VIEWPOINT

Resurgence in Diabetes-Related Complications

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Viewpoint

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The improved long-term outlook for adults after receiving a diagnosis of diabetes is one of the most important clinical and public health successes in recent decades. During the early 1990s, patients with diabetes had reductions in lifespan of 7 to 10 years and an increased risk of lower-extremity amputation (LEA) vs those without diabetes (58 vs 3 cases/10 000 persons/year, respectively) and kidney failure (28 vs 2 cases/10 000 persons/year).[1] Risk of cardiovascular events, which caused the most deaths, also was higher among persons with diabetes vs those without diabetes (141 vs 38 hospitalizations for acute myocardial infarction [AMI] per 10 000 persons/year).[1] But through multifaceted improvements in diabetes care, risk factor management, self-management education and support, and better integration of care, these risk differences were reduced by 28% to 68% across a range of complications between 1990 and 2010, with gains most notable for reductions in AMI, stroke, and death due to hyperglycemia.[1,2] Although the excess morbidity risk remained too high and the reduction in cardiovascular disease mortality led to new types of complications and causes of death,[3] a continued reduction in the overall public health burden caused by diabetes seemed promising.

However, in an unanticipated new challenge to these improvements, a resurgence of diabetes complications has appeared in national statistics and in the epidemiology literature. Between 2010 and 2015, an increase in diabetes-related LEAs occurred nationally, reversing more than one-third of the 20-year decline in only 5 years.[4,5] For hyperglycemic crisis, annual emergency department visits almost doubled between 2009 and 2015 (from 16.2 to 29.4 per 1000), hospitalizations increased by 73% (from 15.3 to 26.6 per 1000), and deaths increased by 55% (from 15.7 to 24.2 per 1000).[4] For end-stage kidney disease, AMI, and stroke, the long-term improvements stalled after 2010. Updated national statistics indicate that the recent increase in complication rates is occurring in young and middle-aged adults (**Figure**), among whom the risk of hyperglycemic crisis, AMI, stroke, and LEAs each increased by more than 25% during only 5 years. Although the rebound in rates has been most apparent in young adults (aged 18-44 years), middle-aged adults (aged 45-64 years) have higher absolute rates and account for most of the increase. Among older adults, the long-term reductions in rates have reached a plateau (Figure). These changes may not be limited just to the population diagnosed with diabetes because improvements in AMI and stroke in the general population also have plateaued, and most counties in the United States have seen an increase in cardiovascular disease mortality among younger adults.[6]

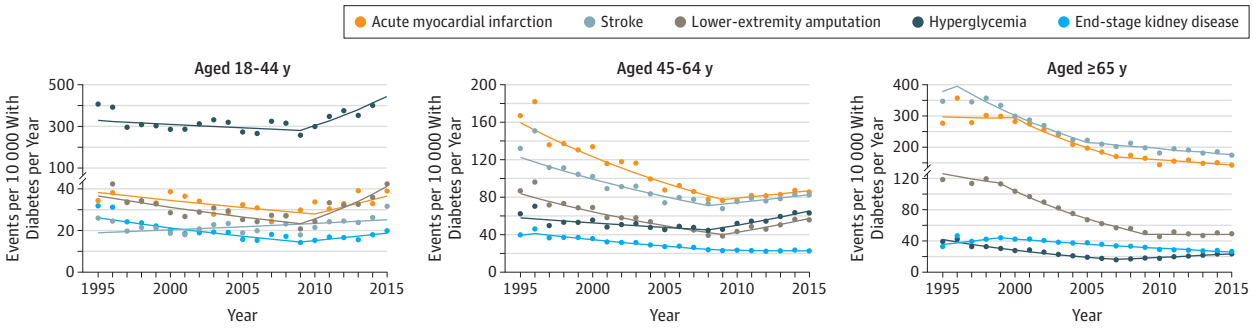
Explaining these trends is difficult because of myriad potential factors in preventive care, patient characteristics, and society. Tracking incidence of major chronic conditions relies on diagnoses and procedures that appear in administrative files, making systematic changes in coding a key consideration. For example, reimbursement incentives that affect upcoding of diabetes or changing diagnostic schemes could conceivably affect rates. However, there are no data to suggest that this has occurred, and the diversity of outcomes, consistency across data sources, and the use of 1 diagnostic classification system (*International Classification of Diseases, Ninth Revision, Clinical Modification*) points to broader causes. Four key plausible sources of these changes warrant examination because understanding the modifiable etiology of this resurgence could be helpful in developing an effective response.

