# The War Against Diabetes

## How will we know if we are winning?

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Diabetes affects nearly 16 million Americans and often causes severe complications and premature death. The economic cost of diabetes alone approaches $100 billion annually. We discuss the national war against diabetes and review and analyze systems for measuring progress in this war. A framework for making use of these systems is proposed along with an answer to the question: How will we know if we are winning?

The number of people in the U.S. with diagnosed diabetes has risen dramatically and is now estimated to be six times what it was in the late 1950s. The total prevalence of diabetes (diagnosed and undiagnosed) is estimated to be about 15.7 million people, or 5.9% of the U.S. population (1,2). Complications such as blindness, limb amputation, cardiovascular disease, and premature death weigh heavily on individuals and their families (2). In addition, the annual economic cost for the nation is approaching $100 billion (3,4). Because the costs, both human and economic, are so great, the nation has intensified its efforts to combat diabetes. The goal in this war is to achieve diabetes prevention and control. Yet, because of the complexity of diabetes, a major question remains to be answered: How we will know if we are winning?

This article briefly describes the history of the war against diabetes in the U.S. and its varied dimensions, and then reviews strengths and weaknesses of currently existing systems for measuring the nation's progress. A series of tables helps simplify and call attention to key concepts. Finally, we propose an answer to the question, "How will we know if we are winning?"

While this article's focus is on the war against diabetes in the U.S., international readers may see parallels to struggles they face in their own countries (5–9). Diabetes knows no national boundaries (10,11).

**HISTORY** — Diabetes has been recognized for thousands of years. In 2nd-century Greece, for example, the disease was viewed as "a melting down of the flesh and limbs into the urine," possibly as a result of bladder and kidney damage (12). In the latter part of the 19th century, scientists, particularly in Europe, were beginning to concentrate on the pancreas as the "defective" organ (13). With the discovery of insulin in 1921, diabetes entered a new era (13). People with diabetes did not die, and many initially thought that diabetes had been cured (13,14).

It soon became clear, however, that insulin sustained life without curing the underlying disease. As people with diabetes lived longer, new manifestations of the disease became apparent. In essence, diabetes had been "transmuted" into a disease far different from what it had been before (15).

More was subsequently learned about diabetes, not just from a pathophysiologic perspective. It was learned that there were different types of diabetes; that the condition was increasing in prevalence; that with time, it was associated with a range of devastating complications; and that much more still needed to be learned and done. New diabetes centers were established, voluntary health organizations and professional societies were formed (16), federal and academic-based research was expanded, journals were published (17), additional interventions and medications were made available, and more health professionals specializing in diabetes and metabolism were trained.

The war was being fought on many fronts, but perhaps not in a coordinated and orchestrated fashion until the mid-1970s, when a broad, sustained national effort was launched to review what was happening and what was needed in this continuing battle (18). The efforts of the National Commission on Diabetes for the first time systematically and thoroughly reviewed the various extant strategies to defeat diabetes and what additional activities or coordination among the units would be necessary. The resultant National Diabetes Act provided not only resources for needed research, but also additional federal responsibilities in diabetes at the National Institutes of Health (NIH), the Centers for Disease Control (now the Centers for Disease Control and Prevention) (CDC), the Indian Health Service, and other agencies (19). Mechanisms were established to facilitate coordination of these federal efforts with the efforts of various components of the diabetes community (20).

In subsequent years, additional information about the scope and magnitude of the emerging burden of diabetes became available (21,22), as well as new ways to think about diabetes (23,24). The importance of diabetes education (25–27) and of psychosocial aspects of diabetes management gained greater recognition (28,29).

By the mid-1990s, diabetes was seen as a major international health problem (30) and a common, serious, and costly clinical and public health disorder (31). Scientific evidence proved the benefits of secondary and tertiary prevention strategies to reduce the burden of diabetes (32,33), as well as the

fact that what could work in clinical practice was not being routinely utilized (34).

Modern diabetes control, at the personal level, involves balancing such factors as diet, exercise, medication (often oral medication and/or self-injected insulin), and frequent blood glucose self-monitoring. Thus, daily self-management by the person with diabetes is now the cornerstone of treatment (35). In carrying out such self-management, the person with diabetes collaborates with partners at the family level, the treatment team level, the community level, and beyond. New community-, state-, and health system–based intervention strategies are evolving, as are national health communication efforts (36–38). Contact information for some of the major organizations involved in state and national diabetes prevention and control is listed in the APPENDIX.

