diabetes." *Diabetes Care* 16S:7-9, 1993.

Position Statement. "Standards of Medical Care for Patients with Diabetes Mellitus." *Diabetes Care* 16S:10-13, 1993.

Position Statement, American Diabetes Association. "Foot Care in Patients with Diabetes Mellitus." *Diabetes Care* 16S:19-20, 1993.

Position Statement, American Diabetes Association. "Standards of Medical Care for Patients with Diabetes." *Diabetes Care* 17:616-623, 1994.

Position Statement, American Diabetes Association. "Foot Care in Patients with Diabetes Mellitus." *Diabetes Care* 18S1:26-27, 1995.

Position Statement, Health and Public Policy Committee, American College of Physicians. "Selected Methods for the Management of Diabetes Mellitus." *Annals of Internal Medicine* 99:272-274, 1983.

Position Statement, Health and Public Policy Committee, American College of Physicians. "Glycosated Hemoglobin Assays in the Management and Diagnosis of Diabetes Mellitus." *Annals of Internal Medicine* 101:710-713, 1984.

Pringle, M., Stewart-Evans, C., Couipland, C., Williams, I., Allison, S., and Sterland, J. "Influences on Control in Diabetes Mellitus: Patient, Doctor, Practice or Delivery of Care?" *British Medical Journal* 306:630-634, 1993.

Reiber, G. "Diabetic Foot Care: Financial Implications and Practice Guidelines." *Diabetes Care* 15S:29-31, 1992.

Reuben, D., Bradley, T., Zwanziger, J., and Beck, J. "Projecting the Need for Physicians to Care for Older Persons: Effects of Changes in Demography, Utilization Patterns, and Physician Productivity." *Journal of the American Geriatric Society* 41:1033-1038, 1993.

Schroth, W., Tenner, S., Rapport, B., and Maim, R. "Multiple Sclerosis as a Cause of Atrial Fibrillation and Electrocardiogram Changes." *Archives of Neurology* 49:422-424, 1992.

Siebert, C., Lipsett, L., Greenblatt, J., and Silverman, R. "Survey of Physician Practice Behaviors Related to Diabetes Mellitus in the U.S. Part I. Design and Methods." *Diabetes Care* 42:759-764, 1993.

Singer, D., Nathan, D., Fogel, H., and Schachat, A. "Screening for Diabetic Retinopathy." *Annals of Internal Medicine* 116:660-671, 1992.

Singer, D., Samet, J., Coley, C., and Nathan, D. "Screening for Diabetes Mellitus." *Annals of Internal Medicine* 109:639-649, 1988.

United States Congress, Office of Technology Assessment. *Health Care in Rural America.* OTA-H-434, Washington, DC: US Government Printing Office, September 1990.
United States Congressional Record, 1989.

United States Department of Health and Human Services, Health Resources Administration, Office of Graduate Medical Education. *Report of the Graduate Medical Education National Committee (GMENAC) to the Secretary of the Department of Health and Human Services, Vol. I: Summary Report*. DHHS Pub. No. (HRA) 81-651, Washington, DC: US Government Printing Office, April, 1981.

Wedig, G., Mitchell, J., and Cromwell, J. "Can Price Controls Induce Optimal Physician Behavior?" *Journal of Health Politics Policy and Law* 14:601-625, 1989.

Weiner, J. "Forecasting the Effects of Health Reform on Us Physician Work Force Requirement: Evidence from HMO Staffing Patterns." *Journal of the American Medical Association* 272:222-230, 1994.

Weiner, J. "HMOs and Managed Care: Implications for Rural Physician Manpower Planning." *Journal of Rural Health* 7:373-376, 1991.

Weiner, J., Garnick, D., Fowles, J., Lawthers, A., and Palmer, R. "Variation in Office-based Quality: a Claims-based Profile of Care Provided to Medicare Patients with Diabetes." *Journal of the American Medical Association* 273:1503-1508, 1995.

Whittle, J., Steinberg, E., Anderson, G., and Herbert, R. "Accuracy of Medicare Claims Data for Estimation of Cancer Incidence and Resection Rates among Elderly Americans." *Medical Care* 29:1226-1236, 1991.

Worrall, G. "Results of the DCCT Trail: Implications for Managing Our Patients with Diabetes." *Canadian Family Physician* 40:1955-1965, 1994.

Worrall, G. "Screening Healthy People for Diabetes: Is it Worthwhile?" *Journal of Family Practice* 33:155-160, 1991.

