The Cost of Diabetes Care—An Elephant in the Room

Matthew C. Riddle[1] *and William H. Herman*[2]

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Everyone dealing with health care today knows there is an elephant in the room, impossible to miss but frequently ignored—the cost of diabetes care. Although clinicians and scientists may wish to neglect the financial side of diabetes care and focus on less contentious and more familiar matters, this option is no longer viable. For people with diabetes and their families, the elephant stands in the way every day, and for those who plan health services and payment, it is a major concern. Fortunately, the scientific methods used in epidemiologic, clinical, and health services research can be applied to the economics of diabetes care. Collecting observations, identifying patterns, forming hypotheses, and prospectively testing the hypotheses can be just as relevant when one of the variables examined is the cost of care. It is the mission of *Diabetes Care* to present the best scientific studies related to diabetes. This issue of *Diabetes Care* has a special section focused on the economic impact of diabetes, including studies designed to understand it and to assess potential solutions.

The American Diabetes Association (ADA) has previously reported the costs of diabetes in the U.S. for the years 2002 (1), 2007 (2), and 2012 (3). This issue of *Diabetes Care* includes a 2017 update (4). Because the methods used in these analyses are similar, comparisons are possible. The most noteworthy findings from the current report are the continuing increase and the remarkable magnitude of the total direct costs of diabetes in the U.S.: $116 billion in 2007, $176 billion in 2012, and $237 billion in 2017. The cost of care for people with diabetes now accounts for ~1 in 4 health care dollars spent in the U.S. Care for a person with diabetes now costs an average of $16,752 per year. As in prior reports, the 2017 analysis also documents substantial indirect costs related to lost productivity due to diabetes and its complications.

The 2017 analysis also indicates that, after adjusting for inflation, costs have increased since 2012 due to both an 11% increased prevalence of diabetes and a 13% increase of the cost per person with diabetes. The observed increase of prevalence highlights the importance of diabetes prevention as a strategy to control the cost of diabetes. The Diabetes Prevention Program (DPP) and its follow-up showed that metformin is safe, effective, and cost-effective or even cost saving for the prevention of type 2 diabetes (T2D), and intensive lifestyle intervention is cost-effective (5). However, metformin is rarely prescribed by primary care physicians for diabetes prevention (6). Coordinated national initiatives to promote lifestyle intervention for diabetes prevention are under way and, although uptake remains low (7–9), there are signs of progress (10,11).

The increased per capita cost of care for diabetes poses an equally urgent challenge and potential opportunity to control costs. Between 2012 and 2017, the fraction of annual per capita health care expenditures for a person with diabetes that were attributed to institutional care has decreased from 50 to 36%. Over the same interval, the percentage attributed to outpatient services other than medications and supplies increased slightly (from 23 to 26%) and that attributed to outpatient medications and supplies increased dramatically (from 27 to 38%). The largest increase occurred in expenditures for insulin. This shift of expenditures from inpatient settings to ambulatory care suggests progress in controlling chronic complications related to diabetes and points to potential targets for intervention to reduce ambulatory costs.

Additional articles in this issue provide further information regarding the trends revealed in the ADA's report and highlight opportunities to control direct medical costs. Several studies examine circumstances associated with increased resource utilization in the U.S. Rubens et al. (12) describe trends in diabetes-related preventable hospitalizations between 2005 and 2014. Most preventable hospitalizations occur in young adults (age 18–44 years), and many are related to ketoacidosis or hypoglycemia. Both improved access to care and primary care interventions that target this at-risk population might help reduce hospitalizations and their costs. Berkowitz

[1]*Division of Endocrinology, Diabetes & Clinical Nutrition, Oregon Health & Science University, Portland, OR*
[2]*University of Michigan Schools of Medicine and Public Health, Ann Arbor, MI*

Corresponding author: Matthew C. Riddle, riddlem@ohsu.edu.

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et al. (13) studied people with diabetes and unstable housing served by federally funded safety-net clinics. This population, characterized by not having enough money to pay rent, staying at places where they do not pay rent, and moving frequently, was hypothesized to be at higher risk for emergency department use or hospitalization. Of this group, 13.7% reported an emergency room visit or hospitalization in the past year. Compared with those with more secure housing, the odds of emergency department visits or hospitalizations were increased more than fivefold. This observation suggests that assistance for patients with unstable housing might reduce their health care utilization and limit costs.