Although good diabetes treatment can prevent or delay severe long-term complications or premature death, the battle to control diabetes is now going completely unfought in about a third of all people with diabetes because they have never been diagnosed (1,2). In addition, most of those who are diagnosed still may not receive adequate care (39–41).

All major racial and ethnic groups in the U.S. have a high prevalence of diabetes, but some are disproportionately affected. Black Americans and Latino Americans may be almost twice as likely to have diabetes as non-Hispanic white Americans of similar age (1,2). American Indians, commonly believed in past centuries to have been a low-prevalence group, now have the highest prevalence of diabetes of any racial or ethnic group in North America, with prevalence ranging from ~5 to 50% for individual tribes (42). Some Asian Americans and some Pacific Islanders, including native Hawaiians, have also been observed to be at increased risk for diabetes (2). For all racial and ethnic groups in America, diabetes is most common among the elderly. It is estimated that 18.4% of U.S. adults >65 years old have diabetes (1,2).

In the U.S., as throughout the world, the history of the war on diabetes has evolved rapidly within this century. Thus far, efforts have focused on blood sugar control and treatment or prevention of complications. In recent years, however, prospects for primary prevention of diabetes have also gained greater attention (43,44).

## TRACKING THE WAR'S PROGRESS — The most basic tracking of the war against diabetes is the self-monitoring of blood glucose levels and other factors that is performed throughout each day by people with diabetes (Table 1). The health care team also monitors such factors over time as part of its collaboration in the treatment process. In addition, family members may, in appropriate situations, contribute a valuable form of adjunctive surveillance by keeping track of meal schedules, meal planning, and family physical activity schedules and by being observant for signs of metabolic imbalance in the person with diabetes. Environment and quality of life are also important factors to be monitored and discussed by the person with diabetes, the family, and the treatment team, both for their intrinsic value and because they may affect the success of diabetes treatment.

At the community level and at the health system level, surveillance and evaluation by clinics, hospitals, and managed care organizations can elucidate morbidity and mortality trends and help to pinpoint areas in which good diabetes care is present and those in which improvement is needed. Surveillance and evaluation at these levels can also provide clues regarding biopsychosocial risk factors within the community and help guide prevention and control strategies.

Current national and state surveillance relies on diabetes-related questions within general-purpose public health surveys, such as the National Health Interview Survey (NHIS), the Behavioral Risk Factor Surveillance System (BRFSS), and the National Health and Nutrition Examination Survey (NHANES), as well as data from death certificates, hospital discharge summaries, and disease registries. Census Bureau population estimates and data from individual research projects are also used.

Government officials use information from multiple levels to derive national and statewide estimates regarding the incidence and prevalence of diabetes and its complications. The greatest strength of such estimates lies in their use of standardized scientific methodology to provide information that helps guide diabetes control, planning, and education. Their greatest weakness is that they are only rough estimates. Because diabetes and many of its complications often go undiagnosed until more severe damage has been done, and because, even when diagnosed, diabetes is not a reportable disease, public health officials face many challenges in estimating how many people in the U.S. have diabetes.

National and state surveillance systems (Table 2) use questions and sampling techniques that have been honed over several

**Table 1—*Systems for tracking progress at each level of the war against diabetes***

| Level | Key systems used to track progress |
|---|---|
| Individual | Self-monitoring of feelings, general condition, symptoms, environment, meal planning, exercise, medications, and blood glucose levels |
| Family | Attention to aspects of the above variables, daily family interactions, and to opportunities for diabetes prevention among family members |
| Treatment team | Attention to biological, psychological, and social aspects of health including, but not limited to, blood glucose control, overall quality of life, and prevention of diabetes and its clinical complications |
| Community | Attention to relevant psychosocial/environmental factors, access to care issues, and the burden of diabetes |
| Health system | Clinic, hospital, and managed care organization surveillance of morbidity, mortality, cost, and quality of care |
| State | BRFSS, Medicaid expenditures, and quality indicators |
| National | NHANES, NHIS, Medicare expenditures, and quality indicators |

Information from these systems and from laboratory-, clinical-, and population-based research guide development of new tools and strategies for use at each level of the war on diabetes.