Worrall, G., Freake, D., Kelland, J., Pickle, A., and Keenan, T. "Care of Patients with Type Ii Diabetes: a Study of Family Physicians; Compliance with Clinical Practice Guidelines." *Journal of Family Practice* 44:374-381, 1997.

APPENDIX A

Table 11

Prevalent Cases Surviving 6 Months or More in 1994: Patients with NIDDM Not Having Any of the Listed Services

Region n=20,806	Complete H&P	Dm Related Visits (Not H&P)	Dilated Eye Exams	Specialty Visits	Diabetic Education Visits
1 n=2,303	1,384 (60.1%)	312 (13.5%)	1,398 (60.7%)	2,010 (87.3%)	2.303 (100%)
2 n=1,794	893 (49.8%)	264 (16.4%)	1,199 (66.8%)	1,573 (87.7%)	1,794 (100%)
3 n=4,484	2,563 (57.2%)	457 (10.2%)	2,811 (58.1%)	3,976 (88.4%)	4,481 (100%)
5 n=7,964	4,581 (57.5%)	917 (11.5%)	4,693 (62.3%)	6,984 (87.7%)	7,960 (100%)
6 n=4,261	2,278 (53.5%)	543 (12.7%)	2,727 (64.0%)	3.630 (85.2%)	4,255 (99.9%)

Prevalent Cases Surviving Less Than 6 Months in 1994: Persons Not Having Any Claims for Listed Service in 1994

Region n=997	Complete H&P	Dm Related Visits (Not H&P)	Dilated Eye Exams	Specialty Visits	Diabetic Education Visits
1 n=126	106 (84.1%)	65 (51.6%)	116 (92.1%)	117 (92.9%)	126 (100%)
2 n= 89	74 (83.1%)	46 (51.7%)	83 (93.3%)	86 (96.6%)	89 (100%)
3 n=198	154 (77.8%)	99 (50.0%)	188 (94.9%)	189 (95.0%)	198 (100%)
5 n=349	302 (86.5%)	177 (50.7%)	333 (95.4%)	337 (96.6%)	349 (100%)
6 n=235	202 (86.0%)	122 (51.9%)	226 (96.2%)	226 (96.2%)	235 (100%)

Table 12

Laboratory Texas

Prevalent Cases 1994: Patients with NIDDM Not Having Any of the Listed Services

Region n=20,806	Blood Glucose	HgbA1c	Serum Cholesterol	HDL	Triglycerides	Serum Creatinine	Urine Protein, Includes Micro-albuminuria
1 n=2,303	1,457 (63.3%)	1,377 (59.8%)	1,927 (83.7%)	2,114 (91.8%)	2,079 (90.3%)	2,228 (96.7%)	2,295 (99.7%)
2 n=1,794	1,232 (68.7%)	1,124 (62.7%)	1,578 (88.0%)	1,516 (84.5%)	1,662 (92.6%	1,728 (96.3%	1,785 (99.5%)
3 n=4,484	2,731 (60.9%)	940 (21.0%)	3,750 (83.6%)	4,165 (92.9%)	4,294 (95.8%)	4,323 (96.4%)	4,462 (99.5%)
5 n=7,964	4,518 (56.7%)	1,616 (20.3%)	6,868 (86.2%)	6,650 (95.3%)	7,440 (93.4%)	7,638 (95.9%)	7,887 (99.0%)
6 n=4,261	2,653 (62.3%)	1,010 (23.7%)	3,404 (79.9%)	3,603 (84.6%)	3,861 (90.6%)	4,023 (94.4%)	4,070 (98.7%)

Prevalent Cases Who Lived Less Than 6 Months in 1994: Persons Not Having Any of the Listed Services

Region	Blood Glucose	HgbA1c	Serum Cholesterol	HDL	Triglycerides	Serum Creatinine	Urine Protein, Includes Micro-albuminuria
1 n=126	113 (89.7%)	121 (96.0%)	126 (100%)	125 (100%)	119 (94.4%)	122 (96.8%)	126 (100%)
2 n= 89	77 (86.5%)	75 (87.2%)	86 (96.6%)	86 (96.6%)	87 (87.8%)	85 (95.5%)	89 (100%)
3 n=198	169 (85.4%)	178 (89.9%)	193 (97.5%)	195 (98.5%)	193 (97.5%)	190 (95.9%)	198 (100%)
5 n=349	298 (85.4%)	317 (90.8%)	345 (98.9%)	339 (97.1%)	337 (96.6%)	336 (96.3%)	349 (100%)
6 n=235	205 (87.2%)	214 (91.1%)	230 (98.8%)	228 (97.0%)	231 (98.3%)	225 (95.7%)	235 (100%)