First, there may be increasing heterogeneity or a changing profile for the population of new diabetes cases. The age divide in trends points toward the millennial generation (born roughly between 1980 and 2000) and their high obesity prevalence (approximately 35% with body mass index [calculated as weight in kilograms divided by height in meters squared] >30), compounded by higher levels of smoking and poorer blood pressure and lipid level management seen among younger than older adults.[2] These factors may be combining with chronic kidney disease to influence an earlier onset of macrovascular complications. Whether trends in complication rates vary between type 1 and type 2 diabetes is not clear due to data limitations in national surveys, but it is possible that a greater increase in type 2 diabetes than type 1 diabetes among nonwhites is gradually increasing the ratio of type 2 to type 1 diabetes and affecting the character of diabetes-related morbidity. For the middle-aged and older population in particular, the combination of decreasing mortality among those with diabetes and recent decreases in diabetes incidence is increasing the average duration of diabetes in the population.[4] This shift in the distribution for the duration of diabetes may now be affecting the risk of complications. The effect of Medicaid expansion on detection of diabetes and the characteristics of the underlying population with diagnosed diabetes is also an open question.

Second, there may be stagnation in preventive care, again most prominent among young adults. After encouraging reductions in hemoglobin A_{1c} (HbA_{1c}) levels among patients with diabetes through most of the 2000s, the proportion meeting individualized HbA_{1c} targets declined from the 1990s to 2011-2014 by 6 percentage points overall and by 10 percentage points among young adults.[7] The increase in suboptimal HbA_{1c} levels occurred at a time when clinical organizations have encouraged better age and comorbidity personalization of treatment targets and prevention of hypoglycemia for older adults. Such efforts have been accompanied by a reduction in major hypoglycemic events,[4] but also could be accompanied by an unintended relaxation of glycemic control targets for younger adults.

The increases in LEAs could be driven more by clinical decision making about the management of

Figure. Incidence of Hospitalization for Major Diabetes-Related Complications Among the US Population With Diagnosed Diabetes by Age Group



Dots indicate observed yearly rates. The lines are modeled rates and are based on joinpoint regression analysis. Incidence rates were calculated according to methods described previously,[1,4] with extension to year 2015, and addition of hyperglycemic crises, defined as hospitalization with *International Classification of Diseases, Ninth Revision, Clinical Modification* codes 250.1-250.2 as the first-listed clinical diagnosis. Data are from the US Centers for Disease Control and Prevention.[4]

patients at high risk for foot-related complications. Most of the recent increase in amputations has occurred in toes and feet, suggesting that surgeons may be performing minor amputations sooner rather than prolonging attempts to heal infected ulcers, possibly driven by incentives to prevent rehospitalizations.[5] However, smaller preemptive amputations do not account for all of the increase in LEA rates because long-term reductions in more severe amputations also have plateaued.

Third, some broader policy-level factors may be driving the access to preventive care and influencing the risk for complications. Although the proportion of the population that is uninsured has decreased in the United States since passage of the Affordable Care Act, the use of high-deductible health plans (HDHPs) has proliferated and may have contributed to reductions in early preventive care. Employer-based switches to HDHPs, which now cover 43% of the young adult and middle-aged population, have a particularly deleterious effect on those of low income, and have led to both delayed and more frequent treatment for high-acuity complications.[8] Variation in coverage of foot care services could be further affecting the risk and timing of amputations. In addition, the continually increasing cost of insulin and other antihyperglycemic medications could be leading patients to cut back on treatment to cut costs,[9] although the effects of these cost increases on health outcomes has not been quantified.

Fourth, and perhaps most concerning, broader social and economic factors may be affecting vulnerable populations that drive trends in outcomes. Increasing mortality rates during middle age following the economic recession that started in 2008-2009 have received considerable attention and were initially thought to be driven by suicides, opioid overdoses, and social disadvantage.[10] However, other analyses suggest that the increase in middle-age mortality may also include metabolic causes. The economic downturn, employment loss, and financial hardship disproportionately occurred in communities that also have high diabetes prevalence, which means that upstream socioeconomic factors could contribute to a range of adverse complications of diabetes.[4]

Even though concurrent observations of declining rates of diagnosed diabetes are encouraging, the population prevalence of diabetes is 12% and is unlikely to decrease soon because of the long-term increases in prevalence of obesity and lifespan.[4] This means that the future direction of diabetes complications has enormous collective implications for health and costs. The fact that it is only possible to speculate about the causes of such trends in the diabetes-related burden exposes gaps in epidemiology and surveillance, and in the interconnectedness of valuable clinical data. National averages can obscure important variation in morbidity, and conversely, minorities of high-risk individuals can influence overall trends. However, current monitoring systems do not have the granularity to detect or characterize the subgroups that are driving the trends. Rather than assessing the static etiology of disease (whether behavioral, genetic, physiological, or environmental), the current questions call for a more textured comparison of health care practices, policies, and environmental changes underway and how such factors affect the etiology of trends in population health.

ARTICLE INFORMATION

Published Online: April 15, 2019. doi:10.1001/jama.2019.3471

Conflict of Interest Disclosures: None reported.

Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the US Centers for Disease Control and Prevention.

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