**Table 2—*Comparison of CDC's general health-related surveillance systems for adults***

|  | NHIS | BRFSS | NHANES |
|---|---|---|---|
| Cooperating field agency | Census Bureau | State health departments | Contractors and communities |
| Survey frequency | Annual | Annual | Periodic |
| Survey venue | Home | Home | Mobile evaluation center |
| Survey method | Face-to-face interview (sometimes telephone is used) | Telephone interview | Face-to-face interview and physical and laboratory measurements |
| Confidentiality | Yes | Yes | Yes |
| Age range | All ages | >18 years | >2 months |
| Approximate sample size | >60,000 | 2,000 per state* | 40,000 |

*In all states, the BRFSS contains a diabetes section asking respondents if they have been diagnosed with diabetes. In 43 states, those answering "yes" are given an additional diabetes module of questions to answer. This special diabetes module is, on average, administered to ~94 people per state.

years. Each includes some questions specifically related to diabetes and many others relevant to diabetes and its risk factors and complications. Arrangements can sometimes be made to obtain survey questions and results directly from the federal government (Table 3). Diabetes Control Programs located in each state health department often serve as a repository for state-specific public health data that includes and sometimes extends beyond that obtained from BRFSS.

**Table 3—*Current locations of CDC's General Purpose Health Survey data***

| Type of information | Source |
|---|---|
| NHIS data | Data Dissemination Branch<br>National Center for Health Statistics<br>Centers for Disease Control and Prevention<br>6525 Belcrest Road, Room 1064<br>Hyattsville, MD 20782<br>(301) 436–8500<br>http://www.cdc.gov/nchswww<br>nchsquery@nch10a.em.cdc.gov |
| BRFSS data | BRFSS/Division of Adult and Community Health<br>National Center for Chronic Disease Prevention and Health Promotion<br>Centers for Disease Control and Prevention<br>4770 Buford Highway, NE<br>Atlanta, GA 30341<br>http://www.cdc.gov |
| NHANES III data | Data Dissemination Branch<br>National Center for Health Statistics<br>Centers for Disease Control and Prevention<br>6525 Belcrest Road, Room 1064<br>Hyattsville, MD 20782<br>(301) 436–8500<br>http://www.cdc.gov/nchswww<br>nchsquery@nch10a.em.cdc.gov |
| State-specific surveillance data, including BRFSS | State Diabetes Control Program (located within each state's health department) or CDC Diabetes Home Page, http://www.cdc.gov/diabetes |

**NHANES** — NHANES is particularly relevant to diabetes, as it includes blood analysis, history, physical examination, and added emphasis on nutrition. Because each version of NHANES is conducted over a period of several years, however, new results are not available annually. The most recent available NHANES data are from NHANES III, which was conducted between 1988 and 1994. The data from this survey were compiled and released in 1997.

In addition to its diabetes-specific content (Table 4), NHANES III included measurement of factors related to diabetes and its complications, such as blood pressure, height, weight, body fat, electrocardiogram reading, cholesterol, renal function, and oral health. Additional NHANES III questions relevant to diabetes and its complications covered such topics as physical activity, nutrition, weight, demographic data, social supports, functional status, health, renal disease, reproductive health, oral health, mental health, and alcohol and tobacco use.

Because it is the only major national surveillance system that asks participants whether they have a history of diabetes and performs actual blood analysis, NHANES is used to help generate national prevalence estimates for diabetes in years when new results are available. Otherwise, NHIS has typically been used to generate such estimates. Unlike NHANES, NHIS does not include blood analysis and thus, by itself, can only provide national estimates of how many people are aware of having been diagnosed with diabetes (Table 5).