Table 13

Tables for Services and Laboratory Tests Recommended More Than Once Each Year for Care of Persons with NIDDM (1994)

Prevalent Cases 1994 Who Lived More Than 6 Months: Number of Diabetes-Related Visits in 1994

Region n=20,806	No Dm Related Visits	Only 1 Dm Related Visit	Only 2 Dm Related Visits	Only 3 Dm Related Visits	4 or More Dm Related Visits
1 n=2,303	312	242	229	202	1,318
2 n=1,794	264	215	222	196	897
3 n=4,484	457	476	474	4,534	2,624
5 n=7,964	917	813	941	862	4,431
6 n=4,261	543	531	481	506	2,200

Number of Persons with Zero to Four or More Serum Glucose Measurements in 1994

Region n=20,806	No Serum Glucose Tests	Only 1 Serum Glucose Test	Only 2 Serum Glucose Tests	Only 3 Serum Glucose Tests	4 or More Serum Glucose Tests
1 n=2,303	1,457	366	163	96	221
2 n=1,794	1,232	269	103	65	125
3 n=4,484	2,731	766	343	233	411
5 n=7,964	4,815	1,311	661	434	743
6 n=4,261	2,653	764	316	215	313

Number of Persons with zero for Four or More HgbA1c measurements in 1994.

Region n=20,806	No HgbA1c	Only 1 HgbA1c	Only 2 HgbA1c	Only 3 HgbA1c	4 or More HgbA1c
1 n=2,303	1,377	481	261	120	641
2 n=1,794	1,124	372	177	87	345
3 n=4,484	2,643	940	500	229	172
5 n=7,964	4,975	1,616	792	375	206
6 n=4.261	2,260	1,010	563	273	155

Table 14

Complications: Number of Persons with Complications Listed

Prevalent Cases in 1994 Who Lived 6 Months or More

Region	Eye	Renal	Neurological	Cardiovascular	Amputations
1 n=2,303	2,055	28	37	1,605	29
2 n=1,794	1,625	20	46	1,219	17
3 n=4,484	4,097	52	132	3,232	46
5 n=7,964	7,094	71	168	5,628	47
6 n=4,261	3,853	66	110	3,136	29

Prevalent Cases in 1994 Who Lived Less Than 6 Months

Region	Eye	Renal	Neurological	Cardiovascular	Amputations
1 n=126	95	1	6	86	2
2 n= 89	70	3	1	59	0
3 n=198	157	6	10	136	6
5 n=349	246	10	11	213	3
6 n=235	187	13	9	160	5

APPENDIX B

Codes for Identification of NIDDM Cohort

Codes for NIDDM Complications

List of Diagnostic Codes for NIDDM:
(Assume All Persons with Dm are NIDDM Unless Specifically Coded Otherwise)

1994 Codes

Diabetes	250.0 – 250.9
Gangrene	785.4
Angiopathy	443.81
Autonomic neuropath	337.1
Cataracts	366.41
Dorsal sclerosis	340
Glaucoma	365.44
Glycogenics	259.8
Intercapillor Glomerulosclerosis	581.81
K-W	581.81
Lancereaux's	261
Latent D.M.	790.2
Lipodosis	272.7
Microaneursym – retinal	335.9
Nephropathy	581.81
Neuralgia	357.2
Nonclinical diabetes mellitus	790.2
Polyneuropathy	357.2
Retinal hemorrhage	362.83
Retinal edema	362.01
Retinitis	362.01
Retinopathy	362.01
Retinopathy – proliferative	362.02
Skin ulcer	707.9, 707.1, 707.8
Xanthoma	272.2

1994 Codes

Blood sugars	
Blood sugars	(82947-82950, 82962)
GTT	(82951, 82953, 82961)
Hemoglobin A1C	(83036)
Urine dipstick for protein	(81005, 81000, 81002, 81003)
Urine albumin or protein	
24 hour microalbuminuria	(82043, 82044)
Urine culture	(87086, 87086-87088)
Lipids	
Cholesterol	(82465)
HDL	(83718)
Triglycerides	(84478)
Lipids panel	(80061)
Serum creatinine	(83552, 82550)
BUN	(84520, 84525, 84545)
Creatinine clearance	(82575)
TSH	(84443, 84800)
ECG (EKG)	