Other studies have demonstrated that interventions to reduce utilization and costs in the short term may have unintended effects in the long term. Wharam et al. (14) studied the effect of an employer-mandated switch from a low-deductible to a high-deductible health plan for adults with diabetes. In the overall population experiencing this switch, greater out-of-pocket costs were associated with a 4% decline in emergency room visits, a 6% decline in hospitalizations, and a 4% decline in total health care expenditures. However, the subset of members who lived in low-income neighborhoods experienced a 24% increase in expenditures for high-severity emergency department visits and a 27% increase in high-severity hospitalization days. These results suggest that although shifting costs to patients and their families as out-of-pocket expenses may decrease utilization of services in the general population with diabetes, it may present a barrier to appropriate care in vulnerable populations and increase adverse outcomes and costs. Changes in accessibility of glucose-testing equipment for patients with insulin-requiring diabetes were examined by Puckrein et al. (15), who had previously reported on the effects of a competitive bidding and distribution program for glucose-testing supplies initiated by the Centers for Medicare & Medicaid Services. This program was designed to reduce expenditures for glucose testing, which it accomplished. After its initial implementation in a subset of markets, however, the reduction in glucose strip use was associated with increases in hospitalizations, inpatient costs, and mortality. The investigators' current report (16) includes observations from nearly 530,000 patients with insulin-requiring diabetes who were studied after the national rollout of the Competitive Bidding Program in 2013. In the first 6 months after the national rollout, a reduction in the acquisition of glucose strips was observed. Whether reduced strip acquisition was again associated with adverse health effects was not reported, but the finding that the new program restricted access to monitoring supplies prescribed for insulin-requiring patients is of concern.

Changes in health insurance coverage among people with diabetes were studied by Casagrande et al. (17) after implementation of the Affordable Care Act in 2010. Between 2009 and 2012, the proportion of adults with diabetes younger than 65 years of age who reported having health insurance increased from 84.7 to 90.1%, an increase of approximately 770,000 individuals with diabetes. Increases in coverage were most evident for those with family incomes $<$\$35,000 (+10.5%), those with less than high-school education (+15%), and those with known duration of diabetes $<$5 years (+9.1%). For the low-income group, the percentage of family resources spent on out-of-pocket costs of health care decreased. Whether greater access to insurance coverage by these subgroups has altered the rates of adverse health outcomes is unknown.

Nuckols et al. (18) performed a systematic review of the economic impact of quality improvement programs to improve glycemic control in patients with diabetes. A heterogeneous group of 46 studies was reviewed, including 19 randomized controlled trials (RCTs), 11 before-after comparisons, and 16 with other less rigorous designs. In the RCTs, the overall mean reduction of HbA_{1c} was 0.26% versus usual care. In the 8 RCTs lasting $\leq$3 years, incremental net costs including both program costs and changes in health care expenditures were \$116 per patient per year (95% CI $-$612 to 843 U.S. dollars), suggesting that short-term quality improvement programs can improve glycemic control at a relatively small incremental cost. In the 9 studies that used modeling to simulate the longer-term outcomes ($\geq$20 years) of short-term RCTs, incremental cost-effectiveness ratios (ICERs) were reported to range from \$115,000 to cost-saving (more effective and less costly than the comparator) with the median ICER $<$\$50,000 per quality-adjusted life year gained. In general, interventions that cost $<$\$50,000 to \$100,000 per quality-adjusted life year gained are considered to represent a good value for the money spent (19). The results suggest that quality improvement interventions using electronic registries, treatment team redesign, disease management, clinical decision support, and patient self-management support and education are often effective; that the costs of implementing the interventions are largely offset by short-term reductions in health expenditures; and that over 20 years, such interventions may represent a good value for the money.