**Table 4—*Summary of diabetes-specific content in NHANES III, 1988–1994***

Laboratory tests (e.g., fasting plasma glucose, HbA$_{1c}$, insulin, C-peptide)
Oral glucose tolerance test
Diagnosis of diabetes outside of pregnancy ("Have you ever been told by a doctor that you have diabetes or sugar diabetes?")
Age at diagnosis
Insulin: frequency of doses, dosage, number of months or years of use
Oral hypoglycemic agents: are they used?
Self-monitoring: blood glucose and urine glucose
Visual health: eye examinations and retinopathy
Family history of diabetes

**Table 5—*Current approaches to estimating diabetes prevalence***

| Method | Most important weaknesses |
|---|---|
| Drawing blood and measuring fasting plasma glucose levels | More costly and intrusive than an interview |
| Asking whether respondent was ever diagnosed with diabetes | Relies on individual recall rather than objective blood test; does not detect people who have diabetes but have not yet been diagnosed |
| Analyzing clinic or health care system data | Only includes people who have been enrolled in the clinic or health care system |
| Analyzing death certificate data | Diabetes is often underreported on death certificates |

**ANNUAL SURVEYS: NHIS AND BRFSS** — Because NHIS is designed as a national probability sample of the U.S. population, it is usually used to make national estimates. It is not designed to generate data generalizable to individual states, although statistical methodology can be applied to NHIS data to derive state, regional, or local area estimates (45–47). BRFSS, in contrast, is designed to provide samples representative of individual states, rather than the nation as a whole. BRFSS, like NHIS, does not include actual blood analysis, so by itself, it can be used to estimate the prevalence of diagnosed diabetes within a state, but not the prevalence of undiagnosed diabetes.

There are four core questions specifically pertaining to diabetes in the NHIS and one in the BRFSS (Table 6). In addition, in 43 states, a supplementary diabetes module is added to the BRFSS for people who report a history of diabetes outside of pregnancy. In addition to diabetes-specific questions, each survey contains many other diabetes-relevant questions. Extensive additional (supplemental) questions pertaining to diabetes are periodically asked in the NHIS when resources are available, as most recently occurred in 1989.

Other diabetes-relevant questions in the NHIS address demographic information, such as age, sex, and place of birth, and information about potential complications of diabetes, such as hypertension, myocardial infarction, heart disease, stroke, visual impairment, renal health, and oral health. Pregnancy is also addressed, as are diabetes-relevant preventive practices, such as flu and pneumonia vaccination and physical activity. Additional questions that may be relevant ask about mood, employment, absenteeism, state of health, activity limitations and their causes, other health behaviors, tobacco and alcohol use, height, weight, health care access and utilization, dental care, contacts with health care providers, and work status.

In addition to its one diabetes-specific question (Table 6), BRFSS also includes questions on the following core topics that may be relevant to diabetes: health status, health care coverage, routine checkup, smoking, pregnancy, women's health, demographics, cholesterol, hypertension, injury, alcohol use, flu and pneumonia vaccination, physical activity, consumption of fruits and vegetables, and weight control. Optional modules that may be relevant to diabetes include those on sexual behavior, health care coverage, health care utilization, oral health, preventive counseling services, cardiovascular disease, arthritis, quality of life, consumption of fruits and vegetables, exercise, weight control, and social context.

For summary purposes, a comparison of some of the key limitations of BRFSS, NHIS, and NHANES is presented in Table 7. These three systems clearly are not the only ones used for tracking progress in the war against diabetes, nor are they always the best systems to use to answer a given question. As the war evolves, the three systems will continue to change, as will the depth and diversity of alternative sources of information.

**OTHER DATA SOURCES** — In addition to the above three surveillance systems and the state diabetes control programs, individual registries and research studies play a role in monitoring progress in the war against diabetes. For example, end-stage renal failure and dialysis are monitored through the U.S. Renal Data System (48), and quality of care indicators are monitored at the health systems level through the Health Plan Employer Data and Information Set (HEDIS) (49). Vital statistics records, including diabetes morbidity and mortality data, are compiled annually by CDC's National Center for Health Statistics, accessible through CDC's internet home page (see APPENDIX). Medicare and Medicaid data are also used to monitor the diabetes epidemic.

**SITUATIONS WHERE DATA APPEAR TO CONFLICT** —Research indicates that previously diagnosed diabetes tends to be underreported on death certificates for a variety of reasons (50). Still, diabetes remains ranked as the 7th leading cause of death in the U.S., behind diseases of the heart, malignant neoplasms, cerebrovascular diseases, chronic obstructive pulmonary diseases, accidents and adverse effects, and pneumonia and influenza (51).

Sometimes, diabetes has been referred to as the 6th leading cause of death by dis-

**Table 6—*Comparison of diabetes-specific core questions in NHIS and the state-based BRFSS U.S., 1997***

| NHIS | BRFSS* |
|---|---|
| (Other than during pregnancy) Have you EVER been told by a doctor or health professional that you have diabetes or sugar diabetes? | Have you ever been told by a doctor that you have diabetes? (Was this only when you were pregnant?) |
| How old were you when a doctor FIRST told you that you had diabetes or sugar diabetes? | |
| Are you NOW taking insulin? | |
| Are you NOW taking diabetic pills to lower your blood sugar? These are sometimes called oral agents or oral hypoglycemic agents. | |

*In 43 states, people reporting a history of diabetes are also given a special 12-question diabetes module that inquires about age at diagnosis, insulin use, glucose self-monitoring, vision, exposure to the term glycosylated hemoglobin, frequency of diabetes health care visits, and frequency of foot exams, eye exams, and glycosylated hemoglobin exams.

**Table 7—*Comparison of limitations of three primary sources of diabetes data***

| Data source | Most important limitations |
| --- | --- |
| NHIS (national data) | Excludes homeless, institutionalized people, and military personnel; does not provide information about undiagnosed diabetes |
| BRFSS (state-specific data) | Excludes homeless, institutionalized people, people without phones, and military personnel; does not provide information about undiagnosed diabetes; sample size for the diabetes module in each state is small, generally <100 |
| NHANES (national data) | Excludes homeless, institutionalized people, and military personnel; new results are only available every several years, rather than annually |

ease (excluding accidents and adverse effects, because such events are not diseases). Others have referred to diabetes as the 4th leading cause of death by disease, combining diseases of the heart and diseases of the cerebrovascular system into one category as the leading cause of death, considering malignant neoplasms as the 2nd leading cause of death, and combining chronic obstructive pulmonary disease, pneumonia, and influenza into one category, lung diseases, as the 3rd leading cause of death.

When analyzing mortality data, as in the case of any other form of surveillance data, it is important to look beyond the actual numbers. For example, a sudden "outbreak" of diabetes-related mortality was recently reported (52). On further investigation, it was determined that just before the outbreak, all but one of the states in which it occurred had just added a 4th line under contributing conditions on their death certificates—giving doctors an extra line in which to list diabetes as a cause of death, where previously they had not. The one state that had not added such a line to its death certificate had, just before the outbreak, changed the instructions for its death certificates so as to include diabetes as a cause of death in the example given of how to fill out a death certificate. In all of the above cases, reports of increasing mortality were attributed to new forms or instructions that promoted identification of diabetes as a cause of death.

Worsening morbidity may not always mean exactly what it seems to mean either. For example, after more generous government funding increased the availability of renal dialysis and renal transplants, the number of people with diabetes who experienced end-stage renal failure—defined by the use of dialysis or renal transplant—

increased dramatically (53,54). By itself, the increase in end-stage renal failure would not necessarily tell us that renal problems were becoming more common among people with diabetes. More information would be needed to know how much of the increase was due to factors related to the effects of diabetes on the kidneys and how much was due to the fact that dialysis and renal transplant were now being made available to people who would otherwise have suffered or died without ever receiving those procedures.

Finally, even increasing prevalence of diagnosed diabetes may not always be completely attributable to a worsening of the diabetes epidemic. For example, in 1997's national estimates, the dramatic increase in diagnosed diabetes was partially a result of changes in the clinical definition of diabetes and changes in the method used for calculating the estimates (2,55). In addition, it is possible that enhanced detection through improved education may have played some role. Likewise, a drop in diabetes prevalence, were it to occur, could mean either that the growth of the epidemic was slowing or that more cases were going unreported.

## EVOLUTION OF MEASURES OF SUCCESS — Sometimes, the variables that need to be monitored change with advances in science. For example, 50 years ago, tight blood glucose control was not yet seen as an important factor in prevention of long-term complications of type 1 diabetes; now it is. Thus, frequent blood glucose monitoring and the use of the $HbA_{1c}$ test are now counted among the many standards against which quality of diabetes care can be judged at the individual and health system levels (40,56–58). It is likely that as we continue to learn more about the nature

and treatment of diabetes, additional new measures of success and failure will continue to be found.

In some cases, public health officials have developed methods for estimating the impact of illness on such complex issues as quality of life (59–61). Such estimates are based on simple self-reports of health and physical limitation and are sometimes used to track the impact of chronic diseases over time.