Three articles report international experience that supports and extends the U.S. observations. Bommer et al. (20) project changes in the total economic burden of diabetes in 180 countries worldwide. They estimate the global cost of diabetes will increase from \$1.3 trillion in 2015 to between \$2.1 and \$2.5 trillion in 2030. Using a large representative German population with T2D, Kähm et al. (21) estimate and compare the direct medical costs related to the complications of diabetes. The most costly complications are end-stage renal disease (ESRD), lower-extremity amputations, and acute cardiovascular events. Acute events, often accompanied by hospitalization, cause a marked increase in costs that later decline but do not return to pre-event levels. For example, new onset of ESRD in a 60- to 69-year-old man is estimated to cost 34,547 euros in the year of the event and 24,662 euros in each subsequent year. Magliano et al. (22) studied the impact of diabetes on workforce productivity in Australia. They found that for adults 20 to 65 years of age, diabetes reduced "productivity-adjusted life years" by 11.6% in men and 10.5% in women, with the largest effect occurring during young adulthood.

What can we conclude from all this information? The most secure observations are those from the ADA's study of the economic costs of diabetes in the U.S. in 2017 (4). That report documents that both the increasing prevalence of diabetes and the increasing per capita cost of diabetes are driving a continuing rise in the costs of diabetes in the U.S. We may be gaining some ground in diabetes prevention, but the continuing low awareness of prediabetes, the low uptake of preventive interventions, and the increasing per capita cost of diabetes remain major concerns. Individuals at high risk for diabetes should be screened for prediabetes, and those with

prediabetes should be strongly encouraged to adopt metformin or lifestyle interventions for diabetes prevention.

For people with known diabetes, interventions targeting specific groups should be considered. The evidence that preventable hospitalizations and reduced workforce productivity due to diabetes occur most often among young adults suggests a need for greater attention to this age-group. Evidence that low-income and socially disadvantaged individuals are especially at risk for hospitalization suggests additional targets for intervention. It is also important to recognize that in complex systems of health care delivery and payment, system-level interventions to control costs may have unwanted and unexpected consequences. The temporal association noted between the reduction in the use of glucose test strips among people with insulin-treated diabetes and an increase of hospitalizations, hospital costs, and death is a worrisome finding. Similarly worrisome is the increased total cost of insulin usage, which is partly due to an increased cost-per-unit of insulin that can pose a serious dilemma for patients who must use insulin but may not be able to afford it. Savings on costs of ambulatory management must be assessed with regard not only to patient-reported outcomes but also to costs of hospital care for acute and chronic complications that may result from suboptimal ambulatory care. Because the largest contributors to costs of complications are ESRD, amputations, and cardiovascular events—as suggested by the study from Germany (21)—we might focus on ways to prevent these complications.

Assessing the effectiveness and cost-effectiveness of short-term interventions to prevent long-term complications is always a challenge in chronic diseases like diabetes. In most cases, both economic planning and clinical research have short timelines. Most clinical interventions for chronic diseases are not cost-effective over the short term because treatment costs are incurred early, and many health benefits are accrued late. Projecting longer-term benefits based on short-term empiric data can be helpful, but convincing payers to increase spending to provide potential (but often unproven) long-term medical benefits is difficult. Limiting short-term spending while hoping this will not cause either short-term or long-term harm is tempting. For these reasons, two recent reports from Hong Kong (23,24), published in the January and February 2018 issues of *Diabetes Care*, provide welcome encouragement.

The investigators conducted a territory-wide 5-year intervention comparing a multidisciplinary program for diabetes management with usual primary care in the Hong Kong health system. Although not randomized, the design allowed propensity score matching of two cohorts, each with more than 26,000 participants with ~8 years' average duration of T2D. A largely government-subsidized and integrated system allowed retrieval and analysis of both medical and financial data. The main medical outcomes of the intervention, adjusted for baseline characteristics, were an ~59% reduction of hospitalization, ~57% reduction of risk of a first cardiovascular event, and 66% reduction of mortality (23). Economic outcomes included a mean added (relative to usual care) per capita cost of $157 during the 5 years of study and a net per capita saving of $7,451 over the same time period (24). This large improvement of medical outcomes accompanied by cost savings within 5 years is a spectacular finding, calling for replication in other health systems. While this degree of success may not be attainable in other settings, the experience in Hong Kong sets an example to be studied, with the aim of adapting the strategies used to circumstances in other regions, and with the common goal of improving health outcomes while controlling the costs of diabetes over an intermediate interval of time.

In summary, the costs of diabetes present large problems to patients and their families and to health systems, insurers, and the entire community. These problems are not yet coming under control, but scientific studies reported in *Diabetes Care* and elsewhere are beginning to clarify how best to limit the complications of diabetes while both containing costs and avoiding unintended harms.

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