Many of the more complex psychosocial results of diabetes are not tracked by today's public health surveillance systems. Examples include actual number of hours per day spent on diabetes-related activities and thoughts; actual impact on ability to effectively carry out leisure, work, or child care responsibilities; and impact on family. Likewise, many complex, but potentially mediating, psychosocial and environmental variables relevant to diabetes are not tracked by today's public health surveillance systems. Examples of such factors include overall educational status pertaining to diabetes, motivation and skills pertaining to diabetes self-management, availability and affordability of healthy food and of the medical supplies necessary for diabetes self-monitoring, and the presence of sidewalks or paths that are safe to walk on. Although not traditionally monitored by clinicians or public health systems, the absence of even one such factor, such as safe venues in which to walk, can inhibit people with diabetes from engaging in necessary physical activity, obtaining healthy food, obtaining medicine, or attending scheduled clinic appointments.

The number and diversity of significant public health events and outcomes that appear to be relevant to diabetes may be so large as to preclude monitoring all of them on a regular basis. Given limited resources (62) and the amount of effort involved in monitoring each variable—not only for diabetes, but for every disease that affects Americans—decisions must be made each year as to which variables will be monitored as part of public health evaluation and tracking systems and which will not.

In the case of HEDIS, a private system for quality assurance, eye exams among those with diabetes are monitored, but other measures of quality of diabetes care are not. Epidemiologists are currently arguing for the addition of foot exams for people with diabetes as another quality measure. It is already known that foot exams are an important part of quality care,

**Table 8—*Multilevel model for consideration of gains and losses in the war on diabetes***

| | Morbidity, mortality, and quality of life | Economic and other costs | Health promoters | Health inhibitors | Other factors |
|---|---|---|---|---|---|
| Individual level | | | | | |
| Family level | | | | | |
| Treatment team level | | | | | |
| Community level | | | | | |
| Health system level | | | | | |
| State level | | | | | |
| National level | | | | | |
| World level | | | | | |

A blank box like this may be used to consider progress at the various levels of the war on diabetes and then the overall picture, including how events at different levels are interacting.

but those advocating the inclusion of foot exams must compete with those advocating other measures to be included instead, as well as with those trying to limit the costs and time that come with adding another variable to the list of factors monitored.

## CONCLUSION: HOW WILL WE KNOW IF WE ARE WINNING? — As we enter the 21st century, monitoring the nation's war against diabetes will require the tracking of many variables at multiple levels: individual, family, treatment team, community, health system, state, and national. Most importantly, information gained at a given level needs to be used to combat diabetes at that level and also shared so that it can be used to combat diabetes at other levels. Even those working to combat diabetes at just one level—the community, for instance—require information regarding the status of diabetes and the battles against diabetes at each of the other levels from the individual to the national level. Such information includes current information and trends over time.

At each level of the war against diabetes, gains and losses are occurring that may be measured in health outcomes (such as morbidity, mortality, and quality of life), economic and other costs, or changes in health-promoting and health-inhibiting factors. A blank box, as shown in Table 8, may be used to begin to consider progress at the various levels and then the overall picture, including how events at different levels are

interacting. In such a box, the last column is reserved for factors that go undetected by current monitoring systems (for instance, unmeasured environmental factors and methodological flaws in the systems themselves). Finally, each level and each column within the box must be viewed both as a whole and as component parts. Component parts must be assessed carefully so that trends in specific generational, ethnic, racial, or geographic groups are not missed.

In essence, diabetes surveillance over the coming years will likely include both larger and smaller subsegments of the population. Outcome variables monitored will range from those that are predominantly biological to those that are predominantly behavioral, social, environmental, or economic. In addition to focusing on measures of adverse outcome, such as morbidity and mortality, diabetes surveillance of the future will likely place more emphasis on positive outcomes, such as quality of life, and intermediate measures, such as presence of proven preventive and self-care measures.

Identification and monitoring of intermediate measures of success, such as $HbA_{1c}$ levels and eye or foot exams, are particularly important in light of the long time it takes for complications of diabetes to develop. If we only measure complications, it will take much longer to know if we're winning and more damage may be done by diabetes while we wait. For situations in which solid efficacy trials have been performed regarding the benefit of complica-

tion prevention, such as retinal exams to prevent blindness, then surveillance systems should emphasize process measures (retinal exams performed) versus outcome indicators (blindness).

A caveat regarding intermediate measures is that their limitations must always be recognized, and their routine monitoring cannot fully replace the monitoring of the longer-term outcomes they are designed to predict. It is always possible that positive results in the short run could fail to be sustained in the long run, even in the presence of scientifically tested indicators that had predicted otherwise.

Given the rapid pace of research in recent decades, optimism should exist regarding the likelihood of controlling, reducing, and preventing the burden of diabetes. It is important to reflect, however, on both the "law of unintended consequences" (63,64) and the concept of "disease transmutation" (15) as they might pertain to the potential evolution of diabetes. The law of unintended consequences tells us that new treatments that initially seem to control diabetes can have unanticipated consequences. Disease transmutation is the process whereby the nature of diabetes may change substantially, and at times unpredictably, with new discoveries or treatments. If diabetes continues to change, the variables monitored to gauge its impact may also need to change.

In summary, a variety of tools can be used to determine whether we are winning the war against diabetes at its various levels and in aggregate. Such tools continue to evolve, as do definitions of what actually constitutes winning. Thus, we suggest that new goals be periodically set by stakeholders at the national, state, local, family, and individual levels and that progress against such goals be continually monitored. As part of this process, further attention to environmental factors with proven health impact is necessary. Such added focus, coupled with advances in biological and behavioral science, may further empower people with diabetes and their allies to win the war against diabetes during the next century.

## APPENDIX — Examples of national and state organizations involved in the war against diabetes are shown in Table A1.

**References**
1. Harris MI, Flegal KM, Cowie CC, Eberhardt MS, Goldstein DE, Little RR, Wied-

**Table A1—***Examples of national and state organizations involved in the war against diabetes*

| Organization | Description | Address, phone number | Internet address |
| --- | --- | --- | --- |
| American Association of Diabetes Educators (AADE) | Professional organization | 444 N. Michigan Ave., Suite 240 Chicago, IL 60611-3901 (312) 644-2233 | http://www.aadenet.org |
| American Diabetes Association (ADA) | Voluntary organization | 1660 Duke St. Alexandria, VA 22314 (703) 549-1500 | http://www.diabetes.org |
| American Dietetic Association (ADA) | Professional organization | 216 W. Jackson Blvd., Suite 800 Chicago, IL 60606 (312) 899-0040 | http://www.eatright.org |
| Centers for Disease Control and Prevention (CDC) | Federal agency | CDC—Mail Stop K 10 4770 Buford Hwy., NE Atlanta, GA 30341 (770) 488-5000 | http://www.cdc.gov/diabetes |
| Department of Veterans Affairs (VA) | Federal agency | (800) 827-1000 | http://www.va.gov/health/diabetes/ |
| Health Care Financing Administration (HCFA) | Federal agency | 7500 Security Blvd. Baltimore, MD 21244 (410) 786-3000 | http://www.hcfa.gov |
| Health Resources and Services Administration (HRSA) | Federal agency | 5600 Fishers Ln., Room 14-45 Rockville, MD 20857 (301) 443-3376 | http://www.hrsa.dhhs.gov |
| Indian Health Service (IHS) | Federal agency | 5300 Homestead Rd., NE Albuquerque, NM 87110 (505) 248-4182 | http://www.ihs.gov |
| Juvenile Diabetes Foundation International (JDF) | Voluntary organization | 120 Wall St., 19th Floor New York, NY 10005 (212) 479-7500 | http://www.jdfcure.org |
| National Diabetes Education Program (NDEP) | Public-private partnership | See CDC and NIH | http://ndep.nih.gov |
| National Institute of Diabetes, Digestive and Kidney Diseases (NIDDK) of the National Institutes of Health (NIH) | Federal agency | 31 Center Dr. Bethesda, MD 20892 (301) 496-3583 | http://www.niddk.nih.gov |
| Office of Minority Health (OMH) of the Department of Health and Human Services | Federal agency | OMH Resource Center PO Box 37337 Washington, DC 20013-7337 (800) 444-6472 | http://www.omhrc.gov |
| State Diabetes Control Programs (DCPs) | State programs | Contact individual state health departments | Listed on CDC diabetes website |

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